DISSERTATION

THE DEVELOPMENT OF A MULTISECTORAL MODEL FOR THE THAI ECONOMY (MUTE)

Submitted by

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WE HEREBY RECOMMEND THAT THE DISSERTATION PREPARED UNDER OUR SUPERVISION BY AUTTAPOL SUEBPONGSAKORN ENTITLED THE DEVELOPMENT OF A MULTISECTORAL MODEL FOR THE THAI ECONOMY (MUTE) BE ACCEPTED AS FULFILLING IN PART REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

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ABSTRACT OF DISSERTATION

THE DEVELOPMENT OF A MULTISECTORAL MODEL FOR

THE THAI ECONOMY (MUTE)

The MUTE model is a multisectoral model developed for the Thai economy. The structure of the MUTE model resembles INFORUM type models consisting of 3 main modules, namely, (1) the real side which estimates 7 components of the final demand, (2) the price – income side which calculates the 5 value added components, and (3) the accountant which includes the identity equations and some important behavioral equation in order to link both the real side and the price - income side. The model combines the time series data of the Thai economy from 1975 to 2000 with the latest 7 I/O tables in order to predict the long – run path of the Thai economy at both the aggregate and the sectoral levels.

The major difference of the MUTE model from the INFORUM models, especially a Thai Interindustry Dynamic Model (TIDY) is the inclusion of a dummy variable representing the event of the political disorder, which is widely believed as one of the non – economic factors affecting the performances of the economy. Moreover, the use of the time – series technique called AICc to forecast some series (when the explanatory variables are non – stationary and the cointegration test reports the nonexistence of the cointegrating vector), the use of the RAS technique instead of Across the Row method in estimating the direct input requirement matrices, and the application of the ADF and the cointegration tests for all equations are among the new contributions aimed at improving the model reliability.

After the estimation process, the model is employed to forecast the performances of the Thai economy from 2005 to 2020 under the impacts of the Baht appreciation and the political disorder. The results show that these two impacts will adversely cause the growth rate of GDP to slowdown. The Baht appreciation against U.S. dollar worsens the net export, while the political disorder causes both consumers and producers to lose their confidences in the Thai economy, which results in the reduction in the personal consumption expenditure and the gross fixed capital formation. However, both impacts do not affect the income and output structures of the Thai economy. The Thai economy still moves toward the industrialized country by reckoning on manufacturing and service sectors as the main sources for generating income and employment with or without the presence of these two impacts. Ultimately, the model suggests three main problems encountering the Thai economy in the next decade, namely (1) the slowdown of the labor productivity growth, especially in the agricultural sector, (2) the low saving rate, and (3) higher degree of dependency on the foreign market.

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Chapter I

Introduction

Many economists expected that the Thai economy will return to the stable growth path after recovering from the Asian financial crisis. Notwithstanding, the direction of the Thai economy recently seems obscure, since the attack of Tsunami at the end of 2004 followed by the avian – flu situation, which decreases poultry production. Moreover, the instability of internal political system and the continual increase of oil prices aggravate the situation. Consequently, Thai real GDP has increased only slightly from 972,272 million of Bahts in the 4^{th} quarter of 2004 to 1,012,250 million of Bahts in the first quarter of 2006, or approximately by only 4.1 percents.

Evaluation of these impacts requires thorough examinations on the structure of the Thai economy, combining with the understanding of the linkage between micro and macroeconomic variables. Therefore, the objective of this study is to build a macroeconomic model in order to explain the structure of the Thai economy per se and investigate the outcome of the proposed policies such as the tax reform, government expenditure, and trade policies.

1.1 Overview of the Economic Models

According to Yu (1999), economic models are classified into 2 main groups (with 3 and 4 subcategories in the first and the second groups) as the following:

1.1.1 Macroeconomic Model

The macroeconomic model is a system of equations that explain the relationships among macroeconomic variables. This model can be divided into 3 groups, which are:

1.1.1.1 Structural Model

The structural model is a set of equations estimated by basing on macroeconomics theory such as Keynesian, Classical, Monetarist, etc. The model is appropriate for conditional forecasts, since the forecast of some variables depends on the behavioral assumptions of consumers, producers, and policymakers.

1.1.1.2 Equilibrium Model

This model depends on the optimization concept of economic actors and the theory of general equilibrium of neoclassical economists. Consumers will maximize their utilities, producers will maximize their profits (and minimize costs of production). Parameters of each equation are normally obtained from the method of calibration, but in some case, the coefficients are estimated by econometrics especially by using the maximum likelihood estimation.

1.1.1.3 Non – Structural Model

The non – structural model requires just small number of equations in explaining the economy as a whole. The model imposes only few restrictions and is free from the structural equation in determining the behavior of economic agents. As a result, this model is quite appropriate for unconditional forecasts and the short – run situations where policy changes do not occur.

From definitions above, the non – structural model is not suitable for studying the impact of policy change. The structural and equilibrium models are more popular in this case since they can detect the outcome of the change in government policies. However, the main criticism on these models is on the difficulty of defining the validity of estimated coefficients. The break down of economic relationships will occur when there is a change in the rules or policy actions which affects the personal expectations and economic circumstances. This is the well – known "*Lucas Critique*" (Lucas, 1976).

Since equations in the system of both structural and equilibrium models are computed from aggregating the behavioral equations of each individual which in turn are determined by the expectation under the circumstance that each individual encounters, the change in policy rules by themselves will cause the change in individuals' expectation, the conditions of budget constraint, and finally the way they make their optimal decisions, which are translated into the change in the parameter values of the model. As a result, the forecasts by the macroeconomic model cannot be reliable. The Phillips curve and temporary changes of taxes are the familiar applications of the Lucas critique.

Moreover, the objective of macroeconomic models usually focuses on a determination of macroeconomic variables such as aggregate inflation, level of output, employment rate and etc., thus the models lack the linkage between micro and macro levels. For example, most macroeconomic models cannot explain a fluctuation in sectoral unemployment rate.

Despite all weaknesses, macroeconomic models are quite prevalent in forecasting the macroeconomic variables, since the main objective of general models is to approximate the operation of our real economy. As a result, even the best built model in the world will produce only an approximation.

1.1.2 Macroeconomic Model with Sectoral Detail

Due to the weakness of macroeconomic models in evaluating the impacts of aggregate and industrial policies on the industry – level variables, Monaco (1997) suggested that a model should compose of both macroeconomic and industrial portions. A common trait of this kind of models is to include Input – Output table (I – O table) in their analysis. The model can be classified into 4 categories as follows:

1.1.2.1 The Simple I – O Model

The logic of a simple I – O model (, or sometimes called static I – O model) is to estimate the impact of a small change in final demand on the total output of industry, since an I – O table shows the interdependency (backward and forward linkages) among industries) and the optimal solution for production, given the vector of final demand. The interrelation between industries and final demands can be expressed by the following equation:

$$q = A * q + f \tag{1.1}$$

or,

$$q = (I - A)^{-1} * f \tag{1.2}$$

where, q = total output or total sales of an industry

f = final demand vector by categories

A[1] = a matrix of "production (input) coefficient" or sometimes called "direct requirement" matrix

$(I - A)^{-1}$ = Leontief inverse, and

I = identity matrix

The advantage of this model comes from equation (1.1) and (1.2). In this case, matrix A is assumed given and the final demand vector (f) is absolutely exogenous to the model. Thus, for a given matrix (A) and vector (f), the total output (q) can be easily obtained from equation (1.2), or we can solve back for vector (f) if we know vector (q) and the input coefficient matrix (A).

However, the main drawback of the model emerges from the assumption of final demand components. In order to compute the change in vector (q), we arbitrarily determined the final demand vector (f) which may not be consistent with empirical data. In other words, final demands are completely exogenous to the model. Secondly, the model is timeless since the I – O table is estimated in a given year, and it fails to inform us about the time for adjusting output when shocks occur. Thirdly, the model lacks the connection with macroeconomic variables. It will produce the same outcome no matter what the differences in macroeconomic conditions. Finally, the model does not separate the components of final demand between consumption and investment. Consequently, this model is only suitable for evaluating the impact of small changes in the variables but inappropriate when we need to analyze dynamic issues such as the response of productivity and production capacity to a change in capital investment.

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[1] Each element in the direct requirement matrix is computed by simply divided each value in an I – O column by the total inputs (output) of the industry represented in the column.

The extension of static I – O is called "Leontief's dynamic I – O model". Under this modification, the model separates consumption demand from investment demand. The basic equation for dynamic I – O model is:

$$q_t = A * q_t + f + B * (q_t - q_{t-1}) \tag{1.3}$$

The subscript (t) denotes a time period for the variable. (q) and (A) are the same vector and matrix as before. However, vector of final demand (f) excludes capital investment and matrix B is a matrix of fixed capital coefficients. The model assumes matrix A, B, the time path of all final demand components, and the initial value of output (q_0) as given. Then, (q_t) can be computed from the set of equations in the model.

Despite its usefulness, this model is plagued with many defects. The main weakness comes from the fact that the components of final demand except investment demand are still exogenous to the model. Besides, the initial value of (q_0) and the time path of final demand components are arbitrarily assumed as given. (Thus, there exists the possibility when estimated output level (q_t) is negative.) Furthermore, the model per se is unable to explain the relationships among the macroeconomic variables, thus it is not only unable to thoroughly describe how the economy works, but also incapable to produce a good approximation of the economic development and the change in government policies.

1.1.2.2 Macroeconomics combining with I – O Model (Macro – IO Model)

To solve the problem of exogenous property of final demand components, Macro – IO model combines macro model with the I – O table. The final aggregate demands such as consumption, investment, export, and import are determined by macro regression equations matching up with I – O industrial sectors.

The advantages of this model are to make final demands endogenous based on macroeconomic foundation. Macro model will generate experimental impacts via final demand components and each I – O industry outcome can be easily computed from the I – O table by taking into account the estimated results from macro model. Thus, the model as a whole can explain the variation in each industry. Moreover, macro model demonstrates the interrelationships among macro variables. The explanatory variables in each equation are the policy variables (and sometimes including dummy variables) which capture the variation of the economic environments or specific phenomenon. As a result, the model can be used to approximate the impacts of both policy changes such as fiscal and monetary policies and qualitative changes such as the impact of oil crises, recession, Tsunami event, and etc. on the interesting macroeconomic variables.

However, Almon (1966) points out some disadvantages of the Macro – IO model. In most cases, the model shows large error in prediction when there is small shock in a particular sector (Monaco, 1997). Furthermore, the main defect emerges from the irrelevance of outcomes between industry and aggregate economy. For example, the summation of all industry outputs in most cases does not equal to the aggregate output of the economy. In order to maintain the consistency between industry output with the aggregate economy' s output, equation (1.1) and (1.2) above must hold true. Moreover, the model requires the consistency between aggregate price and sectoral price as the following:

$$p = p^* A + v \qquad (1.4)$$

where, (p) is the vector of industrial prices, matrix (A) has the same meaning as before, and (v) is the vector of value added (final costs)[2] per unit of output vector. Equation (1.4) must hold true by accounting identity, since the price of each industrial product must equal intermediate costs of production plus value added. Unfortunately, the inconsistencies of price and income data between the I – O table and the estimated price and income in macro model are unavoidable.

1.1.2.3 Computable General Equilibrium Model (CGE Model)

The CGE model shares the same logic as equilibrium model which relies on the optimal decisions of economic agents such as consumer's utility maximization, producer's cost minimization and profits maximization and etc., and combining with the analysis of I – O table altogether. Normally, there are two versions of CGE model, i.e., dynamic and static models. The static version treats investment demand as another final demand equation and it does not concern about the decision to save. By contrast, the dynamic version takes into account the concept of intertemporal decision making. The model assumes that consumers will make a decision on how much they want to consume now and how much they want to save for the future consumption. Moreover, sectoral investment in the first period will carry on as capital accumulation in the second period. As a result, the productive capacity in that sector will increase. While dynamic CGE model introduces a single growth model to each industry and merges it with the intertemporal concept in one model, the static CGE model depends on the logic of neoclassical general equilibrium and business life cycle model.

[2] Value added composes of labor costs (wages), capital depreciation, interest charges (costs of capital), taxes and profits.

CGE model is built by assuming distinct forms of production function and utility function. Each industry (consumer) has its own production (utility) function and tries to maximize its profit (utility) given the budget constraint. Conceptually, both consumer and producer budget constraints are the same in nature and satisfy the basic characteristics of cost and expenditure functions.

Generally, group of consumers are assumed to be a single representative consumer. The solution of the model has to satisfy several optimization constraints. For instance, markets are all clear (demand must equal supply), government performs balanced budget, each industry earns zero economic profit, investment spending must equal domestic saving plus foreign capital inflow, and there is a balance of payments. Moreover, most parameters in the model can be estimated from the method of calibration, statistical technique or predetermined value from previous studies. By using calibration technique, CGE model requires just only moderate to small amount of data comparing with regression method which need long time period of time series or large amount of cross sectional data. Besides, the advantage of CGE model over I – O model comes from the fact that the model combines behavior of all economic agents (consumer, producer, government, and etc.) in calibrating an outcome. An impact of policy changes or market failures can be easily included in the model by varying the parameter value that relates to the specific issue, and once the new parameters are chosen, the model is calculated again in order to find the new equilibrium.

However, there are several limitations of CGE model. Firstly, the weakness of the model emerges from the method of calibration itself. Calibration technique assumes that the values of parameters in the model are calibrated when the economy is in equilibrium.

However, it is hard to believe that the period that we choose for calibration is in the stage of equilibrium. Secondly, the explicit form of production function and utility function are arbitrarily chosen from the mathematical functional forms such as Cobb Douglas, Rawlsian, CES, and etc. As we know that both utility and production functions are not empirically observed, thus the outcomes of CGE model absolutely depends on these assigned functions, which occasionally do not reflect the true situation of the economy that the modeler tries to explain. Ultimately, it is possible that the combination of wide varieties of functional forms can be chosen and still produce the same modeling outcome. Consequently, the appropriateness of CGE model reckon crucially on the validity of assumptions that the model uses.

1.1.2.4 The Interindustrial Macroeconomic Model (IM Model)[3]

According to Grassini (2005), "IM model" is defined as the disaggregated econometric model. The model aims at estimating both the macroeconomic and industrial variables by linking the input – output structure, which includes a large number of industries with macroeconomic model that verifies the relationships among the macro variables. Under this definition, IM model is similar to the Macro – IO model in the way that it uses the technique of regression analysis in estimating a system of equations. However, the difference between these two models is that the origin of Macro – IO model starts from the determination of macro – level variables and allocates them back to industry level (top – down approach), while IM model begins with the industrial details, and the aggregate level of the economy is determined by the summation of all industries

[3] IM model is sometimes called INFORUM type of model, which stands for Interindustry Forecasting at the University of Maryland, and the Cambridge Econometrics model.

(bottom – up approach). The main characteristics of IM model can be concluded as follows:

- The model must begin with the construction of accounting system (a model with large number of exogenous variables). The regression technique is used to generate additional equations in explaining these exogenous variables. In other words, additional econometric equations are employed in order to reduce a number of exogenous variables in the model.
- The model relies on the country I – O table, since it is the only complete source of data on multisectoral industries. The logic of IM model relies on equation (1.1) and (1.4) above, which represent both real side and nominal side of the model.
- The final demand vector and value added components are endogenous to the model. Thus, equation (1.1) and (1.4) can be modified as follows:

$$q_t = A_t q_t + f_t(q_t, p_t, E_{Rt}) \qquad (1.5)$$

$$p_t = H_t p_t + T_t p_t^m + v(p_t, q_t, E_{Pt}) \qquad (1.6)$$

In this case, the vector of final demand (*f*) and value added components (*v*) are functions of output, price, and the exogenous variables on the real side (E_R) and price side (E_P), respectively. Matrix *H* and *T* are the domestic and imported input coefficient matrixes[4], and the summation of matrix *H* and *T* is equal to matrix *A*. the subscript (*t*) denotes the time index for all vectors and matrixes. Finally, (p^m) is the vector of import prices. Equation (1.5) and (1.6) imply that the model generates complete independency between prices (nominal side) and quantities (real side).

[4] The elements in matrix H and T consecutively represent domestic inputs and imported inputs per unit of output for each industry.

- The IM model reckons on the bottom – up approach. Various kinds of total macroeconomic variables such as total wages, profits, depreciations, and etc. can be obtained from the summation of each element on all industries. However, the policy variables such as taxes are collected from households at the aggregate level regardless of where income is earned. By the same token, subsidies are paid at the aggregate level. The additional equations are determined by the technique of regression including saving rate, labor productivity, interest rate and etc. when there is no need for aggregating from the industrial level. As a result, a model fully integrates both sectoral details and macroeconomic level in one model.

With the bottom – up approach, IM model is the same as CGE model but it is more consistent than Macro – IO model, since the summation of the sectoral details is always equal to the aggregate level. By contrast, this condition is hardly seen in Macro – IO model, which firstly determines the aggregate level and then allocate this amount down to each sector. Moreover, IM model is better than CGE in the sense that it depends on observed historical data in determining the coefficients in each equation, while CGE model relies on the method of calibration, which does not take the analysis of time series into account. Consequently, CGE model may exhibit an inconsistency between the model and data.

However, the IM requires large amount of data in estimating the sectoral regression equation. The estimation is time consuming, since modeler has to collect and organize whole series of historical data. Furthermore, all industries in the model are interrelated to one another, thus the error of estimation in one sector will transmit to the whole model.

1.2 The Comparison between CGE and Inforum Modeling Approaches

Since, both CGE and IM models are under my consideration in searching for the proper model for the Thai economy. In this section, I will try to examine both models in more detail, their strengths, weaknesses, the similarities and the differences. Some aspects that already mentioned above are included here as well. The characteristics which most studies pay attention to include:

- Data Base
- Theoretical Foundation and Functional Forms
- The Choice of Parameter Values
- The Numeraire and the Observed Prices
- Maintenance Costs
- Easy to analyze the changes in policies and exogenous variables
- Track Record
- Output of the model (Policy Correspondence)
- Other Aspects

The summary of these traits is presented in the following tables:

Table 1.1:

The Comparison of Strengths, Weaknesses, Similarities and Differences between CGE and IM Model

Characteristics		CGE Model	IM Model
1. Data Base	Similarities	- Both approaches are based on the I – O table and social account matrix (SAM) as an important foundation to build an appropriate model. - Both models include the system of national account in their construction.	
	Differences	- The model does not rely on times series data in estimating the parameters. Thus, it is not relevant to historical data (CGE model does not reflect the observed economy). In this case, CGE model aims at manipulating data to suit the neoclassical assumptions.	- The model relies crucially on economic time series data in estimating sectoral behavioral functions. The Model is quite relevant with observed data.
2. Theoretical Foundation and Functional Forms	Similarities	- Both approaches share the logic of consumer and producer theory in constructing the model.	
	Differences	- CGE model assumes that the human behaviors are relevant with the neoclassical theory and uses the behavioral equations, which are derived from the optimization decision of all economic actors. - The forms of utility, cost, production functions, and so on, are arbitrarily specified. Demand and supply functions are the solution of these predetermined functions subject to the constraints, which sometimes does not lead to reasonable results.	- Using Neoclassical theory in shaping the desirable forms of behavioral equations. However, IM approach does not believe in the concept of maximizing utility or minimizing cost that they will lead to the appropriate systems of demand and supply. - IM model usually employs the functional forms that have desirable properties, such as easy to interpret, accurately explain the observed economy, and completely follow economic theories. Therefore, functional forms do not necessarily come from the solution of optimization.

Table1.1 (Continued)

Characteristics		CGE Model	IM Model
3. The Choice of Parameter Values	Similarities	- None under this topic.	
	Differences	- The values of parameters in each equation are chosen on the basis of microeconomic evidence, and compare the prediction of the model with the empirical data. This method is called calibration. - There are three potential advantages of calibration over the econometric estimation. Firstly, the chosen parameters do not require large amount of time series data in determining their value. Secondly, the model has a higher standard, since the parameter values are selected on the basis of microeconomic theory. Finally, the acceptance or rejection of the parameter values do not depend on the statistical method, thus it increases the possible range of parameter values which are rejected by the econometric model.	- Parameters of the model are estimated from the econometric method such as regression, maximum likelihood, and etc., based on the I – O table and observed data. - There is no problem concerning how to select appropriate values of parameters such as elasticity, and etc., since the parameter was determined by the regression method. - The model needs long series of data in computing the value of parameters. Moreover, the error in one equation will affect another or the whole model, since the sectoral industries are modeled in the way that they are interrelated to one another.
4. The Numeraire (The Concept of Relative Prices)	Similarities	- Relative prices play an important role in determining the outcome in both models	
	Differences	- According to CGE approach, the model needs to verify the fictitious measurement unit called "numeraire". This is the concept of relative price. However, the relative prices are unobservable.	- Relative prices play a significant role in determining some economic variables such as import equations, and personal consumption expenditure system. Moreover, they affect the model performance.

Table1.1 (Continued)

Characteristics		CGE Model	IM Model
5. Maintenance Costs	Similarities	- Data inconsistency between I - O table and national account are the problem concerned in both models. - The development of computer program in manipulating, storing, and forecasting data reduces the cost gap between the two models.	
	Differences	- Both static and dynamic CGE requires smaller amount of data than IM model. Especially for the case of static model, it need only one year of data in calibrating the value of parameters. Thus, the cost of maintenance is lower than IM model.	- The model needs to incorporate as much data as possible, thus the costs of care and maintenance are higher due to the large numbers of equations to be monitored and estimated. The introduction of new data requires re – estimation and re - simulation for the whole set of equations.
6. Easy to analyze the changes in policies and exogenous variables	Similarities	- The more complicated details of the model, the greater the policy applications open to the model users. Moreover, the more complex model will allow users to do directly experiment with specific policies. - Both models inevitably require the comprehension of microeconomics, macroeconomics and econometrics.	
	Differences	- Modelers who particularly specialize in microeconomics are likely to prefer CGE over the IM model.	- IM model is more preferable for modelers or users who are quite familiar with the econometric model.
7. Output of the model (Policy Correspondence)	Similarities	- Each model has its own advantages in presenting the policy results.	
	Differences	- CGE model are able to provide the measurement of welfare in terms of indexes of utility. - In most cases, the model cannot measure the impact of exogenous or policy changes over time, since it is static in nature. - Most CGE models do not include financial sector and the international capital flow.	- The model directly measures the variables in terms of their values rather than utility. - The model is able to measure the long term impacts of policies. - IM model seriously takes both financial and the international sectors into account. Thus, it is quite relevant with empirical economy.

Table1.1 (Continued)

Characteristics		CGE Model	IM Model
8.Track Record	Similarities	- Both models have track records in providing various policy implications and the way to construct the particular model.	
	Differences	- CGE model is constructed in the later period comparing with IM model, thus it has fewer track records.	- IM model has more number of track records, since it has already been developed for almost three decades.
9. other aspects	Similarities	- Both models employ the bottom – up approach. The aggregate level of some variables such as income, employment, and so on can be computed from the summation of all sectoral variables.	
	Differences	- The model depends on a single equilibrium year, thus it is unable to incorporate the growth rate variables in the model. - The model can be built as static or dynamic model. Nevertheless, it concentrates on the steady state equilibrium. Besides, the result from the CGE simulation is always used for the static analysis. Furthermore, the model is timeless. The solution does not relate to calendar time. The model explains the optimal adjustment process from period to period, but does not verify the exact calendar time.	- In contrast, IM model is calculated from the analysis of time series data. Thus, there is no problem incorporating growth variables. - IM model is completely dynamic. It gives the solution in specific period such as month, quarter, or year.

A detailed description on the strength and weakness of IM and CGE models can be found in Grassini (1998), Grassini (2005), Shoven and Whalley (1984), and Monaco (1997).

1.3 The Chosen Model for the Thai Economy

According to various kinds of models mentioned above, the appropriate model for the Thai economy must have the following characteristics:

- Due to the importance of general equilibrium analysis, model must have dynamic characteristic.
- In order to explain the impacts of policies and environmental changes on each industry rather than investigating them at the aggregate level, the model must include sectoral details which inevitably rely on the analysis of I – O table.
- The model must link sectoral microeconomic variables with the macroeconomic variables.
- The model must be relevant with the historical data in explaining the previous economic status, searching for the suitable policies and forecasting the outcome of proposed policies and future trend of main macroeconomic variables.

One interesting model that serves all traits above is IM model. Therefore, the first aim of this dissertation is to develop interindustry model (IM Model) for the Thai economy in order to resemble the growth path of the economy covering both aggregate level and the sectoral details. Finally, the model will be used to forecast the future trend of main economic variables. The two primary scenarios that need to answer include:

- The effect of the appreciation of the exchange rate (Thai Baht per U.S. Dollar)
- The impact of political disorder on Thai economic performances, if the chaos could not be solved in the next couple years.

1.4 Outline of the Dissertation

The chapters of the dissertation are organized as follows:

- Chapter II reviews the previous works on IM model. Some of national IM models included IDLIFT, MUDAN, MIDE, JIDEA, and TIDY, their characteristics and applications are reviewed in this chapter. Finally, the linkage system called INFORUM system of bilateral trade model is briefly reviewed in the last section.
- Chapter III summarizes the situation and the development strategies of Thai economy from the past till present. In this chapter, the historical period of the Thai economy is separated into 3 periods: (1) the period from the first national plan to the seventh national plan, (2) the period of financial crisis during the eighth national plan, and (3) the current situation under the ninth development plan.
- Chapter IV discusses the sources of data and the structure of a Multisectoral Model of Thai Economy (MUTE). The model is similar to other interdyme models in the sense that its structure is divided into three main parts: (1) the real side, (2) the price – income side, and (3) the accountant. However, the chapter is concluded with the new contributions that make the MUTE model different from other previous interdyme models.
- Chapter V estimates the real – side of the MUTE model. The four components from the 7 components of final demands are estimated for 26 sectors including personal consumption expenditures (*pce*), investment expenditures (*gfcf*), inventory investments (*ii*), and imports (*im*). However, government

consumption expenditure (*g*), special export (*es*), and exports (*ex*) are left as the exogenous variables to the model, since they are all treated as the policy variables. Finally, the chapter is ends with the estimation of labor productivity equations in order to provide the linkage between the real side and the price – income side.

- Chapter VI estimates the price – income side of the MUTE model. Here, the 3 value added components (wages, profits, and depreciation) are estimated by the regression technique while the indirect taxes minus subsidies component is treated as the policy variable, thus it is exogenous to the MUTE model. Moreover, three miscellaneous aggregate equations are estimated in order to complete the Accountant part of the MUTE model: (1) the equation of aggregate level of inflation (inf_t), (2) the equation for personal income (pi_t), and (3) the equation for personal saving rate (psr_t).
- Finally, Chapter VII begins with the performance test of the MUTE model in order to prove whether the model is reliable or not. Then, the prediction for the long – term movement of the main economic variables for Thai economy under 4 scenarios (Baseline case and Scenarios 1 - 3) both at the aggregate and sectoral levels by relying on the impacts of Baht appreciation and the expected event of the political disorder in Thailand are estimated and reported. The chapter ends with the conclusion and recommendations for the later studies.

Chapter II

Literature Reviews

The history of interindustrial macroeconomic model (IM model) began in 1967, when Clopper Almon founded the non – profit research center called INFORUM (Interindustry Forecasting at the University of Maryland). The main objectives of INFORUM are to provide the forecasting and policy analysis for both macroeconomic and industrial levels. Currently, INFORUM system contains models from the United States, Canada, Mexico, Japan, Korea, China, Germany, France, United Kingdom, Italy, Spain, Austria and Belgium. Each model is bilaterally linked to the others via the flows of information on prices and import demands.

The IM model is a regression – based structural macroeconomic model. Although, the model still depends on the input – output relationships between industries, the modeling logic differs from other macroeconomic models. As mentioned in chapter I, the model construction follows the bottom – up process which determines the aggregate level of the variable such as output, employment, income and etc., by the summation of their sectoral parts rather than estimating from the aggregate level and distributing this amount among sectors. Prices are computed by adding costs of intermediate input with primary factor costs such as capital, labor, and etc. Thus, this process allows us to build the model that resembles the mechanism of the real economy. Consequently, the model can detect the effect of shock in one industry on the others and on the general economy as a whole without any contrasts between industrial and at the aggregate level.

Moreover, the differences in estimated parameter values in each behavioral equation across commodities and sectors will represent the wide varieties of consumer preferences, price elasticities, industrial structural, and so on. Another advantage of IM models includes the disaggregation of relative price equation by industry. This characteristic permits us to investigate the impact of relative price changes on the performances of overall economy, industrial output, level of productivity, and employment.

The following section briefly summarizes some of individual models from INFORUM in more specific details.

2.1 The IDLIFT Model

The IDLIFT[1] model is the core model for the U.S. economy. The main objectives of IDLIFT are to provide a policy analysis and the forecast for employment, prices, exports, imports, interindustrial flows and the level of output for the American economy. The model is based on the 1987 Benchmark I-O table and consists of 97 commodity sectors, 92 groups of consumption expenditures, 19 categories of construction spending, 55 equipment investments classified by industries, and the value added components for 51 industries. It is the newest version of U.S. interindustrial macroeconomic model which aims at substituting the old version, LIFT (Long-term Interindustry Forecasting Tool).

Like the LIFT model[2], IDLIFT is still composed of three main parts: the real side, the price – income side, and the accountant. The final demand components (the famous C

[1] The "ID" in IDLIFT stands for Interdyme (the C++ framework for building interindustry dynamic macroeconomic models).

[2] More detailed information on LIFT model is available in Margaret (1991).

+ I + G + X – M identity in economics), the sectoral output, and employment by each industry are individually calculated by the real side. In other words, the sectoral output is determined by equation (1.1) or (1.2).

Recall $$q = A * q + f \tag{1.1}$$

$$q = (I - A)^{-1} * f \tag{1.2}$$

The vector of final demand (f) is calculated by the formula

$$\begin{aligned} f_{97*1} &= H^{C}_{97*92} C_{92*1} + H^{EQ}_{97*55} EQ_{55*1} + H^{S}_{97*19} S_{19*1} \\ &+ I_{97*1} + X_{97*1} - M_{97*1} + G_{97*1} \end{aligned} \tag{2.1}$$

The numerical subscripts represent the dimension of particular vectors or matrices.

where,

C	=	consumption vector
EQ	=	equipment investment by purchaser
S	=	structure investment (construction) by type of structure
I	=	an inventory change
X	=	an export vector,
M	=	an import vector
G	=	a vector of government spending, and
H^i	=	the bridge matrix for component i

All vectors and matrices in the above equations have time subscript, and the A and H matrices are assumed to be varied with trends in the across – the – row totals. Finally, given the matrix of the estimated output (q^*), the model calculates employment rate or the number of jobs (n^*) by sector as follows:

$$n^* = q^* \left[\frac{1}{(q/l)^*} \right] \left(\frac{1}{n} \right)^* \tag{2.2}$$

An asterisk represents the variable that is forecasted by the model and (l) denotes the labor hour requirement. Unemployment is determined by subtracting the predicted employment from the estimated labor force. Another main macroeconomic equation includes labor productivity which both directly affects and indirectly influences the real side and price – income side via the unemployment variable.

The price – income side covers the computation of value added components such as labor compensation, profits, indirect taxes, and etc. Thus, prices by commodities are determined by cost of intermediate inputs (using others industrial products as inputs) and direct input (such as capital, labor, and so on) used in each production as shown by equation (1.4).

Recall
$$p = p * A + v \tag{1.4}$$

Each component in value added vector (v) is individually calculated by the regression method. Every component in vector (v) except labor compensation is scaled to be consistent with equation (1.4), while labor compensation is a function of the growth in the broad definition of money divided by GNP (*M2/GNP*), supply shock, and labor productivity growth. Other significant macroeconomic variables such as the saving rate and the interest rate are modeled separately by econometric method, and some policy variables such as money supply variables, tax rates, and dummy variables are left as exogenous variables to the model.

Finally, the accountant depends on the U.S. national income and product account (NIPA). The accountant part per se is the model. It takes into account the identity equations which determine economic transactions and the aggregate level of variable from their fragmented parts. The model is simulated iteratively until the solution is found.

Recently, there is an attempt to improve the performance of IDLIFT. Wilson (2001) tries to build a regression – based system of labor productivity equations that incorporate the effects of capital-embodied technological change into IDLIFT, since labor productivity is the main variable in determining the solution in both real side and price – income side. However, the productivity equations currently used in the model do not include any factor inputs as explanatory variables. The regressors only consist of time trend and the difference between industry output and its previous peak as follows:

$$\ln(q^i / l^i) = \beta_0^i + \beta_1^i t_1 + \beta_2^i t_2 + \beta_3^i qup_t + \beta_4^i qdown_t \qquad (2.3)$$

where,

where,	t_1	=	a linear time trend starting in the first year of data
	t_2	=	a second time trend, starting in 1972
	qup_t	=	dq_t when $dq_t > 0$, 0 otherwise
	$qdown_t$	=	$-dq_t$, when $dq_t < 0$, 0 otherwise
	dq_t	=	$\ln(q_t) - \ln(qpeak_{t-1})$
	$qpeak_t$	=	q_t, if $q_t > qpeak_{t-1}(1\text{-}spill)$,
			otherwise $= qpeak_{t-1}(1\text{-}spill)$
	$spill$	=	depreciation rate of capacity
	(q/l)	=	labor productivity, and
	i	=	indexes of 55 industries/sectors

According to neoclassical theory, the growth in labor productivity will generate the growth in output and then stimulates an increase in consumption spending and investment which enhances the level of capital stock. Finally, when labor has more capital to work with the labor productivity and output will increase in the second round, and so on. Therefore, the model should include a relationship between investment (or the level of capital stock) and labor productivity. Nevertheless, the inclusion of capital stock variable in productivity equation is not an easy task due to two main reasons:

- In most cases, the relationship between productivity and capital stock is not statistically significant (not different from zero in term of t statistic) and sometimes yields an incorrect sign. This is the problem of mismeasurement of capital due to unobserved changes in embodied technology. More detailed discussion under this topic is found in Wilson (2000).
- The inclusion of capital stock in productivity equation will cause the explosion of outputs. As mentioned above, the exogenous shock that causes the labor productivity to grow will finally generate the growth in outputs indefinitely if the model lacks the supply constraint to put the breaks on investment and consumption spending.

In order to solve the first problem, Wilson (2001) creates the series called quality -adjusted capital stocks (K_t), following the neoclassical theory. The series are computed from the equation:

$$K_t = \sum_{s=1}^{t} I_{t-s}\left[\left(\frac{1}{p_{t-s}}\right)D_{t,t-s}(1+\gamma)^{t-s-t_0}\right] \tag{2.4}$$

where,	K	=	the capital stock (either equipment or structures)
	I	=	nominal investment
	P	=	the price deflator
	γ	=	the rate of embodied technological change, and

$D_{t,t\text{-}s}$ = physical depreciation (i.e., wear and tear), or the fraction of vintage t-s capital still in production in year t.

The idea of equation (2.4) is that the fluctuation of capital stocks in future period is based on the weighted average of nominal investment (I). In order to take the technological change (quality change) into account, the weight (all components in the parenthesis of equation (2.4)) is modified to include three main components which measure the price change, physical depreciation, and quality change, consecutively. Equation (2.4) is used to build two separate series of capital stocks for structures (S_{it}) and equipments (J_{it}) by assuming that technological change is negligible for structures (γ = 0), while the (γ)parameters for each industry in equipment sector are estimated econometrically.

By using the constructed series of (S_{it}) and (J_{it}) and depending on the Cobb – Douglas production function, all 11 different specifications of productivity equation both including and omitting the intermediate inputs are derived from:

$$Q_{it} = M_{it}^{\theta} L_{it}^{\beta} J_{it}^{\alpha} S_{it}^{\eta} \qquad (2.5)$$

where,

Q_{it} = real output

M_{it} = real materials including energy

L_{it} = labor hours

J_{it} = real equipment stocks

S_{it} = real structure stocks, and

θ, β, α, and η = Elasticities of Output with respect to the variable

The author tries to estimate the productivity equation under a wide varieties of functional forms such as including embodied R&D as a separate regressor, controlling for unadjusted variation in factor utilization by inserting energy - capital ratio and including the general terms (*qup*) and (*qdown*) in the equation, and introducing time trend variable which represents disembodied technological change. The following results can be concluded from Wilson (2001)'s experiment:

- The inclusion of quality adjusted equipment capital stock (J_{it}) will improve the fit and sensibility (in terms of average value and the sign of the coefficients) of productivity equation.
- Despite the loss of fit, an imposition of constant return to scale assumption will improve the sensibility of the productivity equation.
- The average fit will improve if the equation includes both index of embodied R&D and non – quality adjusted (J_{it}), however the inclusion will affect the computed value of capital elasticities.
- The estimated R^2 are slightly higher in equations that include intermediate inputs and time trend as explainatory variables. However, the intermediate input variables (M_{it}) are dropped from the equation due to the problem of correlation between dependent variable (productivity) and the disturbance term which generates an upward bias in estimated parameters.
- Finally, although the inclusion of the energy/capital ratio will improve the fit and increase the estimated elasticities of structures, it decreases the estimated elasticities of equipment (reducing the reasonability of parameter values). Thus in order to control for unadjusted variation in factor utilization without the loss of reasonability, the better alternative is to include (*qup*) and (*qdown*)

variables, since the inclusion, however slight, reduces the fit of an equation but, the estimated values of capital elasticities are more reasonable.

Therefore, the two final forms of productivity equation which satisfy above criteria are:

$$q - l = c^0 + c^1 t + \alpha(j - l) + \eta(s - l) \tag{2.6}$$

and,

$$q - l = c^0 + c^1 t + \alpha(j - l) + \eta(s - l) + b^0 qup + b^1 qdown \tag{2.7}$$

The lower - case letters of variables (q), (l), (j), and (s) represent the log of (Q), (L), (J), and (S) in equation (2.5). The variable (t) denotes the time trend. (*qup*) and (*qdown*) variables have the same meaning as before. (c^i), and (b^i) are estimated parameters. Finally, (η) and (α) are elasticities of output with respect to real structure stocks and equipment stocks, respectively.

Equation (2.6) and (2.7) are both used to estimate the productivity equation for each industry in IDLIFT. The equations are estimated with the soft constraint[3] in order to limit the value of particular parameter in the reasonable range. The capital elasticities are constrained in the range of [0, 0.4] while variables (*qup*) and (*qdown*) are limited in the range of [0, 1] and [0,-1], consecutively.

Moreover, the mixed empirical - Monte Carlo test[4] are performed so as to detect the problem of measurement error in real output (q). This is an important problem, since equation (2.7) includes the (*qup*) and (*qdown*) variables which are derived from the dependent variable (q). Thus, the existence of measurement error in (q) will make the

[3] The soft constraint sometimes is called "Theil's mixed constraints" or "stochastic constraints". This is the Bayesian technique for regression which permits the econometricians to take the expected value of some parameters from the previous theoretical basis into account. The method of soft constraint is to add a number of artificial observations in the data. By running regression with added data, the interested parameter value is constrained in the suitable range but soft constraint will reduce the fit of an equation.

[4] For more discussion under this topics, see Wilson (2001).

estimated parameters (*qup*) and (*qdown*) biased. The result shows that the estimated biases are always close to zero even if the size of measurement errors in real output (*q*) are large.

After replacing the old version of productivity equations with the new one in IDLIFT, the simulation results show that the behavior of main macroeconomic variables such as GDP, consumption expenditure, and etc. in response to the change in investment are more in line with the prediction of neoclassical theory. The new set of equations seems to have better fit with the historical data than the previous one. This is because the new productivity equations take into account both capital deepening (more units of capital to work with) and embodied technological change (high quality of labor). Furthermore, there is no sign of output explosion due to the lack of supply constraints. Finally, unlike the previous model, there exists a permanent improvement in macroeconomic variables due to an increase in equipment investment, even if the increase is only a temporary shock.

2.2 The MIDE Model

The MIDE[5] model is the first macroeconomic, dynamic, multisectoral forecasting model of the Spanish economy. MIDE is developed by Werling (1992). The primary objective of the MIDE model is to analyze the impact of Spain's participation in the European Community in 1986 under various scenarios. The model is based on the 1980 input – output table and the time series data of Spain's national accounts, and is linked to the system of INFORUM via the international prices and transfers.

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[5] MIDE stands for *El Modelo Macroeconomico Intersectorial de Espana*. The English definition is "to measure".

Like general INFORUM model, MIDE consists of three main parts: production block, price – income block and the accountant. On the production side (based on equation (1.1) and (1.2)), it consists of 43 commodity sectors, 43 private interior consumptions by type of commodity, 3 categories of government consumption, 36 kinds of investment expenditures (10 categories for investment in equipment, 25 categories for inventory investment, and residential construction), and 33 sectors of both exports and imports in services and merchandises. Aggregate consumption function is modeled in the way that include both wealth and the unemployment rate as explanatory variables. Investment expenditure is represented by the accelerator function based on the lag values of investment spending per se, monetary conditions, and the production costs. Exports and import functions depend on relative prices and exchange rates. Moreover, labor productivity, average employee work year, and employment are separately modeled for 43 industries.

The aim of the price – income block (based on equation (1.4)) is to calculate the sectoral price indices from the value added for 43 industries. Value added components are the combination of total labor compensation, gross profits, net indirect taxes on production, and import taxes. Both aggregate and sectoral wage equations in this model reckon on the movement of inflation and the gap between actual employment and natural employment rates. Furthermore, to capture the variation in sectoral profit, profit equations include wage costs, world price and tariff rate as regressors.

All value added elements are summed up and divided by the unit of output so as to generate the value added per unit of output in sector j (v_j). Sectoral producer prices can be computed from the identity:

$$P_j = \sum_i d_{i,j} P_i (1 + t_{i,j}) + \sum_i m_{i,j,t} PM_i (1 + t_{i,j}) + v_j \tag{2.8}$$

where, P_j = the domestic production prices of product j

$d_{i,j}$ = the I – O coefficient of row i and column j for domestically produced inputs

$m_{i,j,t}$ = the I – O coefficient of row i and column j for imported inputs at time t

$= \left(\dfrac{m_{i,t}}{q_{i,t} + m_{i,t}} \right) \times a_{i,j,t}$

$q_{i,t}$ = the output of sector i

$t_{i,j}$ = the effective VAT rate on sales of product i to sector j

$a_{i,j,t}$ = the I - O coefficient for the amount of product i required for the production of one unit of product j at time t

$= d_{i,j} + m_{i,j}$

PM_i = the price index of imports, inclusive of taxes, for product i, and

v_j = the value added per unit of output in sector j

Equation (2.8) states that the domestic price is the weighted average of domestic intermediate input price and imported input price plus value added components. In this case, $d_{i,j}$ and $m_{i,j}$ represents the weights for domestic and imported input, respectively.

Moreover, another interesting topic under consideration of the MIDE model is the impact of the change in value added tax (VAT) rate after the country's integration or the VAT incidence, thus the VAT rate variable is determined and treated as exogenous variable. By multiplying VAT rate to each transaction of I – O table, the total VAT revenue can be computed from the following formula:

$$VAT_i = \sum_j t_{i,j} P_i a_{i,j} Q_j + t_{i,c} P_i C_i + t_{i,v} P_i V_i \tag{2.9}$$

where,	VAT_i	=	the total VAT yield from producers of product i
	$t_{i,j}$	=	the effective tax rate on sales of product i to sector j
	P_i	=	the price index of sector i
	C_i	=	real private consumption of product i
	$t_{i,c}$	=	tax rate on consumption of product i
	Q_j	=	output of sector j
	$t_{i,v}$	=	tax rate on investment purchases of product i, and
	V_i	=	real investment purchases of product i

The accountant completely closes the model via the national account identities. Four main identities which link both production and price - income blocks together include the determination of Net National Disposable Income from Gross Domestic Product (GDP), the determination of net household disposable income, the computation of government deficit, and the balance on the current account. As a result, several significant macroeconomic quantities such as total disposable income, nominal GDP, saving and their distribution are computed within this block.

Finally, the MIDE model is utilized to examine and forecast the impact of the European single market policy on the Spanish economy. The simulation mainly focuses on five important topics during the transition period. Tables 2.1 – 2.5 summarize the simulating methods, the theoretical foundation and the simulation results of each scenario in the MIDE model.

Table 2.1: The Simulating Result for Scenario #1 in the MIDE model

Scenario #1: The Elimination of Customs Controls Over Flows of Goods

Theoretical Backgrounds:

- Customs controls such as tariffs and quota restrictions, border controls, and custom formalities substantially create additional transportation costs, which worsen the trade among EC members.

- Eliminating customs controls will reduce the prices of the bilateral trade by decreasing the costs of importing firms. Moreover, government employment is decreased by the reduction in the numbers of redundant custom officers.

Methods:

- The model assumes that the elimination of customs controls will create a reduction in each country's sectoral export prices.

- The sectoral export price reduction for each country can be computed by the following formula:

$$WARF = \sum_{k} \left(s_{i,k} \times RF_{k} \right) \tag{2.10}$$

where, ($WARF_i$) denotes weighted average reduction factors, ($s_{i,k}$) is the share of the country's exports of sector i to country k in total value of the country's exports to country k ($\sum s_{i,k} = 1$), and (RF_k) is the price reduction factors for exports to country k.

- Moreover, scenario #1 assumes that the sectoral import prices will fall when Spain removes the customs controls. Thus, the movement of import prices are predicted by a foreign price index which is computed as:

$$FPI_{i,t} = \sum_{k} \left(w_{i,k,87} \times p_{k,i,t} \times r_{k,t} \right) \tag{2.11}$$

where, (FPI_{it}) denotes the foreign price index for imports of commodity i in year t, ($w_{i,k,87}$) represents the share of Spanish imports of commodity i from country k in 1987, ($p_{k,i,t}$) is the export price index of commodity i, country k in year t (1980 = 1.0), and ($r_{k,t}$) is the exchange rate index of country k in year t (1980 = 1.0).

- In simulating the result of eliminating customs controls, the model assumes that the country's sectoral export prices are reduced by the ($WARF_i$) fraction and import price indexes are adjusted via ($p_{k,i,t}$).

- Finally, the simulating results are compared with the base case (the border control is remained).

Results

- All the results are the prediction by 2000 compared with the base case in the same year.

- All of macroeconomic variables are improved. The growth rate of GDP increases by .26 percent, while GDP deflator and consumption prices decreases by .45 and .94 percent, respectively.

- The model predicts that employment rises by more than 25,000 jobs.

- Although the effects of an increase in income and a reduction of import prices will increase the volume of import, the terms of trade of Spain will improve. This will reduce the current account deficit of the Spanish economy by .20 percent.

- Ultimately, the government deficit decreases by .35 percent.

Table 2.2: The Simulating Result for Scenario #2 in the MIDE model

Scenario #2: The Opening of Domestic Public Procurement to Foreign Suppliers

Theoretical Backgrounds:

- Although the contractual procurements granted to the particular domestic industries such as health and defenses, telecommunications, transportation, and etc. will generate government revenue, they inevitably enhance a monopoly in these activities.

- The main costs of the distortion due to public procurement contracts include not only higher overall inflation rate and prices of goods in granted industries, but also lower incentive to improve efficiency in protected production. Thus, the opening of domestic public procurement to foreign suppliers will enhance competitiveness and efficiency in production.

Methods:

- In order to simulate these effects in the MIDE model, the average import penetration factor and price shock variables computed are included in the model by the following formula:

$$\delta IMP_{i,t} = \sum_j \left(b_{i,j} \times INV_{i,t} \times PF_t\right) \qquad (2.12)$$

where, ($\delta IMP_{i,t}$) denotes the predicted increases in imports for capital - goods industry i at time t, ($b_{i,j}$) is the share of investment purchases from industry i bought by public sector j, ($INV_{i,t}$) represents total investment sales of capital - goods industry i, and (PF_t) is the import penetration factor[6].

- Price reductions in capital goods due to elimination of monopoly rent and improvement in labor productivity are included in the model via the reduction in gross profits and labor costs (due to improvement in productivity). The profits and wages reduction is obtained from:

$$\delta VA_{i,t} = \sum_j \left(b_{i,j} \times PRF_{j,t}\right) \qquad (2.13)$$

where, ($b_{i,j}$) has the same definition as equation (2.12), ($\delta VA_{i,t}$) and ($PRF_{j,t}$) denote a predicted decrease in the profits and wages for capital goods industry i at time t, and the price reduction factor for public procurement sector j, consecutively.

- Another effect is the saving in government expenditure, since the enhancement of competition will lead to the reduction in the prices of public enterprise production and public services. the expenditure savings can be computed from the following formula:

$$\delta PROF_{j,t} = \sum_i \left(b_{i,j} \times INV_{i,t} \times PV_{i,t} \times PRF_{j,t}\right) \qquad (2.14)$$

where, ($\delta PROF_{j,t}$) represents a predicted decrease in gross profits for public sector j at time t, and the rests of the variables have the same definition as quoted before. Finally, the reduction in gross profits will lead to a decrease in producer prices via the I – O price equation (1.4).

- Finally, the simulating results are compared with the base case

Results

- All the results are the prediction by 2000 compared with the base case in the same year.

- The simulating results show that the opening of domestic public procurement to foreign suppliers enhances the level of competitiveness in the Spanish economy will make the GDP deflator and consumption deflator decrease by 1.7 and 1.4 percent, respectively. The main price reduction comes from the energy, transportation and communication sectors.

- The reduction in price level leads to an increase in domestic and export demands which stimulate the economic growth in intermediate and long run. However, in the short run, the scenario #2 leads to a net loss of jobs in 1993.

[6] More detailed information about import penetration factor sees Catinat et al. (1998).

Table 2.3: The Simulating Result for Scenario #3 in the MIDE model

Scenario #3: The Liberalization of Financial Services
Theoretical Backgrounds:
- The movement toward a single currency, the harmonization of financial regulations and the elimination of discriminating law against foreign entities in domestic market will stimulate the competitive environment which enhances efficiency and productivity of financial market. - Moreover, the program will reduce transaction costs among EC members.
Methods:
- The shocks are included in the model through both lower profit margins, and higher level of productivity in domestic industries. - The model assumes that the Spanish price level for financial services will converge to the predicted average EC level which is 21 percent for the Spanish economy[7]. The price is gradually reduced from - 2.09 percent in 1993 to fully adjusted at – 21 percent in 2000. - An improvement in efficiency and productivity due to the enhancement of competitive level in financial sector is included to the model via the reduction in wage and profit margins. The reduction rate can be computed in the same way as scenario #2 by equation (2.13). - However, the exogenous shock to productivity is not permitted to feed back into the wage rate since the model wants to separate the impact of scenario #3 from other factors on the aggregated economy. - Finally, the simulating results are compared with the base case when financial services liberalization program is not accepted by the Spanish Economy.
Results
- All the results are the prediction by 2000 compared with the base case in the same year. - The results show that since financial services act as the intermediate input to other sectors, the 21percent decrease in financial services leads to the reduction in price level of other productions. Consequently, the overall impact of financial service liberalization is a 3.4 percent reduction in GDP deflator by 1998. - The reduction in price level will support the extension in the export sector and domestic demand which finally increase overall GDP growth rate by 1.7 percent. - Besides, fixed investment increases 2.0 percent by the year 1998. - However, the worsted terms of trade and the rising domestic demand will result in an increase in the current account deficit by .43 percent of GDP.

[7] Cecchini (1988) calculates the financial – service price reduction for EC members. The mid-range estimations for other countries includes 11 percent for Belgium, 12 percent for France, 10 percent for Germany, 14 percent for Italy, and 7 percent for United Kingdom.

Table 2.4: The Simulating Result for Scenario #4 in the MIDE model

Scenario #4: The Supply Effects of Firm's Strategic Reactions when the competitive environment is changed due to a result of the internal market
Theoretical Backgrounds:
- This scenario focuses on the change in producer behavior due to the integration policy. - Theoretically, the single market program will increase the level of competitiveness, enhance efficiency both in production and management, and prevent the market from monopoly power. Moreover, the size of the economy is enlarged which provides the chances for firms to extend their productions in order to take advantage from economies of scale.
Methods:
- Like Scenarios #2 and #3, the efficiency or productivity improvement and the reduction of monopoly power resulted in the decrease in profit margins and the wage costs. However, the exogenous shock to productivity is not permitted to feed back into the wage rate since the model wants to separate the impact of scenario #4 from other shocks on aggregated economy. - Some values of exogenous variables which generate shocks to the model are computed from the study of Catinat et al. (1988). However, the amounts of shock are linearly increased from the beginning year 1993 to the full impact in 2000. - The size of cost reductions in each industry varies due to the nature of production and employment. - To include the economies of scale effects, the model assumes that the average size of initial established factories will converge to the minimum efficient technical scale (METS)[8]. METS are different among various types of industries. - By taking into account both METS and other variables which are the proxies to measure economies of scale, and the level of competitiveness, the cost savings from each source are computed and implemented in the MIDE model via the positive labor productivity shocks. However, the average size of initial established factories in wholesale and retail trade sector is allowed to deviate from METS, and the cost reduction is much larger than other sectors, since this sector is expected to have large growth after pursuing the economic integration program. - Finally, the simulating results are compared with the base case
Results
- All the results are the prediction by 2000 compared with the base case in the same year. - The significant impact of this scenario is on the inflation rate. GDP deflator decreases approximately 3.0 percent by 1998. - In the short run, the positive productivity shock causes the employment to reduce by 37,000 jobs. However, the net effects on employment after the adjustment in growth rate are positive. - However, the adverse effect is an increase in current account deficit. Exports are outpaced by imports and the terms of trade is worsened.

[8] The detailed information and computation of the minimum efficient technical scale (METS) can be found in Pratten. (1988).

Table 2.5: The Simulating Result for Scenario #5 in the MIDE model

Scenario #5: The Harmonization of Value Added and Excise Taxes
Theoretical Backgrounds:
- The disparity in VAT and excise tax rate across European countries leads to the fear of both government revenue losses in high – tax countries after the elimination of borders. - The tax disparity among countries in the same products will induce people to buy those particular goods in low – tax regions. As a result, it generates high demand in low –tax regions, and leaves the high – tax region with disadvantages. - It is possible that some producers can move their production bases to the low – tax countries and leaves high – tax countries underdeveloped. - In order to eliminate these problems, the EC members propose the harmonization plan for VAT and excise tax rates especially focusing on the sectors that have high variations in tax rates such as alcoholic beverages and tobacco products.
Methods:
- In order to simulate the outcomes of tax harmonization, the model assumed that both VAT and excise taxes rates (beginning in 1995) converge to the current EC – proposal rates which are 4 – 9 percent for necessities and 14 – 20 percent for other products. - Specifically, the tax rate for normal goods is changed from 13 to 14 percent in 1995. For luxury goods, the current rate of 28 percent is adjusted to meet the 20 percent threshold. The plan is to reduce the luxury tax rate by 4 percent in 1995 and another 4 percent in 1996. - Moreover, indirect tax rates are raised to 10 percent for beverages (5 percent in 1995 and another 5 percent in 1996), and 20 percent for tobacco products (10 percent each for the year 1995 and 1996). - Finally, the simulating results are compared with the base case
Results
- All the results are the prediction by 2000 compared with the base case in the same year. - As expected, an increase in tax rates on most products will boost the inflation rate which obstructs the growth rate of the Spanish economy due to the sluggishness in export sector and lower domestic demand. - Although, the tax rates are raised in most products, the government deficit as a percentage of GDP slightly increases from 0.01 percent over the base case in 1997 to 0.02 percent over the base case in 2000. This is because of the reduction in employment. The result of simulation shows that the numbers of job loss are 57,000 positions in 1998 which lead to the reduction in both consumption spending and tax bases.

By combining all 5 scenarios above it is possible to examine the total impact on Spanish economy, and forecast the trend of main macroeconomic variables by the year 2000. The result shows the evidences that support the single market program in the long run. For instance, the main macroeconomic variables such as GDP growth, inflation rate, unemployment rate, current account surplus, and etc. are improved. The economic growth is stable due to the reduction in inflation rate and unemployment. Moreover, the structure of the economy will change toward a more service – oriented economy at the expense of manufacturing and agriculture sectors, while in the short run, the problem of current account deficit is unavoidable. The economy is more open to the world economy in both intraregional and international trade due to the elimination of trade barriers and the harmonization of law and regulations. Higher competitive level from abroad will encourage domestic firms to improve their efficiency and productivity.

Finally, Werling (1992) concludes his study with the directions for further works. The first direction is to include the newer version of I - O table in the MIDE model by disaggregating the economy into 56 sectors rather than 43 sectors. Secondly, in order to enhance the model's foreign trade predictive capabilities, the model should separate the sectoral import functions by source between the EC and the rest of the world, since the price relationships in both regions will be more different in the future. Finally, the model needs to improve the specification of profit function, labor productivity, and the relationships among investment, capital stock, potential output and prices if more data are available.

2.3 The MUDAN Model

MUDAN is a multisectoral dynamic model of the Chinese economy developed by Yu (1999). It is an annual long – term interindustry model built to examine the impact of industrial development of China from 1980 to 2010. The model is based on a 59 sectors commodity – to – commodity input – output table of the Chinese economy. By following the framework of IM model, the structure of MUDAN relies on equation (1.1) and (1.4), and it is composed of three main parts: production side, price – income side, and the accountant.

The real side computes the components of final demand (*f*) such as consumption, investment, government expenditures, imports, exports, and other final demands in constant price. All components except government expenditures are calculated econometrically. Consumption expenditures are estimated for 34 categories which are separated into 24 equations for urban and 10 equations for rural residents. These 34 categories are converged by the bridge matrix to 59 producing sectors. Investment expenditure equations are computed for 52 purchasing sectors and also transformed into 59 producing sectors of capital goods by the bridge matrix. Government expenditures are exogenous to the model. Imports and inventory equations are determined by the behavioral equations, and finally, exports are determined by a bilateral trade model in the INFORUM international model system, thus these variables are exogenous to the model if MUDAN is run individually. The real side is based on equation (1.1) which can be disaggregated into the following identities:

$$q = A * q + B_{cr} * h_{cr} + B_{cu} * h_{cu} + c_s + B_{inv} * i_{nv} + i_{vn} + x - m + o_{thdm} \tag{2.15}$$

where,

q	=	gross output by 59 sectors
h_{cr}	=	household consumption of rural residents by 10 categories
h_{cu}	=	household consumption of urban residents by 10 categories
c_s	=	social or public consumption by 59 sectors
i_{nv}	=	investment in fixed – assets by 52 purchasing sectors
i_{vn}	=	inventory changes by 59 sectors
x	=	exports by 59 sectors

m	=	imports by 59 sectors
o_{thdm}	=	other final demand by 59 sectors (an error term)
A	=	the direct requirement (59×59) matrix

B_{cr}, B_{cu}, and B_{inv} are the bridge matrices for rural (59×59) and urban (59×24) consumption expenditure, and the converting matrix (59×10) from investment by purchasing sectors into products purchased, consecutively. Another set of equations included in this block is the productivity equations. The productivity variable is simply calculated for each industry as real output divided by employment. The normal form of productivity equation in MUDAN model is as follows:

$$\ln prt_{i,t} = \alpha_{i,0} + \alpha_{i,1} * t + \alpha_{i,2} * d\lg q_{i,t} + \alpha_{i,3} * \lg kl_{i,t-1} + \alpha_{i,4} * D \qquad (2.16)$$

where,	$prt_{i,t}$	=	labor productivity of industry i at time t
		=	$out_{i,t}/emp_{i,t}$
	$out_{i,t}$	=	real output of sector i at time t
	$emp_{i,t}$	=	total employment in industry i at time t
	t	=	a simple time trend
	$dlgq_{i,t}$	=	$\ln(out_{i,t}) - \ln(out_{i,t-1})$
	$lgkl_{i,t-1}$	=	the log of capital – employment ratio of industry i at time t
	D	=	dummy variable for data irregularities when there exists broken trends, and
	$\alpha_{i,i}$	=	estimated parameters

Equation 2.16 of MUDAN differs from equation 2.3 of IDLIFT, since dummy variables and the capital/labor ratios are the main components in determining the variation of

productivity. Moreover, the aim of an inclusion of ($dlgq_{i,t}$) variable as an explanatory variable is to test for the labor hoarding[9] hypothesis of production function.

Like other INFORUM model, the aim of the price – income side is to calculate the value added components (depreciation, labor compensation, taxes, and profits). MUDAN estimated each component for 59 sectors by following the basic equation (1.4). However, the wage equations in MUDAN are calculated both in aggregate level (for agricultural and non – agricultural sectors), and individual wage equations for each industry. All components are calculated at current prices and transformed to the value added per unit of real output by simply dividing each total value added by the real output for each 59 industries.

Finally, the accountant is based on the national income and product accounts. These identities are used to check and determine the convergence of the model. The model employs the bottom – up process which determines the aggregate level of some macro variables such as nominal and real GDP by summing up the sectoral components of their parts. GDP deflator is simply computed as the ratio of nominal to real GDP. Other variables which are calculated within this block include disposable income, saving, consumption for rural and urban residents both in current and constant prices. The model computes the real variables by deflating the nominal variables with their price deflators. There are two types of price deflators in this model: urban and rural consumption price

[9] When the business is in the downswing, firms will hoard the existing labors by forcing unpaid or partially paid labor to leave or by temporarily reducing the working hours rather than reducing their employments despite falling levels of outputs. By the same token, firms will extend the normal working hours when the economy is in the upswing stage rather than hiring more labors. As a result, the levels of output will adapt at the faster rate than the employment, and the productivity will increase during economic boom and decrease during the bust.

deflators are calculated as the weighted average of user prices between domestic and imported prices.

The solution of the MUDAN model can be obtained via the iteration process. In each year, the model begins with a set of predetermined value of income and prices. The real side will calculate the final demands, employment, productivity and output based on these assumed values. Then, the price – income side will compute the value added components and prices. All of the computed data will feed into the accountant block. Finally, the accountant will estimate the value of incomes via the main identities and comparing the estimated income with the predetermined value. If the differences are small, the model accepts the solutions and the same cycle will start again with the next year's data, but if the differences are large, the estimated price and income from the first round will feed back into the model again as an predetermined value and the process of calculation will begin in the next round until the convergence exists.

As a macroeconomic model, the first task of MUDAN model is to forecast the future trend of the Chinese economy if China stays outside the WTO. To provide the long – term forecast for the Chinese economy from 1995 to the year 2010, the values of exogenous variables such as population, labor force, money supply, exchange rate, import prices, exports and government expenditures are assigned. The model assumes that population will reach 1,425 million in 2010. The labor force can be computed by multiplying total population with the labor participation rate which is expected to decline from 57 percent in 1998 to 55 percent in 2010 due to the expected increasing proportion of Chinese aging population in the next decade. The growth of money supply (*M2*) is expected to slowdown, the government consumption expenditure is assumed to expand at

6.2 percent per year. Besides, the Yuan currency is expected to depreciate relative to U.S. dollar from 8.5 Yuan/$U.S. in 2000 to 10 Yuan/$U.S. in 2010.

The results of simulation based on the value of these exogenous variables shows that the Chinese economy by 2010 will have stable economic growth. The average growth rate of GDP is 7.0 percent per year during 2000 – 2005 period, and 6.4 percent per year from 2006 – 2010, mainly driven by the strength of foreign trade, the growth in private consumption expenditure, and the improvement in non – state investment efficiency. Due to the industrialization policy, the growth rate of rural personal income outpaces that of urban income, however, Chinese economy still encounters the problem of income distribution, since the real income per capita for rural is only 47.8 percent of urban income. The structure of the Chinese production has changed from the agricultural production to higher value added production such as industrial and service industries. Moreover, unemployment rate is at higher rate particularly in urban area, since laborers still move from rural to urban area in order to find employment opportunities in industrial and service sectors and the governmental policy in reducing the redundant workers in state enterprises.

Inflation rate is quite stable at 3 percent during the forecasting periods, contrasting to historical average at 10 percent. One reason for the lower inflation rate relies on the price reform policy that changes the way of price setting from using governmental central plans to market driven especially in agriculture products, raw materials, and energy. Secondly, an improvement in efficiency coming from the highest development level in transportation, energy, infrastructure and raw material sectors helps other industries to reduce their costs of production and their products' prices. Finally, the higher degree of competition both from non – state enterprises and foreign companies requires Chinese firms to improve their own productivity and efficiency in production which reduces the pressure on inflation.

One of the advantages of the MUDAN model is the effort in forecasting the economy at the sectoral level. Based on the assigned value of exogenous variable, the model predicts that motor vehicles, gas utility, telecommunication, and electronic and communication equipment are the industries with high growth rate in the forecasting period. Service sectors are the most important industries in the Chinese economy both in increasing shares of output in GDP and as the main source of employment. The high increase in employment rate exists in industries such as commerce, education and entertainment, real estate, and social services, while the employment in government and textile sectors totally reduces by 5.1 million jobs from the 1994 level. The pattern of consumer spending has changed for both rural and urban consumers. Consumers tend to spend more on goods and services such as automobiles, education and entertainment, clothes, and household goods and spend less on foods.

Moreover, the result shows that highway transportation, water transportation, finance, telecommunication, and electricity are the sectors that experience significant increase in investment spending, since these sectors are among the priorities in the Chinese development plan. In contrast, primary iron, steel, and leather product are among the sectors with the lowest investment growth. Finally for the international trade, the model predicts that China will have the trade surpluses during the forecasting period although there are deficits in some sectors such as machinery, chemicals, and motor vehicles, since all intermediate inputs in these sectors are imported and relied heavily on advanced foreign technology.

The last application of MUDAN model in this study is to detect the impact of China's accession to the World Trade Organization (WTO). The scenario in this case is based on the Sino – US bilateral negotiations on tariff reduction (USTR, 1999). The model's simulation focuses only on trade liberalization measures in agricultural and industrial sectors. The plans and the simulation methods are shown in table 2.6.

Table 2.6: The Liberalization Measures and the Methods of Simulation in MUDAN

Plan	Methods of Simulation
1. The reduction of average tariffs for agricultural products to 17 percent by 2004	- This plan will leads to an increase in import quotas in agricultural sectors - The model assumes that the import share of domestic demand in farming sectors is increased from 1.5 percent in 2000 to 4.0 percent in 2005, and will remain at this level until 2010.
2. The reduction of average tariffs for industrial products from 24.6 percent in 1997 to 9.44 percent in 2005	- For the sectors such as agriculture, forestry, food, paper, chemicals, and automobiles, the reduction in tariff rate is fully specified by the USTR (1999) plan. - For other industries, the model assumed the uniform tariff rate cut of 62 percent. - For agricultural sectors, the phase in - period for tariff cut is between 2000 and 2004, while the implementation of tariff cut in other sectors is between 2000 and 2005. - The rate is reduced in an equal proportion during the phase - in period and remains at the final rate until 2010.
3. Import prices and export prices	- The expected impact of trade liberalization is on the prices of goods and services traded in international market. However, both export and import prices in the MUDAN model are exogenous variables and their values are forecasted by the INFORUM international model system.

Table 2.6 (Continued)

Plan	Methods of Simulation
4. Elimination of Non – Tariff Barriers (NTBs)	- The model uses the estimation of tariff equivalent (NTBs) if all (NTBs) are completely eliminated from particular sectors. - All tariff equivalent (NTBs) are reduced in the same proportion in each year starting from 0 percent in 2000, and reach the full impact in 2005. - Only imported prices used in calculating import demand for the product are reduced due to the tariff equivalent NTBs.
5. The Multi – Fiber Arrangement (MFA) According to Uruguay Round, starting from 1995, MFA must be gradually phased out over a ten - year period via the increase in growth rate of MFA quotas and the integration of both textiles and clothing product into the GATT system.	- MFA is the measure used by developed countries which impose quotas on textiles and clothing when these imports cause market disruption in importing countries. - The model assumes that if China gains benefits from MFA, the clothing and textiles export growth will increase by an extra 1.2 percentage point for each year from 2000 to 2004. However, if the MFA quota is quite restrictive, export growth for textile and clothing industries will gain an extra growth of only 0.5 and 0.6 percent per year starting in 2000 and reach their peak of 2.4 and 2.6 percent in 2005, consecutively.

Two scenarios: trade liberalization with restrictive MFA quota growth (S - I), and trade liberalization with moderate MFA quota growth (S - II) are simulated in the MUDAN model. The results confirm that China will benefit from WTO accession. The advantage comes from the elimination of trade barriers enhancing foreign demand on Chinese exports especially for textile and clothing products which China has comparative advantage over trading partners. The model predicts that China's growth rate will reach 4.5 percent in 2010 under scenario (S - I). Trade liberalization will offer the way to increase personal income and employment opportunities via the expansion of exports and lower costs of intermediate input in imported industries. However, the model forecasts that Chinese trade surplus will vanish by the end of 2010 since imports will finally outpace exports. The balance of payment deficit will be the main problem to worry about, and need the implemented policies to find the way out for the Chinese economy. Moreover, rural residents will benefit from trade liberalization. Both rural income level and consumption increase although the agricultural sector is much less important by the end of the forecasting period.

Both scenarios report that the benefits from WTO accession are not evenly distributed among sectors. The firms with labor intensive and consumer product industries are among the largest expansion after China's WTO accession, while capital intensive industries will suffer losses especially in an initial period. Moreover, the adjustment period is an important topic. In the short run, it is quite hard for some firms to avoid the high competition from foreign firms, which causes their outputs to fall. However, when all firms are fully adjusted for their technology and costs of production, Chinese firms will gain the benefits in the long run.

Ultimately, Yu (1999) concludes his study with the directions for further works. Presently, MUDAN uses the 117 sector input – output table of China for 1992 as a benchmark. Moreover, some of the time – series data used for regression are collected from different sources, and some are constructed due to the unavailability of data. Thus, the main concern for further study is based on the consistency of data among various sources. The development of 1995 industrial consensus and the utilization of new version of I – O table are the ways to improve the model's performances. Secondly, the current model incompletely verifies the influence of money and labor supply conditions on the Chinese economy. The establishment of these relationships will make the model more realistic. Finally, the further model needs to include the relationship among investment, capital stock, potential output and price, between labor market conditions and prices, and between capacity utilization and profits. However, the success of doing so depends on the availability of data in future periods.

2.4 The JIDEA Model

JIDEA stands for Japan Interindustry Dynamic Econometric Analysis Model. The model was developed by IITI (The Institute for International Trade and Investment) in 1993, and was revised in 2003 as JIDEA version 5. The new version of JIDEA is based on Japanese I – O table for 1985 – 1999 and the annual times series data from 1985 - 2003. Each I – O table component such as household consumption, investment, wages, profits, and etc. is calculated equation by equation for all 100 interindustrial sectors. The model also contains other important macroeconomic variables such as employment, saving rate, and labor productivity.

Like all IM type models, the model can be separated into 3 main parts: final demand side, value added side, and the accountant. The final demand side is based on equation (1.1). The household consumption function is explained by the relative price, dummy variables, and disposable income per capita. The simple accelerator model is still used for investment function. Exports are function of foreign demand and the relative prices. The variation in imports is explained by the summation of domestic demand and export, and the relative prices between import price and domestic price for each sector.

However, the foreign demands and their prices are exogenous variables collected from INFORUM system of bilateral trade model. On the value added side, the model determines each component of the value added. The wage function depends on productivity and wage index for tradable goods. Depreciations are explained by the value of purchasing sectors' investment and time trend. Besides, profits are function of labor productivity and nominal GDP. Finally, the specification of productivity equation in some sectors is the same as equation (2.3) if the fit of the equation is acceptable. However, for the sectors with low correlation between actual and estimated data, productivity is treated as exogenous to the model. The newest version of JIDEA (JIDEA 5) is improved in the following ways:

- The calculation of domestic output prices in the model includes import prices, and average import to domestic demand ratios.
- The model recalculated export and import price equations with new data.
- The employment and productivity equations are computed on the basis of working hours rather than the number of jobs.
- The exchange rate, foreign demand, and final demand discrepancy are added to the model.
- The revision of profit equations to include the percentage change in output, relative price of exports, and time trend as the explainatory variables which improve the dynamic forecasting properties of the model.
- Labor force in the current model is defined as the product between projected population and labor participation rate.

- The accountant block takes the calculation of disposable income into account, and the wage function is based on productivity growth and money supply growth.

The base line model is used to describe the real Japanese economy from 1998 to 2003 and forecast the performance of the economy from 2004 to 2010. In order to forecast the trend of the Japanese economy, the model assumes the following characteristics:

- The number of Japanese population reaches its peak in 2008, while the highest number of labor population is reached in 2000.
- The growth rate of GDP maintains at the low rate after 2005 due to the long term impact of economic stagnation in Japan.
- The high growth rate of Japanese exports prevailed during the forecasting period because of a continuous upward trend in foreign demand.
- The level of government budget deficits is high and this is the reason that the growth rate of government investment is kept at 2 percent, the low rate from 2003 to 2010.
- Japan still encounters scarcity of labor force. As a result, the labor participation rate in Japan is assumed to increase from 63 percent in 1998 to 68 percent in 2010, and the unemployment rate is positive at 1.9 percent in 2010.

Based on these assumptions and modified equations, the model seems to fit the data quite well. On the real side, the household consumption and private investment grow at low rate, while export and import growth are quite high during the forecasting period.

Government sector shrinks due to the problem of budget deficits. On the value added side, the model predicts that the share of labor compensation fluctuates in the same pattern as business cycle (decrease during the recession and recovery after the economic boom). Only the share of indirect tax has an increasing trend, and inflation rate is still at the low level by the end of 2008.

For the sectoral forecast, there exists the continuity of the slow growth rates in agriculture, fishery, forestry, construction and mining sectors. The model predicts that Japan will moves toward the service – oriented economy in the next decade, since the share of manufacturing output decreases after 2005 especially in communication equipments and electrical machinery, while the share of service industry increases. However, the manufacturing sectors such as transportation equipment, motor vehicle, medicine and computer and communication equipment industries are among the most important sectors which have the potential to stimulate the growth for the Japanese economy.

In stead of the ability to forecast the future trend of the Japanese economy, JIDEA are utilized to examine several aspects of possible scenarios. One of the most interesting papers belongs to Meade (1996), who uses JIDEA to detect the impact of price cut (deflation) in some industries such as agriculture, forestry, mining, construction, transport and communication, wholesale and retail trade, finance, insurance, and services.

In JIDEA, prices are modeled as the summation between value added components and cost of intermediate inputs, thus in order to cut prices, the model assumes that each components of valued added and the price of intermediate inputs in each sector are reduced to meet the expected target of price reduction while keep producing the same quantity of output as in the base case. For instance, in agricultural sector, incomes returned to farmer as the labor or the owner are treated as operating surplus, and these incomes are cut so as to meet the target of 37 percent reduction in the agricultural price. For other sectors such as construction, profit and wage are the main components to focus on. The decrease in price level comes from a reduction in monopoly power via a decrease in profits and an increase in productivity through a decrease in both labor hours per unit of output and wage rate. Furthermore, in order to control the unemployment rate in the reasonable range, the deviation of current unemployment rate from the natural unemployment rate variable is included in profit equation.

Comparing with the base case, the results show that GDP is slightly lower after the price cuts in 1996 but it maintains at higher rate than the base case after 2003. Undoubtedly, the inflation rate in terms of GDP deflator is lower by 10.8 percent in 2000 and 11.3 percent in 2005. As expected, the lower domestic price level stimulates exports and reduces imports which improve the current account. Moreover, investment spending increases due to the lower nominal interest rate. However, both lower price level and lower saving rate are not enough to make disposable income to increase during the forecasting periods. As a result, consumption expenditure decreases slightly comparing with the base case. The only concern is on the higher unemployment rate which is the consequence of higher improvement in productivity.

Although the JIDEA model is modified from the old version in many aspects, it still has defect. The main criticism is on the specification of productivity equation (2.3) which lacks the linkage between the level of capital stock or investment and productivity. Meade (1996) tries to incorporate aggregate investment to GDP ratios and aggregate capital stock to GDP ratios in productivity equations, since these variables are highly correlated with productivity level. However, the attempt seems to be unsuccessful because the results of the simulation and the dynamic behavior of the model are not economically sensible.

2.5 The TIDY Model

TIDY stands for the Thai Interindustry Dynamic Model. It is the first IM model of Thailand developed by Somprawin Manprasert (2004). The main objective of this study is to develop econometric model that is consistent with the Thai economic data both in terms of historical simulation and the accuracy of predictions. Moreover, the model must be dynamic and has ability to explain the sectoral details. According to the 1998 benchmark I – O table of Thailand, the I – O table used in the TIDY model is recomputed in constant 1990 price. The model consists of 26 commodity sectors, 33 groups of consumption expenditures, 11 and 26 categories of gross investment and government expenditure, and 26 export and import sectors classified by commodities.

Like all IM type models, TIDY consists of three main parts: the real side, the price – income side and the accountant. The real side calculates all final demand components and sectoral outputs. Based on equation (1.1), the identity is disaggregated into the following equation:

$$q = A*q + BMC*c + BMV*vf + vi + g + e + es - m \tag{2.17}$$

where q = 26×1 vector of gross output

A = 26×26 input – coefficient matrix

c = 33×1 vector of private consumption by commodity

vf = 11×1 vector of gross investment

vi = 26×1 vector of inventory change

g = 26×1 vector of government expenditure

e = 26×1 vector of exports

es = 26×1 vector of special exports

m = 26×1 vector of imports

BMC = 26×33 consumption bridge matrix

BMV = 26×33 investment bridge matrix

Each element on the right - hand side of equation (2.17) except (*g*) and (*e*) is estimated by the technique of regression. Government expenditure (g) and exports (e) are regarded as exogenous, since they are treated as policy variables.

The price – income side of TIDY computes the prices of sectoral outputs from summation of intermediate costs and value added. Technically, vector of price per unit at particular period is calculated by the Seidel iterative process[10] to satisfy equation (1.4). Each value added component except tax rates is econometrically estimated for each sector. The tax rates are left as policy variables, thus are exogenous to the model. Wage equations are modeled both in aggregate and sectoral levels. The aggregate wage equation is modeled by following the logic of Phillip curve, and the sectoral equation is depended on the aggregate wage.

The accountant computes various macroeconomic variables such as real GDP, personal disposable income, personal saving, and etc. It closes the model with identity equations from national income accounting. GDP at constant 1990 prices are calculated

[10] Seidel iterative method is the mathematical method to solve a system of linear equations. The method begins with the construction of a series of solution approximations that (under some assumptions) converges to the solution of the system. For more discussion on Seidel method see Almon (1967).

from both expenditure side and income side. In order to capture the difference in computing real GDP from both sides, the statistical discrepancy is included in the model. Other main variables in TIDY include productivity and saving rate which are endogenous to the model. The saving rate in TIDY is a function of growth rate of real income, unemployment rate, nominal interest rate, and inflation rate, while productivity equations still follow the basic form of equation (2.3).

The simulation process of TIDY begins with the assignment of initial value for sectoral outputs, prices and personal disposable income at the outset of period *t* in the model. Then, the model will compute final demand, output, employment, prices and incomes variables and the conclusion of various macro economic variables via the accountant block. If the estimated results of sectoral output and sectoral prices converge to the initial value, the model will begin the same process in period *t+1*. Otherwise, the model will use the estimated value as the initial value and the cycle of process will start again until the results converge.

The most important aspect that makes this study differ from above studies in constructing the IM model is the introduction of new technique called "the optimization in a complete model". The technique is used to solve the problem of simultaneity bias[11] rather than using the two - stage least squares or instrumental variables. This method allows all coefficients in the particular equation to vary and choose the value that satisfy the objective function. Moreover, it does not use the regression technique, thus the correlation between the disturbance term and endogenous independent variables is not the

[11] Simultaneity bias or sometimes called endogeneity is the main problem in estimating simultaneous equations when one or more independent variables in the equation are endogenous to the model. In other words, simultaneity occurs when there is a feedback relationship between the independent variables and the dependent variable. This problem is quite severe because the method of OLS in estimating the value of coefficients and standard error will yield the bias result.

problem. One interesting application in this study is to apply this technique to the following saving rate equation:

$$savrat_t = \alpha_0 + \alpha_1 YC_t + \alpha_2 U_t + \alpha_3 i_t + \alpha_4 \pi_t + \alpha_5 dummy + \varepsilon_t \qquad (2.18)^{12}$$

where,

$savrat_t$	=	saving rates (total savings/personal income)
YC_t	=	growth rate of real income
U_t	=	unemployment rate
i_t	=	nominal interest rate
π_t	=	inflation rate, and
α_i	=	estimated parameters
$dummy$	=	dummy variable (1998 = 1, otherwise 0)

According to the optimization method, the appropriate values of parameters for (U_t) and (π_t) are computed by minimizing the sum of squared errors of the unemployment rate and the inflation rate. Moreover, the result shows that all estimated (α_i) give the correct sign and the forecasting result is more reasonable than the method of soft constraint.

Like all macroeconomic models, the main task of TIDY is to forecast the long – term performance of the Thai economy both at the aggregate and the sectoral levels from 2000 to 2020. The base forecasting case depends on the assumption on the following exogenous variables:

- The Thai population is projected to grow from 62.2 million people in 2000 to 70.8 million people by 2020.

[12] In this case, unemployment rate (U_t) and inflation rate (π_t) are determined by other equations in the model, thus they are endogenous to the model. The OLS regression for equation (2.18) will definitely give the bias results.

- On the expenditure side, government consumption expenditures are projected to grow at 2.5 percent per year during the forecasting period and the growth of export is expected to increase from 4.0 to 4.5 percent per year in real term, and 8.0 to 9.0 in nominal term throughout the forecasting period.
- The indirect tax rates still remain constant at 1998 level, while the increase in personal income tax rates is estimated by the simple linear time trend. The nominal interest rates are expected to increase from 1.44 percent in 2003 to 3.5 percent in 2020. The Thai currency (Baht) is assumed to appreciate from 41 Bahts per $U.S. in 2000 to 36 Bahts per $U.S. in 2020.
- Finally, the money supply is anticipated to increase at the rate of 4 – 6 percent per year.

Based on these assumptions, the results of the simulation show that Thai economies will grow at the steady rate. The average growth rate of GDP during the forecasting period is at 4.4 percent per year which is the result of the sustainable growth in both private consumption and fixed investment. Trade deficit still remains at low level due to the increase in imports of machinery and industrial equipment. However, the expansion of exports after 2015 will relieve this problem. Moreover, the model predicts that negative growth of real disposable income during the recession period (1998 - 2003) will return to the positive rate after 2004. Labor productivity is expected to grow by 4.6 percent per year throughout the forecasting period, while unemployment rate tends to increase after 2002 but still remains at low level by the end of 2020. Inflation is not the problem in the next decade due to the assumption of conservative monetary policy.

The changes slightly occur in the structure of GDP both on expenditure and income sides. On expenditure side, share of private consumption expenditure in GDP declines overtime, although it is still the largest share of GDP. By contrast, fixed investment share in GDP increases and by the end of 2020, it will be almost as large as the private consumption expenditure. On income side, labor income share exhibits declining trend, while corporate profits is still the large proportion of GDP.

For the sectoral forecast, the growth of the Thai economy in the next decade still relies on the manufacturing and service sectors. The model predicts a strong growth in industries such as banking and insurance, fabricated metal products, chemical, mining, electricity and water works both in terms of their output share to GDP and employment share to total employment. Agricultural sectors such as crops and forestry (used to be the main source of employment) continually lose their jobs to the manufacturing and service sectors. Its employment share to the total employment by the end of 2020 is only 33.4 percent comparing with 50.8 percent in 2000.

Furthermore, the TIDY model is used to examine the optimal path of direct taxes that minimizes the deviation of unemployment rates (u) and inflation (π) from their desired value (both are set at 3 percent). By applying the technique of optimization, the objective function in this case is in the following quadratic form which allows for trade offs between unemployment and inflation:

$$M = \alpha_1(u-3) + \alpha_2(u-3)^2 + (u-3)(\pi-3) + \beta_1(\pi-3) + \beta_2(\pi-3)^2 \qquad (2.19)$$

and,

$$-\frac{\partial u}{\partial \pi} = \frac{\left(\beta_1 + 2\beta_2(\pi-3) + (u-3)\right)}{\left(\alpha_1 + 2\alpha_2(u-3) + (\pi-3)\right)} \qquad (2.20)$$

where, M = objective function (misery function)

α, β = weights put on unemployment and inflation variables, which are arbitrarily set as:

- $\alpha_1 = 2,\ \alpha_2 = 4,\ \beta_1 = 1,\ \beta_2 = 1$ (for employment averse case)
- $\alpha_1 = 1,\ \alpha_2 = 1,\ \beta_1 = 2,\ \beta_2 = 4$ (for inflation averse case)

The simulation allows the tax rate to vary every four years according to the future political term from 2000 to 2020. The result shows that in order to maintain lower inflation rate on one hand, the direct tax rate should be increased from 3.9 percent in 2000 to 10.3 percent in 2020. However, increasing tax has the pros and cons. The negative effects are high unemployment rate, lower level of personal consumptions and gross outputs in all commodities and the consequent lower GDP growth, while the positive effects are the improvement in trade balance. On the other hands, to achieve the desired level of unemployment, the government should pursue the tax cut policy but the economy will suffer losses from the higher level of inflation and the trade deficit. Notwithstanding, tax cut will stimulate GDP via rapid growth in real disposable income.

Finally, despite the advantages of TIDY, the model still has several defects. Firstly, in order to gain a better result, private consumption expenditure equations should be more disaggregated and take into accounts the variables that reflect the income distribution among Thai population such as ages, education level, and other demographic variables. Secondly, the investment function needs to be improved, since the simple accelerator model is not enough to explain the behavior such as the impact of capital costs on investment decision, and etc. Thirdly, the productivity equations need to be revised as well, and the definition of productivity should be changed to the output per hour so as to detect the negative trend in sectoral labor productivity. However, the possibility of these changes depends on the availability of data in the future. Ultimately, import and export equations needs to be improved and should be linked to other international variables such as foreign demands and relative prices.

2.6 The INFORUM International System

The INFORUM international system, developed by Nyhus (1991), currently incorporates all of thirteen national INFORUM models into one system[13]. The main objective of this international system is to link all national models through the bilateral trade model (the process that uses trade flows and prices at the individual industrial level). At first glance, the main problem in integrating national models is that all models must link to one another at the sectoral level. This means that not only the I – O system of one country has to connect with those of other countries, but also the relationships of the flows of information such as domestic prices, import and exports must be determined. Thus, in order to link all models together, the four primary country – specific equations must be specified as follows:

- Export Equations:

$$e_{i,t} = \left(a_0 + a_1 \sum_k w_k m_{k,i,t} / m_{k,i,0}\right)\left(p_{i,t} / f_{i,t}\right)^{\eta} \tag{2.21}$$

- Foreign Price Equations:

$$f_{i,t} = \sum_k s_k p_{k,i,t} r_{k,t} / p_{k,i,0} r_{k,0} \tag{2.22}$$

- Import Equations:

$$m_{i,t} = \left(b_0 + b_1 d_{i,t}\right)\left(p_{m,i,t} / p_{i,t}\right)^{\lambda} \tag{2.23}$$

[13] The 13 national INFORUM models include United States of America, Mexico, Korea, Germany, United Kingdom, Spain, Belgium, Canada, Japan, China, France, Italy, and Austria. Presently, the TIDY model of the Thai economy is not linked with the INFORUM system.

- Import Price Equations:

$$p_{m,i,t} = \sum_k v_k p_{k,i,t} r_{k,t} / p_{k,i,0} r_{k,0} \qquad (2.24)$$

where, $e_{i,t}$ = one country's exports of input – output sector i in year t

w_k = the fraction of those exports which went to country k in the base year of the national model

$m_{k,i,t}$ = imports into country k for commodity i in year t

$p_{i,t}/f_{i,t}$ = a moving average of domestic (p) and foreign (f) prices of commodity i in year t

s_k = country k's share of world exports of commodity i in year 0 (the base year of national input – output table)

$p_{k,i,t}$ = domestic price index of commodity i in country k in year t

$r_{k,t}$ = exchange rate (foreign currency units per unit of home currency) of country k in year t

$m_{i,t}$ = volume of imports of commodity i in year t

$d_{i,t}$ = domestic demand for commodity i in year t (domestic production + imports - exports)

$p_{m,i,t}$ = price of imports of commodity i in year t

$p_{i,t}$ = domestic price of commodity i in year t

$\mathrm{v_k}$ = share of imports of commodity i originating from country k in base year of national model

a_0, a_1, b_0, b_1, λ, and η are the estimated parameters

Under this system, exchange rate (r) is treated as exogenous variable. This is because the variables such as the nominal rate of interest and the rate of inflation which are the determinants of exchange rate are not modeled as endogenous variables in most national models. Moreover, in most cases, exchange rate is a policy variable and the forecast of exchange rate is not accurate.

The system requires modification of equation (1.4) in each national model as:

$$p = (p \times D) + (p_m \times M) + v \qquad (2.25)^{14}$$

Equation (2.25) implies that the domestic prices can be computed from the summation of domestic prices (p), import prices (p_m), and value added components (v). This functional form is the same as equation (2.18) in the MIDE model but the vector of value added components is a function of imports, import prices, exports and competing prices of exports.

Finally, The INFORUM system is used to detect the impacts of various scenarios relative to the base case (when there is no change in assumptions) such as the effects of a return to a high U.S. dollar exchange rate, the effect of oil shock if the oil price gradually increases over the next ten year, the impacts on 7 INFORUM countries if there is no growth in the rest of the world, the impacts of a regional trade war (see Nyhus, 1991), and etc.

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[14] Notice that the input – output coefficient matrix A is equal to the summation of matrix D (matrix of input – output coefficients of domestically produced goods) and matrix M (matrix of input – output coefficients of imports goods), i.e.,

$$A = D + M \qquad (2.26)$$

Equation (2.26) implies that if import in a given industry increases, then the domestic production in the same product will decrease.

Chapter III

An Overview of the Thai Economy

3.1 A Bird's Eye View of the Thai Economy

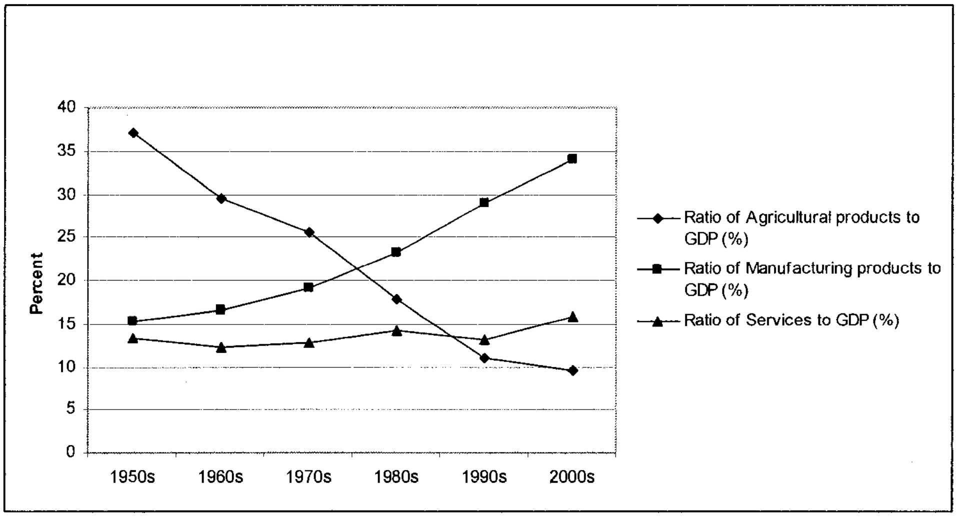
The objectives of this chapter are to describe both the economic and political situations and the detailed development strategies for the Thai economy from the past till present in order to fully understand the weaknesses, the strengths, and the opportunities of the Thai economy as well as the changes in its structure of production overtime.

The timeline for the history of the Thai economy in this chapter is divided into 3 periods: (1) the period from the first national plan to the seventh national plan, (2) the period of financial crisis during the eighth national plan, and (3) the current situation under the ninth development plan.

3.1.1 The Development Strategies for Thailand: Experiences from the First to the Seventh National Plan

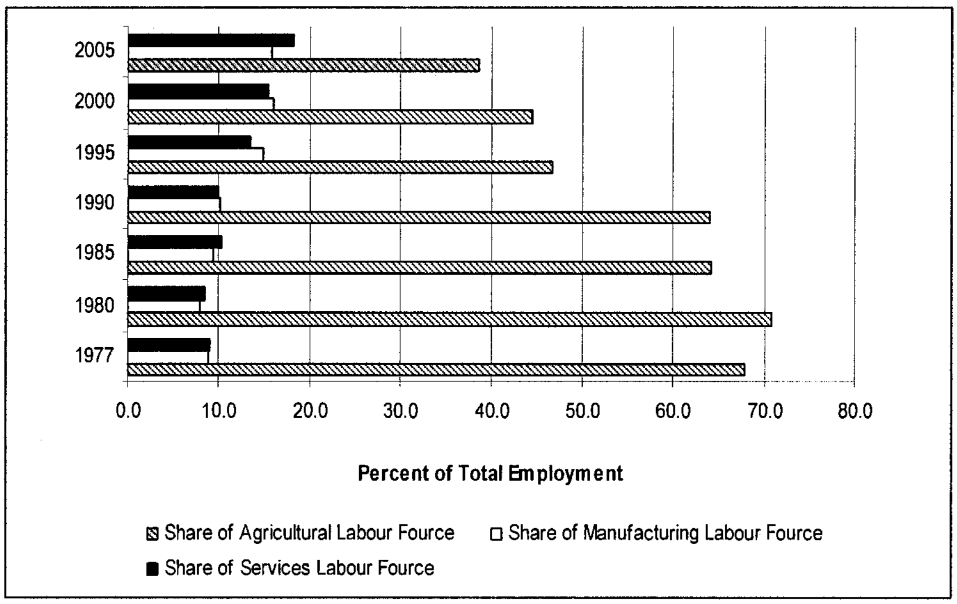
Before the introduction of the Thai national economic development plan in 1961, the Thai economy relied on the agricultural sector both as the source of employment (about 70 percent of total employment) and as the main export sector in generating foreign revenue (See figure 3.1 and 3.2). Major crops and primary products such as rice, rubber, maize, tin and teak were among the main commodities for domestic consumption and export. The growth rate of overall economy was low at approximately 2 – 3 percent per year, while the population growth exceeded 3 percent per year. Although the economy at that time had low level of income per capita, she had a capacity of being developed due to the abundance of labor supply and natural resources.

Figure 3.1: The Ratio of Domestic Product to GDP (Percent) by Selected Sectors



Source: National Economic and Social Development Board (*NESDB*)

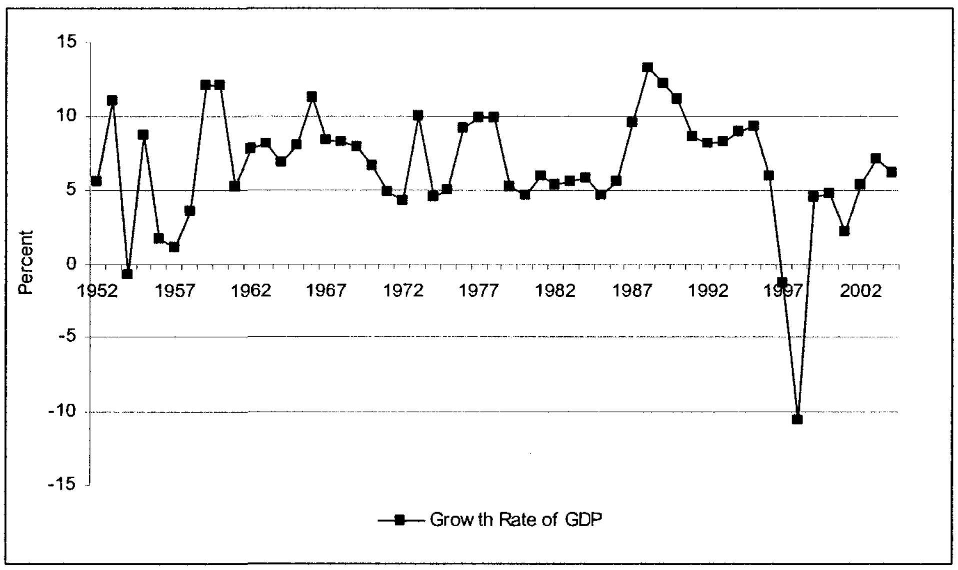
Figure 3.2: Share of Employment by Sector (Percent of Total Employment)



Source: National Economic and Social Development Board (*NESDB*)

The first 1961 – 1966 national economic development plan and the second continuous 1967 – 1971 plan were quite successful in transforming the Thai economy from an agrarian society to a newly industrialized country. The plans aimed at providing basic infrastructure and restructuring the operation of governmental agencies in order to accommodate the expansion of productive investment. Under these two plans, growth and the economic expansion were treated as the most significant objectives of economic development (See figure 3.3), thus investment and capital accumulation were undoubtedly used as the means to achieve these ends.

Figure 3.3: Growth Rate of Real GDP during 1952 - 2004

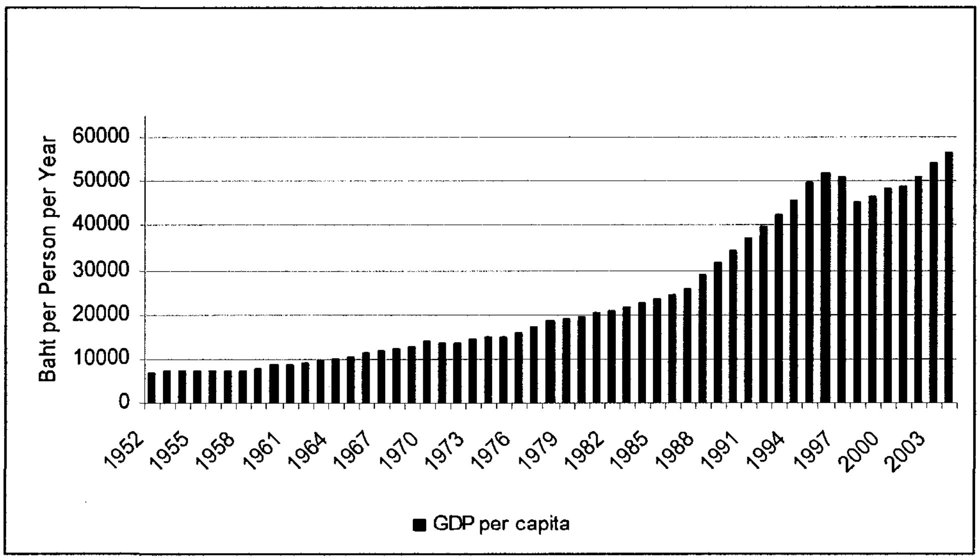


Source: Bank of Thailand (BOT)

The political condition during these time periods was characterized as a central – planning system. Most goods and services are produced under the governmental control and government intervention was prevalent in order to keep the economy stable. However the Thai government began to support private firms by offering them the incentives to invest in some efficient activities and transactions. Policymakers believed that import substitution policy was the solution to trade deficits. By producing every final goods and services domestically, the country would import less from abroad. Nevertheless, the volume of import did not reduce from the previous period since the country still needed some intermediate inputs and more advanced machinery from developed countries. Other factors that contributed the growth to the Thai economy included foreign investment and U.S. army expenditures during the Vietnam War.

After a decade of emphasis on growth and economic expansion, the national plan was criticized for ignoring the problems of poverty, income inequality, social welfare, and environmental degradation. Thus, the third 1972 – 1976 national economic and social development plan was the first plan that took into account the population policy as a second priority.

Figure 3.4: GDP per Capita of Thailand during 1952 – 2004

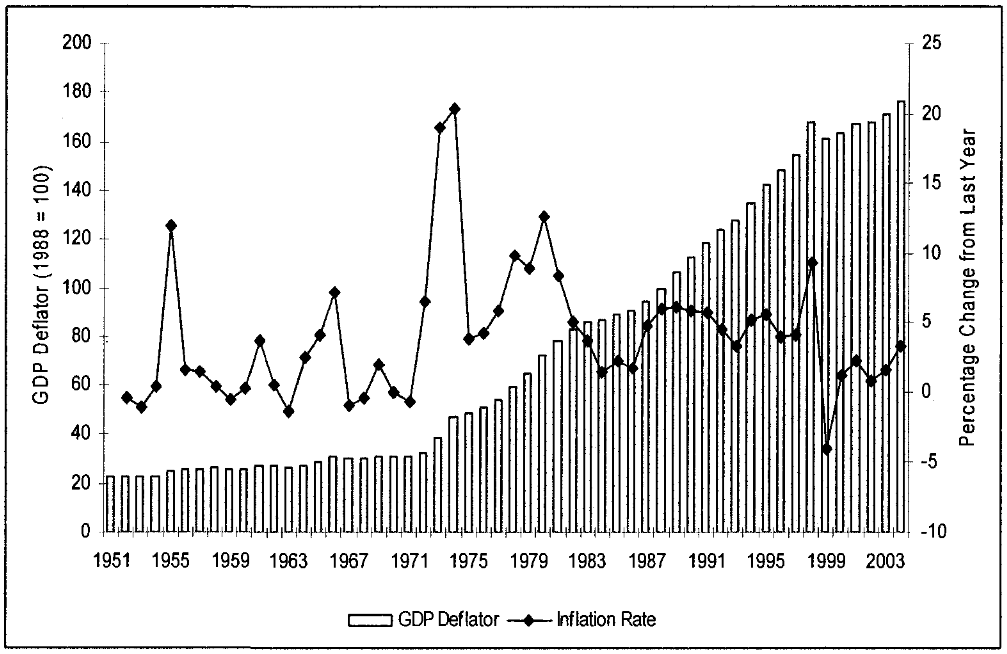


Source: Bank of Thailand (BOT)

The Third plan concentrated on the reduction of population growth and the increase of employment opportunities and income per capita (See figure 3.4) by giving the priority to labor – intensive projects, extending both labor training program and education to underdeveloped areas, and revising the issues on labor protection, minimum wages, labor relations, and some aspects of social insurance. However, only the goal of reducing population growth appeared to have succeeded during this period.

The main priorities of the third national development plan not only paid attention to the economic growth but also the target of internal stability, since the Thai economy at that time encountered the first oil shock. The supply - induced inflation was the serious problem concerned by policymakers.

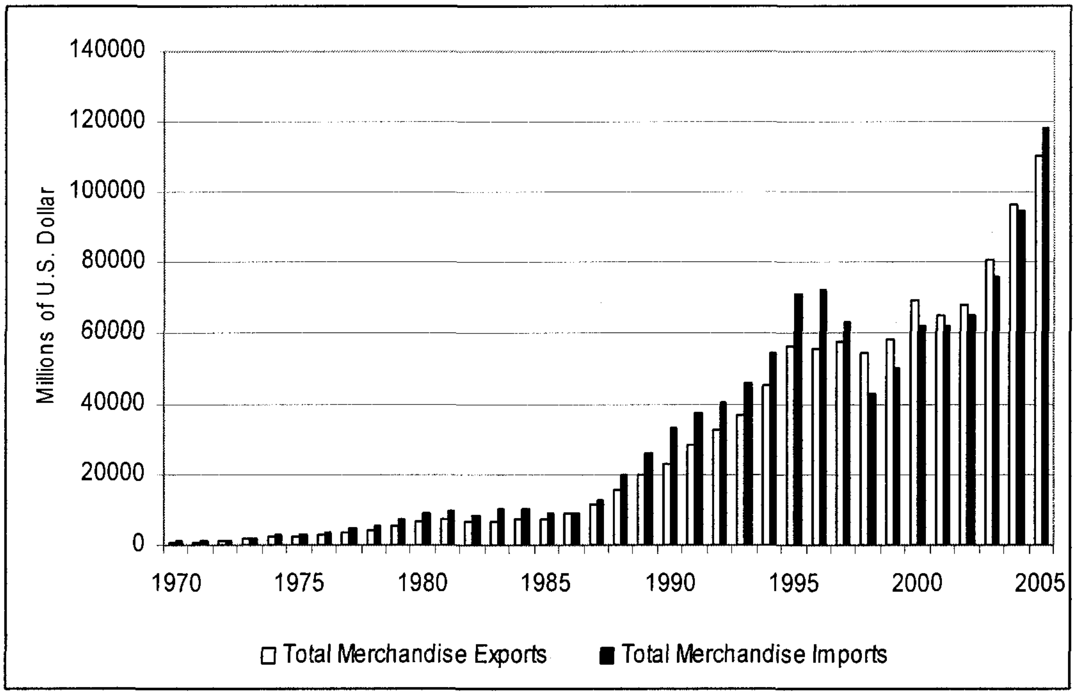
Figure 3.5: GDP Deflator and Inflation Rate (1988 = 100) of Thailand



Source: Bank of Thailand (BOT)

Moreover, because of the chronic problem of trade deficit (See figure 3.6), Thai government changed its industrial promotion policy from import substitution to export oriented policy beginning in 1972.

Figure 3.6: Total Import and Export Merchandise of Thailand during 1970 – 2005



Source: World Trade Organization (WTO)

The policy focused on the strength of the Thai economy which was the availability of cheap labor and the abundance of natural resources in producing the goods and services that were able to serve domestic demand and compete in international market. As a result, the plan was quite successful not only in controlling the amount of trade deficit in this period, but also in diversifying Thai exports from primary agricultural products into more value - added industries such as textiles, electronics, and etc.

The fourth 1977 – 1981 national plan took place during the period of political instability in Thailand. Two political events that contributed the instability in political conditions were the uprising on 14th October, 1973[1] and the riot on 6th October, 1976[2]. The country was under a state of emergency and most development projects were suspended. The country at that time was plagued with the problems of income disparities, and environmental degradations. Thus, the maintenance of national security was the main objective in this period. However, the fourth national plan was the first plan that was concerned about the environmental problems although the plan still lacked guideline and operational measures.

The circumstances during the fifth national plan (1982 - 1986) differed from situations in the previous period. Politic in Thailand returned to the state of stability, but the imbalances of macroeconomic variables such as the increase of investment – saving gap, trade deficits, the rising budget deficits, and public debt obligation were prevalent (See figure 3.7 and 3.8). Thus, the Thai government under the fifth plan paid attention to economic stability and continuously executed the exports – led – growth policy by focusing on the improvement of efficiency in industrial production. The discovery of low – cost petroleum helped spurring the development of most industries. The development policy for agricultural sector still remained the same as in the fourth plan. Although, the fifth plan tried to improve the efficiency of production in both agricultural and

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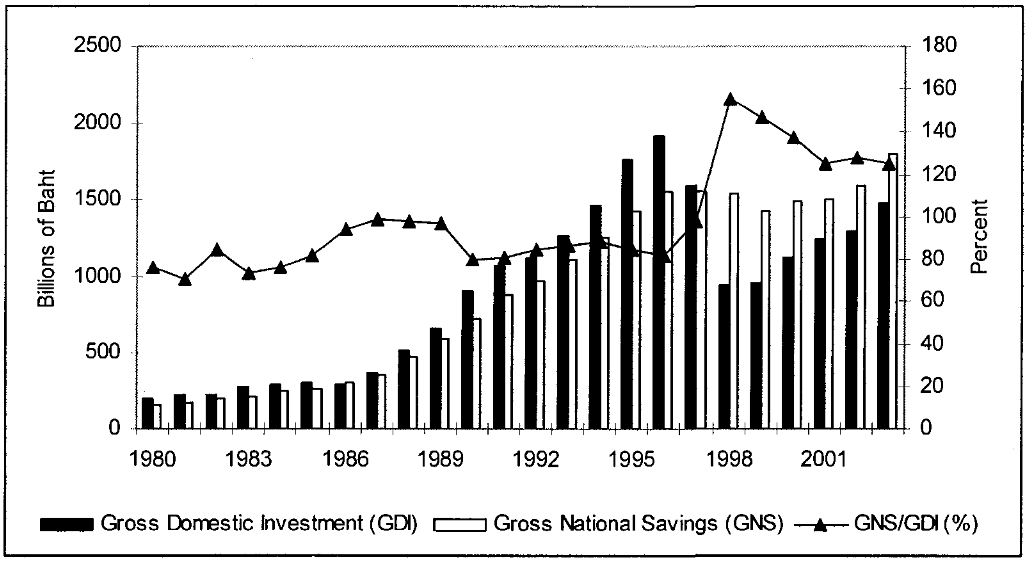
[1] The tragedy on 14th October, 1973 will be remembered as one of the murkiest events in the Thai political history. Thousands of Thai people, especially students gathered on the street of Bangkok in order to demand for the resignation of corrupt military dictatorships. The situation ended up with confrontation between the army and the protestors. Over hundred of Thai people died on that day. This event is marked as the beginning of the democracy reform in Thailand.

[2]The riot on 6th October, 1976 was another gloomy day in Thai history. At that time, the fear of communism was spread over the South East Asian region, since the neighboring countries such as Cambodia, Laos, and Vietnam became communist. Some people, especially students and the middle class were suspected as the communists. The bloody uprising began when students and supporters gathered at Thammasat University in order to protest the return to Thailand of Thanom Kittikachorn, one of the former corrupted dictators from the 14th October, 1973 event. After surrounded by the Thai police and the army, some of protesting students were atrociously killed. Survivors fled to the jungles and some of them escaped to the neighboring countries.

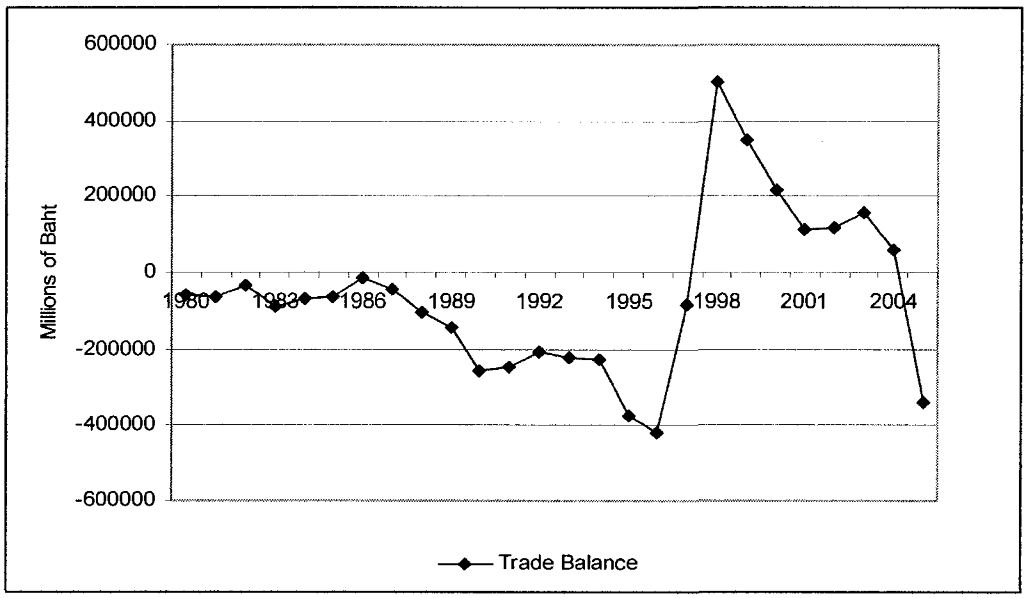
manufacturing sectors, the poor structure of science and technology was still the main problem obstructing this goal.

Figure 3.7: Thailand Gross Domestic Investment (GDI), Gross National Saving (GNS), and the Percentage of (GNS/GDI)



Source: Bank of Thailand

Figure 3.8: Trade Balance during 1980 – 2005



Source: Bank of Thailand

For two decades since the first development plan in 1961, Thailand followed a policy of purchasing technologies from developed countries, especially in hard industrial and iron – based material sectors, while the agricultural sectors, albeit had been able to generate its own fundamental techniques, were still based on inputs from foreign countries such as fertilizers, pesticides, and etc. Consequently, not only trade deficits were an unavoidable problem, the country still lacked incentive to develop her own technology. Other problems, at that time included the world recession followed by the second oil shock which made the world economy stagnant. However, the severity of these situations on the international trade side was alleviated by the first devaluation of Baht in 1984, and the achievement of export promotion policies included such as the reduction of tariffs, the incentives for exports, and the construction of export – processing zones.

Although the socio – economic and political conditions during the sixth national plan period (1987 – 1991) were the same as those during the fifth plan period, this period was the prosperous time for the Thai economy, since the overall growth rate of the Thai economy increased at an average rate of more than 10 percent per year with the highest growth of 13.2 percent in 1988 (See figure 3.3). The situations seemed to support the extension of the Thai economy to become the fifth tiger of Asia. However, by concentrating only on high growth rate while ignoring the development on other aspects, the Thai economy still encountered several interrelated economic and social problems. The lack of improvement in rural areas (most of these lands were used for agricultural purpose) which involved the majority (approximately 65 percent) of the total population caused the uneven distribution of income among labors between rural and urban areas.

The migration of rural people to big cities in order to find higher pay jobs, and urbanization were the normal phenomena of Thailand's development. The rise of urban areas and the migration brought various problems such as the increase of urban slums, congestion, urban pollution, deforestation, poverty and the abandonment of rural areas. Therefore, the sixth national development plan focused on these chronical problems and set objectives on both economic and social sides. On economic side, the plan aimed at maintaining the growth rate of at least 5 percent per year in support of the increase of labor forces during the plan period. In this regard, both economic expansion and stability were the main objectives needed to be emphasized. On social side, the plan intended to improve the general standard of living and upgrade the quality of human resources by targeting at an even distribution of income between rural and urban residences, an improvement of education system and training program that were compatible with market demand for labor, and an expansion of health services to the rural areas. Besides, more precise and practical guideline for solving the problems of environmental degradation and pollutions were initially incorporated in this plan.

Due to the success of the sixth national plan and the favorable situations of the world market, the Thai economy still continued to grow during the seventh national plan period (1992 - 1996). The collapse of USSR and socialistic countries were the main factors that changed the political situation of the country into a more democratic system. The decision making about policies came from the unanimous opinions of elected members of the parliament. Globalization was the main idea that made people around the world anxious about the concepts of democracy, human rights and opportunities, and the preservation of environment. Thus, it was necessary that the seventh national plan had to be concerned about the balance between qualitative and quantitative development in parallel with social neutrality (sustainable development concept). Three main objectives were assigned to this plan, including:

- Simultaneously maintained the target of continuous growth rate and the economic stability
- Evenly distributed income and development to provincial and rural area
- Urgently improved human and natural resources, quality of life, and environment

The consequences of the seventh national development plan were quite successful in expanding the Thai economy. The growth rate of GDP during this plan grew rapidly at the average rate 8.09 percent per year. Income per capita increased from 49,135 baht in 1992 to 76,982 in 1996 (See figure 3.3 and 3.4). Most of the Thai people could widely access basic infrastructures and social services. The achievement of poverty reduction and the lower unemployment policies helped to transform the Thai economy from a poor society to a newly industrialized country. However, the overall economy still faced the problems of imbalance growth, especially the uneven distribution of income and benefits between rural and urban areas and among the interest groups in the society. These severe problems affected the quality of life of Thai citizens and created other social problems such as addictive drugs and crimes. Moreover, the inefficient uses of natural resources led to the degradation of environment. In conclusion, the development strategies from the first to the seventh national plan which focused only on the objective of economic expansion and ignored other aspects of the society were far from the concept of sustainable development.

3.1.2 The Situation under the Eighth Development Plan: Thailand Financial Crisis

In order to achieve a balance between economic and social aspects as well as the long – run sustainable development, new developing strategies were determined in the eighth national development plan (1997 - 2001). The main ideas included:

- The plan modified the previous focus only on economic development to the concept which emphasis on human as the center of development. Economic development was only the tools for improving human well beings. Moreover, the plan paid more attention to the target of economic stability than maintaining the high economic growth rate.
- The plan emphasized the interrelationship between economic and other dimensions of the Thai society and allowed for greater popular participation in every step of economic and social development.
- Since the eighth development plan was a plan used to adjust the way of working procedures and the thinking methods, it stated a clear determination of specific objectives and goals so as to avoid an overlap of duties among the operation units.

However, the economic situation during the beginning of the eighth plan did not facilitate the country's growth. The Thai currency (Baht) was devalued in July 1997 along with other major problems, which contributed to the onset of the economic crisis in Thailand. The four major problems that caused the slump of the Thai economy included:

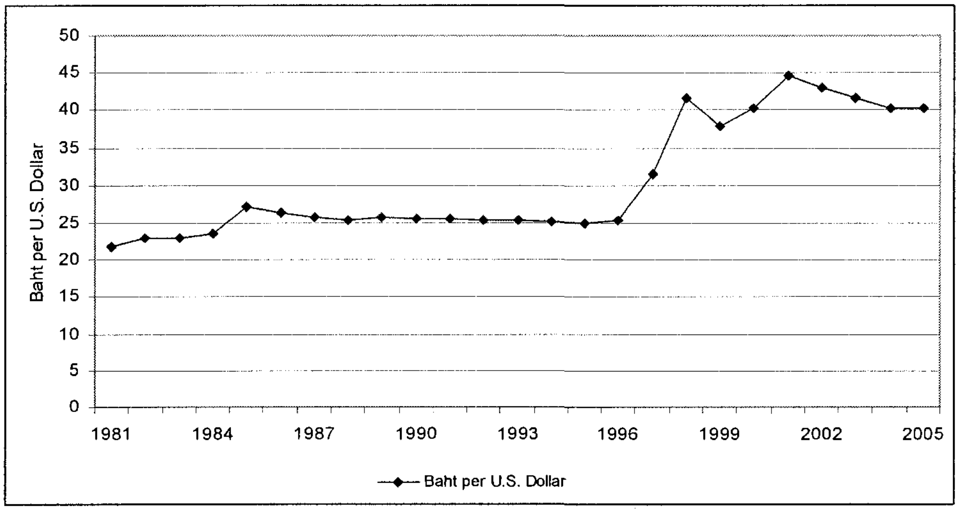
- *The High Interest Rate*

This was one of the causes that curtailed the progress of the Thai economy during this period. The government used high interest rate as a contractionary monetary policy in controlling the inflation rate. High interest rate induced capital inflows which were suitable for the situation of the country that faced the problem of current account deficits. Moreover, high interest rate was also a potential tool for the Bank of Thailand to discourage the speculative activities on Baht, since the cost of borrowing Baht was higher under high interest rate. However, the higher the rate of interest, the lower would be the investment expenditure to stimulate the economy.

- *The attack on the Thai Currency (Baht) by Currency Speculators*

Before 1997, the Thai Baht was pegged to the U.S. dollar and other major currency such as the Japanese Yen (See figure 3.9). Under the fixed exchange rate system, the country's reserves were the main component in maintaining the constant value of the country's currency, since when the Baht fluctuated above or below the desirable value, the central bank of Thailand would have to intervene in the currency market by using its reserves to buy or sell foreign currencies in order to get rid of the excess supply or demand of foreign currencies. However, the appreciation of the U.S. dollar during that time against other currencies made Baht overvalued. Currency speculators expected Thai Baht to depreciate and began to sell Baht and buy the U.S. dollar. The central bank had to use almost all of its reserves in attempting to maintain the value of Baht. Finally, the system of fixed exchange rate was tumbling down and the country turned into a system of managed float in July 1997. The impact of changing the exchange rate system was quite severe since the exchange rate immediately changed from 25.85 to 29.80 Baht per U.S. dollar by the day of announcement.

Figure 3.9: Exchange Rate (Baht/U.S. Dollar) during 1981 – 2005



Source: Bank of Thailand

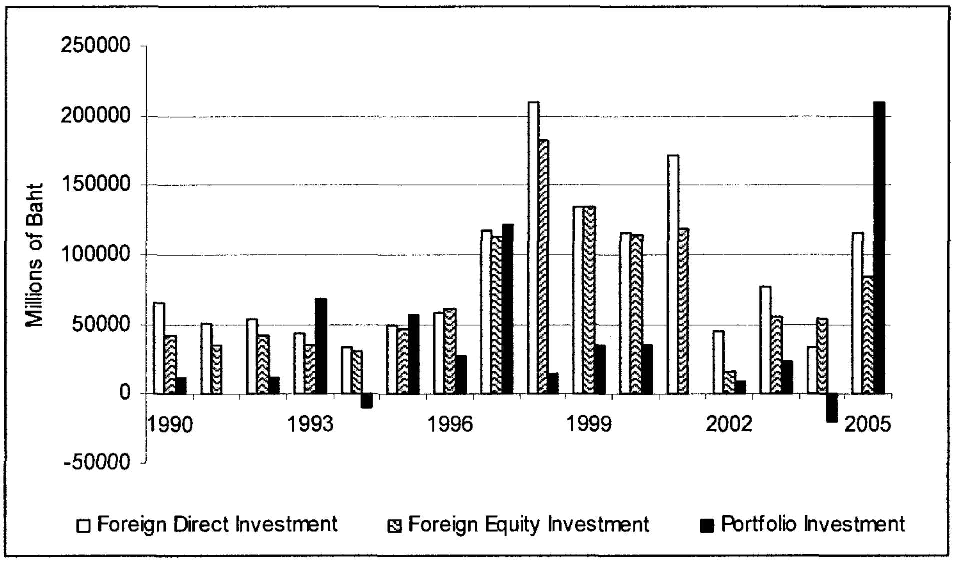
- *The Bankruptcy of Thai Commercial Banks*

Bad loans, especially the loan that banks and other financial institutions made to real estate developers, became the main problem that the Thai economy encountered. Due to the high interest rate, careless banking regulations, and the lack of considering domestic demand, the excess supply of real estates including luxurious condominiums, hotels, and apartments was prevalent during the prosperous time period. These real estates failed to sell during the slack time and their developers defaulted on loans. As a result, both commercial banks and other financial institutions faced the increase of non – performance loans (NPLs) which finally led to their bankruptcy.

- *The Investment – Saving Gaps*

According to the national policy of opening up the domestic capital market in the early 1990's, the Bangkok International Banking Facility (BIBF) was founded in order to close the gap between investment and saving, and to support Thailand as the center of the capital market in the South – East Asian region. BIBF allowed domestic investors to access to cheap offshore funds. This measure enhanced the liquidity in domestic financial market, since domestic investors were able to borrow freely without close monitoring by the central bank. Moreover, the influxes of foreign capitals were in the forms of portfolio investments, bank loans and short – term loans, rather than direct investments (See figure 3.10). (As a result, not only the amount of NPLs significantly increased, the amount of portfolio investment also rose much faster than that of direct investment.)

Figure 3.10: Foreign Direct Investment, Foreign Equity Investment , and Portfolio Investment in Thailand



Source: Bank of Thailand

After the country changed to the managed float system on July 2nd, 1997, the Thai economy encountered the problem of economic instability. The increased amount of NPLs was the main problem that affected the credit of commercial banks and other financial institutions. The lack of careful regulations in monitoring the financial institutions led to the suspension of 56 troubled financial and securities companies. Several measures were used to bring back the confidence of investors. However, these measures seemed to be ineffective when foreign investors, especially the short – term lenders, tried to shift their money back and the domestic financial market began to crumble due to the lack of liquidity. Finally, in August 1997, Thailand decided to receive a rescued loan worth approximately 20 billion of U.S. dollars from IMF and Japan in order to stabilize the situation. However, the loans came with several conditions that Thailand had to strictly obey. On the fiscal side, the country had to maintain a fiscal balance budget, increase value-added tax from 7% to 10% by August 1997, and restrict government spending to essential purposes such as education, public health, infrastructure and social welfare. On the monetary side, the country had to control the money supply in order to limit the 1997 inflation rate in the range of 8 – 9 percent, stabilize the Baht value, and retain the international reserves equal to 3.5 months' import value. Finally, on the real side, the country had to maintain annual economic growth at the rate of 3 – 4 percent for both 1997 and 1998, reduce the current deficit from 5% in 1997 to 3% of GDP in 1998, restructure the finance and banking sectors by following the advices from IMF and other foreign financial institutions so as to alleviate the burden on the government, and bring the confidence and trust from both domestic and international investors back to these industries.

Although these IMF structural adjustment policies helped Thailand to survive the 1997 financial crisis, there were several reasons to claim that the IMF package was inadequate for solving the problems. In other words, IMF policies will do nothing to enhance the sustainable development of the Thai economy in a long run. Firstly, instead of focusing on the mismanagement of export – led growth strategies and the lack of thorough banking regulations that allowed Thailand to open her own economy to the world when she was not ready, the IMF structural adjustment program by contrast made the Thai economy more dependent on foreign sectors. The policies such as maintaining high interest rate, keeping the wage rate low, reducing the tariff and eliminating the restrictions on foreign ownership of financial and non – financial businesses were used in order to attract more funds and investment from abroad. Secondly, IMF still believed that export promotion was the suitable policy for stimulating the economy. However, it concentrated only on enhancing the ability to produce more goods and services in order to generate more foreign exchange, but ignoring to consider the demand side. As a result, overproduction and export price reduction were the main problems to concern. Finally, the objective of offered loan from IMF was successful only to guarantee that export firms, financial institutions and commercial banks were enabled to pay back their international debts. These loans were used to protect the benefit of some interest groups that were the riches and had immense power in the Thai society rather than benefiting overall population. The policies such as cutting spending on social program, limiting the growth rate and maintaining low wage rate were pursued, even though they have worsened the poverty rate, the unemployment rate, and the working and living conditions for the majority of Thai's citizens

Despite the unsuitable IMF policies, since 1999 the Thai economy began to recover from the 1997 financial crisis. However, the recovery was quite slow due to the chronic effects of bad loans, the weakness of Thai institutions, and the slow growth rate of the global economy. The survived businesses started to enlarge but their industrial size was smaller than it was in 1996. Moreover, the slow expansion of export due to the depreciation of the Baht had somewhat alleviated the problem of trade deficits.

The lesson from the crisis during the first year of the eighth national plan showed that the main cause of the chaos came from the accumulated structural problems that reflected the irresponsibility and inactivity of Thai authorities and policymakers in creating the measures to deal with these problems. The lack of personnel and legal mechanisms, poor institutions, inappropriate restrictions and the obsolescence of working procedures made the Thai economy unable to adjust itself to support the challenge of globalization and new economic environments. Moreover, the existence of adverse factors such as the problem of foreign short – term debts, unproductive private investment, the weak production structure that relied heavily on foreign technology, the lack of monitoring law and regulations when the financial market was freely opened, the centralized economic and political systems as well as the ineffectiveness and mismanagement of public sectors, and finally the alteration of consumer behavior toward materialism and luxurious goods, were the problems that required urgent attention.

As a result, the eighth national plan was modified in 1999 so as to deal with these economic problems. Four additional strategies were included:

- The adjustment of overall economic targets in line with the change in economic situations by concentrating on the establishment of the confidence in financial sectors, strictly follow the fiscal disciplines and the encouragement of the economic stability as well as the development of economic warning system for unanticipated events,

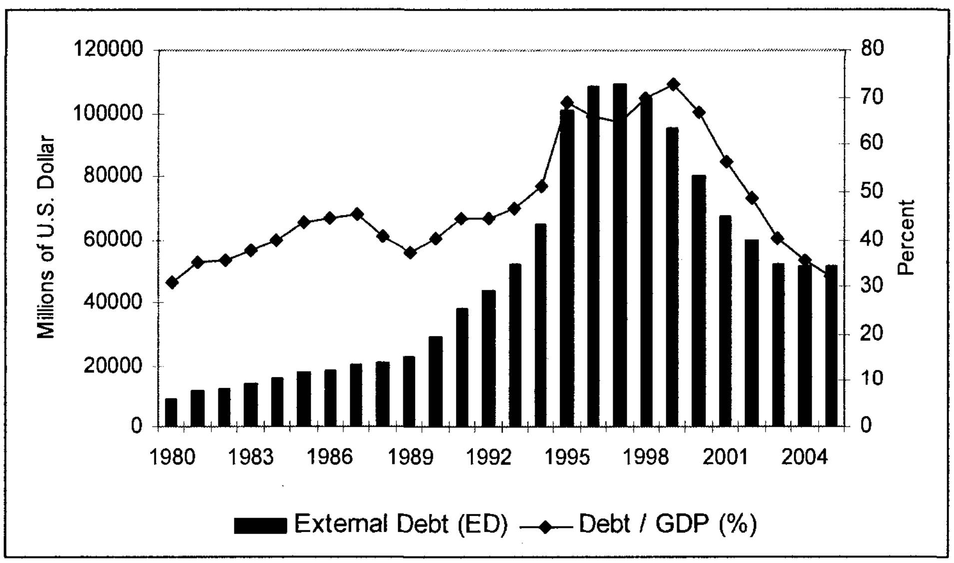
- The alleviating measures for the adverse effects of economic crisis on the development of human and the Thai society by focusing on the unemployment problem in both rural and urban areas, the reduction of social problems as well as the development of management mechanism in order to pave the way for the future social, educational, public health and social - welfare program reformations,
- The economic restructuring by emphasizing the productivity improvement in both agricultural and manufacturing sectors coupled with the balance between the production and the environmental preservation, an increase of the potential in service sectors to foster sources of national income and employment, the development of national science and technology, and infrastructures as well as an increase of private participation in public activities such as the determination of both qualities and quantities of education system, the construction of basic infrastructures, tax reforms, and etc.,
- Finally, the restructuring of public operation and management by focusing on an improvement in bureaucratic operations and budgetary mechanisms, an efficient decentralization of power to the provincial areas, a promotion of private participation in every level of government activities, and the establishment of social and economic development committees as well as the construction of economic and tracking indicators for measuring the level of development.

In conclusion, the five years of the eighth development plan was the struggling years for the Thai economy to survive and to gradually recover from the financial crisis. Parts of the recovery came from both IMF measures and the results of the eighth development plan. The growth rate of the country slowly returned to the acceptable level despite lingering problems.

3.1.3 The Current Situation under the Ninth Economic and Social Development Plan and the Prospect for the Future of the Thai Economy

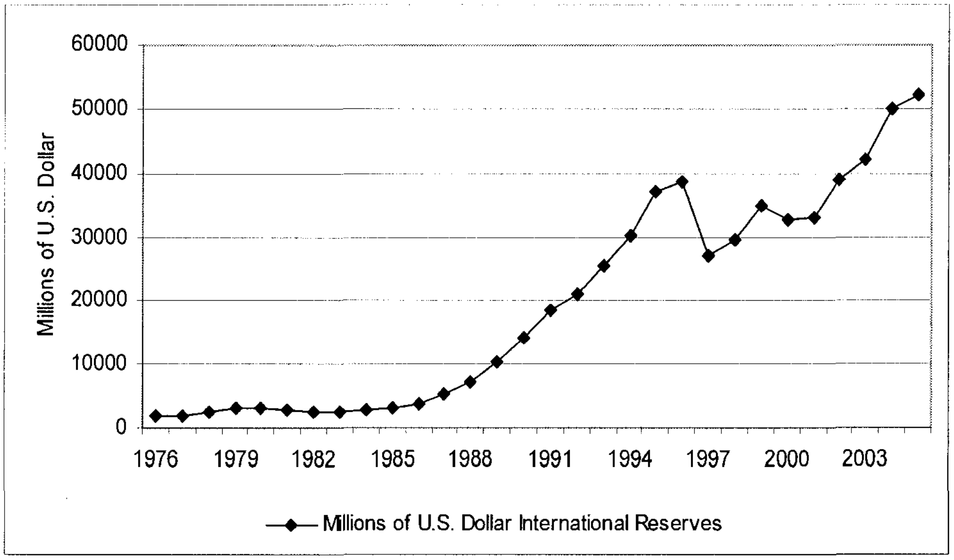
After the period of financial crisis, the Thai economy shows a strong trend of recovery. The growth rate was returned to the average rate of around 5 percent. External debts were reduced from 109,276 million U.S. dollars at the end of 1997 to 59,459 million U.S. dollars at the end of 2002. Official reserves rose sharply from the lowest level of 1,914.9 million U.S. dollars at the peak of financial crisis in August 1997 to 42,147.7 million U.S. dollars in 2003 (approximately 138 percent of short - term external debt) and exports grew faster than GDP.

Figure 3.11: Thailand External Debt and Its Percentage to GDP (Debt/GDP)



Source: Bank of Thailand

Figure 3.12: International Reserves of Thailand



Source: Bank of Thailand

Moreover, the IMF loans approved to Thailand during the 1997 financial crisis were fully repaid in July 2003, faster than the original schedule by a year. Most economists at that time believed that this was attributable to the success of governmental policies under the Prime Minister Thaksin Shinawatra which boosted the economy by enhancing domestic demand via the increase of government spending and private consumption expenditures.

Nevertheless, the experiences that the country has gone through in the past four decades revealed some weaknesses and some strengths in the Thai economy. On one hand, the main weaknesses of the development strategies came from political, economic, and the bureaucratic systems that were centralized and inefficient. The outdated laws and regulations, the impotent educational system, poor scientific and technological bases, inefficient management skills, uneven distribution of income, and the deterioration of natural resources and environments are the main problems which created more conflicts in the Thai society. Besides, the increase of poverty level and unemployment rate has been the problems that were handed down from the 1997 crisis. Moreover, the tide of materialism which alters the consumer behavior and attitudes toward a more luxurious life style and hedonism made the country suffer from a lack of moralities and ethics. Consequently, the declining rates of saving and investment and the trade deficits were inescapable problems which obstructed the sustainable growth of the Thai economy in the long run, since most people tend to spend almost of their entire earnings in unproductive activities and luxurious imports rather than saving for the future.

On the other hand, the strength of Thailand relies on the current constitution which lays down the basic foundation for the social and political reformation that allows for more participation of the majorities in every step of development as well as the improvement of public management and the decentralization of power. Furthermore, the potential of Thailand as the world's kitchen, the wide varieties of agricultural products, the beautiful sceneries, low – cost traveling areas, and the prominence of the Thai culture are the strong points that the country should promote as the leading sectors that would have the potential to generate foreign reserves.

Under the present world situation, the tide of globalization represents both chances and hurdles for the country's development. The rapid change and the more complicated system of the world economy as well as the interrelation among countries lead to the adaptation of new economic rules in order to support the expansion of international trade and investments. Moreover, the new era of trades and investment moves toward the use of highly technological production as the base of development. Thus, it is necessary that Thailand adjusts herself both in developing a flexible and security system in line with the rapid changes of economic situations and human capitals in order to maintain her competitive status in the world economy.

By taking all the strengths, weaknesses, and opportunities into accounts, the current ninth economic and social development plan (2002 - 2006) invited His Majesty the King' s philosophy of a "self - sufficient economy" as the leading idea for the country's development. At the personal level, self - sufficiency means that people should live on what they have, what they own, and should abstain from a luxurious and an extravagant life. This concept of self – sufficiency can be applied to the broader level in the sense that the communities, states, region or the country can produce the amounts of goods and services that are enough for raising themselves without depending on uncontrollable factors that do not belong to them. As a result, the country not only reduces the dependency on the foreign factors, but also leads to the balance of qualitative and quantitative development under the tide of globalization. Therefore, the ninth development plan is the strategic plan that determines intermediate targets which corresponds with the visions of long – run development. Moreover, the plan still follows the ideas of the eighth plan that human being is the center of development and every parts of the society including economic and political systems, and the environment is supposed to develop concomitantly. The four main objectives and targets of the ninth development plan include:

- To revive the strength and the stability of the Thai economy by setting the targets of economic growth on average at 4 – 5 percent per year so as to create new jobs at about 230,000 positions per year, keeping the inflation at the rate lower than 3 percent per year, maintaining the surplus of current account at 1

– 2 percent of GDP and keeping the foreign reserves at the suitable level (about 3.5 months of import value) in order to bring back the confidence of investors

- To provide the basis for sustainable and self – sufficient development as well as the reduction of dependency on foreign technology and factors of productions by controlling the reproductive rate of Thai population at the appropriate rate (1 – 1.2 percent per year), improving both private and public health services, extending compulsory schooling from 6 to 9 years, and encouraging more participation of local community to be responsible for natural resources and environments
- To improve the efficiency of management and administration in both public and private sectors and create both economic and political systems that promote transparency and easy to monitor as well as the encouragement of private participation in every step of development by eliminating corruptions and other fraudulent activities.
- To solve the problem of poverty and increase the potential and opportunities for the Thai people to rely on their own abilities and efforts by focusing on the policies that give priorities to the underprivileged groups as well as the reduction of the poor to the level below 12 percent of total population by the end of 2006.

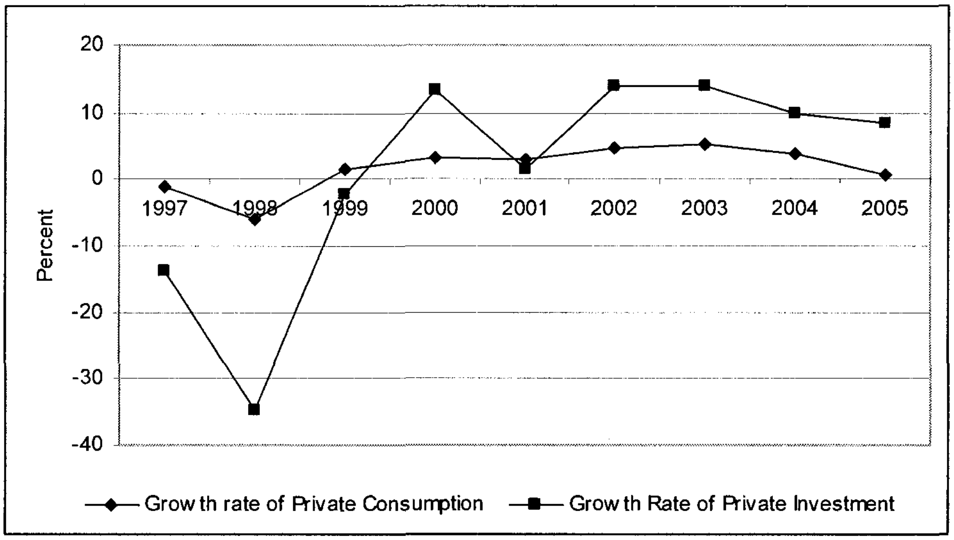
Not only does the ninth development plan determine the overall targets and objectives for Thailand, it also sets up eight development strategies for specific sectors and regions. The eight strategies can be divided into three groups and the details of each strategy are summarized in table 3.1

The high performance of the Thai economy during the first three year of the ninth development (2002 - 2004) plan seemed to guarantee the success of the plan that helped the Thai economy to recover from the 1997 financial crisis, however the growth rate of the country in 2005, though remained strong, was lower than that of the previous year due to the tsunami at the end of 2004. Moreover, the unrest in the south, the chronicle drought problem, the avian flu, and the persistence of high oil prices were some of the unexpected events that would have adverse effects on the growth of the Thai economy.

The main source of economic growth came from strong domestic consumption and export. Private consumption rose at a rate of 0.6 percent in 2005 which was lower than the 3.9 percent in 2004. The slower growth rate of private consumption was the results of high oil prices, inflation, and rising interest rate. Private investment grew at a moderate rate of 8.5 percent in 2005 comparing with the 9.9 percent in 2004. The decelerating trend of private investment was a consequence of a reduction in construction investment and real estates.

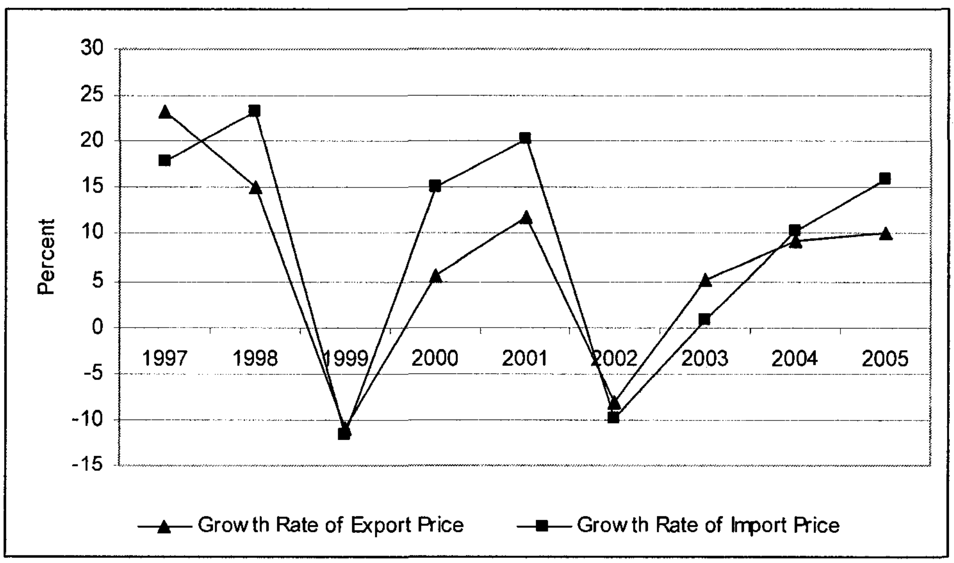
On the fiscal side, the government pursued a balanced budget policy in 2005 and the increase in government revenue came from the continuous rise in tax revenue especially in corporate income and value added taxes. As a result, the government budget showed a surplus of 16.8 billion baht. On the monetary side, the Bank of Thailand still pursued a tightening monetary policies which caused most commercial banks increased deposits and lending rates. Besides, the growth rate of export value at 10.2 percent and the continuous expansion of import value at 15.9 percent in 2005 turned the trade balance from surplus to a deficit of 339,716.01 million of U.S. dollars.

Figure 3.13: Growth Rate of Private Consumption and Investment of Thailand



Source: Bank of Thailand

Figure 3.14: Growth Rate of Export and Import Prices of Thailand



Source: Bank of Thailand

Table 3.1: The Eight Development Strategies of the Ninth National Development Plan

Group 1: The establishment of effective administration and management system for every part of Thai Society
Strategy #1: A better system for administration and management - The adjustment of public administration and management in order to achieve a system that is efficient and transparent - The transparent decentralization of duties and responsibilities to the local government - The protection and extermination of corruptive and fraudulent activities - The development of detecting and evaluating mechanism of government operations - The improvement of private administration and management - The family and community reinforcement
Group 2: The reinforcement of the Thai basis for development
Strategy #2: The development of human resources and social protection - An improvement of manpower in order to support the fast change of world economy - The adjustment of social security system - The development of job training programs - The establishment of preventive measures and remedies for the problem of drugs and crimes - The encouragement of families, schools, temples, communities and other social organization as the center of development **Strategy #3: The restructuring for sustainable development in both rural and urban areas** - The reinforcement of communities and the development of livable towns and cities - The correction for the poverty problem in both urban and rural areas by allowing the participation from every parties in the society **Strategy #4: The management and administration system for natural resources and environments** - The improvement of management and administration system for natural resources and environments - The preservation and restoration of natural resources - The preservation and restoration of community environments, arts, cultures, and traveling areas - The efficient reduction of pollution problems

Table 3.1 (Continued)

Group 3: The balanced and the self – sufficient development for the Thai economy
Strategy #5: Overall management procedures for Thai economy - The achievement of monetary policy in order to establish the immunization to the economic crisis, and fair distribution of income - The conduction of fiscal policy in order to build the stability of fiscal status, and the fair distribution of prosperity - The preparedness of domestic economy and society to the changes of world situations **Strategy #6: The improvement of the capability to compete in the world market** - The restructuring of trade and manufacturing sectors - An increase of standards and qualities of infrastructures - An improvement of national productivity - The development of local economy by supporting the small and medium – sized local manufacturing sectors and cooperative system - Encouragement of international cooperation via bilateral and multilateral agreements - Concentration on the potential trade and service sectors that create more jobs and income distribution as the main priorities **Strategy #7: The reinforcement of national science and technology** - The development of applied technology - Human development in the field of science and technology - The improvement of telecommunication technology - The development of science and technology that aims at the improvement of productivity
The conversion of the strategic plan into the operating plan
Strategy #8: The comprehension of the ninth development plan and the development of its body of knowledge - The establishment of interrelated plans in every level including the set up of general plan and operating plans which allow for the participation of every party in the society - The restructuring of governmental headquarter in supporting the operating units - The construction of indicator and monitoring tools for evaluating the achievement of the plan

For sectoral details, High prices of major crops due to drought and flood in Thailand made farm income grew at 20.2 percent in 2005 in spite of decreases in the production of major crops from the 2004 level. In the meantime, the growth rate of manufacturing production in 2005 decreased from the 2004 level. Both export production and the index of capacity utilization continued to increase. Moreover, the service sector in 2005 grew at the lower rate than that of 2004 due to the impact of tsunami and the unrest in three southernmost provinces of Thailand. The overall picture of the Thai economy in 2005 was quite stable. The core inflation, unemployment and the public debt as percentage of GDP were quite low and confined in the expected ranges. Exchange rate narrowly fluctuated between 39 – 41 baht per U.S. dollar and the international reserves still remained at a high level. The similar situations were true for the Thai economy as a whole until the 3rd quarter of 2006. Nevertheless, the political situation in Thailand seemed to contrast with the economic situation. For more than 5 years since Thaksin Shinawatra became the Prime Minister of Thailand, his government was corrupt and has granted privileges to particular industries for tax exemption and deduction, limiting competition in some activities associated with his own businesses, setting up fake companies in order to take advantage from bidding governmental projects, privatizing the state enterprises and rushing to open the free trade areas by ignoring the facts that the Thai economy is not well prepared, and so on. These fraudulent policies and activities facilitated his family, followers, and the closely – related interest groups to generate wealth and exploit national wealth regardless of adverse impacts on the economy as a whole. Moreover, his initiated policies employed to maintain the peace and securities in the three southernmost provinces of Thailand such as the division of the country's areas into separate zones according to the cooperating level with his government so as to determine the amount of budget and developing projects in each zone, the measure using violence in confronting with the terrorists, and etc. have caused conflicts and eroded unity of the Thai people as never before in history. With this reason, The Democratic Reform Council under Constitutional Monarchy (CDRM) by Gen. Sonthi Boonyarataglin declared itself on September 20, 2006 in control and declared martial law nationwide. The objective of the reformation is to suspend the corrupted administration of the Thaksin government by emphasizing that this operation is reformation not revolution. The council does not aim at taking over the Thai government permanently and it will give the power back to the Thai people as soon as possible. Under the time of writing, the council is in the process of selecting a new Prime Minister and examining the securities and assets of dishonest politicians.

At the present, it is difficult to say whether the reformation by CDRM will improve or aggravate the development of the Thai economy. All that I know for certain is that if the political situation has eased positively, the Thai economy will expect to return to her economic growth path, since other factors which affect the economy in the previous period such as the higher growth rate of world economy, the moderate oil prices, an amelioration of supply side risks (drought, tsunami, and avian flue), and the execution of investment projects with well – defined work plans are all anticipated to adjust in the way that supports the growth of Thailand.

Therefore, the multisectoral macroeconomic model of Thailand in this study is constructed by relying on all of these facts and conditions of the Thai economy. The detailed information on the industrial sectors in both prices and outputs is possibly captured by the input – output table and the macroeconomic time series variables of Thailand, while the political situation and the unusual movement of the data are seized by the dummy variables and time trend. The sources of data and the structure of the multisectoral macroeconomic model including the general functional form for each equation, and the simulation process are discussed in the next chapter.

Chapter IV

The Data Requirement and the Structure of a Multisectoral Model for The Thai Economy (MUTE)

This chapter reviews the sources of data used in formulating the model and the structure of multisectoral model for the Thai economy (MUTE). The model still follows the fundamental pattern of the interdyme model by dividing the main structure into the following three interrelated blocks:

- *Real Side* which computes the final demand components and sectoral outputs of the Thai economy,
- *Price – Income Side* which calculates the prices of sectoral outputs and the four value added components (wages and salaries, operating surplus, depreciation, and net indirect taxes), and
- *The Accountant* which is used to close the model with the set of identity equations by gathering data from real side and price income side to compute the macroeconomic variables.

The chapter ends with the new contribution of this study in order to improve the quality of multisectoral model of Thailand.

4.1 Sources of Data

The main objective of multisectoral model is to verify the sectoral details for each industry both in historical simulation and to forecasts the future of the Thai economy. Furthermore, the regression techniques are employed to determine the values of the major parameters. Therefore two kinds of data that are definitely required to formulate the model are the input – output table, and the time series data for the aggregate economy and the sectoral details.

The I – O table of Thailand was published by the National Economic and Social Development Board (NESDB) in five connected tables, including:

- flows in purchaser prices,
- wholesale margins on these flows,
- retail margins on these flows,
- transportation - cost margins on these flows, and
- import margins on these flows

The input – output table in producer - price format can be computed from subtracting all margin tables from the flows of the purchaser price table. Also, the total sales and sectoral prices for each industry are computed from the input – output table via the identity equation (1.1) and (1.4), respectively. Because the table was released every five year since 1975, the gross output, the final demand components, and the parts of value added in the intervening periods are calculated by using the aggregate data from the published national account as the guideline in order to guarantee the consistency between sectoral output and the total output. Currently, the latest version is the 2000 benchmark I – O table. Moreover, the tables are available in various dimensions such as 16 ×16, 26 × 26, 58 × 58, and 180 × 180 sectors and can comfortably be downloaded from the website http://www.nesdb.go.th/.

The time series data for the Thai economy and the data on national accounts were annually published by both NESDB and the Bank of Thailand (BOT). However, the downloadable tables in excel format can be easily obtained via the website http://www.bot.or.th/. Some series such as GDP, GDP per Capita, and etc. are available from 1951 to the current period, but some classified series such as trade indices, capacity utilizations, and so on have different historical periods. The data are available in monthly, quarterly, and yearly format and the whole series can be categorized into 6 groups, including: 1) Money and Banking, 2) Public Finance, 3) Foreign Trade and Balance of Payments, 4) Real Sectors and Price indexes[1], 5) Price of Gold and the Rate of Exchanges, and 6) Recent Development Charts.

The data on economic activities of the population including detailed information on unemployment and employment rate, some characteristics of labor forces, labor participation rate and the traits of economically inactive persons can be obtained from the Labor Force Survey (LFS)[2] initiated by the National Statistic Office since 1963. Currently, four rounds of surveys per year have been undertaken for the whole kingdom; 1st round in February, 2nd round in May, 3rd round in August, and the final round in November. Moreover, beginning in 1994, the sample size of survey is enlarged in order to take into account the data at provincial level. The online data dissemination including summary statistical information, definition, concept, and data dictionary can be easily downloaded from the website http://portal.nso.go.th/otherWS-world-context-root/index.jsp.

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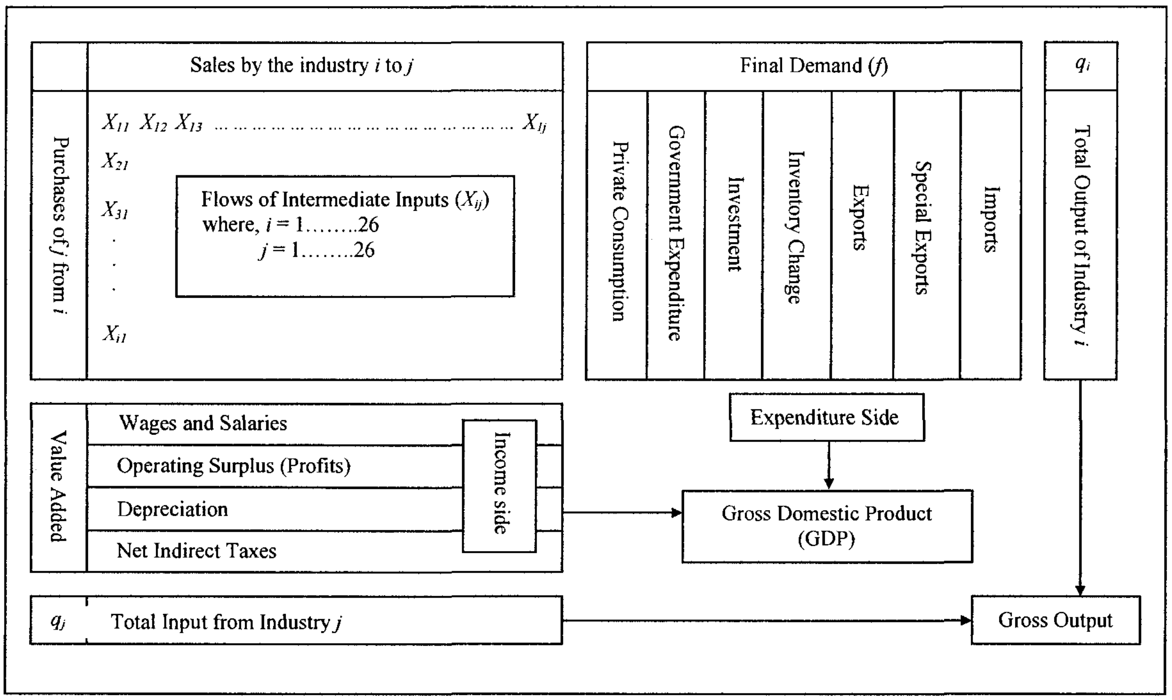
[1] The latest based year for prices indexes is computed by using the price of the year 2000. However, the historical series with different based year can be obtained from the economic and financial statistics which are published quarterly. The most recent publication at the time of writing is volume 46, no. 2, for the second quarter of 2006.

[2] The survey overlays the total number of civilian which are non – institutional population living in private households and special households (persons living in groups) but not include diplomatic personnel and their families.

4.2 The Structure of a Multisectoral Model for the Thai Economy (MUTE)

Like all interdyme – type model, the foundation of the MUTE model depends on the 26 sector input – output table of Thailand. The I – O table as shown in figure 4.1 displays the interactions among the 26 local industries[3]: 4 final – payment sectors (wages and salaries, profits, depreciation, and net indirect taxes), and 7 categories of final demand (private consumption, government expenditure, investment, inventory change, exports, special exports and imports).

Figure 4.1: The Structure of Input – Output of Thailand



Source: National Economic and Social Development Board (NESDB)

[3] The input – output 26 local industries includes: (1) Crops, (2) Livestock, (3) Forestry (4) Fishery (5) Mining and Quarrying, (6) Food Manufacturing, (7) Beverages and Tobacco Products, (8) Textile Industry, (9) Paper Products and Printings, (10) Chemical Industry, (11) Petroleum Refineries, (12) Rubber and Plastic Products, (13) Non – Metallic Products, (14) Basic Metal, (15) Fabricated Metal Products, (16) Machinery, (17) Other Manufacturing, (18) Electricity and Water Works, (19) Construction, (20) Trade, (21) Restaurants and Hotels, (22) Transportation and Communication, (23) Banking and Insurance, (24) Real Estate, (25) Services, and (26) Unclassified

Each row in figure 4.1 accounts for the sales by industry named at the left - hand side (industry *i*) to the industries at the top of the table (all industries *j*) and to the seven categories of final demand (*f*), while each column represents the purchases or inputs of the industries at the top of the table (industry *j*) from the industries identified at the left - hand side of the table (industries *i*). The final payment by industries to employees (wages and salaries), holders of capital (profits and depreciation), and government (net indirect taxes) are shown in lower left corner matrix of value added components. As a result, the sum of all items in each column is equal to the total input or purchases (q_j) by industry named at the top of the table (industry *j*). By the same token, the summation of all entries in each row represents the total output (q_i) of the industries identified at the left side of the table (industry i). Finally, the addition of all q_j in the last row or all q_i in the last column of figure 4.1 will yield the gross output of the economy.

The I – O table connects with the national income account via the components of value added and final demand. From figure 4.1, the following two methods are employed to calculate the Gross Domestic Product (GDP):

- On the expenditure side, the summation of all final demand components including private consumption, government expenditure, investment, inventory change, exports, special exports, and imports, is equal to GDP.
- On the income side, the addition of all value added components, including wage and salaries, profits, depreciation, and net indirect taxes, also yields GDP.

According to macroeconomic theory, if the statistical discrepancies do not exist, both methods of computing GDP will give the same result.

From figure 4.1, each element of the direct requirement matrix, or sometimes called the input – output coefficient matrix A (denoted by $a_{i,j}$) of equation (1.1) and (1.4), can be computed by the formula:

$$a_{i,j} = \frac{X_{i,j}}{q_j} \qquad (4.1)^4$$

where, $a_{i,j}$ = input – output coefficient

$X_{i,j}$ = the intermediate inputs that industry i supply to industry j

q_j = total input requirement of industry j

By following the construction of the interdyme – type model, MUTE also consists of three main parts: 1) the real side or production side, 2) the price – income side, and 3) the accountant.

4.2.1 The Real Side (or the Production Side)

As mentioned above, the objective of the real side is to estimate the final demand components and the sectorial output for each industry. The sectorial output can be computed from the Leontief equation (equation 1.1):

$$q = A * q + f \qquad (1.1)$$

Equation (1.1) implies that at least, the quantity of the produced output must be enough to serve its use as intermediate inputs and final demands. All variables in equation (1.1) have subscript t in order to emphasize that all variables, especially the A matrix, vary over time, or we can write equation (1.1) as:

[4] It is worth to notice that since each I – O coefficient is smaller than 1 and the total input is equal to total output in each producing unit, thus the sum of I – O coefficients and value added coefficients in each column of the I/O coefficient table is equal to 1.0.

$$q_t = A_t * q_t + f_t \tag{4.2}$$

The problem from this approach is that the I – O table is published every fifth year since 1975. Thus, in order to compute the value of input – output coefficient for the intervening and forecasting periods, the RAS or bi – proportional technique developed by Stone (1961) and Stone and Brown (1962) is employed in the MUTE model. The RAS technique is the method used to generate the coefficient matrix in a target year when only a prior year table, total intermediate industry inputs and outputs, and total industry outputs in the target year are known. The RAS method is based on the following equation:

$$A_{(t+1)} = \hat{r}A_{(t)}\hat{s} \tag{4.3}$$

where, $\hat{r}$ and $\hat{s}$ are treated as multipliers that implicitly transform an initial matrix to a target matrix, and subscripts t and $t+1$ represent the base year and the target year, respectively. Equation (4.3) can be rewritten in the general form as:

$$A_{(t+1)} = f\left(A_{(t)}, u_{(t+1)}, v_{(t+1)}, X_{(t+1)}\right) \tag{4.4}$$

where, $u_{(t+1)}$ = the vector of total intermediate outputs in period $t+1$

$v_{(t+1)}$ = the vector of total intermediate inputs in period $t+1$

$X_{(t+1)}$ = the vector of total output in period $t+1$

Assuming that the matrices $u_{(t+1)}$, $v_{(t+1)}$, *and* $X_{(t+1)}$ are known, $\hat{r}$ and $\hat{s}$ can be computed by the following iterative procedure:

Step 1): By using matrix $A_{(t)}$ and vector $X_{(t+1)}$ to compute an estimated vector of intermediate outputs (u_1) as:

$$u_1 = A_{(t)}X_{(t+1)} \tag{4.5}$$

Equation (4.5) implies that (u_1) is gradually adjusted to the observed value $u_{(t+1)}$ through the adjustment of observed matrix $A_{(t)}$.

Step 2): A new matrix of A_1 can be obtained via the formula:

$$A_1 = r_1 A_{(t)} \tag{4.6}$$

$$r_1 = \hat{u}_{(t+1)} \hat{u}_1^{-1} \tag{4.7}$$

where, $\hat{u}_{(t+1)}$ and $\hat{u}_{(1)}$ are the diagonal matrices of $u_{(t+1)}$ and u_1, respectively, and the superscript (– 1) denotes the inverse of the matrix.

Step 3): By using the computed matrix A_1 in Step 2), the new estimation of intermediate input vector (v_1) and further adjustment of matrix A_1 to A_2 can be obtained from:

$$v_1 = \hat{X}_{(t+1)} A_1^T i \tag{4.8}$$

$$A_2 = A_1 s_1 \tag{4.9}$$

$$s_1 = \hat{v}_{(t+1)} \hat{v}_1^{-1} \tag{4.10}$$

where, superscript T denotes the transpose of the matrix and (i) is a vector of 1 in all elements. The first iteration ends here and the new round of iterative process begins again by substituting the computed A_2 in Step 3) into Equation (4.5) of Step 1), which yields:

$$u_2 = A_2 X_{(t+1)} \tag{4.11}$$

Step 4): The overall process is complete when the conversions of vectors r_k and s_k are achieved (the value of r_k and s_k in the final iteration are slightly different from the previous iteration). The values of vectors r_k and s_k at the n iterative process can be computed via the formula:

$$r = r_n \times \cdots \times r_2 \times r_1 \quad \text{and} \quad s = s_n \times \cdots \times s_2 \times s_1 \tag{4.12}$$

Finally, the result for the new input – output coefficient matrix $A_{(t+1)}$ can be calculated by substituting equation (4.12) into equation (4.3).

According to Randall and Murray, the input – output coefficient matrix derived from the RAS procedure has some desirable properties. Firstly, the derived target matrix is as close as possible to the prior matrix in the sense that the structure of the prior is assimilated into the target matrix. Secondly, the pre and post – multiplicative matrices (r_k and s_k) can be interpreted in economic terms as Stone's (1962), vector (r) is defined as a measure of the "substitution effect" in the way that the input of industry i substitutes other inputs, or is substituted by them. The vector (s) can be defined as the vector that measures the "fabrication effect" in the sense that in the production of goods j, industry j has reduced (expanded) its intermediate inputs use per unit of total output. Besides, under Leontief (1941)'s definition, vector (r) is treated as a measure of the rising productivity of input i for all industries, and vector s is defined as a measure of the joint effects between an increase in productivity of industry j and a decrease of its investment rate. Thirdly, the elements in the derived input – output coefficient matrix by the RAS procedure will have the same signs as those in the original matrix and RAS guarantees the non – negative computed coefficients. Finally, the RAS approach is quite easy to understand and the method itself is not complicated to calculate.

The second element in equation (1.1) is the final demand components. In the MUTE model, final demands can be separated into seven parts, namely, private consumptions, government expenditures, investments, exports, special exports[5], and imports. Moreover, the behavioral equations for each final demand component are

[5] Generally, special exports are the non – commercial goods such as export – related transportation, insurance fees, expenditures from international organizations, and other non – specified final demands from abroad.

estimated by the regression technique and the independent variables in each equation are determined by the economic theory. The plans and the details for estimating each final demand component are as follows:

- *The Equation for the Private Consumption Expenditure (pce)*

The possible independent variables inserted in order to explain the variation in private consumption are shown in the following function:

$$pce_t^i = f[y_t / P_t, \Delta(y_t / P_t), T, (P_t^i / P_t^c), (P_t^i / P_t^s), Dummy] \qquad (4.13)$$

where,

pce_t^i	=	private consumption expenditures per capita for 26 goods ($i = 1 \ldots\ldots 26$)
y	=	nominal income
P	=	general price indexes
T	=	time trend
P_i/P_c	=	relative prices between own price and the prices of complementary goods
P_i/P_s	=	relative prices between own price and the prices of substituting goods
Dummy	=	the dummy variables which represent the unusual movement of *pce* data

Subscripts i, t and Δ denote the sector, the time period, and the change of particular variable from the previous time period, respectively. According to the available BOT database, the system of PCE of Thailand consists of 33 consumption goods and services[6].

[6] The 33 private consumption goods and services include: (1)Rice and Cereals, (2) Meat, (3) Fish, (4) Milk, Cheese and Eggs, (5) Oil and Fat, (6) Fruits and Vegetables, (7) Sugar, Preserves, and Confectionery, (8) Coffee, Tea, Cocoa, (9) Other foods, (10) Non – Alcoholic Beverages, (11) Alcoholic Beverages, (12) Tobacco, (13) Footwear, (14) Clothing, (15) Other Personal Effects, (16) Rent and Water Charges, (17) Fuel and Lights, (18) Furniture and Furnishing, (19) Household Equipment, (20) Domestic Services, (21)

However, These 33 commodity goods and services are transformed into the 26 input – output industries by using the information from the converter of the input – output classification table.

Furthermore, there are wide varieties of choices for the specific functional form for the *PCE* equation system such as the Linear Expenditure System (LES), the Almost Ideal Demand System (AIDS), the Perhaps Adequate Demand System (PADS), and so on. However the first choice for the *PCE* system in the MUTE model depends on which functional form generates the best fit to the data. This topic will be discussed again in chapter 5.

- *The Equation for the Investment Expenditure (ie)*

Based on economic theory, the investment expenditure function should be verified as:

$$ie_t^i = f[Rp_t^i, \Delta q_t^i, ir_t, K_{t-1}, Q_t, T, (M2_{t-1} / GDP_{t-1}), Dummy] \tag{4.14}$$

where,

ie_t^i	=	investment expenditures for 11 categories ($i = 1 \ldots\ldots 11$)
Rp_t^i	=	investment for the replacement purpose in sector i at time t
Δq_t^i	=	the change in output of sectors i from period t-1 to t
ir_t	=	interest rate in period t
K_{t-1}	=	capital stock in period t-1
Q_t	=	gross output in period t
T	=	time trend

Other Expenditure, (22) Personal Care, (23) Health Expenses, (24) Personal Transportation Equipment, (25) Operation of Personal Transportation, (26) Public Transportation, (27) Communication, (28) Entertainment, (29) Hotels, Restaurants, and Cafes, (30) Books, Newspapers, and Magazines, (31) Other Recreation, (32) Financial Services, and (33) Other Services.

$M2_{t-1}/GDP_{t-1}$ = the ratio between the broad definition of money supply and nominal GDP in period *t-1* which represents the financial condition

Dummy = the dummy variables capturing the unusual movement of *ie* data

The variables on the right hand side of equation (4.14) are chosen by relying on the investment theory and the concept of accelerator model. By following the classification of the TIDY model discussed in Chapter 3, investment expenditure in the MUTE model is categorized into 11 groups[7] which are then transformed into the 26 input – output sectors by using the definition of I – O and the relevant information. The underlying economic theory, the transformation process and the estimation method under this topic will be thoroughly discussed in Chapter 5.

- *The Equation for the Inventory Investment (ii)*

By following the estimated method for the inventory investment in the TIDY model, the general functional form of the inventory investment in the MUTE model is determined by:

$$ii_t^i = f[Q_t, FS_t^i, \Delta FS_t^i, T, Dummy] \tag{4.15}$$

where, ii_t^i = inventory investment for 26 sectors at time *t* ($i = 1......26$)

FS_t^i = final sales of sector *i* in period *t*

= the summation of consumption expenditure, investment,

---

[7] Gross investment is classified into 11 expenditures by sector including (1) Agricultural, (2) Mining and Quarrying, (3) Manufacturing, (4) Construction, (5) Electricity and Water Supply, (6) Transportation and Communication, (7) Wholesale and Retail Trade, (8) Banking, Insurance, and Real Estate, (9) Ownership of Dwelling, (10) Public Administration and Defense, and (11) Services.

government consumption and exports

ΔFS_t^i = the change of final sale from the previous period

T = time trend

$Dummy$ = the dummy variables capturing the unexpected movement of ii data

Because the amount of inventories in each sector is determined by subtracting the gross output in the focused industry from the amount actually sold in the market, the change in inventory can be explained by the final sales and the gross output of that industry.

- *The Equation for Imports* (im)

Owing to the international trade theory, the general functional form of import is determined by the following equation:

$$im_t^i = f[exr_t, PD_t^i, IMT_t^i, IMP_t^i, DD_t^i, T, Dummy] \tag{4.16}$$

where, im_t^i = imports for 26 sectors at time t ($i = 1......26$)

exr_t = the exchange rate at time t

PD_t^i = domestic price of good i at time t

IMT_t^i = import tax rate of good i at time t

IMP_t^i = import price for good i at time t

DD_t^i = domestic demand for good i at time t

T = time trend

$Dummy$ = the dummy variables capturing the unexpected movement of im data

The last two components of the final demand: government expenditure and exports are left as exogenous to the model, since government expenditure is a policy variable, while the estimation of export demand is beyond the scope of this study, since the data such as foreign demand, foreign export tax, exchange rate, and the interactions among the countries are obtained from the external sectors, which require the development of bilateral or multilateral trade models.

All final demand components are linked with the input – output table via equation (4.2), which can be rewritten in more disaggregated form as:

$$q_t = (A_t \times q_t) + pce_t + ie_t + ii_t + g_t + ex_t + es_t - im_t \tag{4.17}$$

where,

q_t	=	a vector of total output (26×1)
A_t	=	an input – output coefficient matrix (26×26)
pce_t	=	a vector of private consumption expenditure (26×1)
ie_t	=	a vector of investment expenditure (26×1)
ii_t	=	a vector of inventory change (26×1)
g_t	=	a vector of government expenditure (26×1)
ex_t	=	a vector of exports (26×1)
es_t	=	a vector of special exports (26×1)
im_t	=	a vector of imports (26×1)

The set of linear equations in (4.17) are solved for each sectorial output by calculating the Leontief's inverse matrix $(I - A)^{-1}$ and multiplying it with the vector of final demand components. This procedure is shown in equation (1.2).

Finally, after the calculation of the sectoral outputs, another main variable that needs to be explained under the real side is labor productivity, since it links the real side and the price – income side of the model via the wage equation. Moreover, labor productivity determines the level of aggregate economic growth and the sectoral employment. In the MUTE model, the labor productivity equation for each sector is estimated by:

$$LP_t^i = f[T, q_t^i, (K_t^i / L_t^i)] \tag{4.18}$$

where,

	T	=	time trend
	q_t^i	=	the output of sector i in period t
	LP_t^i	=	labor productivity of sector i in period t ($i = 1 \ldots\ldots 26$)
		=	$\frac{q_t^i}{L_t^i}$
	K_t^i / L_t^i	=	capital/labor ratio of sector i in period t

Equation (4.18) shows that labor productivity is simply defined as the sectoral output (q_t^i) per unit of worker employed in that sector (L_t^i), and the employment in each sector can be computed as the ratio between the solution from equation (4.17) and the predicted value of equation (4.18).

4.2.2 The Price – Income Side

As mentioned above, the main objectives of the price – income side are to calculate the prices for each of 26 input – output industries and estimate the value added components. The price for each input – output industry can be computed by equation (1.4):

$$p = p * A + v \tag{1.4}$$

Since the value added in the structure of the input – output table consists of 4 components (wages and salaries, profits, depreciation, and indirect taxes), equation (1.4) can be rewritten as:

$$p_t = (p_t \times A) + ws_t + pf_t + dep_t + itx_t \tag{4.19}$$

where, p_t = a (26×1) vector of price per unit of output of sector i at time t ($i = 1 \ldots\ldots 26$)

A = the input – output coefficient matrix (26×26)

ws_t = a vector of sectoral wages (26×1)

pf_t = a vector of sectoral profits (26×1)

dep_t = a vector of sectoral depreciation (26×1)

itx_t = a vector of sectoral net indirect taxes (26×1)

Each valued added component except the net indirect taxes is estimated by the regression technique for all 26 input – output industries. The net indirect taxes are treated as an exogenous variable to the MUTE model, since they are policy variables. The general functional form for each component and the details for the independent variables included in each equation are as follows:

- *The Equation for Wages*

In order to estimate the sectoral wages and maintain the consistency between sectoral and aggregate wage level, two sets of equation must be estimated: (1) the aggregate wage equation, and (2) the ratio of wage in a particular sector to the aggregate wage rate (This set of equations is treated as sectoral wage equations). The general functional forms for these two sets of equations are:

(1) Aggregate Wage Equation (W)

$$W_t = f[ALP_t, P_t, (unemp_t - \tilde{u}), Dummy, T] \qquad (4.20)$$

where,	W_t	=	the average annual wage in period t
	APL_t	=	the average rate of labor productivity in period t
		=	gross output (Q_t) / total labor force (L_t)
	P_t	=	price indexes at time t
	$unemp_t$	=	unemployment rate at time t
	$\tilde{u}$	=	natural rate of unemployment (theoretically, 3% per year)
	T	=	time trend
	$Dummy$	=	the dummy variables capturing the unexpected movement of W data

(2) Sectoral Wage Equation (ws_t)

$$\frac{ws_t^i}{W_t} = f\left[LP_t^i, (emp_t^i / temp_t), T, Dummy\right] \qquad (4.21)$$

where,	ws_t^i	=	the sectoral wage for sector i at time t ($i = 1......26$)
	LP_t^i	=	labor productivity of industry i in period t
	$\frac{emp_t^i}{temp_t}$	=	the ratio of employment in sectors i to the total employment in period t
	T	=	time trend
	$Dummy$	=	the dummy variables capturing the unexpected movement of (ws) data

Normally, equations (4.20) and (4.21) are estimated in logarithmic form. The time trend and the ratio of employment variables are included in the model in order to represent other effects such as labor contracts, law and regulation, and the demand condition in the labor market. The consistency between the sectorial wage and the aggregate wage can be reached by using the predicted ratio of the dependent variable from equation (4.21) to extract the sectoral wages from the estimated aggregate wage by equation (4.20).

- *The Equation for Sectoral Profits (pf_t)*

The sectoral profits (operating surplus) in this study can be determined by the following equation:

$$pf_t^i = f[q_t^i, \Delta q_t^i, ws_t^i, unemp_t, T, Dummy] \tag{4.22}$$

where,

pf_t^i	=	profit in sector i at time t ($i = 1......26$)
q_t^i	=	the sectoral output of sector i in period t
Δq_t^i	=	the change of sectoral output of sector i from the previous period
ws_t^i	=	the sectoral wage for sector i at time t
$unemp_t$	=	unemployment rate at time t
T	=	time trend
$Dummy$	=	the dummy variables capturing the unexpected movement of *(pf)* data

Generally, the primary factors that determine the level of profit in each industry are its demand condition and the costs of production, thus q_t^i and ws_t^i are included in equation (4.22) to represent these factors, respectively. The regressor Δq_t^i tries to verify the pro cyclical movement of the profit at the sectoral level, while the $unemp_t$ variable is included in the equation in order to capture the recession phase of the economic cycle. Finally, time trend and *Dummy* variables are represented to capture other effects such as political situation and social regulations on the level of profit that are unable to be explained by the demand condition and costs of production.

- *The Equation for Depreciation (dep_t)*

Depreciation is treated as the change in the market value of capital over time. Basically, it is computed by subtracting the market prices of capitals at the end of the period from their initial prices. Like other value added components, depreciation equations in the MUTE model are estimated for 26 input – output industries. The general functional form for each equation is determined by:

$$dep_t^i = f[K_{t-1}^i, T, Dummy] \tag{4.23}$$

where,

	dep_t^i	=	the value of depreciation of sector i in period t ($i = 1 \ldots\ldots 26$)
	K_t^i	=	capital stocks of sector i in period t
	T	=	time trend
	Dummy	=	the dummy variables capturing the unexpected movement of *(dep)* data

Equation (4.23) shows that depreciation is simply determined by the value of capital stocks in each sector. If equation (4.23) is fitted with the linear function, the coefficient of K_t^i can be interpreted as the depreciation rate. Besides, the time trend and the dummy variables are included in the equation in order to capture all other effects that have influences on the level of sectorial depreciation.

Ultimately, after all value added components are estimated, equation (4.19) can be used to solve for the prices of 26 input – output industries by finding the Leontief inverse matrix $(I - A)^{-1}$ and multiply it with the vector of value added:

$$p = (I - A)^{-1} * v \tag{4.24}$$

4.2.3 The Accountant

The final part of the MUTE model is the accountant. The accountant consists of the sets of identity equations from the National Accounts and some additional macroeconomic regression equations, which combine all variables from both the real side and the price – income side in order to calculate the macroeconomic variables (All identities and regression equations in the accountant block are summarized in Table 4.1).

Table 4.1: Summary of the Accountant in the MUTE Model

<table>
<tr><td>(1) The Computation of GDP by the Income Side:

+ Wages and Salaries
+ Operating Surplus
+ Depreciation
+Net Indirect Taxes

= Gross Domestic Product (GDP)</td><td>(2) The Computation of GDP by the Real Side:
+ Private Consumption Expenditure
+ General Government Consumption Expenditure
+ Change in Inventories
+ Exports of Goods and Services
- Imports of Goods and Services

= Gross Domestic Product (GDP)</td></tr>
<tr><td colspan="2">(2) – (1) = Statistical Discrepancy</td></tr>
<tr><td>(3) Personal Income and Saving:</td><td>+ Personal Income (estimated by regression)
- Direct Taxes and Transfer (exogenous variable)
= Personal Disposable Income (computed from eq. (4.29))
- Personal Saving (estimated by regression)
= Total Private Consumption Expenditure</td></tr>
</table>

Source: National Economic and Social Development Board (*NESDB*)

National Accounts of Thailand are currently a hybrid between the 1953 and 1968 editions of the international standard system of the National Accounts (SNA). The structure of National Income Accounts including product, income, expenditure, and capital are constructed under the 1953 SNA code, while the compilations of input – output tables, flow – of – funds account, and national balance sheets are determined by the 1968 SNA. Moreover, in the case of Thailand, the National Income Accounts are the core structures which are employed to construct other accounts such as input – output tables, flow – of – funds accounts, and the national balance sheets.

The main macroeconomic variable necessarily calculated in this block is the Gross Domestic Product (GDP). As mentioned above, GDP can be computed in two ways from the National Account Data. On the price – income side, GDP is the summation of all value added components, while GDP on the expenditure side can be obtained by adding up all final demand components. The relevancy between the price -

income side and the expenditure side can be reached by allowing the existence of statistical discrepancy (*sdisc*) in the model. Moreover, because both sides are constructed by using the value of the variables at their current prices, the GDP deflator equation is estimated by regression method so as to transform the nominal GDP (*ngdp*) into the real GDP (*rgdp*) by the formula:

$$rgdp = ngdp/(GDPdeflator/100) \tag{4.25}$$

By relying on the concept of the Phillips curve, the GDP deflator can be estimated by the following equation:

- *The Equation for Aggregate level of Inflation (inf_t)*

$$\left(\frac{gdpd_t - gdpd_{t-1}}{gdpd_{t-1}}\right) \times 100 = f[unemp_t, T, Dummy] \tag{4.26}$$

where, $gdpd_t$ = GDP deflator in period t

$unemp_t$ = unemployment rate at time t

T = time trend

$Dummy$ = the dummy variables capturing the unexpected movement of inflation data

In order to complete the accountant block, the regression equations for personal saving and personal income must be estimated. In the MUTE model personal saving and personal income are the main components in determining the total personal disposable income. The regression equations for personal saving rate and personal income are separately estimated and determined by:

- *The Equation for Personal Income (pi_t)*

$$pi_t = f[W_t, tpf_t, T, Dummy] \tag{4.27}$$

where, pi_t = personal income at time t

W_t = total wage at time t

tpf_t = total profit at time t

T = time trend

$Dummy$ = the dummy variables capturing the unexpected movement of pi_t data

- *The Equation for Personal Saving Rate (psr_t)*

$$psr_t = f[psr_{t-1}, unemp_t, inr_t, gri_t, T, Dummy] \tag{4.28}$$

where, psr_t = personal saving rate at time t

$unemp_t$ = unemployment rate at time t

inr_t = nominal interest rate at time t

gri_t = growth rate of real income at time t

T = time trend

$Dummy$ = the dummy variables capturing the unexpected movement of ps_t data

By using the estimated value of personal income from equation (4.27), the personal disposable income (pdi_t) can be calculated by:

$$pdi_t = pi_t \times (1 - dtax_t) \tag{4.29}$$

where, pdi_t = personal disposable income in period t

pi_t = personal income at time t

$dtax_t$ = direct tax rate in period t

Then, the amount of personal saving (ps_t) can be calculated by multiplying the result from equation (4.29) with the estimated value from equation (4.28):

$$ps_t = psr_t \times pdi_t \tag{4.30}$$

Finally, total private consumption expenditure ($tpce_t$) can be easily computed by subtracting personal saving (ps_t) from the personal disposable income (pdi_t):

$$tpce_t = pdi_t - ps_t \tag{4.31}$$

The computed amount of total private consumption expenditure is used as the main tool to check the accuracy and the relevancy of the estimation of sectorial private consumption expenditure in equation (4.13).

4.3 The Simulation Process

The solution of the MUTE model can be obtained via the iterative process (see figure 4.2 at the end of this section). The iterative procedure in a given year begins by choosing the initial value of sectoral outputs, prices, personal disposable income, saving, and other values of exogenous variables. The total private consumption expenditure is computed here by subtracting saving from the personal disposable income.

In a given time period, the process begins on the real side. According to the assumed values of exogenous variables, sectoral outputs and prices, consumption expenditure which is one of the final demand components is computed for 26 input – output industries, and then followed by investment expenditure, inventory, and imports, while government expenditure, special exports, and export are left as exogenous variables to the model. The first six components are added up together and are subtracted by the imports so as to form a 26×1 vector of final demand (f), which is then substituted into equation (4.2) to compute the sectoral outputs for 26 industries. After sectoral outputs are calculated, the sectoral productivities are computed via equation (4.18), and the labor requirements for each sector can be easily obtained by dividing sectoral output by its productivity level.

After the computation of sectoral outputs on the real side, the process continues on the price – income side so as to compute the prices and vectors of value added components. All valued added components except net indirect taxes (the policy variable which is left as exogenous to the model) are estimated by equations (4.20) to (4.23). Then, all components including wage and salaries, profits, depreciation, and net indirect taxes are summed up to form a 26×1 vector of value added (v) which is then inserted into equation (4.19) to calculate the sectorial prices for 26 input – output industries.

The next step is to compute the macroeconomic variables via the accountant. Nominal Gross Domestic Product (GDP) can be calculated from the identities in Table 4.1. The difference between the nominal GDP computed from the real side and the price – income side reflects the statistical discrepancy. The real GDP can be computed from equation (4.25) by using the estimated value of GDP deflator from equation (4.26).

Personal income can be computed via equation (4.27) by substituting the calculation of total wage and total profit from the price – income side. Total private consumption expenditure can be obtained either by the summation of all 26 sectoral consumption expenditures from the real side or determining by equation (4.31).

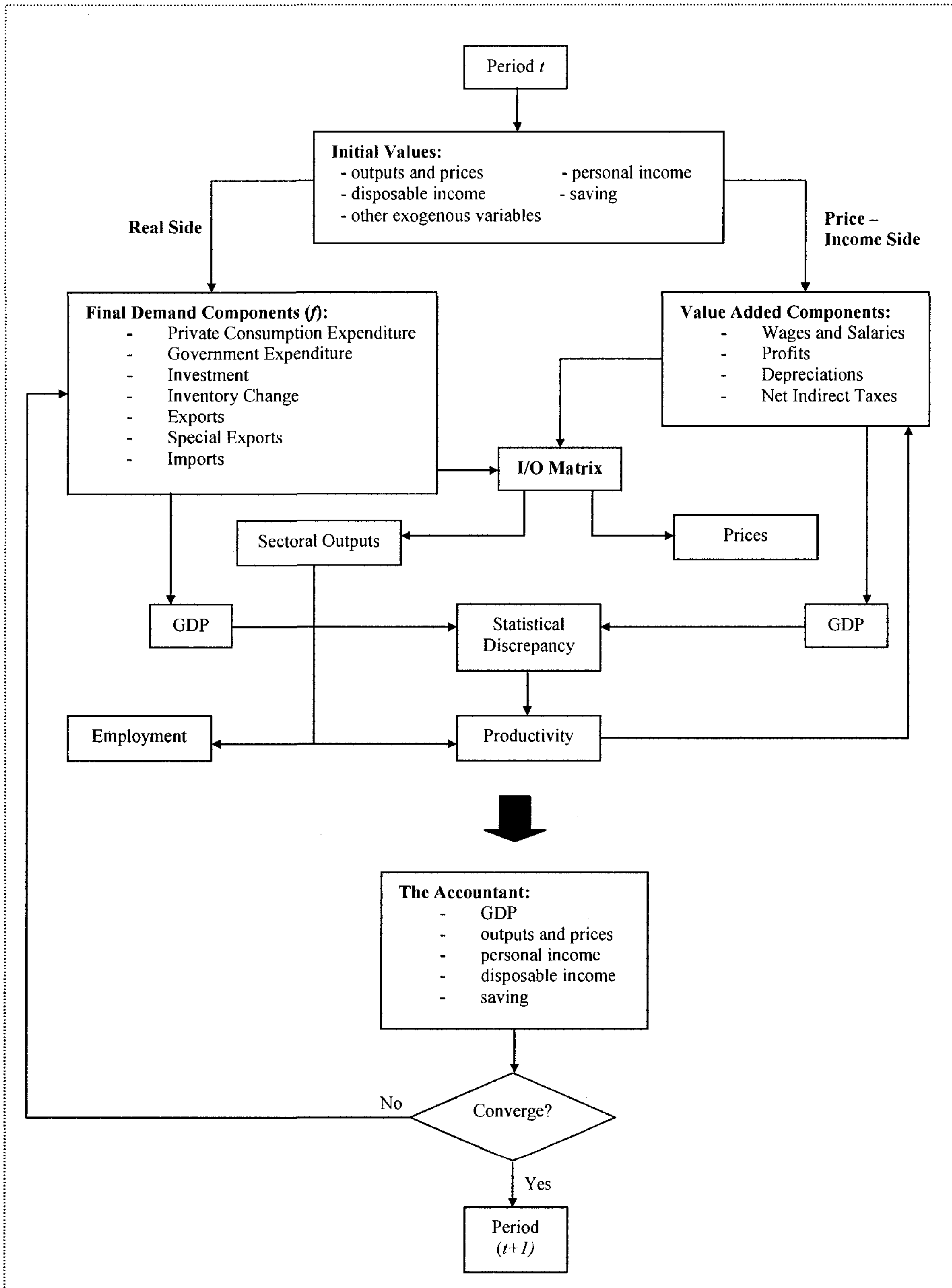
Finally, if the values of all sectoral outputs and prices converge to their initial values, the model will move forward to period $t+1$. Otherwise, the estimated values from the first iterative will be used as the initial value and the same iteration will continue until the convergence of the data is accomplished.

4.4 The New Contribution

Although, MUTE shares the same structure as the interdyme – type model in which the main components are built by relying on three main blocks: the real side, the price – income side, and the accountant, there are some aspects that make the MUTE model different from previous multisectoral models of Thailand, especially TIDY.

- Firstly, the model employs the RAS method instead of the logistic curve in projecting the input – output coefficient matrix (A). The advantage of the RAS method is already discussed in section 4.2.1 of this chapter.
- Secondly, the MUTE model is calculated by relying on the latest available data from both national statistics and national income accounts: the newest version of the 2001 input – output table and the use of the time series data from 1975 to 2005 including 30 observations for each variable.
- Thirdly, in this study, the time – series technique called "the corrected Akaike's information criterion (AICc)" is not only employed to estimate the labor productivity and inventory investment series, but also used to forecast most of the exogenous variables such as unemployment rate, government consumption expenditure, interest rate, and etc. This technique is quite useful when the data exhibits the non – stationary characteristic and the inexistence of the cointegrating vector among the related variables (See Appendix B for the discussion on the AICc technique).

Figure 4.2: The Simulation Process in the MUTE model



- Fourthly, since the model deals with time series data. The non – stationary test is performed for each variable. Furthermore, for some equations dealing with the estimation of the relationships among the non – stationary series, the cointegration test is used to confirm that the estimated equations are not spurious.
- Fifthly, the historical data validation test is employed to examine whether the bahaviors of the MUTE model are consistent with the real world system. In this case, the ranges of accuracy for some important variables are determined as a reference boundary for comparing the model outcomes with the empirical data (See Section 7.1).
- Finally, besides, the dummy variable representing the financial crisis (*Cridum*) in Thailand, the model includes another dummy variable (*Poldum*) that captures the impact of political condition on the economic performance.

Chapter V

The Estimation for the Real Side

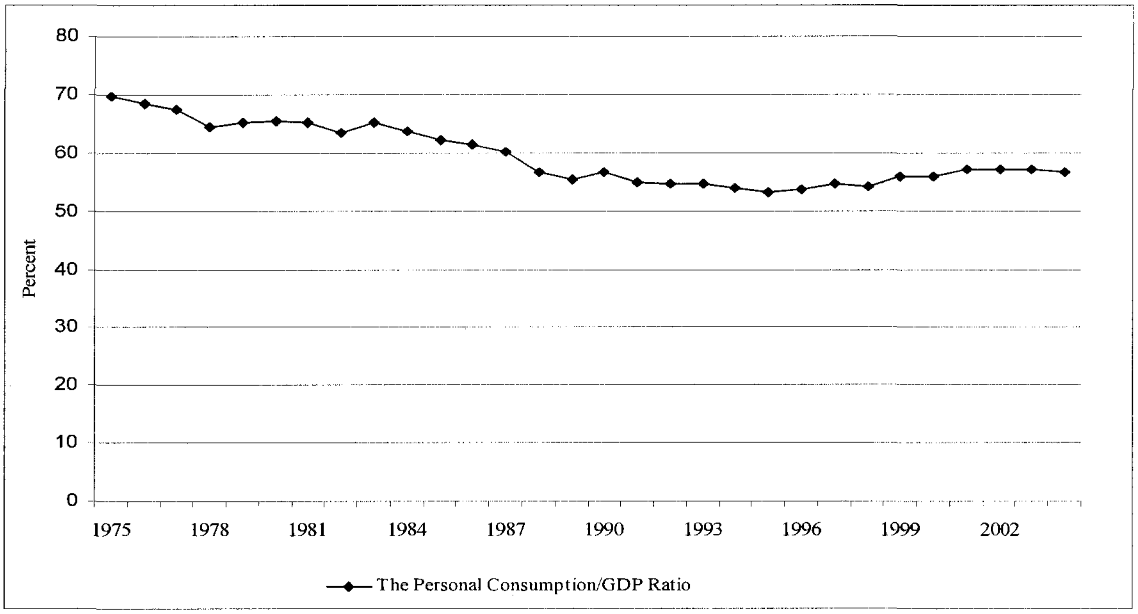
The real side of the MUTE is estimated in this chapter. The four from the 7 components of final demands are estimated for 26 sectors including personal consumption expenditures (*pce*), investment expenditures (*gfcf*), inventory investments (*ii*), and imports (*im*). However, government consumption expenditure (*g*), special export (*es*), and exports (*ex*) are left as exogenous variables to the model, since government expenditure is treated as a policy variable (the surplus or deficit of government budget depends on the decision of the Thai government), while exports and special exports are the variables that rely on various factors such as the relative prices between the world prices and the domestic prices, exchange rate, the wealth of the trading partners, the trade policies, and so on, which require more complicated model to deal with.

The chapter begins with the estimation of personal consumption expenditure, investment expenditure, inventory investment, and the imports equation for 26 IO sectors, consecutively. Finally, after all final demand equations are estimated, the productivity equations are also estimated for these sectors, since they are the main component in linking the real side with the price – income side.

5.1 The Estimation of the Personal Consumption Expenditure (*pce*)

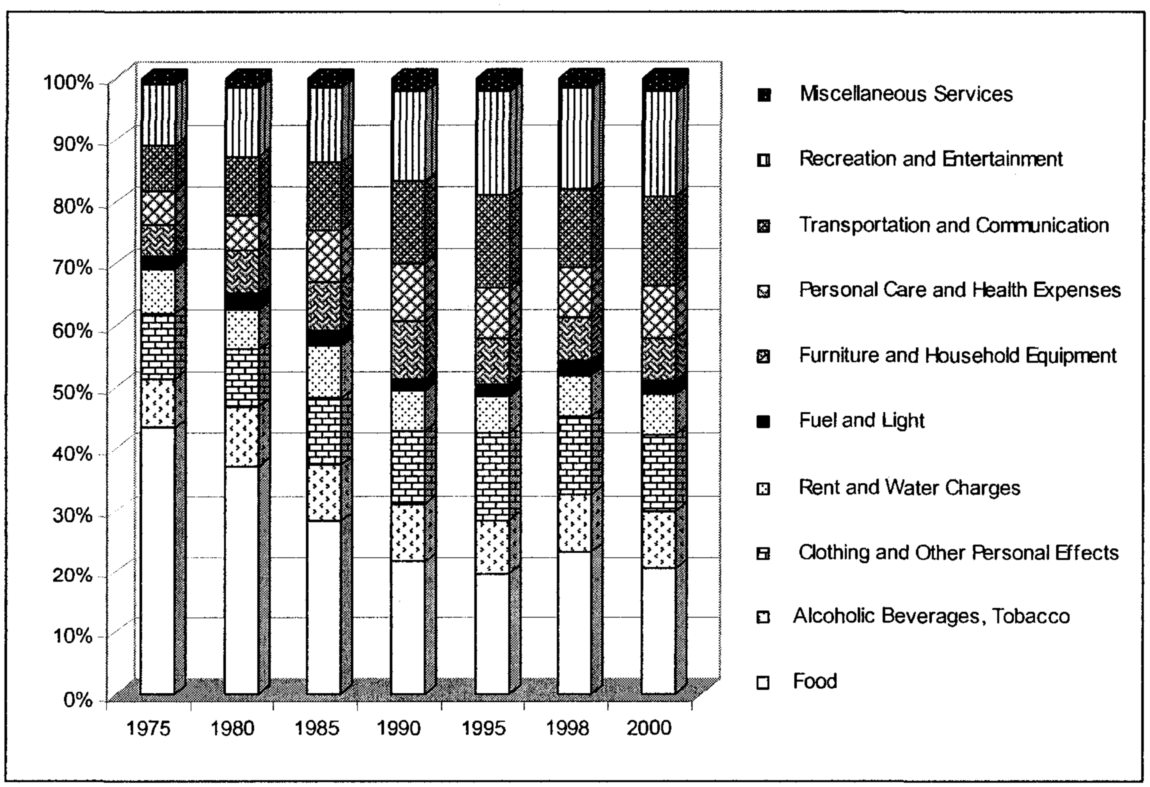
For several decades, there are tremendous changes in the personal consumption expenditure in Thailand. The changes occur not only in magnitude, but also in structure. This is confirmed by Figures 5.1, and 5.2.

Figure 5.1: Total Personal Consumption Expenditures to GDP Ratio in Thailand (Percent)



Source: National Economic and Social Development Board (*NESDB*)

Figure 5.2: The Structural Changes of Personal Consumption Expenditures



Source: National Economic and Social Development Board (*NESDB*)

Figure 5.1 shows that personal consumption expenditures (*pce*) are the main component of the Thai's final demand, because it accounts for more than 50 percent of GDP and has remained at this level since 1975.

The proportion of the spending on items such as beverages, fuel and lights, rent and water charges, and clothing remained the same (see Figure 5.2) for several decades. On one hand, most of the spending (approximately 35 – 40 percent) since 1975 was on food items. However, spending on food items has the downward trend to about 20 percent after 1990. On the other hands, the upward trend of *pce* can be seen in recreation, entertainment, health cares, transportation, and communication. These situations are similar to those in developed countries when societies are more advanced. People will be concerned more about their health, recreation, and accommodations. The progression of telecommunication and transportation technology such as the new types of vehicles, mobile phones, and internets is another reason that the spending in these sectors has increased.

5.1.1 The System of Personal Consumption Expenditures for Thailand

As mentioned in previous chapter, there are various forms of functions in estimating the system of personal consumption expenditures such as the Perhaps Adequate Demand System (PADS), the Linear Expenditure System (LES), and so on. The Almost Ideal Demand System (AIDS) is employed in this study due to its advantages over the use of single equation models, and it has the desirable properties over other demand systems[1].

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[1] For instance, AIDS combines both times series and cross sectional data in determining the main parameters of the demand function such as the own - price elasticities and the cross - price elasticities.

According to Deaton and Muellbauer (1980a)[2], the origin of AIDS comes from the following PIGLOG class[3] cost function:

$$\ln c(u,p) = (1-u)\ln[a(p)] + u\ln[b(p)] \tag{5.1}$$

where, $c(u,p)$ = the cost or expenditure function, which depends on the level of utility (u), and the price vector (p)

u = the utility level $(0 \le u \le 1)$ (0 = Subsistence Level, and 1 = Bliss Point)

$a(p)$, $b(p)$ = the costs of acquiring the subsistence, and bliss, consecutively

Deaton and Muellbauer choose the functional forms for $a(p)$ and $b(p)$ in the way that makes the cost function (5.1) flexible[4] and yields the demand functions that have the appropriate characteristics. Thus, the suitable functional forms for $a(p)$ and $b(p)$ in their study are:

$$\ln a(p) = a_0 + \sum_k \alpha_k \ln[p_k] + \frac{1}{2}\sum_k\sum_j \gamma_{kj}^{*} \ln[p_k]\ln[p_j] \tag{5.2}$$

Moreover, its functional form allows the possible values of elasticities to be calculated without imposing the restrictions on them (This characteristic sometimes called the locally flexible functional form). Unlike other demand systems, the functional form of AIDS is derived from a known cost function. Finally, AIDS is quite easy to estimate, since the specification of the system does not depend on the procedure of the non – linear estimation.

[2] Deaton, A.S. and Muellbauer, J. (1980a). "An almost ideal demand system", *American Economic Review,* 70, 312 – 326.

[3] The PIGLOG stands for the Price Independent Generalized Logarithmic. It is the function that represents the minimum cost or the expenditure which is enough to attain the desirable level of utility at a given price.

[4] The flexible cost function in this case means the cost function that includes sufficient number of parameters in order to guarantee that at any point, the derivatives of the cost function ($\partial c/\partial p_i, \partial c/\partial u, \partial^2 c/\partial p_i \partial p_j, \partial^2 c/\partial u \partial p_i$, and $\partial^2 c/\partial u^2$) can be set equal to the derivatives from other arbitrary cost functions.

$$\ln b(p) = \ln[a(p)] + \beta_0 \prod_{k=1}^{n} p_k^{\beta_k} \tag{5.3}$$

where, α_k, γ_{kj}^*, and β_i are the estimated parameters. By inserting equation (5.2) and (5.3) in equation (5.1), this yields:

$$\ln c(u,p) = \alpha_0 + \sum_k \alpha_k \ln[p_k] + \frac{1}{2}\sum_k \sum_j \gamma_{kj}^* \ln[p_k]\ln[p_j] + u\beta_0 \prod_k p_k^{\beta_k} \tag{5.4}$$

In order to derive the AIDS demand equations in budget shares, the Shephard's lemma[5] in logarithmic form is required. From the Shephard's lemma, if both sides of the equation are multiplied by $\frac{p_i}{c(u,p)}$, it becomes:

$$\frac{p_i q_i}{c(u,p)} = \frac{\partial c(u,p)}{\partial p_i} \times \frac{p_i}{c(u,p)} = \frac{p_i q_i}{m} \tag{5.5}$$

Equation (5.5) shows that rational consumer will always equate *c(u, p)* to the total expenditure (*m*). As a result, equation (5.5) can be rewritten as:

$$\frac{p_i q_i}{m} = w_i = \frac{\partial \ln c(u,p)}{\partial \ln(p)} \tag{5.6}$$

where, w_i denotes the share of the personal consumption expenditure on sector *i* to the total expenditure. In other words, equation (5.6) implies that the differentiation of the ln(*c*, *u*) with respect to the ln(*p*) will give the compensated demands in the share equation form. Thus, for AIDS equation (5.4), the differentiation with respect to log price will give:

$$\frac{p_i q_i}{m} = w_i = \alpha_i + \sum_j \gamma_{ij} \ln[p_j] + \beta_i u \beta_0 \prod_k p_k^{\beta_k} \qquad (5.7)^{6}$$

[5] The derivatives of expenditure function with respect to prices are equal to the quantities demand (q_i).

where, $\gamma_{ij} = \frac{1}{2}\left(\gamma_{ij}^{*} + \gamma_{ji}^{*}\right)$, and from equation (5.2) and (5.3), the third term of equation (5.7) is equal to $u\beta_i\left(\ln(b) - \ln a(p)\right)$. Moreover, solving equation (5.1) for u (indirect utility function) and for the utility maximizing consumer who always sets $c(u, p)$ equal to m, we obtain:

$$u = \frac{\ln m - \ln a(p)}{\ln b(p) - \ln a(p)} \tag{5.8}$$

Then, substituting the value of u from equation (5.8) into equation (5.7), the AIDS in budget shares is given by:

$$w_i = \alpha_i + \sum_j \gamma_{ij} \ln(p_j) + \beta_i \ln\left(\frac{m}{P}\right) \qquad i, j = 1..........26 \tag{5.9}$$

and,

$$\ln P = \alpha_0 + \sum_k \alpha_k \ln(p_k) + \frac{1}{2}\sum_j \sum_k \gamma_{kj}^{*} \ln(p_k)\ln(p_j) \tag{5.10}$$

where, P is the price index for the logarithm of income ($\ln(m)$) which is equal to the first three terms of equation (5.4). Thus, equation (5.9), and (5.10) are the basic forms for AIDS. However, equation (5.10) is seldom estimated due to the non – linear system of the equations (the substitution of equation (5.10) for P will make equation (5.9) non – linear in the parameters). In order to avoid this technical problem, Deaton and Muellbauer suggest using the Stone index (P^{*}) instead of (P) in estimating equation (5.9). The Stone Index is represented by:

$$P^{*} = \prod_{k=1}^{n} p_k^{w_j} \qquad \text{, or} \qquad \ln(P^{*}) = \sum_{k=1}^{n} w_k \ln p_k \tag{5.11}$$

where, w_j denotes the expenditure share of good j, and equation (5.9) becomes:

[6] The second term in equation (5.7) comes from the fact that a quadratic form can be rewritten in the symmetric form.

$$w_i = \alpha_i + \sum_j \gamma_{ij} \ln(p_j) + \beta_i \ln\left(\frac{m}{P^*}\right) \quad (5.12)$$

Equation (5.12) is normally called the linear approximation of the AIDS model (LA/AIDS). However, Eales and Unnevehr (1988) argue that the substitution of Stone's price index (P^*) in equation (5.12) will cause the simultaneity problem, since P^* consists of $w_{k,t}$ terms. Thus, they suggest using $w_{k,t-1}$ instead of $w_{k,t}$. As a result, P^* is modified as:

$$\ln(P^{**}) = \sum_{k=1}^{n} w_{k,t-1} \ln p_k \quad (5.13)$$

Substituting (5.13) in (5.12) yields:

$$w_i = \alpha_i + \sum_j \gamma_{ij} \ln(p_j) + \beta_i \ln\left(\frac{m}{P^{**}}\right) \quad (5.14)$$

The following 3 sets of restrictions allow AIDS to confirm with the theory of demand:

(1) $\sum_{i=1}^{n} \alpha_i = 1$, $\sum_{i=1}^{n} \gamma_{ij} = 0$, and $\sum_{i=1}^{n} \beta_i = 0$ (*Adding Up*) in order to guarantee that $\sum w_i \equiv 1$

(2) $\sum_{j=1}^{n} \gamma_{ij} = 0$ for *Homogeneity* in all prices and income, and

(3) $\gamma_{ij} = \gamma_{ji}$ for *Slutsky Symmetry*

According to Deaton and Muellbauer, the first restriction does not necessitate the test, since the data are added up by construction. Moreover, all of these restrictions are linear, which can be imposed or tested for the appropriateness of the AIDS model by using the basic techniques shown in the later section.

Finally, the AIDS provides the full set of elasticities for the demand system. The uncompensated and the compensated price elasticities (e_{ij}, e^*_{ij}) and the expenditure elasticities (η_i) for LA/AIDS can be computed by using the following formulas[7]:

$$e_{ij} = -\delta_{ij} + \frac{\hat{\gamma}_{ij}}{\overline{w}_i} - \hat{\beta}_i\left(\frac{\overline{w}_j}{\overline{w}_i}\right) \tag{5.15}$$

$$e^*_{ij} = e_{ij} + \overline{w}_j + \hat{\beta}_i\left(\frac{\overline{w}_j}{\overline{w}_i}\right) = -\delta_{ij} + \frac{\hat{\gamma}_{ij}}{\overline{w}_i} + \overline{w}_j \tag{5.16}$$

$$\eta_i = \left(\frac{\beta_i}{\overline{w}_i}\right) + 1 \tag{5.17}$$

where, δ_{ij} denotes the Kronecker delta (δ_{ik} = 1 when $i = j$, and δ_{ik} = 0 otherwise). $\hat{\beta}_i$ and $\hat{\gamma}_{ik}$ are the estimated parameters from equation (5.14), w_i is the expenditure share of good i.

5.1.2 Statistical Properties of the Data

The data of personal consumption expenditures and prices[8] for the 26 input – output sectors (SIO) are summed up or averaged from the 44 – sector system of national accounts (SNA) published by NESDB and BOT, respectively. Since, the format of SNA system is not relevant with that from SIO, thus in a given year the data in some sectors are stacked by using the consumption expenditure shares from the derived I – O table

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[7] For the computation of the elasticities see Buse, A. "Evaluating the Linear Almost Ideal Demand System." American Journal of Agricultural Economic 76 (November, 1994): 781 – 793.

[8] Due to the availability of data, the relevant producer price indexes are used to represent the prices of sector 1 – 5, 8 – 17, 19, 23, and 26, while the corresponding consumer price indexes are used to represent the prices for sector 6, 7, 18, 21, 22, and 25. Finally, the wholesale price index and the average housing price index are employed as the prices for sector 20 and 24, respectively.

shown in appendix C. Before these data are employed to estimate the AIDS, the stationary characteristic of these data has to be examined.

5.1.2.1 The Stationary Test

In this section, the variables w_i, $\ln(p_i)$, and $\ln\left(\frac{m}{P^{**}}\right)$ are tested for whether they are stationary (constant means and variances). This test is really important, since the combination of non – stationary data and the regression technique will lead to the problem of spurious regression (obtaining a very high R^2 even though there are no meaningful relationships among the variables). By applying the Augmented Dickey – Fuller test (ADF) to the equation:

$$\Delta Y_t = \beta_1 + \beta_2 t + \rho Y_{t-1} + \alpha_i \sum_{i-1}^{n} \Delta Y_{t-i} + \varepsilon_t \tag{5.18}$$

where, ΔY_t denotes the first difference $(Y_t - Y_{t-1})$ of the testing series, and t is the time trend. In this case, the intercept term, time trend, and the appropriate - period lag of ΔY_t are included in the ADF test equation. The result is reached simply by comparing the computed absolute τ statistic of the coefficient ρ with the MacKinnon DF absolute critical τ value: if the computed value exceeds the critical value from the table, then the given time series is stationary, otherwise, it is nonstationary. The result of the ADF test for the variables w_i, $\ln(p_i)$, and $\ln\left(\frac{m}{P^{**}}\right)$ are shown in Table 5.1.

Table 5.1: The ADF Test for the Consumption Expenditure Share (w_i), the Logged Price ($\ln(p_i)$), and the Variable $\ln(m/P^{**})$

Sector	Coefficient for (w_i)	Tau (τ) Statistic	Coefficient for $\ln(p_i)$	Tau (τ) Statistic
1	-0.068	-0.508	-1.468	-3.350^{*}
1st diff.	-1.129	-6.080^{***}	-0.872	-4.284^{**}
2	-0.343	-2.443	-1.533	-2.104
1st diff.	-1.131	-5.677^{***}	-3.252	-5.552^{***}
3	-0.348	-2.176	-0.099	-2.166
1st diff.	-1.137	-5.822^{***}	-1.533	-4.024^{**}
4	-0.101	-1.056	-0.469	-2.737
1st diff.	-0.775	-4.226^{**}	-1.287	-6.918^{***}
5	-0.388	-2.746	-0.449	-3.558^{*}
1st diff.	-1.069	-5.406^{***}	-1.265	-3.727^{**}
6	-0.146	-1.638	-0.775	-2.635
1st diff.	-1.133	-5.909^{***}	-0.623	-3.325^{*}
7	-0.910	-2.268	-0.447	-2.203
1st diff.	-1.239	-6.653^{***}	-0.867	-4.342^{***}
8	0.069	0.491	-0.265	-2.250
1st diff.	-0.868	-4.378^{***}	-0.972	-4.895^{***}
9	-0.221	-2.313	-0.219	-1.562
1st diff.	-0.578	-2.916^{***}	-0.745	-4.078^{**}
10	-0.339	-2.858	-0.428	-2.550
1st diff.	-1.041	-5.195^{***}	-1.252	-4.070^{**}
11	-0.210	-1.720	-0.181	-1.670
1st diff.	-1.014	-5.068^{***}	-1.193	-3.298^{**}
12	-0.355	-2.532	-0.224	-1.854
1st diff.	-1.137	-5.908^{***}	-0.921	-4.999^{***}
13	-0.427	-1.151	-0.202	-1.887
1st diff.	-2.045	-3.813^{**}	-0.718	-3.728^{**}
14	-0.436	-2.499	-1.480	-3.128
1st diff.	-1.755	-3.849^{**}	-0.932	-4.245^{**}
15	-0.454	-3.020	-0.331	-2.286
1st diff.	-1.377	-4.865^{***}	-1.151	-5.820^{***}
16	-0.187	-1.589	-0.139	-1.875
1st diff.	-1.077	-5.403^{***}	-0.978	-4.915^{***}
17	-0.086	-0.830	-0.829	-3.364^{*}
1st diff.	-1.071	-5.382^{***}	-0.960	-4.770^{***}
18	-0.330	-2.295	-0.193	-1.921
1st diff.	-0.964	-4.815^{***}	-0.901	-4.483^{***}
19	-0.308	-2.326	-0.266	-2.532
1st diff.	-0.996	-4.969^{***}	-0.750	-3.802^{**}
20	-1.526	-3.190	-0.251	-2.326
1st diff.	-1.288	-4.904^{***}	-2.438	-5.171^{***}
21	-0.081	-0.944	-0.173	-2.903
1st diff.	-0.992	-4.815^{***}	-0.966	-3.598^{*}
22	-0.317	-2.822	-0.148	-2.181
1st diff.	-0.634	-3.406^{*}	-1.158	-5.328^{***}
23	-0.688	-2.735	-0.232	-1.900
1st diff.	-0.839	-4.227^{**}	-1.101	-5.540^{***}
24	-0.288	-2.090	-0.047	-0.807
1st diff.	-0.943	-4.727^{***}	-0.670	-3.567^{*}

Table 5.1: (Continued)

Sector	Coefficient for (w_i)	Tau (τ) Statistic	Coefficient for ln(p_i)	Tau (τ) Statistic
25	-0.312	-2.136	-0.184	-2.878
1st diff.	-1.076	-5.402***	-0.722	-3.868**
26	-0.173	-1.451	-0.281	-3.579*
1st diff.	-1.094	-5.462***	-0.887	-4.427***
	Coefficient for ln(m/P**)		Tau (τ) Statistic	
	0.004		0.128	
1st diff.	-2.256		-4.869***	

Notes: (1) *, **, *** denoted the significant level at 10%, 5%, and 1%, respectively for testing the null hypothesis that the particular series has a unit root.

According to the ADF test, only the price series of sectors 1, 5, 17, and 26 have the significant statistics at 10% level. However, in most cases the 1st difference of these series gives the stationary series. Thus, all series used in estimating the PCE equation exhibit a unit root, and alls are integrated of order 1. Consequently, in this case the first difference format of equation (5.14) is used to estimate the system of PCE. It is quite easy to show that the first difference form of equation (5.12) is:

$$\Delta w_i = \beta_i \Delta \log\left(\frac{m}{P^*}\right) + \sum_j \gamma_{ij} \Delta \log p_j \qquad (5.19)$$

where, Δ represents the difference of the series from the previous period e.g. $\Delta wi = w_{it} - w_{it-1}$.

5.1.3 Properties of the Demand Function

5.1.3.1 Adding Up

As mentioned in section 5.1.1 that the adding up restriction does not need to be tested, since the data are added up by construction. However, by maintaining this property in the estimated demand system, it will cause the singularity problem of the error covariance matrix, and the system as a whole can not be estimated. Thus, in order to avoid this problem, one of the expenditure share equations is dropped from the system (in this study, equation of sector 26 (unclassified group) is chosen), and the coefficients of the dropped equation can be computed by using the adding - up restrictions. This method is called iterative seemingly unrelated regression (ISUR)[9].

5.1.3.2 Homogeneity of Degree Zero

Homogeneity requires that the summation of all price and the income coefficients in each share equation to be zero, or $\sum_{j=1}^{n} \gamma_{ij} = 0$. This means that if all prices and income increase in the same proportion, they will not affect the expenditures on the particular goods. In this study, the Wald statistic is employed to test the existence of homogeneity in the AIDS under the null hypothesis of homogeneous of degree zero in all prices against the alternative hypothesis of non – homogeneous prices. This statistic has a limiting chi – squared distribution with degrees of freedom equal to the number of restrictions (in this case, it is equal to 1 for each equation). The results of Wald test (the chi – squared statistics and their corresponding p – values) for each equation in AIDS are shown in Table 5.2.

Table 5.2: The Wald Test for the Existence of Homogeneity in LA/AIDS

Wald Test			
$H_0: \sum_j \gamma_{ij} = 0$ against $H_1: \sum_j \gamma_{ij} \neq 0$			
Sector	**Wald Statistic**	***P* - Value**	**Results**
1	117.984	0.000	Reject H_o
2	163.459	0.000	Reject H_o
3	34.473	0.000	Reject H_o
4	291.208	0.000	Reject H_o
5	1.949	0.163	Fail to Reject H_o
6	4.223	0.040	Reject H_o
7	52.672	0.000	Reject H_o

[9] For more information on ISUR see Zellner, Arnold, "Estimators for Seemingly Unrelated Regression Equations: Some Exact Finite Sample Results," Journal of the American Statistical Association, 58, 1963, pp. 977-992.

Table 5.2: (Continued)

Wald Test			
$H_0: \sum_j \gamma_{ij} = 0$ against $H_1: \sum_j \gamma_{ij} \neq 0$			
Sector	**Wald Statistic**	***P* - Value**	**Results**
8	1.961	0.161	Fail to Reject H_o
9	0.253	0.615	Fail to Reject H_o
10	0.202	0.652	Fail to Reject H_o
11	32.061	0.000	Reject H_o
12	77.758	0.000	Reject H_o
13	156.165	0.000	Reject H_o
14	100.637	0.000	Reject H_o
15	10.247	0.001	Reject H_o
16	0.626	0.429	Fail to Reject H_o
17	12.370	0.000	Reject H_o
18	78.131	0.000	Reject H_o
19	43.476	0.000	Reject H_o
20	25.172	0.000	Reject H_o
21	14.790	0.000	Reject H_o
22	4.011	0.045	Reject H_o
23	40.723	0.000	Reject H_o
24	6.144	0.013	Reject H_o
25	29.080	0.000	Reject H_o
26	170.524	0.000	Reject H_o

According to the Wald test, the homogeneity property of demand can be maintained only in sectors 5, 8, 9, 10 and 16. At first, the whole system is estimated by imposing the homogeneity on the sectors that have the significant Wald statistics, however including the five restrictions for these particular sectors at the same time causes the singularity problem and the whole system can not be estimated. Moreover, after inspecting the system, the estimation allows only one restriction. Thus in this case, the homogeneity assumption is completely rejected from the model. In my opinion, the rejection of the homogeneity assumption in this study did not put the question on the validity of the demand theory. The cause of the rejection possibly comes from the defect in the data employed in estimating the demand system.

5.1.3.3 Symmetry

Owing to Deaton and Muellbauer, the proof for symmetry requires the computation of the true price index in equation (5.10). However due to the limitation of number of observations in the sample, the true price index (5.10) can not be calculated. Since this is the estimation of long term consumption expenditure function by using annual data, the symmetry restriction is expected to hold in the long – run. Thus, the results of the estimation for AIDS in this study are based on the assumption of non – homogeneity but symmetry for the whole system. One thing that is worth mentioning here is that because of the omission of one expenditure share equation (equation of sector 26) from the system, the symmetry assumption cannot be held in sector 26 due to the combination of non – homogeneity assumption and the adding – up condition.

After the first round of estimation, the values of Durbin – Watson statistics in every equation lay in the zone of indecision. However by applying the rule of modified d test[10], the result indicates that there exists a significant evidence of autocorrelation problem. Thus, the structure of *AR(1)* is added in every equation in order to solve this problem. The final results of the estimation for AIDS parameters are shown in Tables 5.3 and 5.4. By applying equations (5.15) – (5.17), the corresponding uncompensated, compensated price elasticities, and the income elasticities for each sector are shown in Tables (5.5) and (5.6).

5.1.4 The Results

The estimated parameters from the ISUR method give reasonable results for the sign of computed elasticities (negative values for all uncompensated and compensated

[10] For details, see Henri Theil, Principles of Econometrics, John Wiley & Sons, New York, 1971, p. 201.

own - price elasticities, and positive values for all income elasticities). The last rows of Table 5.3 and 5.4, which represent $\sum_j \gamma_{ij}$, are used to measure the deviation of each sector from the homogeneity assumption. These rows should be zero if the homogeneity assumption is valid. Thus, the result shows that the proportional increase in expenditure and all prices will increase expenditure on sectors 1, 2, 4, 6, 7, 9 – 11, 13, 16, 18, 21, 23 and 26, but decrease the expenditure on the remaining sectors.

According to income elasticities, all goods are normal goods. On one hand, the values of income elasticities in the sectors that relate to the food items such as sector 1 (crops), 2 (livestock), 4 (Fishery), 6 (Food Manufacturing), and 7 (Beverages and Tobacco Products) have a positive sign but less than 1 as expected, indicating the necessities in these sectors. Sector 17 (Other Manufacturing Products), 18 (Electricity and Water Works), 21 (Restaurants and Hotels), 22 (Transportation and Communication), and 26 (Unclassified) are also included in this group. This result contrasts Manuprasert (2004)'s study which indicates that sectors 21 and 22 are luxury goods. On the other hands, Thai people will spend more than the proportion of the increase in their incomes in the sectors such as 8 (Textile Industry), 10 (Chemical Industries), 24 (Real Estates), 25 (Services), and so on, which are treated as luxury goods.

By considering own - price elasticities, all of these values are negative, confirming to the theory of demand. As expected, sectors 1, 2, 4, and 6 show the price inelasticity of demand, since all of these sectors are necessities (the agricultural sector and the sector that relies on the agricultural products as the primary input). The price – inelastic demand is also found in the sectors 8, 11 (Petroleum Refineries), and 23 (Banking and Insurance). On the other hands, the remaining sectors (3, 5, 7, 9, 10, 12 –

22, and 24 – 26) exhibit elastic price in demand, since most of the goods in these sectors consist of manufacturing goods and services, which are luxury and have higher degree of substitution.

Finally, the cross – price elasticities are also shown in Table 5.5. A negative sign for cross – price elasticity indicates complementarity between the two goods, while a positive sign suggests that these two goods are substitute to each other. For example, among the agricultural products, sector 1's product is complementary to goods from sectors 2 and 4, while substitute with the commodities from sector 3.

However, the unexpected results are also found in this study and might not correspond to the theoretical prediction. For instance, the prediction of the complementarity between the products from livestock and fishery sectors is not relevant to the empirical result, since both foods are the sources of protein and can be used as substitution goods. Moreover, although products from textile industry are substitute goods for commodities from crops sectors, they are complementary to the goods from livestock sectors. These strange results possibly come from the fact that each sector covers large varieties of goods which create different effects on other products within and outside the sector. Consequently, the results show the net effect that one particular sector has on other sectors. In my opinion, the way to solve this problem is to apply the AIDS model to the specific goods and services in order to avoid the interactive effect of the goods within and outside the group, or categorize the goods and services that might have the same effect to the goods and services from other groups.

Table 5.3: Parameter Estimation for the AIDS (Sector 1 – 13)

	Expenditure Share (Dependent Variable: Δw_i)												
	Δw_1	Δw_2	Δw_3	Δw_4	Δw_5	Δw_6	Δw_7	Δw_8	Δw_9	Δw_{10}	Δw_{11}	Δw_{12}	Δw_{13}
$\Delta\ln(p_1)$	0.109 **(9.87)**	-0.019 **(-3.79)**	-0.054 **(-5.95)**	0.023 **(3.74)**	-0.005 (-1.22)	0.064 **(8.75)**	-0.039 **(-6.06)**	-0.007 (-0.95)	-0.007 (-1.49)	0.012 **(2.61)**	-0.010 **(-2.57)**	0.007 **(2.22)**	0.026 **(4.55)**
$\Delta\ln(p_2)$	-0.019 **(-3.79)**	0.022 **(5.94)**	0.026 **(5.18)**	-0.013 **(-3.79)**	-0.004 (-1.33)	-0.022 **(-4.32)**	0.007 (1.50)	-0.007 (-1.36)	-0.011 **(-2.68)**	-0.017 **(-5.23)**	-0.004 (-1.67)	0.006 **(3.17)**	-0.019 **(-4.83)**
$\Delta\ln(p_3)$	-0.054 **(-5.95)**	0.026 **(5.18)**	-0.007 **(-5.99)**	-0.010 **(-3.12)**	-0.029 **(-4.11)**	-0.014 (-1.48)	0.015 **(2.55)**	-0.040 **(-3.96)**	-0.005 (-0.91)	-0.011 **(-2.61)**	-0.017 **(-4.15)**	0.018 **(4.18)**	-0.028 **(-6.55)**
$\Delta\ln(p_4)$	0.023 **(3.74)**	-0.013 **(-3.79)**	-0.010 **(-3.12)**	0.000 (0.03)	0.010 **(3.92)**	0.003 (0.66)	0.005 (0.98)	0.024 **(4.94)**	-0.010 **(-3.32)**	-0.006 **(-2.05)**	0.004 (1.47)	0.005 **(2.51)**	-0.003 (-0.97)
$\Delta\ln(p_5)$	-0.005 (-1.22)	-0.004 (-1.33)	-0.029 **(-4.11)**	0.010 **(3.92)**	-0.022 **(-3.69)**	-0.025 **(-5.05)**	-0.015 **(-3.50)**	0.016 **(2.13)**	0.024 **(5.37)**	0.006 (1.39)	0.005 (1.84)	-0.023 **(-7.69)**	0.026 **(4.20)**
$\Delta\ln(p_6)$	0.064 **(8.75)**	-0.022 **(-4.32)**	-0.014 (-1.48)	0.003 (0.66)	-0.025 **(-5.05)**	0.032 **(3.66)**	0.046 **(7.62)**	-0.059 **(-6.78)**	-0.016 **(-3.01)**	0.029 **(7.20)**	0.002 (0.53)	0.026 **(5.91)**	0.053 **(6.33)**
$\Delta\ln(p_7)$	-0.039 **(-6.06)**	0.007 (1.50)	0.015 **(2.55)**	0.005 (0.98)	-0.015 **(-3.50)**	0.046 **(7.62)**	-0.009 (-1.10)	-0.008 (-0.99)	-0.016 **(-2.65)**	-0.001 (-0.26)	-0.010 **(-2.57)**	0.018 **(5.45)**	-0.025 **(-4.97)**
$\Delta\ln(p_8)$	-0.007 (-0.95)	-0.007 (-1.36)	-0.040 **(-3.96)**	0.024 **(4.94)**	0.016 **(2.13)**	-0.059 **(-6.78)**	-0.008 (-0.99)	0.029 (1.78)	0.028 **(3.59)**	0.018 **(2.85)**	0.008 (1.82)	-0.019 **(-4.38)**	0.022 **(2.42)**
$\Delta\ln(p_9)$	-0.007 (-1.49)	-0.011 **(-2.68)**	-0.005 (-0.91)	-0.010 **(-3.32)**	0.024 **(5.37)**	-0.016 **(-3.01)**	-0.016 **(-2.65)**	0.028 **(3.59)**	-0.005 (-0.64)	-0.020 **(-4.83)**	0.021 **(6.15)**	-0.001 (-0.27)	0.011 (1.71)
$\Delta\ln(p_{10})$	0.012 **(2.61)**	-0.017 **(-5.23)**	-0.011 **(-2.61)**	-0.006 **(-2.05)**	0.006 (1.39)	0.029 **(7.20)**	-0.001 (-0.26)	0.018 **(2.85)**	-0.020 **(-4.83)**	-0.028 **(-5.18)**	-0.006 (-1.93)	0.017 **(6.05)**	-0.028 **(-7.03)**
$\Delta\ln(p_{11})$	-0.010 **(-2.57)**	-0.004 (-1.67)	-0.017 **(-4.15)**	0.004 (1.47)	0.005 (1.84)	0.002 (0.53)	-0.010 **(-2.57)**	0.008 (1.82)	0.021 **(6.15)**	-0.006 (-1.93)	0.008 **(2.77)**	-0.007 **(-3.46)**	0.000 (0.07)
$\Delta\ln(p_{12})$	0.007 **(2.22)**	0.006 **(3.17)**	0.018 **(4.18)**	0.005 **(2.51)**	-0.023 **(-7.69)**	0.026 **(5.91)**	0.018 **(5.45)**	-0.019 **(-4.38)**	-0.001 (-0.27)	0.017 **(6.05)**	-0.007 **(-3.46)**	-0.010 **(-4.48)**	0.007 (1.54)
$\Delta\ln(p_{13})$	0.026 **(4.55)**	-0.019 **(-4.83)**	-0.028 **(-6.55)**	-0.003 (-0.97)	0.026 **(4.20)**	0.053 **(6.33)**	-0.025 **(-4.97)**	0.022 **(2.42)**	0.011 (1.71)	-0.028 **(-7.03)**	0.000 (0.07)	0.007 (1.54)	-0.057 **(-5.07)**
$\Delta\ln(p_{14})$	-0.024 **(-3.45)**	-0.012 **(-2.69)**	-0.038 **(-7.85)**	0.005 (0.96)	0.053 **(9.35)**	-0.035 **(-4.66)**	-0.023 **(-3.93)**	0.054 **(5.73)**	0.014 **(2.35)**	-0.012 **(-2.28)**	0.014 **(3.58)**	-0.038 **(-7.63)**	-0.015 (-1.55)
$\Delta\ln(p_{15})$	-0.013 **(-3.48)**	-0.002 (-0.60)	0.025 **(4.68)**	-0.017 **(-5.38)**	0.001 (0.29)	-0.008 **(-2.07)**	-0.014 **(-3.37)**	0.002 (0.40)	-0.008 (-1.71)	-0.025 **(-8.09)**	-0.007 **(-2.55)**	0.007 **(2.92)**	-0.017 **(-3.52)**

Notes: (1) Parameters are estimated by the iterative seemingly unrelated regression (ISUR).
(2) The t – statistics are shown in the parenthesis, and bold numbers indicate the statistical significant level at 5%.

Table 5.3: (Continued)

	Expenditure Share (Dependent Variable: Δw_i)												
	Δw_1	Δw_2	Δw_3	Δw_4	Δw_5	Δw_6	Δw_7	Δw_8	Δw_9	Δw_{10}	Δw_{11}	Δw_{12}	Δw_{13}
$\Delta\ln(p_{16})$	0.008 (0.60)	0.014 (1.83)	-0.044 **(-6.32)**	0.020 **(2.36)**	-0.019 (-1.95)	-0.035 **(-2.78)**	-0.005 (-0.46)	-0.089 **(-4.80)**	0.046 **(4.73)**	0.039 **(4.23)**	0.016 **(2.01)**	-0.022 **(-3.47)**	0.114 **(8.51)**
$\Delta\ln(p_{17})$	0.108 **(4.76)**	-0.059 **(-4.91)**	-0.009 **(-6.91)**	0.017 **(2.68)**	0.029 **(2.01)**	0.099 **(3.84)**	-0.019 (-1.55)	-0.046 **(-2.45)**	-0.052 **(-4.56)**	0.048 **(5.43)**	-0.006 (-0.64)	0.009 (0.94)	0.092 **(4.06)**
$\Delta\ln(p_{18})$	-0.011 (-1.55)	0.019 **(4.04)**	0.033 **(3.96)**	-0.003 (-0.49)	-0.024 **(-3.94)**	-0.001 (-0.15)	0.026 **(3.65)**	-0.044 **(-3.89)**	-0.004 (-0.60)	0.022 **(3.70)**	-0.007 (-1.34)	0.003 (0.62)	-0.007 (-1.13)
$\Delta\ln(p_{19})$	0.010 (1.54)	0.011 **(2.85)**	0.042 **(4.94)**	-0.007 (-1.75)	-0.048 **(-9.04)**	0.048 **(5.81)**	0.031 **(5.43)**	-0.074 **(-9.01)**	0.000 (-0.05)	0.042 **(7.86)**	-0.018 **(-4.66)**	0.018 **(4.17)**	0.022 **(2.19)**
$\Delta\ln(p_{20})$	-0.068 **(-4.20)**	0.042 **(4.85)**	0.013 **(8.40)**	-0.034 **(-6.26)**	-0.053 **(-4.40)**	-0.055 **(-3.07)**	0.111 **(10.29)**	0.002 (0.09)	-0.042 **(-3.73)**	0.016 (1.76)	-0.003 (-0.34)	-0.008 (-0.97)	-0.008 (-0.46)
$\Delta\ln(p_{21})$	-0.026 **(-3.39)**	-0.019 **(-3.89)**	-0.047 **(-3.45)**	-0.006 (-1.50)	0.048 **(12.29)**	0.041 **(4.39)**	-0.047 **(-7.77)**	0.091 **(6.91)**	0.072 **(8.47)**	-0.018 **(-2.68)**	-0.002 (-0.44)	-0.033 **(-7.15)**	-0.072 **(-14.49)**
$\Delta\ln(p_{22})$	0.073 **(7.93)**	-0.047 **(-7.54)**	-0.040 **(-3.08)**	-0.008 (-1.41)	0.039 **(6.30)**	-0.010 (-0.88)	-0.040 **(-5.55)**	0.049 **(5.16)**	-0.040 **(-6.05)**	-0.011 **(-2.14)**	0.015 **(3.09)**	0.002 (0.44)	0.008 (0.83)
$\Delta\ln(p_{23})$	-0.004 (-1.07)	-0.006 **(-2.65)**	-0.024 **(-7.51)**	-0.008 **(-3.17)**	0.013 **(6.84)**	-0.002 (-0.57)	-0.010 **(-3.86)**	0.020 **(5.53)**	0.002 (1.07)	-0.010 **(-5.44)**	0.006 **(3.44)**	-0.001 (-0.54)	-0.009 **(-3.11)**
$\Delta\ln(p_{24})$	0.023 **(2.97)**	0.040 **(6.52)**	0.029 **(3.17)**	-0.008 (-1.31)	-0.037 **(-10.61)**	0.027 **(3.51)**	0.028 **(4.18)**	-0.152 **(-13.94)**	0.014 **(2.23)**	0.021 **(3.37)**	-0.025 **(-5.04)**	0.022 **(4.34)**	0.053 **(5.45)**
$\Delta\ln(p_{25})$	-0.029 **(-2.92)**	0.027 **(3.89)**	-0.032 (-1.80)	0.018 **(3.57)**	-0.032 **(-3.24)**	-0.052 **(-4.54)**	0.016 **(2.22)**	-0.030 (-1.85)	-0.006 (-0.62)	0.033 **(5.51)**	-0.002 (-0.33)	-0.005 (-0.73)	0.063 **(8.74)**
$\Delta\ln(p_{26})$	-0.120 **(-4.46)**	0.169 **(5.05)**	0.032 **(7.06)**	0.010 (0.86)	-0.031 (-1.93)	-0.142 **(-5.08)**	0.022 (1.52)	0.134 (1.53)	0.136 **(2.64)**	-0.059 **(-5.47)**	0.051 (1.02)	-0.004 (-0.44)	-0.012 **(-4.72)**
$\Delta\ln(m/P^*)$	-0.099 **(-7.12)**	-0.023 **(-4.01)**	0.003 (0.50)	-0.027 **(-2.67)**	0.000 **(4.10)**	-0.042 **(-7.70)**	-0.017 **(-2.75)**	0.064 **(4.35)**	-0.014 **(-2.93)**	0.034 **(7.05)**	0.010 (1.76)	-0.003 (-0.53)	0.000 **(4.39)**
AR(1)	0.006 (0.06)	0.552 **(3.14)**	-0.823 **(-10.69)**	0.264 (1.95)	0.156 (1.33)	-0.706 **(-7.40)**	-0.463 **(-5.04)**	0.899 **(14.23)**	-0.803 **(-6.43)**	-0.152 (-1.54)	0.210 (1.34)	0.865 **(5.31)**	-0.706 **(-11.05)**
$\sum_j \gamma_{ij}$	0.027	0.124	-0.215	0.010	-0.097	-0.006	0.043	-0.077	0.125	0.053	0.029	-0.006	0.198

Notes: (1) Parameters are estimated by the iterative seemingly unrelated regression (ISUR).
(2) The t – statistics are shown in the parenthesis, and bold numbers indicate the statistical significant level at 5%.

Table 5.4: Parameter Estimation for the AIDS (Sector 14 – 26)

	Expenditure Share (Dependent Variable: Δw_i)												
	Δw_{14}	Δw_{15}	Δw_{16}	Δw_{17}	Δw_{18}	Δw_{19}	Δw_{20}	Δw_{21}	Δw_{22}	Δw_{23}	Δw_{24}	Δw_{25}	Δw_{26}
$\Delta\ln(p_1)$	-0.024 **(-3.45)**	-0.013 **(-3.48)**	0.008 (0.60)	0.108 **(4.76)**	-0.011 (-1.55)	0.010 (1.54)	-0.068 **(-4.20)**	-0.026 **(-3.39)**	0.073 **(7.93)**	-0.004 (-1.07)	0.023 **(2.97)**	-0.029 **(-2.92)**	-0.148
$\Delta\ln(p_2)$	-0.012 **(-2.69)**	-0.002 (-0.60)	0.014 (1.83)	-0.059 **(-4.91)**	0.019 **(4.04)**	0.011 **(2.85)**	0.042 **(4.85)**	-0.019 **(-3.89)**	-0.047 **(-7.54)**	-0.006 **(-2.65)**	0.040 **(6.52)**	0.027 **(3.89)**	0.045
$\Delta\ln(p_3)$	-0.038 **(-7.85)**	0.025 **(4.68)**	-0.044 **(-6.32)**	-0.009 **(-6.91)**	0.033 **(3.96)**	0.042 **(4.94)**	0.013 **(8.40)**	-0.047 **(-3.45)**	-0.040 **(-3.08)**	-0.024 **(-7.51)**	0.029 **(3.17)**	-0.032 (-1.80)	0.424
$\Delta\ln(p_4)$	0.005 (0.96)	-0.017 **(-5.38)**	0.020 **(2.36)**	0.017 **(2.68)**	-0.003 (-0.49)	-0.007 (-1.75)	-0.034 **(-6.26)**	-0.006 (-1.50)	-0.008 (-1.41)	-0.008 **(-3.17)**	-0.008 (-1.31)	0.018 **(3.57)**	-0.001
$\Delta\ln(p_5)$	0.053 **(9.35)**	0.001 (0.29)	-0.019 (-1.95)	0.029 **(2.01)**	-0.024 **(-3.94)**	-0.048 **(-9.04)**	-0.053 **(-4.40)**	0.048 **(12.29)**	0.039 **(6.30)**	0.013 **(6.84)**	-0.037 **(-10.61)**	-0.032 **(-3.24)**	0.066
$\Delta\ln(p_6)$	-0.035 **(-4.66)**	-0.008 **(-2.07)**	-0.035 **(-2.78)**	0.099 **(3.84)**	-0.001 (-0.15)	0.048 **(5.81)**	-0.055 **(-3.07)**	0.041 **(4.39)**	-0.010 (-0.88)	-0.002 (-0.57)	0.027 **(3.51)**	-0.052 **(-4.54)**	-0.135
$\Delta\ln(p_7)$	-0.023 **(-3.93)**	-0.014 **(-3.37)**	-0.005 (-0.46)	-0.019 (-1.55)	0.026 **(3.65)**	0.031 **(5.43)**	0.111 **(10.29)**	-0.047 **(-7.77)**	-0.040 **(-5.55)**	-0.010 **(-3.86)**	0.028 **(4.18)**	0.016 **(2.22)**	-0.022
$\Delta\ln(p_8)$	0.054 **(5.73)**	0.002 (0.40)	-0.089 **(-4.80)**	-0.046 **(-2.45)**	-0.044 **(-3.89)**	-0.074 **(-9.01)**	0.002 (0.09)	0.091 **(6.91)**	0.049 **(5.16)**	0.020 **(5.53)**	-0.152 **(-13.94)**	-0.030 (-1.85)	0.211
$\Delta\ln(p_9)$	0.014 **(2.35)**	-0.008 (-1.71)	0.046 **(4.73)**	-0.052 **(-4.56)**	-0.004 (-0.60)	0.000 (0.05)	-0.042 **(-3.73)**	0.072 **(8.47)**	-0.040 **(-6.05)**	0.002 (1.07)	0.014 **(2.23)**	-0.006 (-0.62)	0.011
$\Delta\ln(p_{10})$	-0.012 **(-2.28)**	-0.025 **(-8.09)**	0.039 **(4.23)**	0.048 **(5.43)**	0.022 **(3.70)**	0.042 **(7.86)**	0.016 (1.76)	-0.018 **(-2.68)**	-0.011 **(-2.14)**	-0.010 **(-5.44)**	0.021 **(3.37)**	0.033 **(5.51)**	-0.112
$\Delta\ln(p_{11})$	0.014 **(3.58)**	-0.007 **(-2.55)**	0.016 **(2.01)**	-0.006 (-0.64)	-0.007 (-1.34)	-0.018 **(-4.66)**	-0.003 (-0.34)	-0.002 (-0.44)	0.015 **(3.09)**	0.006 **(3.44)**	-0.025 **(-5.04)**	-0.002 (-0.33)	0.022
$\Delta\ln(p_{12})$	-0.038 **(-7.63)**	0.007 **(2.92)**	-0.022 **(-3.47)**	0.009 (0.93)	0.003 (0.62)	0.018 **(4.17)**	-0.008 (-0.97)	-0.033 **(-7.15)**	0.002 (0.44)	-0.001 (-0.54)	0.022 **(4.34)**	-0.005 (-0.73)	0.002
$\Delta\ln(p_{13})$	-0.015 (-1.55)	-0.017 **(-3.52)**	0.114 **(8.51)**	0.092 **(4.06)**	-0.007 (-1.13)	0.022 **(2.19)**	-0.008 (-0.46)	-0.072 **(-14.49)**	0.008 (0.83)	-0.009 **(-3.11)**	0.053 **(5.45)**	0.063 **(8.74)**	-0.209
$\Delta\ln(p_{14})$	-0.071 **(-7.30)**	-0.023 **(-4.87)**	0.061 **(4.44)**	0.051 **(3.91)**	-0.048 **(-5.75)**	-0.070 **(-7.02)**	0.021 (1.46)	0.031 **(2.51)**	0.051 **(6.77)**	0.015 **(4.68)**	-0.074 **(-7.89)**	0.053 **(3.51)**	0.058
$\Delta\ln(p_{15})$	-0.023 **(-4.87)**	-0.012 **(-3.24)**	0.001 (0.12)	-0.063 **(-6.50)**	0.039 **(7.81)**	0.034 **(7.65)**	0.056 **(6.18)**	0.000 (0.07)	-0.047 **(-8.23)**	-0.013 **(-7.57)**	0.041 **(8.28)**	-0.001 (-0.06)	0.082

Notes: (1) Parameters are estimated by the iterative seemingly unrelated regression (ISUR).
(2) The t – statistics are shown in the parenthesis, and bold numbers indicate the statistical significant level at 5%.

Table 5.4: (Continued)

	Expenditure Share (Dependent Variable: Δw_i)												
	Δw_{14}	Δw_{15}	Δw_{16}	Δw_{17}	Δw_{18}	Δw_{19}	Δw_{20}	Δw_{21}	Δw_{22}	Δw_{23}	Δw_{24}	Δw_{25}	Δw_{26}
$\Delta\ln(p_{16})$	0.061 **(4.44)**	0.001 (0.12)	-0.002 (-0.06)	0.255 **(6.31)**	-0.069 **(-4.34)**	-0.074 **(-5.75)**	-0.205 **(-6.54)**	0.105 **(6.61)**	0.151 **(8.71)**	0.050 **(8.01)**	-0.031 **(-2.06)**	-0.147 **(-6.09)**	-0.139
$\Delta\ln(p_{17})$	0.051 **(3.91)**	-0.063 **(-6.50)**	0.255 **(6.31)**	-0.416 **(-4.90)**	-0.080 **(-4.88)**	0.037 **(2.28)**	-0.236 **(-4.34)**	-0.010 (-0.30)	0.099 **(3.19)**	0.038 **(6.31)**	0.059 **(3.18)**	0.085 (1.60)	0.072
$\Delta\ln(p_{18})$	-0.048 **(-5.75)**	0.039 **(7.81)**	-0.069 **(-4.34)**	-0.080 **(-4.88)**	-0.009 (-0.71)	0.012 (1.46)	0.043 **(2.85)**	-0.067 **(-4.45)**	0.015 (1.78)	0.000 (0.15)	0.051 **(4.96)**	-0.026 **(-2.23)**	0.136
$\Delta\ln(p_{19})$	-0.070 **(-7.02)**	0.034 **(7.65)**	-0.074 **(-5.75)**	0.037 **(2.28)**	0.012 (1.46)	-0.036 **(-4.47)**	0.004 (0.23)	-0.034 **(-6.07)**	-0.024 **(-3.01)**	-0.002 (-1.62)	0.035 **(9.84)**	-0.030 **(-4.21)**	0.085
$\Delta\ln(p_{20})$	0.021 (1.46)	0.056 **(6.18)**	-0.205 **(-6.54)**	-0.236 **(-4.34)**	0.043 **(2.85)**	0.004 (0.23)	-0.037 (-0.75)	0.136 **(4.75)**	-0.122 **(-6.28)**	0.003 (0.47)	-0.080 **(-4.68)**	-0.049 (-1.51)	0.553
$\Delta\ln(p_{21})$	0.031 **(2.51)**	0.000 (0.07)	0.105 **(6.61)**	-0.010 (-0.30)	-0.067 **(-4.45)**	-0.034 **(-6.07)**	0.136 **(4.75)**	-0.231 **(-8.16)**	0.020 (1.39)	-0.011 **(-2.67)**	-0.069 **(-4.73)**	0.231 **(11.43)**	-0.086
$\Delta\ln(p_{22})$	0.051 **(6.77)**	-0.047 **(-8.23)**	0.151 **(8.71)**	0.099 **(3.19)**	0.015 (1.78)	-0.024 **(-3.01)**	-0.122 **(-6.28)**	0.020 (1.39)	-0.070 **(-4.85)**	-0.004 (-1.04)	-0.034 **(-3.11)**	0.121 **(5.56)**	-0.145
$\Delta\ln(p_{23})$	0.015 **(4.68)**	-0.013 **(-7.57)**	0.050 **(8.01)**	0.038 **(6.31)**	0.000 (0.15)	-0.002 (-1.62)	0.003 (0.47)	-0.011 **(-2.67)**	-0.004 (-1.04)	0.002 (0.71)	0.003 (0.78)	0.030 **(5.89)**	-0.077
$\Delta\ln(p_{24})$	-0.074 **(-7.89)**	0.041 **(8.28)**	-0.031 **(-2.06)**	0.059 **(3.18)**	0.051 **(4.96)**	0.035 **(9.84)**	-0.080 **(-4.68)**	-0.069 **(-4.73)**	-0.034 **(-3.11)**	0.003 (0.78)	-0.070 **(-5.78)**	-0.039 **(-2.99)**	0.170
$\Delta\ln(p_{25})$	0.053 **(3.51)**	-0.001 (-0.06)	-0.147 **(-6.09)**	0.085 (1.60)	-0.026 **(-2.23)**	-0.030 **(-4.21)**	-0.049 (-1.51)	0.231 **(11.43)**	0.121 **(5.56)**	0.030 **(5.89)**	-0.039 **(-2.99)**	-0.373 **(-8.41)**	0.174
$\Delta\ln(p_{26})$	0.038 **(2.25)**	0.061 **(6.61)**	-0.134 **(-5.30)**	-0.315 **(-5.33)**	0.203 **(5.34)**	-0.009 (-1.05)	0.294 **(4.33)**	-0.004 (-0.10)	-0.151 **(-5.46)**	-0.048 **(-6.12)**	-0.029 (-1.45)	-0.074 (-1.38)	-0.017
$\Delta\ln(m/P^*)$	0.012 (1.39)	0.021 **(4.69)**	0.100 **(4.99)**	-0.008 (-0.55)	-0.019 **(-2.64)**	0.012 (1.45)	0.013 (1.02)	-0.016 (-1.62)	-0.004 (-0.42)	0.008 (1.37)	0.002 (0.25)	0.001 **(6.89)**	-0.009
AR(1)	-0.006 (-0.05)	-0.377 **(-2.11)**	0.607 **(3.15)**	-0.649 **(-11.65)**	-0.088 (-0.43)	0.407 **(3.32)**	-0.607 **(-8.30)**	0.928 **(29.52)**	-0.844 **(-12.08)**	0.204 (1.52)	-0.838 **(-9.98)**	-0.813 **(-17.14)**	-
$\sum_j \gamma_{ij}$	-0.021	-0.001	0.004	-0.287	0.067	-0.081	-0.259	0.083	-0.006	0.029	-0.200	-0.248	1.020

Notes: (1) Parameters are estimated by the iterative seemingly unrelated regression (ISUR).
(2) The t – statistics are shown in the parenthesis, and bold numbers indicate the statistical significant level at 5%.

Table 5.5: The Uncompensated and Compensated Price Elasticities

Sector	1	2	3	4	5	6	7	8	9	10	11	12	13
1	**-0.027** **(-0.001)**	-0.115 (-0.106)	-0.428 (-0.427)	0.204 (0.211)	-0.041 (-0.040)	0.545 (0.554)	-0.254 (-0.239)	0.015 (0.035)	-0.046 (-0.043)	0.109 (0.112)	-0.076 (-0.075)	0.059 (0.060)	0.212 (0.213)
2	-0.115 (-0.106)	**-0.449** **(-0.430)**	0.605 (0.607)	-0.299 (-0.285)	-0.086 (-0.084)	-0.498 (-0.478)	0.216 (0.250)	-0.104 (-0.062)	-0.243 (-0.236)	-0.395 (-0.389)	-0.088 (-0.086)	0.143 (0.145)	-0.448 (-0.446)
3	-0.428 (-0.427)	0.605 (0.607)	**-2.657** **(-2.650)**	-2.498 (-2.446)	-6.775 (-6.770)	-3.441 (-3.367)	3.396 (3.520)	-9.614 (-9.457)	-1.243 (-1.217)	-2.614 (-2.589)	-4.005 (-3.996)	4.322 (4.330)	-6.561 (-6.552)
4	0.204 (0.211)	-0.299 (-0.285)	-2.498 (-2.446)	**-0.966** **(-0.962)**	0.337 (0.337)	0.139 (0.145)	0.234 (0.243)	0.858 (0.870)	-0.324 (-0.322)	-0.192 (-0.190)	0.144 (0.145)	0.165 (0.166)	-0.083 (-0.082)
5	-0.041 (-0.040)	-0.086 (-0.084)	-6.775 (-6.770)	0.337 (0.337)	**-8.201** **(-8.199)**	-8.285 (-8.243)	-4.980 (-4.910)	5.175 (5.264)	8.035 (8.050)	1.845 (1.859)	1.654 (1.659)	-7.715 (-7.711)	8.808 (8.812)
6	0.545 (0.554)	-0.498 (-0.478)	-3.441 (-3.367)	0.139 (0.145)	-8.285 (-8.243)	**-0.213** **(-0.212)**	1.120 (1.122)	-1.270 (-1.267)	-0.359 (-0.359)	0.691 (0.691)	0.052 (0.052)	0.596 (0.596)	1.211 (1.211)
7	-0.254 (-0.239)	0.216 (0.250)	3.396 (3.520)	0.234 (0.243)	-4.980 (-4.910)	1.120 (1.122)	**-1.113** **(-1.057)**	-0.082 (-0.011)	-0.210 (-0.198)	-0.014 (-0.003)	-0.136 (-0.132)	0.242 (0.246)	-0.345 (-0.341)
8	0.015 (0.035)	-0.104 (-0.062)	-9.614 (-9.457)	0.858 (0.870)	5.175 (5.264)	-1.270 (-1.267)	-0.082 (-0.011)	**-0.747** **(-0.590)**	0.293 (0.319)	0.187 (0.211)	0.088 (0.097)	-0.208 (-0.200)	0.230 (0.239)
9	-0.046 (-0.043)	-0.243 (-0.236)	-1.243 (-1.217)	-0.324 (-0.322)	8.035 (8.050)	-0.359 (-0.359)	-0.210 (-0.198)	0.293 (0.319)	**-1.286** **(-1.285)**	-1.307 (-1.306)	1.348 (1.348)	-0.047 (-0.046)	0.751 (0.751)
10	0.109 (0.112)	-0.395 (-0.389)	-2.614 (-2.589)	-0.192 (-0.190)	1.845 (1.859)	0.691 (0.691)	-0.014 (-0.003)	0.187 (0.211)	-1.307 (-1.306)	**-2.978** **(-2.929)**	-0.405 (-0.386)	1.177 (1.192)	-1.947 (-1.931)
11	-0.076 (-0.075)	-0.088 (-0.086)	-4.005 (-3.996)	0.144 (0.145)	1.654 (1.659)	0.052 (0.052)	-0.136 (-0.132)	0.088 (0.097)	1.348 (1.348)	-0.405 (-0.386)	**0.472** **(0.488)**	-1.265 (-1.252)	0.036 (0.050)
12	0.059 (0.060)	0.143 (0.145)	4.322 (4.330)	0.165 (0.166)	-7.715 (-7.711)	0.596 (0.596)	0.242 (0.246)	-0.208 (-0.200)	-0.047 (-0.046)	1.177 (1.192)	-1.265 (-1.252)	**-3.190** **(-3.189)**	1.534 (1.536)
13	0.212 (0.213)	-0.448 (-0.446)	-6.561 (-6.552)	-0.083 (-0.082)	8.808 (8.812)	1.211 (1.211)	-0.345 (-0.341)	0.230 (0.239)	0.751 (0.751)	-1.947 (-1.931)	0.036 (0.050)	1.534 (1.536)	**-12.307** **(-12.30)**

Notes: (1) The compensated price elasticities are shown in the parentheses.
(2) Bold numbers represent the own - price elasticities.

Table 5.5: (Continued)

Sector	1	2	3	4	5	6	7	8	9	10	11	12	13
14	-0.187 (-0.186)	-0.285 (-0.283)	-8.955 (-8.947)	0.153 (0.153)	17.791 (17.796)	-0.803 (-0.803)	-0.319 (-0.315)	0.579 (0.588)	0.918 (0.919)	-0.836 (-0.819)	2.548 (2.563)	-8.093 (-8.091)	-2.924 (-2.919)
15	-0.099 (-0.098)	-0.038 (-0.037)	5.962 (5.968)	-0.552 (-0.552)	0.346 (0.350)	-0.189 (-0.189)	-0.194 (-0.191)	0.022 (0.028)	-0.503 (-0.503)	-1.719 (-1.707)	-1.170 (-1.160)	1.480 (1.482)	-3.361 (-3.357)
16	0.090 (0.096)	0.356 (0.371)	-10.424 (-10.37)	0.695 (0.699)	-6.305 (-6.273)	-0.767 (-0.766)	-0.066 (-0.041)	-0.989 (-0.934)	3.041 (3.044)	2.652 (2.761)	2.750 (2.841)	-4.731 (-4.719)	22.541 (22.574)
17	0.880 (0.885)	-1.391 (-1.380)	-2.173 (-2.133)	0.580 (0.583)	9.743 (9.765)	2.283 (2.283)	-0.249 (-0.231)	-0.513 (-0.473)	-3.398 (-3.396)	3.307 (3.384)	-1.040 (-0.975)	1.919 (1.927)	18.173 (18.196)
18	-0.040 (-0.028)	0.482 (0.508)	7.890 (7.986)	-0.032 (-0.025)	-7.987 (-7.932)	0.029 (0.031)	0.372 (0.416)	-0.518 (-0.421)	-0.199 (-0.195)	1.384 (1.574)	-1.282 (-1.121)	0.624 (0.646)	-1.476 (-1.417)
19	0.079 (0.080)	0.251 (0.252)	9.911 (9.915)	-0.212 (-0.211)	-15.957 (-15.955)	1.098 (1.098)	0.426 (0.428)	-0.797 (-0.793)	-0.019 (-0.019)	2.888 (2.896)	-3.179 (-3.173)	3.850 (3.851)	4.267 (4.269)
20	-0.471 (-0.453)	1.041 (1.081)	2.998 (3.145)	-1.050 (-1.039)	-17.788 (-17.705)	-1.182 (-1.180)	1.545 (1.611)	-0.041 (0.106)	-2.698 (-2.692)	0.907 (1.197)	-0.607 (-0.363)	-1.764 (-1.731)	-1.590 (-1.501)
21	-0.143 (-0.126)	-0.394 (-0.357)	-11.136 (-11.00)	-0.116 (-0.105)	15.945 (16.022)	1.029 (1.031)	-0.622 (-0.560)	0.928 (1.064)	4.806 (4.812)	-1.432 (-1.162)	-0.492 (-0.265)	-7.000 (-6.969)	-14.216 (-14.13)
22	0.686 (0.713)	-1.038 (-0.981)	-9.560 (-9.346)	-0.153 (-0.137)	12.969 (13.090)	-0.100 (-0.096)	-0.522 (-0.425)	0.447 (0.661)	-2.499 (-2.490)	-1.068 (-0.645)	2.368 (2.724)	0.486 (0.535)	1.524 (1.654)
23	-0.021 (-0.018)	-0.128 (-0.122)	-5.679 (-5.657)	-0.260 (-0.258)	4.335 (4.347)	-0.031 (-0.030)	-0.138 (-0.128)	0.205 (0.227)	0.164 (0.165)	-0.746 (-0.703)	1.120 (1.157)	-0.176 (-0.171)	-1.762 (-1.749)
24	0.210 (0.217)	0.961 (0.976)	6.867 (6.923)	-0.226 (-0.222)	-12.471 (-12.439)	0.661 (0.662)	0.395 (0.420)	-1.662 (-1.606)	0.972 (0.974)	1.413 (1.523)	-4.543 (-4.450)	4.816 (4.829)	10.534 (10.568)
25	-0.203 (-0.196)	0.657 (0.673)	-7.527 (-7.468)	0.608 (0.613)	-10.806 (-10.772)	-1.150 (-1.149)	0.232 (0.259)	-0.346 (-0.286)	-0.378 (-0.375)	2.243 (2.361)	-0.417 (-0.318)	-0.973 (-0.959)	12.577 (12.613)
26	-0.929 (-0.920)	4.018 (4.037)	7.611 (7.682)	0.355 (0.361)	-10.364 (-10.324)	-3.206 (-3.204)	0.305 (0.337)	1.416 (1.487)	8.936 (8.939)	-4.192 (-4.051)	8.994 (9.112)	-0.745 (-0.729)	-2.290 (-2.247)

Notes: (1) The compensated price elasticities are shown in the parentheses.
(2) Bold numbers represent the own - price elasticities.

Table 5.5: (Continued)

Sector	14	15	16	17	18	19	20	21	22	23	24	25	26
1	-0.187 (-0.186)	-0.099 (-0.098)	0.090 (0.096)	0.880 (0.885)	-0.040 (-0.028)	0.079 (0.080)	-0.471 (-0.453)	-0.143 (-0.126)	0.686 (0.713)	-0.021 (-0.018)	0.210 (0.217)	-0.203 (-0.196)	-0.929 (-0.920)
2	-0.285 (-0.283)	-0.038 (-0.037)	0.356 (0.371)	-1.391 (-1.380)	0.482 (0.508)	0.251 (0.252)	1.041 (1.081)	-0.394 (-0.357)	-1.038 (-0.981)	-0.128 (-0.122)	0.961 (0.976)	0.657 (0.673)	1.078 (1.112)
3	-8.955 (-8.947)	5.962 (5.968)	-10.424 (-10.37)	-2.173 (-2.133)	7.890 (7.986)	9.911 (9.915)	2.998 (3.145)	-11.136 (-11.00)	-9.560 (-9.346)	-5.679 (-5.657)	6.867 (6.923)	-7.527 (-7.468)	10.057 (10.060)
4	0.153 (0.153)	-0.552 (-0.552)	0.695 (0.699)	0.580 (0.583)	-0.032 (-0.025)	-0.212 (-0.211)	-1.050 (-1.039)	-0.116 (-0.105)	-0.153 (-0.137)	-0.260 (-0.258)	-0.226 (-0.222)	0.608 (0.613)	-0.008 (0.016)
5	17.791 (17.796)	0.346 (0.350)	-6.305 (-6.273)	9.743 (9.765)	-7.987 (-7.932)	-15.957 (-15.96)	-17.788 (-17.71)	15.945 (16.022)	12.969 (13.090)	4.335 (4.347)	-12.471 (-12.44)	-10.806 (-10.77)	1.569 (1.572)
6	-0.803 (-0.803)	-0.189 (-0.189)	-0.767 (-0.766)	2.283 (2.283)	0.029 (0.031)	1.098 (1.098)	-1.182 (-1.180)	1.029 (1.031)	-0.100 (-0.096)	-0.031 (-0.030)	0.661 (0.662)	-1.150 (-1.149)	-3.206 (-3.204)
7	-0.319 (-0.315)	-0.194 (-0.191)	-0.066 (-0.041)	-0.249 (-0.231)	0.372 (0.416)	0.426 (0.428)	1.545 (1.611)	-0.622 (-0.560)	-0.522 (-0.425)	-0.138 (-0.128)	0.395 (0.420)	0.232 (0.259)	-0.502 (-0.444)
8	0.579 (0.588)	0.022 (0.028)	-0.989 (-0.934)	-0.513 (-0.473)	-0.518 (-0.421)	-0.797 (-0.793)	-0.041 (0.106)	0.928 (1.064)	0.447 (0.661)	0.205 (0.227)	-1.662 (-1.606)	-0.346 (-0.286)	5.027 (5.100)
9	0.918 (0.919)	-0.503 (-0.503)	3.041 (3.044)	-3.398 (-3.396)	-0.199 (-0.195)	-0.019 (-0.019)	-2.698 (-2.692)	4.806 (4.812)	-2.499 (-2.490)	0.164 (0.165)	0.972 (0.974)	-0.378 (-0.375)	0.256 (0.268)
10	-0.836 (-0.819)	-1.719 (-1.707)	2.652 (2.761)	3.307 (3.384)	1.384 (1.574)	2.888 (2.896)	0.907 (1.197)	-1.432 (-1.162)	-1.068 (-0.645)	-0.746 (-0.703)	1.413 (1.523)	2.243 (2.361)	-2.646 (-2.635)
11	2.548 (2.563)	-1.170 (-1.160)	2.750 (2.841)	-1.040 (-0.975)	-1.282 (-1.121)	-3.179 (-3.173)	-0.607 (-0.363)	-0.492 (-0.265)	2.368 (2.724)	1.120 (1.157)	-4.543 (-4.450)	-0.417 (-0.318)	0.517 (0.522)
12	-8.093 (-8.091)	1.480 (1.482)	-4.731 (-4.719)	1.919 (1.927)	0.624 (0.646)	3.850 (3.851)	-1.764 (-1.731)	-7.000 (-6.969)	0.486 (0.535)	-0.176 (-0.171)	4.816 (4.829)	-0.973 (-0.959)	0.060 (0.064)
13	-2.924 (-2.919)	-3.361 (-3.357)	22.541 (22.574)	18.173 (18.196)	-1.476 (-1.417)	4.267 (4.269)	-1.590 (-1.501)	-14.216 (-14.13)	1.524 (1.654)	-1.762 (-1.749)	10.534 (10.568)	12.577 (12.613)	-4.965 (-4.961)

Notes: (1) The compensated price elasticities are shown in the parentheses.
(2) Bold numbers represent the own - price elasticities.

Table 5.5: (Continued)

Sector	14	15	16	17	18	19	20	21	22	23	24	25	26
14	**-14.742** **(-14.73)**	-4.558 (-4.546)	11.744 (11.852)	9.852 (9.929)	-9.548 (-9.357)	-13.681 (-13.67)	3.973 (4.263)	5.907 (6.176)	9.684 (10.107)	2.940 (2.984)	-14.410 (-14.30)	10.328 (10.446)	1.386 (1.390)
15	-4.558 (-4.546)	**-4.377** **(-4.352)**	0.091 (0.315)	-17.778 (-17.62)	10.585 (10.978)	9.530 (9.545)	15.185 (15.783)	-0.370 (0.187)	-13.916 (-13.04)	-3.685 (-3.594)	11.328 (11.556)	-0.356 (-0.113)	1.936 (1.938)
16	11.744 (11.852)	0.091 (0.315)	**-1.166** **(-1.034)**	7.794 (7.889)	-2.291 (-2.059)	-2.278 (-2.269)	-6.581 (-6.228)	3.004 (3.333)	4.257 (4.772)	1.517 (1.570)	-1.068 (-0.934)	-4.651 (-4.507)	-3.280 (-3.254)
17	9.852 (9.929)	-17.778 (-17.62)	7.794 (7.889)	**-18.991** **(-18.98)**	-3.451 (-3.414)	1.583 (1.584)	-10.183 (-10.13)	-0.419 (-0.367)	4.343 (4.424)	1.634 (1.643)	2.554 (2.575)	3.690 (3.713)	1.722 (1.740)
18	-9.548 (-9.357)	10.585 (10.978)	-2.291 (-2.059)	-3.451 (-3.414)	**-1.145** **(-1.107)**	0.206 (0.207)	0.787 (0.845)	-1.142 (-1.088)	0.311 (0.396)	-0.004 (0.005)	0.905 (0.927)	-0.439 (-0.415)	3.237 (3.282)
19	-13.681 (-13.67)	9.530 (9.545)	-2.278 (-2.269)	1.583 (1.584)	0.206 (0.207)	**-16.756** **(-16.74)**	1.324 (1.877)	-15.461 (-14.95)	-11.443 (-10.64)	-1.021 (-0.938)	15.315 (15.525)	-13.323 (-13.10)	2.024 (2.026)
20	3.973 (4.263)	15.185 (15.783)	-6.581 (-6.228)	-10.183 (-10.13)	0.787 (0.845)	1.324 (1.877)	**-1.438** **(-1.338)**	1.563 (1.656)	-1.432 (-1.287)	0.028 (0.043)	-0.924 (-0.886)	-0.573 (-0.533)	13.140 (13.209)
21	5.907 (6.176)	-0.370 (0.187)	3.004 (3.333)	-0.419 (-0.367)	-1.142 (-1.088)	-15.461 (-14.95)	1.563 (1.656)	**-3.855** **(-3.791)**	0.269 (0.370)	-0.138 (-0.128)	-0.844 (-0.817)	2.867 (2.896)	-2.030 (-1.966)
22	9.684 (10.107)	-13.916 (-13.04)	4.257 (4.772)	4.343 (4.424)	0.311 (0.396)	-11.443 (-10.64)	-1.432 (-1.287)	0.269 (0.370)	**-1.554** **(-1.432)**	-0.029 (-0.016)	-0.266 (-0.234)	0.956 (0.990)	-3.418 (-3.317)
23	2.940 (2.984)	-3.685 (-3.594)	1.517 (1.570)	1.634 (1.643)	-0.004 (0.005)	-1.021 (-0.938)	0.028 (0.043)	-0.138 (-0.128)	-0.029 (-0.016)	**-0.886** **(-0.865)**	0.208 (0.262)	2.255 (2.312)	-1.834 (-1.823)
24	-14.410 (-14.30)	11.328 (11.556)	-1.068 (-0.934)	2.554 (2.575)	0.905 (0.927)	15.315 (15.525)	-0.924 (-0.886)	-0.844 (-0.817)	-0.266 (-0.234)	0.208 (0.262)	**-3.131** **(-3.096)**	-1.182 (-1.145)	4.045 (4.071)
25	10.328 (10.446)	-0.356 (-0.113)	-4.651 (-4.507)	3.690 (3.713)	-0.439 (-0.415)	-13.323 (-13.10)	-0.573 (-0.533)	2.867 (2.896)	0.956 (0.990)	2.255 (2.312)	-1.182 (-1.145)	**-11.613** **(-11.58)**	4.133 (4.161)
26	7.232 (7.373)	16.683 (16.974)	-4.277 (-4.106)	-13.588 (-13.56)	3.583 (3.611)	-4.244 (-3.975)	3.390 (3.439)	-0.037 (-0.003)	-1.198 (-1.157)	-3.725 (-3.657)	-0.895 (-0.850)	-2.113 (-2.070)	**-1.395** **(-1.361)**

Notes: (1) The compensated price elasticities are shown in the parentheses.
(2) Bold numbers represent the own - price elasticities.

Since, the purpose of this study is to find the general result for 26 I – O sectors, the result is left as a debatable topic for improving future estimations of AIDS model for Thailand. All in all, the possibility of improving the AIDS model relies on the availabilities of the data in future studies.

Table 5.6: Income Elasticities for the AIDS Model

Sector	η_i	Sector	η_i
1	0.212	14	3.346
2	0.458	15	6.902
3	1.695	16	4.076
4	0.126	17	0.641
5	0.961	18	0.671
6	0.029	19	6.378
7	0.769	20	1.148
8	1.692	21	0.803
9	0.071	22	0.972
10	3.349	23	1.629
11	2.815	24	1.063
12	0.386	25	1.015
13	1.026	26	0.794

Before leaving this section, an estimation of the total private consumption expenditure equation is required. Because the AIDS model gives the predicted results for 26 I – O sectors in terms of expenditure shares, the total expenditure function is needed for the sake of the prediction. In this study, the total private consumption expenditure is estimated by using the basic technique of ordinary least square. Again the Augmented Dickey – Fuller test is performed in order to detect the stationary characteristic of each variable in this equation.

According to the economic theory, two variables that are used to explain the variation in total private consumption expenditure (*tpce*) are the personal disposable income (*pdi*) and the interest rate (*ir*)[11]. The expected sign for the coefficient of (*pdi*) is

[11] Here, the 3 – month time deposit rate is used as the interest rate.

positive (an increase in (*pdi*) will cause (*tpce*) to rise), while the expected sign for the coefficient of (*ir*) is unpredictable based on the substitution and income effects[12].

Table 5.7: The ADF Test for the Total Private Consumption Expenditure

Variable	Coefficients (ρ)	Tau (τ) Statistic
(*tpce*)	-0.052	-1.130
1st diff.	-2.924	-4.653***
(*pdi*)	-0.068	-1.490
1st diff.	-5.147	-5.094***
(*ir*)	-0.146	-1.357
1st diff.	-0.886	-4.535***

<u>Notes</u>: (1) *, **, *** denoted the significant level at 10%, 5%, and 1%, respectively for testing the null hypothesis that the particular series has a unit root.

Two more variables inserted in this equation as the explanatory variables are (*poldum*) and (*cridum*). The (*poldum*) variable is the dummy variable, representing the political chaos in Thailand. It takes the value of 1 when the chaos happened in a particular year, and 0 otherwise[13]. The (*cridum*), which takes the value of 1 for 1997 and 1998 and 0 otherwise, is employed to represent the period of financial crisis in Thailand. The sign of the coefficients of these additional variables is expected to be negative.

The result of the Augmented Dickey – Fuller test shown in Table 5.7 indicates that series (*tpce*), (*pdi*), and (*ir*) are non – stationary but they are integrated of order 1. Thus, the 1st difference form is required to guarantee that these series are stationary. The structure of *AR(1)* is added in the equation for solving the problem of autocorrelation.

[12] A movement of interest rate creates both substitution and income effects on the level of consumption. On one hand, a rise (fall) of an interest rate implies that the price of current consumption is increase (decrease). Thus, people will reduce (increase) the current consumption, save more (less), and increase (reduce) their future consumption (the substitution effect). On the other hands, if people has a targeted level of saving for the future consumption, a rise (fall) of an interest rate means that people will save less (more) in order to achieve this targeted level (Income effect). Consequently, the negative (positive) sign for the coefficient of (*ir*) means that income (substitution) effect is overwhelmed by the substitution (income) effect.

[13] During the 1974 – 2004, the political chaos occurs 5 times including both the rebellion and the political revolution (1976, 1977, 1981, 1985, and 1991).

The final result of the estimation and some necessary statistics are shown in the following regression:

$$\Delta tpce = 31885.47 + 0.714\,(\Delta pdi) - 6547.97(\Delta ir) - 22818.08(podum) - 105599.4(cridum)$$

$$(19100.96)\quad (0.098)\qquad (4402.2)\qquad (20930.81)\qquad (38039.28)$$

$$t = (1.669)\qquad (7.255)\qquad (-1.487)\qquad (-1.090)\qquad (-2.776)$$

$$n = 29 \qquad \overline{R}^2 = 0.8036 \qquad D.W. = 2.0844 \qquad F - Statistic = 23.9196$$

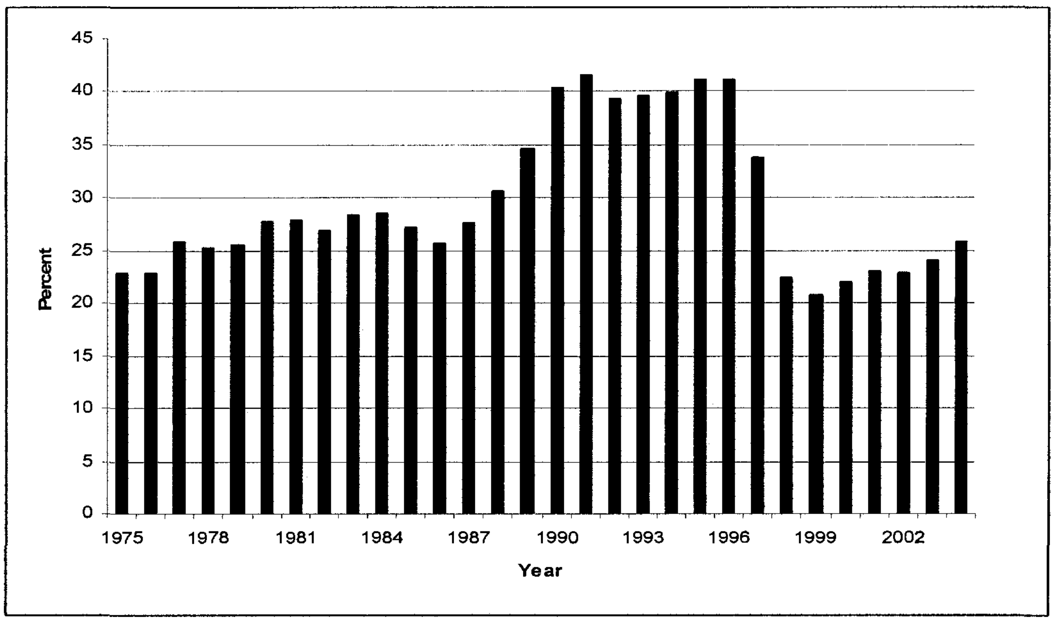
$$AR(1)\text{ coefficient} = 0.2003\ (t = 0.819) \tag{5.20}$$

The regression equation (5.20) gives a reasonable result. All estimated parameters have the expected signs. The negative coefficient of (*ir*) indicates that the substitution effect is larger than the income effect for the change in interest rate. The political crisis will pull down the total private consumption expenditure by 22,818.08 million baht, while the financial crisis reduces this amount by 105,599.4 million baht. Combining the results from the AIDS model with equation (5.20) yields the complete estimation of private consumption expenditure for the MUTE model.

5.2 The Estimation of Gross Fixed Capital Formation (*gfcf*)

The second element of final demand required to be estimated for the MUTE model is the gross fixed capital formation (*gfcf*). During the past several decades, this component of final demand has been changed both in its magnitude and its structure. As shown in Figure 5.3, (*gfcf*) accounted for approximately 22 percent of the overall GDP. This ratio fluctuated around 22 – 25 percent during 1976 – 1987 and jumped up to an average of 38 percent during the 90's, since there was an establishment of BIBF (the Bangkok International Banking Facilities) in March 1993 in order to facilitate the investment flows into the Kingdom. Finally, this ratio swings back to the average of 23 percent during the current period. The structure of (*gfcf*) is represented by the column graph in Figure 5.4. Although, the share of investment in public construction and transport equipment has not changed much during the past 30 years, the structural change comes from the reduction of investment in private construction from 25 percent in 1975 to 17 percent in 2004. The reduction in private construction is compensated by an increase in investment of machinery and other equipments (from 36 percent to 43 percent of gross fixed capital formation).

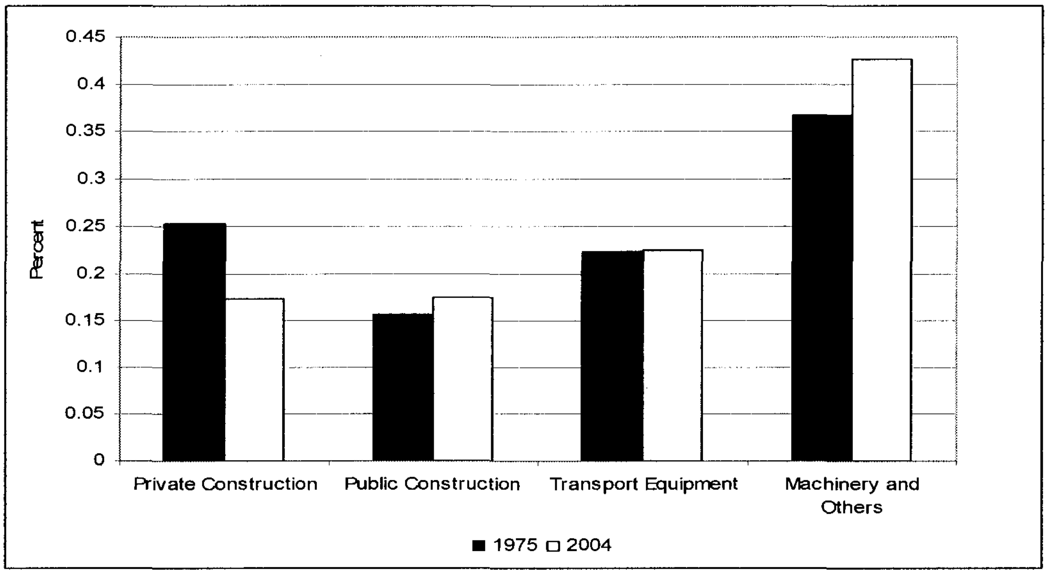
Figure 5.3: The Ratio between Gross Fixed Capital Formation and GDP of Thailand (Percent)



Source: National Economic and Social Development Board (*NESDB*)

Since gross fixed capital formation (or frequently called investment expenditure) is quite important not only as the source of employment and income, but also as the engine of growth for the Thai economy, the comprehension of the variation in this demand component in both the aggregate level and the sectoral level is necessary.

Figure 5.4: Structural Change for Gross Fixed Capital Formation



Source: National Economic and Social Development Board (*NESDB*)

However, the main problem of estimating the sectoral equations for (*gfcf*) is the unavailable sectoral data that are consistent with the 26 I – O sectors. The existing data consist of the annual total gross fixed capital formation (available from 1951 – 2004) and the data on capital stocks (the net capital stock for 11 SNA sectors[14], and the annual capital depreciation from 1970 – 2004). The way out of this problem is to use the method found in Manuprasert (2004)[15] by computing the (*gfcf*) series for 11 SNA sectors and adjusting for the negative investment. However, the contribution of this study to this method is to use the ratio of sectoral (*gfcf*) to the total (*gfcf*) in the consecutive years from the I – O tables which are generated by the RAS method in order to stack the 11 SNA

[14] The 11 SNA sectors include (1) Agriculture, (2) Mining and Quarrying, (3) Manufacturing, (4) Construction, (5) Electricity and Water Supply, (6) Transportation and Communication, (7) Wholesale and Retail Trade, (8) Banking, Insurance and Real Estate, (9) Ownerships of Dwelling, (10) Public Administration and Defense, and (11) Services.

[15] Manuprasert, op. cit., p.86 – 89.

sectors into 26 I – O sectors. The construction of the (*gfcf*) series for 26 I – O sectors can be summarized by the following procedure:

Step 1: Initial gross fixed capital formation or gross investment of SNA sector i at time t can be computed by the formula:

$$I_t^i = K_t^i - K_{t-1}^i + Dep_t^i \qquad (5.21)^{16}$$

where, I_t^i = gross investment of SNA sector i at time t

K_t^i = capital stocks of SNA sector i at time t

Dep_t^i = depreciation of SNA sector i at time t

Step 2: Since, the summation of the computed values ($\sum_i I_t^i$) from equation (5.21) are not equal to the published value of the gross fixed capital formation (Ip) from NESDB, in order to reach the consistency between these two sources of data, the computed values I_t^i from (5.21) are scaled by the ratio $\left(Ip / \sum_i I_t^i\right)$ and the new series is called In_t^i.

$$In_t^i = (I_t^i) \times (Ip / \sum_i I_t^i) \qquad (5.22)$$

Moreover, the adjusted depreciation ($Depn_t^i$) or sometimes called the replacement investment (RI_t^i), can be computed as:

$$Depn_t^i = In_t^i - (K_t^i - K_{t-1}^i) = RI_t^i \qquad (5.23)^{17}$$

[16] Equation (5.21) comes from the fact that investment is the net increase of the capital during the period of time.

[17] Depreciation needed to be adjusted because it can be seen from equation (5.21) that

$$In_t^i \neq (K_t^i - K_{t-1}^i) + Dep_t^i$$

Step 3: According to Somprawin (2004), it is possible that the computed sectoral (*gfcf*) by the first two steps will generate a negative value of investment expenditure, especially for the year that the value of capital stock in period t (K_t^i) is less than that in the previous period (K_{t-1}^i)[18]. In this case, Manuprasert (2004) suggested using the growth rate of the published (*gfcf*) series as the mark up for the maximum reduction rate for each sector in order to avoid negative investment. Moreover, he also recommended that at the sectoral level, the volatility of investment is higher than that at the total level, thus the assigned maximum reduction rate for sectoral investment should be higher than the growth rate of the published (*gfcf*) series. By applying this idea, the result shows that the growth rate of (*gfcf*) in 1976 and 2000 are 14.39 and 11.81 percent, respectively. Thus in this study the negative value of (*gfcf*) series can be replaced by the deflated values of the corresponding data in 1976 and 2000 by the assigned maximum reduction rate of 20 and 15 percent, consecutively[19].

Step 4: The final step is to stack data from 11 SNA sectors into 26 I – O sectors by using the information (the ratio between sectoral investment to the total investment) from the respective I – O tables. According to the converter of I – O table shown in appendix A, the calculated data of 11 SNA sectors are stacked by using the following classification:

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[18]By applying the method in step 1 and 2, the negative values of the (*gfcf*) series during 1975 – 2004 are found only in SNA sector 2 (Mining and Quarrying) in 1975 and 1999, SNA sector 4 (Construction) in 1999, and SNA sector 8 (Banking, Insurance and Real Estate) in 1999

[19] The negative value of -759 millions of baht in 1975 of SNA sector 2 is replaced by 1030.4 (= 80% of the consecutive value in 1976). By the same token, the three negative values found in sector 2, 4, and 8 in 1999 (-2,030, -3,237, and -2,819 millions of baht) are consecutively replaced by 34,324.7, 90,693.3, and 25,989.2, (= 75% of the corresponding values in 2000).

Table 5.8: The Comparison between 11 SNA Sector and the 26 I – O Sectors

SNA Sector #	SIO Sector #
1	1 – 4
2	5
3	6 – 17
4	19
5	18
6	22
7	20
8	23, 24
9	26
10,11	21, 25

Note: SNA and SIO stands for the systems of the national account and input – output table, respectively.

However, the main problem of using the information from I – O tables in stacking the data comes from the advantage of the RAS method. As mentioned above, the RAS method will generate the target matrix that resembles the initial matrix, thus if the initial matrix has the zero elements in some orders, the target matrix will definitely have those in the same positions. Consequently, the generated data by this method yields zero values for the whole series of (*gfcf*) in some sectors such as crops, livestock, restaurants and hotels, and so on. This is an unreasonable result, since it is not likely that these sectors have no investment at all during the long period of time (1974 – 2004).

In order to solve this problem, the shares of sectoral output to the total output are used as the proxy for the scaling factor in stacking the investment data from 11 SNA sectors into the 26 I – O sectors. The reason is that the sectoral investment expenditure is used to increase the productivity of its own sector and to compensate for the damaged factors of production. The sector that has higher amounts of investment will have higher output and is more effective in maintaining its level of production. Therefore, the amount of investment expenditure by sector can be reasonably extracted by making use of the shares of the sectoral output as the guideline.

5.2.1) Literature Reviews and the Appropriate Functional Form for the Gross Fixed Capital Formation (*gfcf*)

There exist wide varieties of theories and models that attempt to explain the factors determining the variation of investment spending. For instance, the net present value (NPV) concept indicates that investment should have the positive relationships with the national income and aggregate demand (since the rise of income or higher cash flows of the project leads to an increase in investment spending), while it appears to be inversely related to the interest rate (high interest rate decreases the NPV of investment). Secondly, the simple accelerator model assumes that firms try to maintain a fixed ratio (γ) between capital stock and output (expected sales)[20], or

At the beginning of period t: $$K_{t-1} = \gamma \times Y_{t-1} \tag{5.24}$$

At the end of period t: $$K_t = \gamma \times Y_t \tag{5.25}$$

where, (K_{t-1}, K_t) and (Y_{t-1}, Y_t) are the capital stock and output in period t and t-1, respectively. From equation (5.24), an increase in firms' demands will cause them to hold a larger amount of capital (in terms of structures and equipment so as to extend their production or to maintain higher level of inventories in order to match with the consumer demand). As a result, the change in expected output should have a positive impact on the net investment, (or minus equation (5.24) from (5.25) yields):

$$I_t^n = (K_t - K_{t-1}) = \gamma \times (Y_t - Y_{t-1}) \tag{5.26}$$

[20] However, this ratio can vary due to changes in interest rates, tax rates and the cost of labor, and capital.

and, the gross investment (I_t^g) can be computed by adding the replacement capital[21] to the net investment:

$$I_t^g = I_t^n + d \times (K_{t-1}) = \gamma(Y_t - Y_{t-1}) + d\gamma(Y_{t-1}) \tag{5.27}$$

where, d denoted the depreciation rate.

The next theoretical foundation comes from the neoclassical theory that attempts to determine the desired level of capital stock (K^*). The neoclassical theory suggests that in equilibrium, the desired level of capital is the level that makes the rental cost of capital equals to the value marginal product of capital, and that the desired level of capital is inversely related to the rental cost of capital, while positively related to the wage rate, marginal product of capital (the productivity of capital), the quantity demanded, and the market price of the product.

Moreover, two other variables that generate the impacts on the level of investment are the expected rate of inflation and the expected depreciation rate. Higher inflation rate will make firms sell their capital at higher price, thus reduces the cost of capital used by the firms, while the wear and tear and the outdated technology (higher depreciation rate) cause firms to sell their capital at lower price, and hence increase the cost of capital. Generally, both expected inflation and depreciation are empirically unobservable. However, the magnitude of depreciation rate change is quite small over time, thus the focus of most economic theories is on the estimation of the expected rate of inflation. Various mathematical models (such as static expectation model, adaptive expectation

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[21] Replacement capital is assumed to be the fixed faction (d) of the capital stock. Thus, d represent the depreciation rate

model, naïve expectation model, and rational expectation model[22]) are used in order to estimate the investment function that takes into account the expected rate of inflation

An important question that challenges neoclassical economists is what is the rate of investment? or how long do firms take to adjust their capital to the desired level? To answer these questions, neoclassical economists developed a model called the flexible accelerator model by assuming that firms will close the gap between the current actual and the desired level of capital stock in each period by a constant proportion, say (*a*). Thus, the net investment (I_t^n) is determined by:

$$I_t^n = a \times \left(K^* - K_{t-1}\right) \tag{5.28}$$

where (*a*) is the adjustment factor ($0 < a < 1$). As a result, any factors (e.g. an increase in product price, a fall of interest rate) that increase the desired level of capital will definitely increase the investment.

Although the neoclassical theory provides thorough understanding of the structure of the rental cost of capital and prepares the estimating method by relying on the available data, the remaining problem that challenges the neoclassical theory is how to measure the rate of return from using the real capital, since generally, the neoclassical theory assumes that the marginal cost of capital (technology attached to the capital) is already known.

[22] The static expectation assumes that our expected inflation is stable no matter what the economic situation is changed. The naïve expectation employs the inflation rate from the last period as the proxy of the expected rate of inflation. The adaptive expectation uses the distributed lags (weighted average) of the past actual inflation rates to represent the expected inflation rate, and finally the rational expectation forecasts the expected rate of inflation by relying on the examination of the economic information.

Fortunately, Tobin (1969)[23] suggests another measure of firm's performance called "Tobin's q" which is the ratio of the market value of a firm's assets measured by the market value of firm's stocks and bonds to the replacement cost of these assets. If the value of Tobin's q is greater than 1, this indicates that the value of a firm's assets is greater than the cost of acquiring them, and this firm is willing to invest more in new equipment. On the other hands, the value of Tobin's q less than 1 indicates that the market value of the assets are less than the replacement costs, thus this firm will not invest in new capital. Accordingly, the incentive to investment is supposed to have a positive relationship with the Tobin's q.

Though, Tobin's q has an advantage in avoiding the estimating problem of the rate of return from capital, the appropriate value of Tobin's q is quite difficult to obtain, since it requires high level of accuracy for computing both firm's capital stocks and bonds value, and their replacement cost. Consequently, most studies during the past two decades concerning the estimation of investment function (such as Abel (1980)[24], Summers(1981)[25], Hayashi (1982)[26]) have paid attention on how to obtain more reliable values of Tobin's q.

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[23] Tobin, James, "A General Equilibrium Approach to Monetary Theory," Journal of Money, Credit, and Banking, 1, February 1969, pp. 15-29.

[24] Abel, Andrew B., "Empirical Investment Equations: An Integrative Framework", Brunner, Karl and Allan Meltzer, editors, On the State of Macroeconomics, volume 12 of the Carnegie-Rochester Conference Series on Public Policy, 1980, pp. 39-91.

[25] Summers, Lawrence, "Taxation and Corporate Investment: A q-Theory Approach," Brookings Papers on Economic Activity, 1981, pp. 67-127.

[26] Hayashi, Fumio, "Tobin's Marginal and Average q: A Neoclassical Interpretation," Econometrica, 50(1), January 1982, pp. 213-224.

After considering the choices of economic models and examining the available data for the Thai economy, the appropriate model for gross fixed capital formation in this study is based on the simple accelerator model[27], expressed as:

$$gfcf_t^i = a_0 + a_1 RI_t^i + a_2 r_t + a_3 (podum) + a_4 (cridum) + a_5 \Delta Y_t + \varepsilon_t \qquad (5.29)$$

where, $gfcf_t^i$ denotes the gross fixed capital formation of sector i at time t. ΔY_t^i is the change of output from the previous period. In this study, the lags of the first and the second period of the output are assumed to have an impact on *gfcf*. RI_t^i represents the replacement investment (depreciation) which is computed by subtracting the change of capital stock of sector i from the previous period (ΔK_t^i)[28] from the newly generated series of gross fixed capital formation (In_t^i) as shown in equation (5.23). The reason why RI_t^i must be added into the regression equation comes from the fact that the (*gfcf*) series is the gross investment but not the net investment. r_t denotes the real interest rate. In this case, the minimum loan rate (MLR) adjusted by the inflation rate is used as the real interest rate. Finally, two dummy variables (*podum* and *cridum*) are also inserted in the equation to capture the irregular movement of the data during the political chaos and the financial crisis. a_0 - a_5 are the estimated parameters. The expected sign for a_5 should be positive and close to 1 (since this parameter measures the depreciation rate for each

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[27] The computation of Tobin's q variables is out of the question because the accurate data for the sectoral value of capital stocks and their replacement costs are not available.

[28] Since, the data of capital stock for 26 I – O sectors are not available, the SNA capital stock series of 11 sectors are stacked in the same way as (*gfcf*) series by using the shares of sectoral output to the total output. The reason is that higher level of capital accumulation will lead to higher output, thus the structure of sectoral output is used as the proxy for detecting the structure of capital stocks.

sector). The sign of a_1 is also expected to be positive, while the expected sign for a_2, a_3, and a_4 should be negative.

Once again, the Dickey – Fuller test is performed in order to test the (non)stationary characteristics of each variable. The results are shown in Tables 5.9 and 5.10.

Table 5.9: The ADF Test for the Sectoral Gross Fixed Capital Formation (*gfcf*^{i}), Sectoral Replacement Investment (*RI*)

Sector	Coefficient for (*gfcf*$_i$)	Tau (τ) Statistic	Coefficient for (*RI*$_i$)	Tau (τ) Statistic
1	-0.791	-4.009**	-1.412	-7.903***
2	-0.813	-4.201**	-12.524	-4.312**
3	-0.958	-5.086***	-1.028	-5.216***
4	-0.652	-3.625**	-1.833	-4.356***
5	-1.021	-5.202***	24.829	3.489*
6	-0.564	-3.094**	-1.720	-5.154***
7	10.986	4.413**	-11.302	-5.386***
8	-1.509	-3.479*	-1.133	-3.744**
9	-0.530	-3.086	-0.199	-0.076
10	1.144	4.067***	-1.700	-4.578***
11	0.070	0.075	-9.026	-3.225
12	1.088	2.741*	-2.051	-5.684***
13	-1.485	-4.114**	-0.850	-4.235**
14	-1.334	-3.556*	-6.300	-3.516*
15	4.396	4.174***	-3.944	-6.806***
16	3.915	4.874***	-11.319	-6.745***
17	-1.391	-3.695**	-1.436	-4.193**
18	-1.348	-3.260*	-1.981	-6.115***
19	-2.793	-4.341**	-2.236	-7.406***
20	-1.505	-4.122**	-1.482	-4.664***
21	-1.196	-3.833**	-1.360	-5.027***
22	-1.544	-4.821***	-1.813	-5.734***
23	-1.100	-5.632***	-1.083	-5.529***
24	-1.129	-5.786***	-1.735	-12.913***
25	-1.792	-3.778**	-10.350	-5.163***
26	-2.068	-4.906***	-7.009	-5.016***

Notes: (1) *, **, *** denoted the significant level at 10%, 5%, and 1%, respectively for testing the null hypothesis that the particular series has a unit root.

According to the results from Tables 5.9 and 5.10, most series are stationary data at least at 5% level of significance. Only the values of Tau (τ) statistics of (*gfcf*) series for sectors 8, 12, and 18, the (*RI*) series of sector 5 and 14, and the (Δy) series of sectors 6, 9, 12, 14, 16, 20, 22 and 25 are significant at 10% level. By contrast, the non – stationary series are found in sectors 9 and 11 for the (*gfcf*) and (RI) series, and sector 8 for the (Δy) series.

Table 5.10: The ADF Test for the Change of Sectoral Output (Δy), the Dummy Variables (*poldum*), (*cridum*), and the Real Interest Rate (R)

Sector	Coefficient for (Δy_i)	Tau (τ) Statistic	Sector	Coefficient for (Δy_i)	Tau (τ) Statistic
1	-6.479	-4.425***	14	-0.742	-3.563*
2	-1.415	-7.735***	15	-0.980	-5.003***
3	-0.903	-4.618***	16	-4.337	-3.277*
4	-0.943	-3.017**	17	-2.589	-4.352**
5	-1.468	-5.129***	18	-2.179	-7.363***
6	-1.059	-3.508*	19	-7.020	-6.729***
7	-1.571	-4.409***	20	-0.659	-3.562*
8	-0.302	-1.975	21	-1.079	-3.973**
9	-0.407	-2.670*	22	-1.546	-2.880*
10	-1.740	-5.533***	23	-0.502	-3.302**
11	-0.768	-4.017**	24	-5.516	-4.464**
12	-5.711	-3.538*	25	-3.592	-3.417*
13	-2.487	-4.693***	26	-1.687	-4.860***

Test for *Poldum* and *Cridum*

Coefficient for (*poldum*)	Tau (τ) Statistic	Coefficient for (*cridum*)	Tau (τ) Statistic
-1.102	-4.414***	-0.459	-2.729*

Test for the Real Interest Rate

Coefficient for (*R*)	Tau (τ) Statistic
-1.114	-5.677***

Notes: (1) *, **, *** denoted the significant level at 10%, 5%, and 1%, respectively for testing the null hypothesis that the particular series has a unit root.

5.2.2) The Estimation Results for the Investment Function

One problem that emerges from using (Δy) as the explanatory variable is the simultaneity bias, since the (Δy) series which are computed from the sectoral output data are endogenous to the MUTE model, adding (Δy) on the right – hand side of the equation will violate the assumption of the independency between the explanatory variable and the disturbance term. As a result, the OLS estimated parameters are not only biased but also inconsistent.

In order to avoid the problem of simultaneity bias and the spurious regression from adding the non – stationary (Δy_i) for the sector that ($gfcf_i$) data are stationary, investment equations of the MUTE model are modified by replacing (Δy) with ($gfcf_{t-1}$):

$$gfcf_t^i = a_0 + a_1 RI_t^i + a_2 r_t + a_3(podum) + a_4(cridum) + a_5 gfcf_{t-1}^i + \varepsilon_t \qquad (5.30)$$

, and for the non – stationary ($gfcf$) (sector 9 and 11), equation (5.29) is modified as:

$$gfcf_t^i = b_0 + b_1 RI_t^i + b_2(cridum) + \varepsilon_t \qquad (5.31)^{29}$$

Both equations (5.30) and (5.31) are estimated equation by equation by using the OLS method. However, equation (5.31) must be checked for cointegration[30]. In this study, two tests (trace test and the maximum eigenvalue test) are performed in order to detect the existence of cointegrating vectors. In brief, the trace statistic tests the null hypothesis of the number of cointegrating vectors being less than or equal to r against the alternative hypothesis of r+1 or more. However, the maximum eigenvalue statistic tests the null hypothesis of the number of cointegrating vectors being less than or equal to r against the alternative hypothesis of r+1. If the test statistics exceed the critical value, then the null hypothesis is rejected[31]. The results of these two tests on equation (5.31) for sector 9 and 11 shown in Table 5.11 indicate that there exists 1 cointegrating vector in

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[29] The difference between equation (5.30) and (5.31) is the omission of the real interest rate variable (r) and the lagged of the dependent variable ($gfcf^i_{t-1}$) from the equation, since the non – stationary series cannot be regressed on the (non)stationary one. However, in this case equation (5.31) is inserted only the (*cridum*) variable because the Dickey – Fuller statistic is significant at only 10% level. As a result, when (*cridum*) is used in equation (5.30), it is treated as the stationary variable. By contrast, if it is used in equation (5.31), it is non – stationary variable.

[30] It is possible that the linear combination of the non – stationary series is stationary.

[31] The test statistics for both tests can be computed by the following formula:

$$\text{Trace Test} = -T\sum_{i=r+1}^{n}\ln(1-\lambda_i) \qquad (5.32)$$

$$\text{Maximum Eigenvalue Test} = -T\ln(1-\lambda_{r+1}) \qquad (5.33)$$

where, T is the number of observations, λ_i is the i^{th} eigenvalue, and r denotes the number of cointegrating vectors.

both sectoral equations at both 5% and 1% level. This evidence confirms that the regressions of (*gfcf*) on (*RI*) and (*cridum*) in these two sectors are not spurious.

Table 5.11: The Cointegration Test for the Sectoral Investment Function of Sector 9 and 11

Sector	Trace Test			Maximum Eigenvalue Test			# of Cointegrating Vector
Vectors	$r = 0$	$r \leq 1$	$r \leq 2$	$r = 0$	$r \leq 1$	$r \leq 2$	
# 9	74.477	5.382	0.091	69.095	5.291	0.091	1
Critical Value							
5%	(29.68)	(15.41)	(3.76)	(20.97)	(14.07)	(3.76)	
1%	(35.65)	(20.04)	(6.65)	(25.52)	(18.63)	(6.65)	
# 11	40.927	7.028	0.297	33.900	6.730	0.297	1
Critical Value							
5%	(29.68)	(15.41)	(3.76)	(20.97)	(14.07)	(3.76)	
1%	(35.65)	(20.04)	(6.65)	(25.52)	(18.63)	(6.65)	

Finally, the structure of *AR(1)* is added to the particular equations (1 – 4, 7, 9, and 11) in order to solve the problem of autocorrelation. The estimated parameters and some important statistics by the OLS method are shown in Table 5.12.

One more statistic value that needs to be computed for the set of equations (5.30) is the Durbin *h* test, since the insertion of the lagged dependent variable on the right - hand side of the estimated equation will make the value of the Durbin – Watson statistic tend toward 2 and give us the wrong conclusion about the autocorrelation problem. According to Durbin (1970)[32], the *h* statistic can be calculated by:

$$h = (1 - \frac{1}{2}d)\sqrt{\frac{n}{1 - n[\mathrm{var}(\hat{\alpha}_i)]}} \tag{5.34}$$

where, *h* denotes the estimated Durbin – Watson. (*n*) is the number of the observations, $\mathrm{var}[\hat{\alpha}_i]$ represents the variance of the coefficient of ($gfcf^{i}_{t-1}$), and *h* is asymptotically normal distribution with zero means and unit variance.

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[32] J. Durbin, "Testing for Serial Correlation in Least – Squares Regression When Some of the Regressors Are Lagged Dependent Variables," *Economatrica*, vol. 38, 1970, pp. 410 – 421.

For the null hypothesis that there is no (positive or negative) 1st order autocorrelation against the alternative that there exist the negative or positive 1st order autocorrelation, on one hand, a computed value of h lying between -1.96 and +1.96 confirms that there is no such problem, or we fail to reject the null hypothesis; on the other hand, if $h > 1.96$ or $h < -1.96$, we will reject the null hypothesis and conclude that there is a problem of positive or negative 1st order autocorrelation, respectively. The estimated Durbin h statistics corresponding to $D.W$ statistics from Table 5.12 are shown in Table 5.13. These results confirm that there is no problem of autocorrelation in the sectoral gross fixed capital formation equations.

Table 5.12: The Estimated Parameter for the Sectoral Gross Fixed Capital Formation

Sector	*C*	RI_i	*r*	*Poldum*	*Cridum*	$gfcf_{t-1}$	*AR(1)*	*Adj.* R^2	*D.W.*
1	2644.59 (0.62)	-0.064 (-0.54)	-	-2027.83 (-0.31)	-20746.6 **(-3.08)**	1.089 **(10.77)**	-0.517 **(-2.36)**	0.711	2.250
2	515.93 (0.77)	-0.071 (-1.63)	-	-318.62 (-0.29)	-3185.9 **(-2.83)**	1.069 **(10.23)**	-0.522 **(-2.74)**	0.686	2.188
3	470.03 **(2.45)**	-0.043 (-0.89)	-	-	-429.25 **(-2.64)**	0.737 **(4.64)**	-0.753 **(-5.21)**	0.344	2.224
4	589.44 (0.53)	-0.093 (-1.56)	-	-569.96 (-0.26)	-7678.7 **(-2.49)**	1.132 **(9.79)**	-0.443 **(-2.21)**	0.778	2.323
5	6286.93 **(3.15)**	0.669 **(9.25)**	-	-3150.98 (-0.89)	-	0.404 **(4.67)**	-	0.807	1.811
6	2921.39 (1.75)	-0.136 **(-2.39)**	-6.345 (-0.62)	-1977.45 (-0.77)	-15618.7 **(-4.55)**	1.041 **(10.56)**	-	0.831	2.056
7	32.65 (0.03)	0.090 **(3.15)**	-	-7.198 (-0.00)	-12486.5 **(-6.54)**	1.139 **(19.74)**	-0.387 (-1.63)	0.901	2.483
8	5473.54 (1.78)	-0.118 (-1.47)	-2.011 (-0.15)	-3831.36 (-0.78)	-32063.3 **(-4.86)**	1.050 **(11.06)**	-	0.832	2.195
9	11569.74 (0.90)	-0.162 **(-3.00)**	-	-	-4723.46 **(-4.33)**	-	0.954 **(13.10)**	0.829	1.688
10	880.91 (1.76)	-0.236 **(-8.86)**	-	-645.27 (-0.76)	-7696.03 **(-6.84)**	1.035 **(14.35)**	-	0.921	1.595
11	42510.11 (0.58)	-0.150 **(-6.70)**	-	-	-9246.55 **(-3.93)**	-	0.972 **(15.73)**	0.879	1.707
12	701.37 (1.64)	-0.258 **(-5.43)**	-	-488.88 (-0.69)	-5223.33 **(-5.80)**	1.044 **(13.74)**	-	0.898	1.787
13	1317.54 (1.96)	0.130 (0.93)	-	-616.51 (-0.56)	-9642.83 **(-6.18)**	1.006 **(12.67)**	-	0.896	1.777
14	374.02 **(2.17)**	-0.167 **(-3.55)**	-0.278 (-0.37)	-251.64 (-0.92)	-1822.50 **(-4.52)**	1.054 **(16.37)**	-	0.914	1.815
15	831.57 (1.67)	-0.187 **(-2.35)**	-	-643.24 (-0.80)	-5560.74 **(-4.96)**	1.065 **(10.33)**	-	0.812	2.255
16	1126.05 (0.52)	-0.417 **(-6.87)**	-0.710 (-0.06)	-	-33713.9 **(-6.08)**	1.126 **(21.35)**	-	0.946	2.034

Table 5.12 (Continued)

Sector	C	RI_i	r	*Poldum*	*Cridum*	$gfcf_{t-1}$	*AR(1)*	*Adj.* R^2	*D.W.*
17	3178.03 (1.59)	-0.319 **(-3.57)**	-2.756 (-0.30)	-2716.87 (-0.83)	-27925.7 **(-6.35)**	1.190 **(13.20)**	-	0.893	2.161
18	18215.80 (1.93)	0.277 (1.78)	-	-10653.0 (-0.72)	-	0.775 **(5.92)**	-	0.651	2.302
19	7047.98 (1.73)	0.010 (0.07)	-17.026 (-0.86)	-5940.14 (-0.87)	-26431.9 **(-3.00)**	0.981 **(9.23)**	-	0.787	1.549
20	10861.28 (1.51)	-0.034 (-0.28)	-26.566 (-0.90)	-6898.32 (-0.65)	-66533.5 **(-4.66)**	1.051 **(11.03)**	-	0.840	2.350
21	2400.88 (1.43)	0.076 (1.08)	-	-939.52 (-0.39)	-11719.5 **(-3.74)**	1.002 **(14.92)**	-	0.919	2.419
22	10902.37 (0.97)	0.232 **(3.61)**	-	-11257.3 (-0.66)	-82472.8 **(-3.61)**	1.025 **(18.78)**	-	0.947	1.944
23	9008.85 **(4.81)**	0.624 **(10.09)**	-	-4271.86 (1.15)	-	0.004 (0.05)	-	0.790	1.480
24	697.44 (0.79)	0.793 **(9.85)**	-20.296 **(-4.70)**	-683.33 (-0.49)	-	0.476 **(5.15)**	-	0.793	1.678
25	2186.76 (0.61)	0.185 **(3.97)**	-29.998 (-1.88)	-	-29563.8 **(-3.76)**	1.062 **(22.63)**	-	0.956	2.269
26	17113.80 (1.29)	-0.011 (-0.10)	-	-872.78 (-0.05)	-81291.4 **(-3.22)**	1.000 **(12.72)**	-	0.861	1.963

Note: (1) The t – statistics are shown in the parenthesis. The Bold numbers represent the significance level at 5%. (2) *C*, *D.W.* and *Adj.* R^2 denote the constant term, the Durbin – Watson Statistics and the adjusted correlation coefficients, respectively.

Table 5.13: Durbin *h* Test for the Sectoral ($gfcf_i$) Equations

Sector	*h*	Sector	*h*	Sector	*h*
1	-0.803	10	1.184	19	1.479
2	-0.613	12	0.630	20	-1.098
3	-1.163	13	0.664	21	-1.210
4	-1.113	14	0.532	22	0.157
5	0.575	15	-0.827	23	1.595
6	-0.190	16	-0.095	24	1.000
7	-1.369	17	-0.495	25	-0.750
8	-0.610	18	-1.145	26	0.109

From Table 5.12, all of the constant terms take positive values which represent the autonomous investment when all other variables are zero. Surprisingly, most of the parameters for replacement investment variables (RI_i), except for sectors 5, 7, 13, 18, 19, 21, 22, 23, 24, and 25, which represent the depreciation rate for each sector, have negative values. One possible reason for the negative depreciation rate is that Thailand is a country that imports most of her capital and equipment from abroad (mostly from the more advanced countries such as U.S., Japan, and etc.), thus the depreciation of Baht against the trading partners' currencies especially during the financial crisis will cause the value of these capital and equipment to increase and hence making the depreciation rate negative.

The real interest rate variable is inserted in sectors 6, 8, 14, 16, 17, 19, 20, 24, and 25, but it is significant at 5% level only in sector 24. The estimated parameters in these sectors have the reasonable sign, i.e., investment expenditure should be a negative function of the real interest rate. Thus, for the rest of the sectors which the estimated parameters have the positive sign, the real interest rate variable is omitted from those sectoral equations. Although the omission will possibly lead to the problem of specification error when the relevant variable is omitted from the estimated equation, the objective of omitting some variables from the equation is to acquire reasonable results in economics.

By the same reason, the (*poldum*) variable is omitted from the investment equations of sectors 3, 9, 11, 16, and 25, while the (*cridum*) variable is left out from equations of sectors 5, 18, 23 and 24, since their estimated parameters have the positive sign, and there is no economic reason to support that the investment expenditures in these sectors would have increased during the period of political chaos and financial crisis. For the rest of the sectors, although (*poldum*) has the adverse effect on investment expenditure, the impact is not significant even at 10% level. This is quite different from the impact of the financial crisis (*cridum*) that has significant influence on (*gfcf*). According to the estimated result, financial crisis has the largest impact on sector 22 (Transportation and Communication) and the least impact is found in sector 3 (Forestry), while the disorder of political system causes the large reduction of investment expenditure in sectors such as 18 (Electricity and Water Works), 20 (Trade), and 22 which are mostly under the government control, or the sectors that rely on the confidence in government.

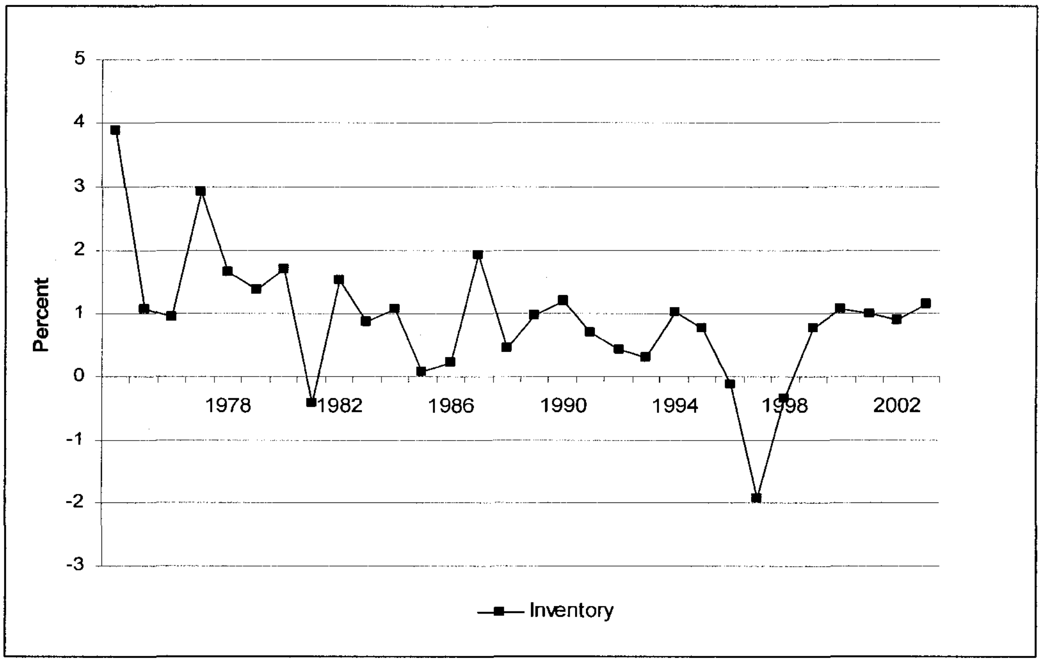
The lagged dependent variable by 1 period is added into the equation in order to raise the value of adjusted R^2, and in most equations, this variable has a significant impact (t statistics of these parameters are greater than 2.00) on the current level of investment. All estimated coefficients for this variable are positive as expected, supporting the idea that if the investment in the prior period is in good condition, then the investment in the current period is also in good shape.

Finally, the values of adjusted R^2 in estimating the (*gfcf*) equation are quite high. In most cases, more than 75% of the variation in the dependent variable can be explained by the variation of the overall explanatory variables. However, two sectors that have low value of adjusted R^2 under this specification are sectors 3 and 18, which require better specification or specific variables that have more explanatory power.

5.3 The Estimation of the Sectoral Inventory Investment (ii_i)

Generally, inventory includes the firm's raw materials, unfinished goods and the finished goods that are ready or will be ready for selling. This component is treated as assets of the firm. Although, inventory investment is quite small in magnitude when comparing with other final demand components of Thailand (3.8 percent of GDP in 1975 and fluctuated around 1 – 1.3 percent of GDP during 2000 – 2004 (see Figure 5.5)), it is an important component in determining the accuracy of estimating sectoral outputs.

Figure 5.5: The Ratio of Inventory Investment to the GDP (Percent)



Source: Bank of Thailand

There exist various specifications of the equation for inventory investment. For example, in the MUDAN model for China, the problem of estimating the inventory investment equations comes from the lack of the historical data for sectoral inventory, thus the set of inventory equations is generated by relying on a stock adjustment model[33]. The study assumes that each firm has a desired level of inventory stock (ivn^d) which is different from the actual level of inventory (*inv*). A firm will adjust its inventory by the constant fraction (α) in each period, if there is an inconsistency between the actual and the desired levels of inventory. Thus, the inventory equation is determined by:

$$\Delta ivn_{i,t} = \alpha_i (ivn_{i,t}^d - ivn_{i,t-1}) \tag{5.35}$$

[33]Qisheng Yu, op. cit., p.141 – 145.

where $\Delta ivn_{i,t}$ denotes the change of inventory stock of sector i in period t. Moreover, the study assumes that the desired level of inventory stock is a fixed proportion (β) to output ($output_{i,t}$), or:

$$ivn^{d}_{i,t} = \beta_i * output_{i,t} \tag{5.36}$$

By substituting equation (5.36) in (5.35), this yields:

$$\Delta ivn_{i,t} = \alpha_i * \beta_i * output_{i,t} - \alpha_i * ivn_{i,t-1} \tag{5.37}$$

The value of α is assumed to be 0.8 in every sectors, while the values of β_i (inventory – output ratio) are assumed to equal the value of this ratio in 1995 (the only year that the data are available).

Unlike the data construction method in the MUDAN model, the regression technique is used to estimate the inventory investment equations for the TIDY model of Thailand[34]. In this study, inventory change is defined as the difference between the firm's sales and the firm's output, and the inventory change equation is specified as:

$$Inven_{i,t} = \alpha_0 + \alpha_1 FS_{i,t} + \alpha_2 \Delta FS_{i,t} + \alpha_3 \Delta FS_{i,t-1} + \alpha_4 dummy \tag{5.38}$$

where Δ denotes the change of the particular variable from the previous time period. $FS_{i,t}$ represents the final sale of sector i at time t, which is computed by the summation of private consumption expenditure, gross fixed capital formation, government consumption and export.

[34] Manuprasert, op. cit., p.31 – 32.

5.3.1 Source of Data, the (Non)Stationary Test, and the Estimated Result for the Sectoral Inventory investment

Since the data for sectoral inventory investment are available only in SIO system, in order to achieve the consistency between SIO and SNA system, the information about the ratio between sectoral inventory change to the total inventory change from RAS I – O table are used as the scaling factors for the corresponding published SNA inventory investment data.

However, under this generating process, both specifications mentioned above have a severe defect if they are employed to estimate the inventory equations for the MUTE model. The defect emerges from the (non)stationary characteristic of the variables in the equation. According to the Augmented Dickey – Fuller test in Table 5.14, the result indicates that all inventory investment series in both level and 1st difference forms are stationary data, while most of the sectoral output series are non – stationary, except for the output series of sector 10 and 19, which are stationary at 5% level.

Table 5.14: The ADF Test for Inventory Investment Series (ii_i) and the Sectoral Output (y_i)

The ADF Test for Inventory Investment Series (ii_i)					
Sector	Coefficient for (ii_i)	Tau (τ) Statistic	Sector	Coefficient for (ii_i)	Tau (τ) Statistic
1	-0.700	-3.749***	14	-0.929	-4.306**
1st diff.	-1.146	-5.907***	1st diff.	-1.001	-5.004***
2	-0.933	-3.917**	15	-0.942	-4.569***
1st diff.	-1.103	-5.537***	1st diff.	-4.291	-3.669**
3	-1.083	-5.473***	16	-0.906	-4.802***
1st diff.	-3.979	-5.409***	1st diff.	-1.201	-4.983***
4	-0.974	-4.550***	17	-0.916	-4.691***
1st diff.	-1.380	-5.038***	1st diff.	-1.863	-5.041***
5	-0.888	-4.059**	18	-1.387	-4.238**
1st diff.	-4.158	-3.730**	1st diff.	-4.583	-3.721**
6	-1.418	-4.212**	19	-0.905	-4.713***
1st diff.	-4.153	-3.784**	1st diff.	-1.894	-4.994***
7	-0.915	-4.134**	20	-0.937	-4.375***
1st diff.	-4.052	-3.844**	1st diff.	-3.734	-3.688**
8	-0.934	-4.426***	21	-0.924	-4.439***
1st diff.	-1.344	-4.931***	1st diff.	-3.662	-3.635**

Table 5.14: (Continued)

The ADF Test for Inventory Investment Series (ii_i)					
Sector	**Coefficient for (ii_i)**	**Tau (τ) Statistic**	**Sector**	**Coefficient for (ii_i)**	**Tau (τ) Statistic**
9	-0.946	-4.447^{***}	22	-0.932	-4.444^{***}
1st diff.	-4.636	-3.858^{**}	1st diff.	-1.307	-4.865^{***}
10	-2.428	-4.144^{**}	23	-0.916	-4.482^{***}
1st diff.	-5.303	-4.041^{**}	1st diff.	-1.337	-4.906^{***}
11	-0.982	-4.353^{***}	24	-0.906	-4.517^{***}
1st diff.	-5.051	-4.086^{**}	1st diff.	-1.898	-4.873^{***}
12	-1.431	-4.248^{**}	25	-0.961	-4.414^{***}
1st diff.	-4.427	-3.647^{**}	1st diff.	-4.190	-3.860^{**}
13	-0.898	-4.556^{***}	26	-1.009	-4.652^{***}
1st diff.	-1.806	-4.743^{***}	1st diff.	-1.479	-5.480^{***}
The ADF Test for the Sectoral Output (y_i)					
Sector	**Coefficient for (y_i)**	**Tau (τ) Statistic**	**Sector**	**Coefficient for (y_i)**	**Tau (τ) Statistic**
1	-0.438	-2.709	14	-0.311	-1.807
2	-0.826	-3.056	15	-0.038	-0.917
3	-0.181	-2.063	16	-0.071	-0.291
4	-0.215	-2.516	17	-0.102	-0.609
5	0.307	2.815	18	-0.012	-0.186
6	0.480	3.133	19	0.687	3.036^{**}
7	-2.352	-3.159	20	-0.123	-2.064
8	-0.132	-2.535	21	-0.231	-2.619
9	-0.309	-1.767	22	-0.073	-1.786
10	5.349	3.665^{**}	23	-0.359	-2.919
11	-0.123	-1.541	24	-0.179	-1.582
12	-0.674	-2.123	25	-0.220	-1.020
13	-0.326	-1.800	26	-0.289	-1.478

Notes: (1) *, **, *** denoted the significant level at 10%, 5%, and 1%, respectively for testing the null hypothesis that the particular series has a unit root.
(2) The result of ADF test for 1st difference of the sectoral output series is already shown in Table 5.10.

Thus, unlike the MUDAN model that specifies the values of the parameters in the first place, if equation (5.37) is estimated by using the regression technique, this is the case where the non – stationary data are regressed on the stationary data. As a result, the OLS estimation for equation (5.37) will lead to the problem of spurious regression.

The same reason can be applied to equation (5.38), although inventory investment series are stationary but the final sale series ($FS_{i,t}$) which is the summation of private consumption expenditure, gross fixed capital formation, government consumption and export are non – stationary[35] (see Table 5.15 for ADF test on the final sale series).

Table 5.15: The ADF Test for the Final Sale Series (FS_i)

Sector	Coefficient for (y_i)	Tau (τ) Statistic	Sector	Coefficient for (y_i)	Tau (τ) Statistic
1	0.085	1.039	14	0.383	2.856
2	-0.301	-2.225	15	-0.223	-2.241
3	-0.611	-3.578**	16	-0.079	-1.085
4	-0.418	-2.877	17	-0.710	-3.246
5	-0.748	-3.729**	18	-0.780	-4.048**
6	-0.215	-1.666	19	-2.678	-4.659***
7	-0.108	-1.449	20	-0.259	-2.230
8	-0.729	-2.318	21	-0.203	-2.462
9	-0.573	-3.477*	22	0.092	0.267
10	-0.180	-0.331	23	-1.822	-4.975***
11	0.071	0.670	24	-0.773	-4.171**
12	1.890	3.997**	25	-0.083	-1.672
13	-0.127	-1.453	26	-2.289	-5.432***

Notes: (1) *, **, *** denoted the significant level at 10%, 5%, and 1%, respectively for testing the null hypothesis that the particular series has a unit root.

Since all inventory investment series (ii_i) are stationary, the time series technique called the corrected Akaike's information criterion (AICc) for model – selection method is used to specify the order of p and q in the *ARMA* (p, q) model for (ii_i) series (see appendix B. for more information on AICc). The result of the AICc method for the sectoral inventory investment is shown in Table 5.16. Finally, the estimated residuals of each equation are tested for whether their characteristics follow the properties of the White noises sequences. Six tests for White - noise residuals include Ljung – Box portmanteau test (Q_{LB}), McLeod – Li portmanteau test (Q_{ML}), Turning point test (Z_{TP}), Difference – sign test (Z_S), the rank test (Z_P), and Minimum – AICc AR order (MAAO) are shown in Table 5.17 (See appendix B. for more information on each test).

[35] The linear combination of non – stationary and stationary data will give the non – stationary data.

Table 5.16: The Estimation Results for Sectoral Inventory Investment by AICc Method

Sector	ARIMA (p, d, q)	Equation	WN Var.
1	(0, 0, 1)	$ii(1)_t = Z_{(t)} + \underset{(0.171)}{0.410} Z_{(t-1)}$	.268702E+07
2	(2, 0, 1)	$ii(2)_t = \underset{(0.146)}{1.146} ii(2)_{(t-1)} - \underset{(0.148)}{0.554} ii(2)_{(t-2)} + Z_{(t)} - \underset{(0.103)}{1.000} Z_{(t-1)}$	.388718E+05
3	(1, 0, 0)	$ii(3)_t = \underset{(0.177)}{0.285} ii(3)_{(t-1)} + Z_{(t)}$	.494075E+04
4	(2, 0, 1)	$ii(4)_t = \underset{(0.140)}{1.102} ii(4)_{(t-1)} - \underset{(0.137)}{0.624} ii(4)_{(t-2)} + Z_{(t)} - \underset{(0.204)}{1.000} Z_{(t-1)}$	.138818E+06
5	(2, 0, 1)	$ii(5)_t = \underset{(0.165)}{1.133} ii(5)_{(t-1)} - \underset{(0.125)}{0.751} ii(5)_{(t-2)} + Z_{(t)} - \underset{(0.184)}{0.742} Z_{(t-1)}$	.114821E+06
6	(2, 0, 1)	$ii(6)_t = \underset{(0.165)}{1.161} ii(6)_{(t-1)} - \underset{(0.129)}{0.740} ii(6)_{(t-2)} + Z_{(t)} - \underset{(0.176)}{0.799} Z_{(t-1)}$	.295170E+06
7	(2, 0, 1)	$ii(7)_t = \underset{(0.138)}{1.148} ii(7)_{(t-1)} - \underset{(0.136)}{0.635} ii(7)_{(t-2)} + Z_{(t)} - \underset{(0.102)}{1.000} Z_{(t-1)}$	.226487E+06
8	(2, 0, 0)	$ii(8)_t = \underset{(0.159)}{0.583} ii(8)_{(t-1)} - \underset{(0.161)}{0.494} ii(8)_{(t-2)} + Z_{(t)}$	.115128E+07
9	(2, 0, 1)	$ii(9)_t = \underset{(0.172)}{1.070} ii(9)_{(t-1)} - \underset{(0.127)}{0.734} ii(9)_{(t-2)} + Z_{(t)} - \underset{(0.222)}{0.750} Z_{(t-1)}$	.254287E+05
10	(2, 0, 1)	$ii(10)_t = \underset{(0.153)}{1.040} ii(10)_{(t-1)} - \underset{(0.116)}{0.806} ii(10)_{(t-2)} + Z_{(t)} - \underset{(0.189)}{0.623} Z_{(t-1)}$	.482892E+05
11	(2, 0, 1)	$ii(11)_t = \underset{(0.148)}{1.079} ii(11)_{(t-1)} - \underset{(0.137)}{0.641} ii(11)_{(t-2)} + Z_{(t)} - \underset{(0.260)}{0.974} Z_{(t-1)}$	.214200E+06
12	(2, 0, 1)	$ii(12)_t = \underset{(0.171)}{1.078} ii(12)_{(t-1)} - \underset{(0.126)}{0.756} ii(12)_{(t-2)} + Z_{(t)} - \underset{(0.205)}{.6630} Z_{(t-1)}$	.276027E+05
13	(2, 0, 0)	$ii(13)_t = \underset{(0.155)}{0.693} ii(13)_{(t-1)} - \underset{(0.158)}{0.543} ii(13)_{(t-2)} + Z_{(t)}$	.623828E+05
14	(2, 0, 1)	$ii(14)_t = \underset{(0.141)}{1.129} ii(14)_{(t-1)} - \underset{(0.138)}{0.624} ii(14)_{(t-2)} + Z_{(t)} - \underset{(0.121)}{1.000} Z_{(t-1)}$	.403062E+04
15	(2, 0, 1)	$ii(15)_t = \underset{(0.194)}{1.056} ii(15)_{(t-1)} - \underset{(0.126)}{0.733} ii(15)_{(t-2)} + Z_{(t)} - \underset{(0.273)}{0.680} Z_{(t-1)}$	.224198E+05
16	(2, 0, 0)	$ii(16)_t = \underset{(0.147)}{0.822} ii(16)_{(t-1)} - \underset{(0.153)}{0.644} ii(16)_{(t-2)} + Z_{(t)}$	.136562E+07
17	(2, 0, 0)	$ii(17)_t = \underset{(0.153)}{0.695} ii(17)_{(t-1)} - \underset{(0.156)}{0.562} ii(17)_{(t-2)} + Z_{(t)}$	.585888E+06
18	(2, 0, 1)	$ii(18)_t = \underset{(0.201)}{1.071} ii(18)_{(t-1)} - \underset{(0.133)}{0.704} ii(18)_{(t-2)} + Z_{(t)} - \underset{(0.265)}{0.708} Z_{(t-1)}$	.293139E+06
19	(2, 0, 0)	$ii(19)_t = \underset{(0.155)}{0.618} ii(19)_{(t-1)} - \underset{(0.152)}{0.496} ii(19)_{(t-2)} + Z_{(t)}$	.745376E+06
20	(2, 0, 1)	$ii(20)_t = \underset{(0.139)}{1.153} ii(20)_{(t-1)} - \underset{(0.136)}{0.643} ii(20)_{(t-2)} + Z_{(t)} - \underset{(0.166)}{1.000} Z_{(t-1)}$	.779893E+07
21	(0, 0, 4)	$ii(21)_t = Z_{(t)} + \underset{(0.181)}{0.508} Z_{(t-1)} - \underset{(0.319)}{0.038} Z_{(t-2)} - \underset{(0.195)}{0.628} Z_{(t-3)} - \underset{(0.304)}{0.842} Z_{(t-4)}$	.727330E+06
22	(2, 0, 1)	$ii(22)_t = \underset{(0.234)}{1.045} ii(22)_{(t-1)} - \underset{(0.131)}{0.697} ii(22)_{(t-2)} + Z_{(t)} - \underset{(0.339)}{0.657} Z_{(t-1)}$	.201119E+07
23	(2, 0, 0)	$ii(23)_t = \underset{(0.160)}{0.572} ii(23)_{(t-1)} - \underset{(0.158)}{0.462} ii(23)_{(t-2)} + Z_{(t)}$	.735481E+06
24	(2, 0, 0)	$ii(24)_t = \underset{(0.160)}{0.608} ii(24)_{(t-1)} - \underset{(0.159)}{0.467} ii(24)_{(t-2)} + Z_{(t)}$	.377371E+05

Table 5.16: (Continued)

Sector	ARIMA (p, d, q)	Equation	WN Var.
25	(2, 0, 1)	$ii(25)_t = 1.110\ ii(25)_{(t-1)} - 0.647\ ii(25)_{(t-2)} + Z_{(t)} - 1.000\ Z_{(t-1)}$ (0.138) (0.135) (0.146)	.674599E+07
26	(2, 0, 1)	$ii(26)_t = 1.063\ ii(26)_{(t-1)} - 0.555\ ii(26)_{(t-2)} + Z_{(t)} - 1.000\ Z_{(t-1)}$ (0.146) (0.143) (0.102)	.610951E+05

Notes: (1) $ii(\#)$ denotes the inventory investment series for sector #.
(2)Each equation is estimated by the maximum likelihood method via the Iterative Time Series Modeling (ITSM) software.
(3) All numbers in the parentheses represent the standard errors of the AR and MA terms.
(4) $Z_{(t)}$ denotes White noise stochastic error term with zero mean and their variance shown in the last column of Table 5.16.

Table 5.17: The Results of the Randomness Test for the Residuals of the Sectoral Inventory Investment Equations

Sector #	Q_{LB}	Q_{ML}	Z_{TP}	Z_S	Z_P	MAAO
1 p - value	6.289 (0.959)	0.731 (1.000)	20.000 (0.551)	14.000 (0.756)	.22600E+03 (0.762)	0
2 p - value	5.666 (0.932)	2.181 (0.999)	19.000 (0.882)	17.000 (0.120)	.21200E+03 (0.844)	0
3 p - value	8.530 (0.860)	18.990 (0.214)	18.000 (0.766)	14.000 (0.756)	.14900E+03 (0.015*)	0
4 p - value	3.445 (0.992)	1.851 (0.999)	19.000 (0.882)	16.000 (0.351)	.25700E+03 (0.159)	0
5 p - value	5.696 (0.931)	0.567 (1.000)	20.000 (0.551)	16.000 (0.351)	.24200E+03 (0.382)	0
6 p - value	5.190 (0.951)	0.639 (1.000)	19.000 (0.881)	17.000 (0.120)	26000E+03 (0.129)	0
7 p - value	4.2078 (0.980)	1.7444 (0.999)	19.000 (0.882)	17.000 (0.120)	.24800E+03 (0.276)	0
8 p - value	6.860 (0.909)	1.112 (1.000)	20.000 (0.551)	16.000 (0.351)	.27000E+03 (0.061)	0
9 p - value	3.567 (0.990)	0.744 (1.000)	18.000 (0.766)	16.000 (0.351)	.26900E+03 (0.066)	0
10 p - value	4.754 (0.966)	0.524 (1.000)	20.000 (0.551)	14.000 (0.756)	.26700E+03 (0.077)	0
11 p - value	3.071 (0.995)	0.594 (1.000)	18.000 (0.766)	18.000 (0.029*)	.24700E+03 (0.293)	0
12 p - value	4.731 (0.966)	1.527 (1.000)	18.000 (0.766)	16.000 (0.351)	.27400E+03 (0.044)	0
13 p - value	6.4275 (0.929)	3.6466 (0.999)	20.000 (0.551)	15.000 (0.756)	.27500E+03 (0.040*)	0
14 p - value	4.9850 (0.959)	6.7491 (0.964)	19.000 (0.881)	16.000 (0.351)	.27300E+03 (0.048*)	0
15 p - value	3.515 (0.991)	0.947 (1.000)	20.000 (0.551)	15.000 (0.756)	.27000E+03 (0.061)	0
16 p - value	6.359 (0.932)	8.673 (0.894)	20.000 (0.551)	15.000 (0.756)	.27900E+03 (0.028*)	0

Table 5.17: (Continued)

Sector #	Q_{LB}	Q_{ML}	Z_{TP}	Z_S	Z_P	MAAO
17 *p* - value	6.820 (0.911)	3.140 (0.999)	20.000 (0.551)	15.000 (0.756)	.27000E+03 (0.061)	0
18 *p* - value	3.456 (0.991)	0.770 (1.000)	20.000 (0.551)	16.000 (.351)	.27900E+03 (0.028*)	0
19 *p* - value	4.209 (0.989)	6.211 (0.976)	20.000 (0.551)	16.000 (0.351)	.25700E+03 (0.159)	0
20 *p* - value	4.6105 (0.970)	2.9622 (1.000)	18.000 (0.766)	17.000 (0.120)	.26600E+03 (0.084)	0
21 *p* - value	4.719 (0.944)	3.684 (0.999)	18.000 (0.766)	16.000 (0.351)	.24600E+03 (0.309)	0
22 *p* - value	3.938 (0.985)	1.258 (1.000)	20.000 (0.551)	17.000 (0.120)	.26900E+03 (0.066)	0
23 *p* - value	4.124 (0.990)	5.962 (0.980)	20.000 (0.551)	15.000 (0.756)	.26600E+03 (0.084)	0
24 *p* - value	5.755 (0.955)	4.959 (0.992)	20.000 (0.551)	14.000 (0.756)	.27100E+03 (0.056)	0
25 *p* - value	4.526 (0.972)	1.822 (0.999)	19.000 (0.881)	16.000 (0.351)	.25400E+03 (0.193)	0
26 *p* - value	6.180 (0.907)	4.692 (0.994)	19.000 (0.882)	17.000 (0.120)	.24400E+03 (0.344)	0

Notes: (1) In this study, the assigned value of h for the Ljung – Box and the McLeod – Li portmanteau tests is 15 (Practically, h is equal to $n/2$).

(2) The results are estimated by the Iterative Time Series Modeling (ITSM) software, and * denotes the significance at the 0.05 level

(3) All numbers in the parentheses represent the corresponding p – value of each statistic at the 5% level of significant.

According to the estimated result, only the rank tests of sector 3, 13, 14, 16, and 18 and the difference – sign test of sector 11 indicate the significant values of the testing statistics at 5% level, while the rest of the testing statistics are not sufficiently significant to reject the null hypothesis of the randomness of the residuals. This means that the assigned models fit the data quite well and these specifications are good enough to forecast the variation in sectoral inventory investments. The forecasting results for sectoral inventory investments from 2005 – 2015 by this specification are shown in Table 5.18.

Table 5.18: The Forecasting Results for the Sectoral Inventory Investment from 2005 - 2020

(Millions of Baht)

Sector	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1	1652.6	1147.7	1147.7	1147.7	1147.7	1147.7	1147.7	1147.7	1147.7	1147.7
2	415.75	256.36	140.17	95.29	108.21	147.87	186.15	208.05	211.94	204.28
3	67.82	72.13	73.36	73.71	73.81	73.84	73.84	73.85	73.85	73.85
4	414.07	-26.85	-182.28	-78.60	132.59	300.67	354.21	308.39	224.50	160.63
5	435.34	-367.35	-589.92	-238.95	325.97	702.32	704.27	423.68	104.29	-46.76
6	818.16	-458.01	-919.10	-510.54	304.73	948.97	1093.90	785.66	320.68	8.87
7	843.77	221.15	-134.38	-147.28	63.63	313.96	467.47	484.78	407.20	307.13
8	699.93	-368.33	3.75	748.65	999.40	777.64	524.36	486.17	589.03	667.91
9	125.24	-209.20	-258.77	-66.41	175.75	293.70	242.20	100.57	-13.17	-30.94
10	23.18	-558.85	-510.35	9.04	509.97	612.23	314.92	-76.58	-244.05	-102.69
11	521.11	-147.20	-386.91	-217.38	119.18	373.78	432.90	333.57	188.49	95.55
12	153.68	-252.54	-322.62	-91.01	211.69	362.89	297.01	111.66	-38.36	-59.94
13	266.50	-91.26	-60.66	154.71	287.35	262.39	173.11	124.79	139.75	176.34
14	103.30	22.54	-10.75	2.09	37.36	69.15	83.03	78.85	65.46	52.96
15	117.15	-187.51	-223.37	-38.06	183.95	282.68	224.33	90.37	-8.38	-14.55
16	1601.30	-1193.30	-1408.50	215.15	1688.60	1853.70	1040.00	264.79	151.75	558.31
17	615.57	-443.29	-228.18	516.08	912.63	770.25	448.55	304.89	385.72	522.60
18	421.40	-608.69	-781.15	-240.90	459.27	829.14	732.60	368.84	47.09	-41.60
19	760.62	229.69	340.77	672.55	822.38	750.47	631.78	594.13	629.71	670.34
20	4268.70	414.90	-1237.90	-664.73	1058.60	2676.30	3432.70	3264.20	2583.80	1907.80
21	-70.29	467.78	286.80	266.29	694.34	694.34	694.34	694.34	694.34	694.34
22	1263.60	-1225.80	-1595.30	-245.40	1422.50	2223.70	1897.60	998.17	285.99	169.15
23	594.47	-52.03	84.20	460.86	613.26	526.33	406.20	377.69	416.90	452.50
24	168.46	6.46	29.46	119.06	162.82	147.60	117.92	106.98	114.18	123.66
25	3914.90	169.90	-1400.10	-722.13	1046.00	2571.00	3121.20	2746.20	1973.90	1358.90
26	367.66	189.21	84.67	72.63	117.88	172.67	205.78	210.57	197.26	180.46

Table 5.18: (Continued)

(Millions of Baht)

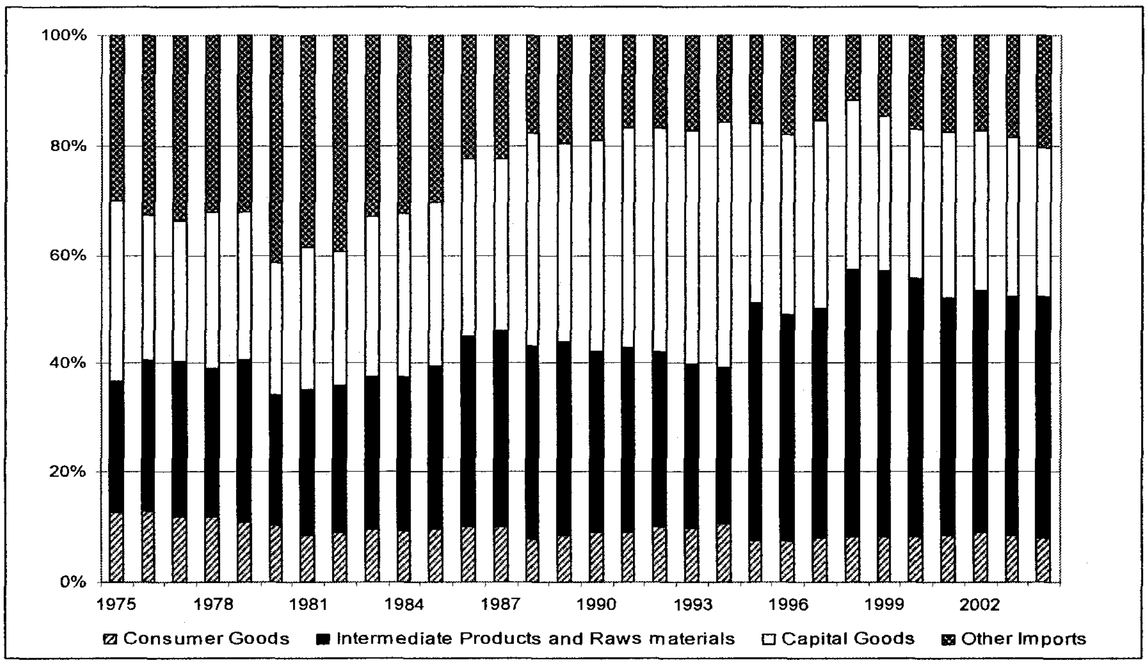
Sector	2015	2016	2017	2018	2019	2020
1	1147.7	1147.7	1147.7	1147.7	1147.7	1147.7
2	193.35	185.06	181.62	182.27	184.91	187.59
3	73.85	73.85	73.85	73.85	73.85	73.85
4	142.55	162.46	195.68	219.87	225.81	217.28
5	22.09	213.60	378.85	422.19	347.13	229.51
6	-9.21	200.40	457.10	600.06	576.18	442.72
7	241.51	229.69	257.78	297.54	325.35	332.04
8	663.11	621.33	599.33	607.14	622.56	627.70
9	33.50	115.48	155.91	139.01	91.27	52.59
10	179.22	358.40	317.53	130.66	-30.68	-47.86
11	88.22	139.85	200.27	232.40	228.36	203.41
12	30.24	143.78	197.99	170.59	100.05	44.72
13	193.58	185.67	170.83	164.84	168.74	174.70
14	47.21	48.52	53.59	58.49	60.86	60.48
15	51.28	125.33	155.32	132.75	86.94	55.09
16	965.37	1038.00	835.50	622.19	577.32	677.89
17	572.34	530.05	472.70	456.60	477.61	501.26
18	89.85	293.10	418.32	409.43	311.77	213.40
19	677.80	662.27	648.98	648.47	654.74	658.87
20	1566.20	1607.20	1874.10	2155.30	2307.90	2302.80
21	694.34	694.34	694.34	694.34	694.34	694.34
22	543.71	1016.50	1249.20	1162.70	909.95	706.29
23	454.73	439.55	429.84	431.31	436.63	439.00
24	126.07	123.11	120.18	119.78	120.91	121.78
25	1175.20	1368.90	1702.80	1948.30	2005.10	1909.30
26	169.99	168.19	172.09	177.23	180.54	181.19

5.4 The Estimation of the Sectoral Import Expenditure (im_i)

The last final demand component on the real side that requires an estimated system of equations is the import expenditure (im_i). The Thailand SNA splits the total import into 4 main categories (consumer goods, intermediate products and raw materials, capital goods, and other imports). Each category has its own subcategories and the detail of the products in each subcategory. Consumer goods are separated into non – durable goods and durable goods, while intermediate products and the raw materials category is separated into the products that are chiefly used as consumer goods and chiefly used as capital goods. Besides, the import data of capital goods are categorized into 9 subgroups[36]. Finally, other imports are separated into the imports of vehicles and parts, fuel and lubricants, and the miscellaneous imports.

Due to the import substitution policy since 1960, Thailand's import expenditure has changed its structure from final goods to intermediate products, raw materials, and capital goods as the major components. The import of intermediate products and raw materials accounted for 24 percent of the total import in 1975, while the imports of capital goods were 33 percent in the same year. These ratios fluctuated in the range of 24 – 30 percent during the 80's and continued to increase over time. The increase of the import of intermediate products and raw materials has been countered by the reduction of the import of consumer goods and others (see Figure 5.6).

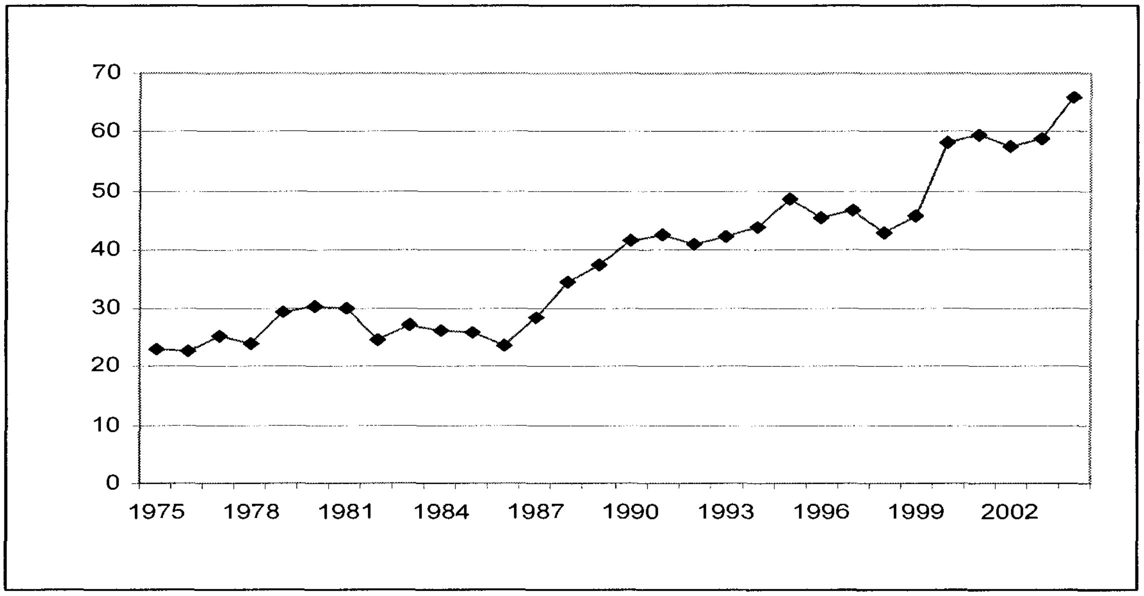
Figure 5.6: The Structure of Imports Classified by Economic Classification



Source: Bank of Thailand (BOT)

[36] The 9 subgroups under capital goods category are composed of (1) Fertilizers and Pesticides, (2) Cement, (3) Construction Materials, (4) Rubber Manufactures, (5) Metal Manufactures, (6) Non – Electrical Machinery and Parts, (7) Electrical Machinery and Parts, (8) Scientific and Optical Instruments, (9) Aircrafts and Ships, and (10) Locomotive and Rolling Stock.

Figure 5.7: The Ratio of Import to the GDP (Percent)



Source: Bank of Thailand (BOT)

Currently, the major share of imports in intermediate products and raw material groups belongs to the import of chemical, electronic parts, and base metals such as iron, steel, and so on. These two products count for 70 – 75 percent of the total imported goods in this category, while the main share of imports of capital goods comes from industrial and electrical machinery and parts (approximately 65 – 70 percent of the total imports of capital goods). Moreover, almost 70 percent of the imports of consumer goods are food and beverages, especially dairy products, electrical appliances and parts, and the medicinal and pharmaceutical products. Finally, for the category of other imports, the major share comes from fuel and lubricants, especially crude oil and vehicle and parts, with these two items accountable for 85 percent of the total imports of the products in this group.

Comparing with the total GDP, import expenditure was a pretty large component (see Figure 5.7). Its magnitude was almost 23 percent of GDP in 1975 and increased to approximately 66 percent of GDP in 2004. The accuracy of the estimation for import equations is quite important in determining the level of sectoral outputs on the real side.

5.4.1 The Data Sources and the Functional Forms for Import Expenditure

According to the macroeconomic theory, the explanatory variables for the import function include outputs, the exchange rate, the trade policy variables, and etc. However, the choices of the explanatory variables in this study rely heavily on the availability and the (non)stationary characteristics of the data. Since the (non)stationary characteristic of the output (y_i) is already checked in the previous section, the first task in this section is to perform the ADF test on the import and the exchange rate series.

The data on import expenditure comes from the published data of Bank of Thailand (BOT). They are available in monthly, quarterly, and annual formats. However, the system of import data under BOT's format is not quite matched up for most of the 26 sectors of SIO system except for sectors 4, 5, 7, 10, 11, 14, and 16 as shown in Table 5.19.

Table 5.19: The Relevancy between the Data from BOT and the 26 Sectors of SIO

IO Sector #	Sources from BOT Import Data			
	Consumer Goods	Intermediate Products and Raw Materials	Capital Goods	Other Imports
4		- Fish and Preparations		
5		- Crude Minerals		
7	- Tobacco Products,	- Unmanufactured Tobacco		
10	- Medicinal and Pharmaceutical Products - Toilet and Cleaning Articles	- Chemicals	- Fertilizers and Pesticides	
11				-Fuel and Lubricants

Table 5.19: (Continued)

IO Sector #	Sources from BOT Import Data			
	Consumer Goods	Intermediate Products and Raw Materials	Capital Goods	Other Imports
14		- Base Metal	-Metal Manufactures	
16	- Electrical Appliances - Cycle, Motorcycles, carts, and etc.		- Electrical Machinery and Parts - Aircrafts and Ships	- Vehicles and Parts

Thus, for the rest sectors, the information on the shares of sectoral import to the total imports from the relevant RAS I – O table are used as scaling factors. Because there is no record of imports from sector 20 (Trade) in both SIO and SNA, the value of imports in this sector is equal to 0 for the whole series, and there is no requirement to find the estimated equation for this sector. Data on the exchange rate are obtained from the annual published data of BOT. In this study, the direct quote between Baht per U.S. dollar[37] is used as the exchange rate variable. Under this data construction, the results of the ADF test for import and exchange rate series are shown in Table (5.20).

Table 5.20: The ADF Test for the Sectoral Import Series (im_i) and the Exchange Rate (er)

The ADF Test for Import Series (im_i)					
Sector	**Coefficient for (im_i)**	**Tau (τ) Statistic**	**Sector**	**Coefficient for (im_i)**	**Tau (τ) Statistic**
1	-0.051	-0.556	6	-0.047	-0.595
1st diff.	-5.321	-5.504^{***}	1st diff.	-1.238	-5.520^{***}
2	-0.082	-1.006	7	-0.354	-2.244
1st diff.	-1.249	-5.719^{***}	1st diff.	-1.303	-4.759^{***}
3	-0.363	-1.410	8	-0.053	-0.570
1st diff.	-9.077	-3.788^{**}	1st diff.	-5.455	-5.490^{***}
4	-2.038	-2.818	9	0.074	0.258
1st diff.	-1.010	-5.034^{***}	1st diff.	-6.453	-4.929^{***}
5	0.140	1.133	10	0.556	2.936
1st diff.	-1.726	-5.521^{***}	1st diff.	-2.015	-5.515^{***}

[37] BOT publishes both selling rate and buying rate of Baht per U.S. Dollars of all commercial banks, however the selling rate is used as the exchange rate variable, since this is the rate that importers encounter with.

Table 5.20: (Continued)

The ADF Test for Import Series (im_i)					
Sector	**Coefficient for (im_i)**	**Tau (τ) Statistic**	**Sector**	**Coefficient for (im_i)**	**Tau (τ) Statistic**
11 1st diff.	-3.354 -0.705	-4.254*** -3.399*	19 1st diff.	-2.026 -1.573	-5.139*** -3.423*
12 1st diff.	0.071 -6.541	0.241 -4.809***	20 1st diff.	*****	*****
13 1st diff.	0.049 -6.618	0.157 -4.457**	21 1st diff.	0.046 -6.612	0.145 -4.419**
14 1st diff.	-0.262 -2.218	-0.625 -2.169	22 1st diff.	0.066 -5.710	0.271 -5.414***
15 1st diff.	-0.067 -1.265	-0.848 -5.711***	23 1st diff.	0.877 -1.434	0.187 -4.240**
16 1st diff.	-0.068 -1.361	-0.782 -5.444***	24 1st diff.	0.074 -6.179	0.278 -5.162***
17 1st diff.	-0.056 -5.613	-0.589 -5.450***	25 1st diff.	-2.712 -1.340	-2.688 -3.830**
18 1st diff.	-0.744 -4.121	-1.635 -5.462***	26 1st diff.	-1.063 -4.132	-1.787 -5.091***
The ADF Test for Exchange Rate Series (er)					
	Coefficient for (ex_i)		**Tau (τ) Statistic**		
level 1st diff.	-0.225 -0.944		-1.891 -4.639***		

<u>Notes</u>: (1) *, **, *** denoted the significant level at 10%, 5%, and 1%, respectively for testing the null hypothesis that the particular series has a unit root.

The result from Table 5.20 exposes that most of the sectoral import series and the exchange rate series are non – stationary, but they are integrated of order 1 except for the series in sectors 10 and 19 that exhibit the stationary characteristic at the level data. Besides, the import series of sector 14 is non – stationary even at the 1^{st} difference level. Therefore, there are three feasible choices for import equations in this case. Firstly, the equations are estimated in the form of 1^{st} difference. Secondly, the cointegration technique is used in order to find the existence of the linear combination among these variables. Finally, the time series technique is employed in finding the appropriate ARIMA model for these 1^{st} difference series.

However, only options 1 and 2 are feasible in this case. The third option is not a suitable model for MUTE, since the objective of this study is to detect the impact of some economic variables on the Thai import expenditure and on the sectoral output as a whole. Thus, the next task is to check whether the cointegration among these series exists. The trace test and the maximum eigenvalue test are performed among 3 variables (im_i, y_i, er) for the sectors that these series are non – stationary. The result is shown in Table 5.21.

Table 5.21: The Cointegration Test for the Sectoral Import Equations

Sector	**Trace Test**			**Maximum Eigenvalue Test**			**# of Cointegrating Vector**
Vectors	**r =0**	**r ≤ 1**	**r ≤ 2**	**r =0**	**r ≤ 1**	**r ≤ 2**	
# 1	48.535	12.696	1.097	35.840	11.598	1.097	1
Critical Value	**29.68**	**15.41**	**3.76**	**20.97**	**14.07**	**3.76**	
# 2	30.742	8.077	1.524	22.665	6.553	1.524	1
Critical Value	**29.68**	**15.41**	**3.76**	**20.97**	**14.07**	**3.76**	
# 3	31.353	7.617	0.861	23.736	6.757	0.861	1
Critical Value	**29.68**	**15.41**	**3.76**	**20.97**	**14.07**	**3.76**	
# 4	30.493	7.481	1.042	21.013	6.438	1.042	1
Critical Value	**29.68**	**15.41**	**3.76**	**20.97**	**14.07**	**3.76**	
# 5	37.814	10.447	2.443	27.367	8.003	2.442	1
Critical Value	**29.68**	**15.41**	**3.76**	**20.97**	**14.07**	**3.76**	
# 6	41.189	11.211	2.536	29.979	8.675	2.536	1
Critical Value	**29.68**	**15.41**	**3.76**	**20.97**	**14.07**	**3.76**	
# 7	31.215	10.250	0.608	21.965	9.642	0.608	1
Critical Value	**29.68**	**15.41**	**3.76**	**20.97**	**14.07**	**3.76**	
# 8	43.529	11.757	2.555	31.772	9.203	2.555	1
Critical Value	**29.68**	**15.41**	**3.76**	**20.97**	**14.07**	**3.76**	
# 9	47.172	23.052	3.026	24.121	20.026	3.026	2
Critical Value	**29.68**	**15.41**	**3.76**	**20.97**	**14.07**	**3.76**	
# 11	34.051	14.375	1.476	23.676	12.899	1.476	1
Critical Value	**29.68**	**15.41**	**3.76**	**20.97**	**14.07**	**3.76**	
# 12	61.752	10.816	0.664	50.935	10.152	0.664	1
Critical Value	**29.68**	**15.41**	**3.76**	**20.97**	**14.07**	**3.76**	
# 13	72.343	29.483	7.326	42.861	22.156	7.326	3
Critical Value	**29.68**	**15.41**	**3.76**	**20.97**	**14.07**	**3.76**	
# 14	67.554	29.220	11.944	38.335	17.276	11.943	3
Critical Value	**29.68**	**15.41**	**3.76**	**20.97**	**14.07**	**3.76**	
# 15	36.777	12.233	3.522	24.543	8.712	3.522	1
Critical Value	**29.68**	**15.41**	**3.76**	**20.97**	**14.07**	**3.76**	
# 16	66.488	35.397	8.571	31.091	26.826	8.571	3
Critical Value	**29.68**	**15.41**	**3.76**	**20.97**	**14.07**	**3.76**	
# 17	57.768	13.654	4.971	44.114	8.684	4.971	1
Critical Value	**29.68**	**15.41**	**3.76**	**20.97**	**14.07**	**3.76**	
# 18	65.646	24.029	8.342	41.617	15.687	8.342	3
Critical Value	**29.68**	**15.41**	**3.76**	**20.97**	**14.07**	**3.76**	
# 21	74.138	18.602	6.793	55.536	11.809	6.793	3, 1
Critical Value	**29.68**	**15.41**	**3.76**	**20.97**	**14.07**	**3.76**	
# 22	60.292	27.009	8.349	33.283	18.661	8.349	3
Critical Value	**29.68**	**15.41**	**3.76**	**20.97**	**14.07**	**3.76**	

Table 5.21: (Continued)

Sector	Trace Test			Maximum Eigenvalue Test			# of Cointegrating Vector
Vectors	r =0	r ≤ 1	r ≤ 2	r =0	r ≤ 1	r ≤ 2	
# 23	55.506	19.125	0.182	36.381	18.943	0.182	2
Critical Value	**29.68**	**15.41**	**3.76**	**20.97**	**14.07**	**3.76**	
# 24	62.010	20.864	4.135	41.145	16.730	4.135	3
Critical Value	**29.68**	**15.41**	**3.76**	**20.97**	**14.07**	**3.76**	
# 25	49.064	15.858	0.552	33.206	15.306	0.552	2
Critical Value	**29.68**	**15.41**	**3.76**	**20.97**	**14.07**	**3.76**	
# 26	56.843	19.810	2.140	37.033	17.671	2.140	2
Critical Value	**29.68**	**15.41**	**3.76**	**20.97**	**14.07**	**3.76**	

Notes: The bold numbers are the critical value at 5% level of significance

The tests prove that there exist relationships among these three variables (cointegrating vector) in all equations. This evidence exhibits that the regression equation in the level form (option 2) is suitable in estimating sectoral import equations. Therefore, sectoral import expenditures are estimated by using the following equation:

$$im_t^i = \alpha_0 + \alpha_1 y_t^i + \alpha_2 er_t + \alpha_3 (poldum) + \alpha_4 (cridum) + \varepsilon_t \qquad (5.40)$$

where, im_t^i is the import expenditure of sector i at time t. y_t^i is the output of sector i at time t. er denotes the exchange rate (Baht per Dollar). (*poldum*) and (*cridum*) represent the dummy variables for political disorder and the financial crisis in Thailand, and $\alpha_0 - \alpha_4$ are the parameters to be estimated. The expected sign of α_1 is positive, since imports are a positive function of income. α_2 is expected to have negative value. The depreciation (appreciation) of Baht causes imports to fall (rise). Finally, α_3 and α_4 are expected to have negative sign, since import expenditure should fall during the crisis period.

5.4.2 The Estimated Equation for Import Expenditure

The estimated results for import equations are shown in Table 5.22. The structure of *AR(1)*, *AR(2)*, and *AR(3)* are also inserted in the particular equation if the Durbin – Watson statistics shows the evidence of autocorrelation. The combination of *AR(i)* is chosen by relying on the result of DW statistics. For instance, in import equation of sector 1, all *AR(1)* to *AR(3)* are added in the equation, since other combinations give worse result. This rule of thumb is applied to every equation in this set. A time trend variable is added to the equation in order to capture the trend movement of the particular series. Moreover, In order to avoid the problem of simultaneity bias due to the correlation of the sectoral output variable (the sectoral output is an endogenous variable to the MUTE model.) and the residuals, each equation is estimated by the method of two – state least squares (2SLS) where the instrumental variable in this case is the lagged value of the sectoral output.

According to the result from Table 5.22, the constant terms in every equation represent the autonomous imports when all other explanatory variables take the value of zero. The coefficients of the sectoral outputs (α_1) in every equation have the expected positive sign and they are significant at 5 percent level. This result confirms the existence of a positive relationship between import expenditure and the output. The estimated parameters of the exchange rate variable (α_2) have negative sign in most cases except for those of sector 4 (Fishery), 13 (Non – Metallic Products), 14 (Basic Metal) and 17 (Other Manufacturing). An unexpected positive sign of α_2 is possibly due to two reasons. Firstly, the variable (*er*) in this study is the real exchange rate. It excludes the impact of relative prices of these products on the imports. During the period of the study, it is possible that the prices of these sectoral products abroad are lower than the domestic prices. Even if the effect of depreciation of Baht is taken into account, it is still cheaper to import these products from abroad. Secondly, the sectoral products from these sectors especially for sector 13, and 14 can be treated as the essential factors of production.

Moreover, by relying on the scarce resources in the country, it is not enough to produce these goods to serve the domestic demand. Consequently, although these products have higher costs of import due to the depreciation of Baht, firms still import these products as long as they do not obstruct the developing paces of their businesses. Furthermore, also note that the exchange rate variable is excluded from the equation of sectors 10 and 19, since the ADF test shows that import series of these sectors are stationary, while the exchange rate series are not (Fortunately, the sectoral output series for these sectors are stationary as shown in Table 5.14, thus only the (*er*) variable is excluded from the equation).

The *poldum* variable which captures the impact of political chaos in Thailand has unexpected positive sign of parameter in some sectors. However the *t* statistic shows that none of these impacts on the import expenditure is significant at 5% level. Finally, the estimated parameters of *cridum* (α_4) in most sectors exhibit a negative relationship between the financial crisis and import expenditures. Import expenditures of sector 10 (Chemical Industries), 11 (Petroleum Refineries), and 14 (Basic metal), are among the sectors that are highly affected by the financial crisis. The unexpected positive sign of *cridum* parameters is found in sector 4 (Fishery), 12 (Rubber and Plastic Products), 15 (Fabricated Metal Products), 19 (Construction), 23 (Banking and Insurance), and 25 (Services) but only the impacts of sector 15, 19, 23, and 25 are significant at 5% level.

Table 5.22: The Estimated Parameter for the Sectoral Import Expenditure

Sector	*c*	*y*	*er*	*poldum*	*cridum*	*Trend*	*AR(1)*	*AR(2)*	*AR(3)*	*Adj.* R^2	*D.W.*
1	-879652.0 (-0.370)	0.053 **(3.053)**	-857.805 **(-5.723)**	791.941 (0.882)	-3926.213 **(-3.306)**	14374.56 (0.784)	0.232 (1.211)	0.054 (0.282)	0.672 **(3.533)**	0.991	1.885
2	-1071.520 (-1.399)	0.113 **(4.231)**	-31.567 (-0.804)	58.891 (0.216)	224.853 (0.658)	-	0.221 (1.022)	0.417 **(2.170)**	-	0.898	2.017
3	711265.8 (0.009)	0.186710 (0.956)	-35.811 (-0.529)	173.441 (0.753)	-5700.786 **(-9.056)**	-	1.209 **(3.550)**	0.258 (0.479)	-0.467 (-1.365)	0.975	1.975
4	-26507.93 **(-3.786)**	0.130 (1.674)	1347.610 **(4.870)**	166.739 (0.134)	3443.940 (1.069)	-	1.150 **(8.568)**	-	-0.440 **(-3.256)**	0.951	2.157
5	-883.084 (-0.010)	3.740 **(5.037)**	-15.866 (-0.004)	35273.14 (0.399)	-32142.65 (-0.827)	-3421.233 (-1.015)	-	-	0.080 (0.170)	0.883	1.782
6	-160010.7 (-0.493)	0.105 (0.805)	-920.526 (-1.217)	1973.098 (0.713)	-91.280 (-0.024)	9258.786 (1.072)	0.472 (1.445)	0.435 (1.521)	-	0.986	2.131
7	5168.699 (0.783)	0.116 (1.341)	-215.482 (-1.019)	-1009.759 (-0.266)	-3234.728 (-1.414)	-56.210 (-0.155)	0.013 (0.060)	-	-	0.779	1.988
8	7189.065 (0.251)	0.727 **(3.145)**	-203.869 (-0.167)	2025.379 (0.262)	-69617.47 (-1.977)	-2250.728 (-1.513)	0.375 (1.899)	-	-0.585 **(-2.207)**	0.925	2.063
9	50689.51 (0.968)	2.158 **(2.395)**	-2257.081 **(-2.237)**	-14588.91 (-0.242)	-6976.032 (-1.103)	229.346 (0.105)	-0.115 (-0.511)	-	-	0.913	1.957
10	-26887.92 (-0.966)	2.958 **(4.202)**	-	818.374 (0.056)	-74473.87 (-1.739)	5310.189 **(2.183)**	0.769 **(3.029)**	-0.303 (-0.985)	-	0.951	2.042
11	56933.32 (1.275)	0.565633 (1.472)	-2749.598 (1.393)	-2368.563 (0.129)	-72021.66 **(-3.344)**	1861.253 **(2.420)**	-0.038 (-0.152)	-	-0.510 **(-2.110)**	0.280	2.074
12	18035.18 (0.860)	1.732 **(3.874)**	-1178.345 (-1.260)	693.073 (0.075)	751.343 (0.069)	1050.579 (1.684)	0.194 (0.517)	-	-	0.963	1.930

Note: (1) The t – statistics are shown in the parenthesis. The Bold numbers represent the significance level at 5%. (2) *C*, *D.W.* and *Adj.* R^2 denote the constant term, the Durbin – Watson Statistics and the adjusted correlation coefficients, respectively.

Table 5.22: (Continued)

Sector	*c*	*y*	*er*	*poldum*	*cridum*	*Trend*	*AR(1)*	*AR(2)*	*AR(3)*	*Adj. R^2*	*D.W.*
13	-5745.764 **(-2.850)**	0.438 **(6.350)**	361.724 **(3.634)**	-379.249 (-0.132)	-11803.56 **(-6.594)**	-490.454 **(-2.071)**	-0.121 (-0.453)	-	-0.039 (-0.161)	0.952	1.992
14	-93143.22 **(-2.348)**	22.242 **(2.975)**	3789.990 **(2.099)**	2602.264 (0.037)	-258444.1 **(-3.405)**	-6438.605 (-1.301)	-	-	-0.558 **(-2.627)**	0.762	2.049
15	48944.43 **(2.483)**	3.411 **(8.083)**	-2515.061 **(-4.817)**	-5790.311 (-0.245)	13146.13 **(2.432)**	553.701 (0.569)	-0.083 (0.337)	-	-	0.983	1.958
16	-45526.00 (-0.456)	2.938 **(9.560)**	-2008.389 (-0.452)	54891.48 (0.793)	-99912.46 (-1.862)	11820.34 **(2.798)**	0.343 (1.799)	-0.572 **(2.935)**	-	0.979	2.065
17	-27582.49 (-1.592)	0.976 **(11.811)**	1657.636 **(3.592)**	-8485.939 (-0.221)	-50743.17 **(-5.696)**	-1283.753 (-0.976)	-0.214 (-0.797)	-0.559 (-1.431)	-	0.976	2.010
18	7072.150 (0.937)	0.126 **(2.738)**	-283.332 **(-2.377)**	-1997.248 (-0.207)	-6652.924 **(-6.534)**	-62.05 (-0.156)	-0.084 (-0.308)	-	-	0.934	2.005
19	-7829.069 (-0.095)	0.0003 **(2.935)**	-	2.371 (0.397)	32.953 **(2.436)**	77.758 (0.191)	-	0.557 **(2.978)**	0.417 **(2.255)**	0.985	1.757
20	**	**	**	**	**	**	**	**	**	**	**
21	-1379.673 (-0.232)	0.208 **(7.660)**	-175.940 (-0.562)	1127.084 (0.524)	-16965.61 **(-7.111)**	-	0.245 (0.811)	0.203 (0.837)	-	0.984	1.931
22	15258.54 **(2.097)**	0.229 **(10.893)**	-849.823 **(-4.717)**	2296.703 (0.215)	-14275.31 **(-6.398)**	-242.831 (-0.516)	-0.304 (-1.119)	-	-	0.988	2.158
23	-40025.33 (-0.350)	0.002 (1.386)	-37.332 **(2.526)**	33.522 (0.335)	5296.195 **(21.114)**	833.655 (0.772)	-	0.325 (1.398)	0.617 **(2.748)**	0.995	2.045
24	-260728.4 (-0.419)	0.105 **(2.960)**	-245.343 **(-3.288)**	439.765 (0.855)	-4789.430 **(6.797)**	5696.859 (0.916)	0.344 (1.593)	-0.116 (-0.493)	0.717 **(3.385)**	0.991	1.969
25	19400.59 **(3.032)**	0.108 **(7.114)**	-1090.069 **(-3.744)**	418.252 (0.167)	14154.77 **(3.302)**	-439.642 (-1.644)	0.239 (1.211)	-	-0.584 **(-2.813)**	0.973	2.056
26	-276941.1 (-0.327)	0.072 (1.929)	-334.1033 **(-5.088)**	607.1450 (1.399)	-16756.71 **(-33.923)**	5594.908 (0.715)	0.098 (0.455)	0.062842 (0.329)	0.782 **(3.076)**	0.991	1.873

Note: (1) The t – statistics are shown in the parenthesis. The Bold numbers represent the significance level at 5%. (2) *C*, *D.W.* and *Adj. R^2* denote the constant term, the Durbin – Watson Statistics and the adjusted correlation coefficients, respectively.

Since, these sectors are among the beginning sectors that are bankrupt during the financial crisis, it is possible that the goods and services from these sectors were imported more from abroad during this period.

5.5 The Estimation of Sectoral Labor Productivity Equation

Before ending this long chapter, labor productivity equations have to be estimated so as to link the real side with the price – income side. According to the neoclassical model of growth, an increase of long – run economic growth is caused not only by an increase in labor supply and the accumulation of capital, but also by the improvement of labor and capital productivities. However, the accumulation of capital via investment raises the growth rate only in short – run, since at first the capita per unit of labor increase, but finally the marginal productivity of the additional unit of capital will decrease and the growth rate will return to its long – term level. Thus, in this study labor productivity is treated as the main vehicle for stimulating the economic growth that is quite essential to place our focus on.

Generally, the sectoral labor productivity is calculated by the output per working hour of labor in that particular sector. However there is no private or public authority that collects that kind of data in Thailand. The only data sources on hand are the sectoral outputs generated by the RAS I – O table and the labor force survey of employment by sector published by the National Statistic Office (NSO). Therefore, the sectoral labor productivity in this study is measured by the sectoral output per unit of labor used in that sector (in terms of millions of baht per thousand persons).

However, the classification of the labor force survey on the number of employment is not in line with the 26 I – O sectors. The labor force survey categorizes employment into two broad groups. The first group is the employment in the agriculture sector, which is separated into two subgroups: 1) Agriculture, Hunting and Forestry, and 2) Fishing. The second group is the employment in non – agricultural sector, which is classified into 14 sectors including 1) Manufacturing, 2) Electricity, gas and water supply 3) Construction, 4) Wholesale and Retail Trade, repair of vehicles and personal and household goods, 5) Hotels and restaurants, 6) Transport, storage and communications, 7) Financial intermediation, 8) Real estate, renting and business activities, 9) Public administration and defense, compulsory social security, 10) Education, 11) Health and social work, 12) Other community, social and personal service activities, 13) Private households with employed persons, and 14) Other[38]. Thus, in order to find the connection between these two systems, the employment data from labor force survey are stacked by the following conversion:

Table 5.23: The Conversion of Employment Data between the 26 I – O Tables and the Labor Force Survey

Labor Force Survey Data	SIO Data
Agricultural Sector	
1) Agriculture, Hunting and Forestry	Sector 1 – 3
2) Fishing	Sector 4
Non Agricultural Sector	
1) Manufacturing	Sector 6 – 17
2) Electricity, gas and water supply	Sector 18
3) Construction	Sector 19
4) Wholesale and Retail Trade, repair of vehicles and personal and household goods	Sector 20
5) Hotels and restaurants	Sector 21
6) Transport, storage and communications	Sector 22
7) Financial intermediation	Sector 23
8) Real estate, renting and business activities	

[38] The "other" category composes of the employment in mining and quarrying sector, extra - territorial organizations and bodies and unknown sector.

Table 5.23: (Continued)

Labor Force Survey Data	SIO Data
9) Public administration and defense, compulsory social security 10) Education 11) Health and social work 12) Other community, social and personal service activities 13) Private households with employed persons	Sector 25
14) Other	Parts of Sector 5 and 25

Thus, the problem of stacking employment data is found only in sector 1 – 3, 5, 25, and 6 – 17. Since employment determines the output level for every sector, the information about the ratio between sectoral output and the total output is used as the scaling factor for the employment data in this case.

Under this generating process, high average productivity (more than 450 millions of baht per thousand persons) is found among sectors 5 (Mining and Quarrying), 18 (Electricity and Water Works), 23 (Banking and Insurance), and 26 (Unclassified), while low productivity (less than 100 millions of Baht per thousand persons) is found in agricultural sectors such as 1 (Crops), 2 (Livestock), 3(Forestry), and 4 (Fishery). This evidence confirms why the level of wage in these sectors is lower than the others. Moreover, the levels of productivity in most sectors declined during the period of financial crisis (1997 - 1998), even though they have increasing long run trend. This evidence is consistent with the data in Manuprasert (2004)[39], which shows the evidence of a slow to negative growth rate of productivity during the same period.

[39] Manuprasert, op. cit., p.144.

5.5.1 The Functional Form of Productivity Equations and the ADF Test

There exist various functional forms for the labor productivity equation. Nadiri (1980),[40] in his studies of the factors that determine the growth of labor productivity in U.S. during the postwar period (1948 – 78), suggested using a functional form relying on a simple three – input Cobb – Douglas production function with neutral technical change. In his study, inputs include levels of man - hours, stocks of fixed capitals, and the stock of R&D. By assuming constant return to scale in the production function, the labor productivity equation is represented by:

$$\ln(P) = \alpha_0 + \alpha_1 \ln(k) + \alpha_2 \ln(U_t) + \alpha_3 \Delta \ln(U_t) + \alpha_4 \ln(R) + \alpha_5 t \tag{5.41}$$

where, P denotes the level of output per man – hour. k is the ratio of capital stocks to man – hour, U_t represents the gap between the growth rates of actual and normal output, R is the aggregate stock of R&D, t is the time trend variable, and Δ denotes the change of a particular variable from the previous period. Equation (5.41) provides an idea on the explanatory variables that should be inserted in labor productivity equation.

While many studies on the determination of productivity (such as Nordhaus (1972)[41], Perry (1977)[42], and so on) are based on the Cobb – Douglas production function, the users of the INFORUM models such as TIDY, IDLIFT, MUDAN, and etc. believe in the concept that labor productivity is procyclical (rising in business expansions and falling in recessions) in determining the labor productivity equation. Usually, three

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[40] M. Ishaq Nadiri, "Sectoral Productivity Slowdown," *The American Economic Review*, Vol. 70, No. 2, Papers and Proceedings of the Ninety-Second Annual Meeting of the American Economic Association. (May, 1980), pp. 349-352.

[41] W. D. Nordhaus, "The Recent Productivity Slowdown," Brookings Papers, Washington 1972, 3, pp. 493-546.

[42] G. L. Perry, "Potential Output and Productivity," Brookings Papers, Washington 1977, 1, pp. 11-47.

hypotheses, namely increasing returns to scale, labor hoarding, and technology shocks are used to explain the procyclical characteristic of the labor productivity.

Increasing returns to scale means that a percentage increase in input will cause the output to increase more than 1 percent, and vice versa. Thus, in the recession period when a firm hires less labor in order to reduce its output, the proportion of the shrunk output is larger than the reduction in labor input. This will cause the firm's labor productivity (which is measured by the output per unit of labor) to fall. In the boom period when the firm utilizes more labor in order to increase its output, the firm's productivity will rise, since its output expands more than the proportional increase in labor inputs.

The second explanation is based on the labor hoarding theory. One clear – cut explanation relates to the work of Oi (1962)[43]. In this study, the cause of labor hoarding comes from the specific human capital existing in the employees. As a result, during the period of recession when the firm's outputs fall, there exist some laborers that are not needed in the process of production at that time, but the firm still needs them in the near future. Thus, the firm chooses to keep these laborers not only to preserve their human capital but also to avoid the costs of laying workers off now and hiring new workers when they are needed in the future (cost of adjusting labor inputs). Consequently, the labor productivity will fall during the recession period but rise during the boom period.

Finally, the technological shocks or sometimes called the productivity shocks that generate the real effect on productivity level are one explanation of the business cycle. Normally, positive shocks such as the invention of new technology, the increase of current wages relative to expected future wages and so on will raise not only the labor

[43] Oi, Walter Y., "Labor as a Quasi-Fixed Factor," *Journal of Political Economy,* December 1962, 70, pp. 538-55.

supply but also the labor productivity which ultimately increases the level of outputs and make the economy grow in the boom period. On the contrary, adverse shocks such as the oil crises, the overthrow of what had been a stable government, national drought, and etc. will cause the productivity to bust as well as the economy.

By relying on the concept of procyclical productivity, the INFORUM models generally use sectoral outputs as one of the explanatory variables for the sectoral productivity equations (one example can be seen from equation 2.3 of the IDLIFT model), since it is believed that the variation in labor productivity can be explained by the variation in the output.

Before choosing the specific functional form and estimating the productivity equations, the ADF test is performed on the feasible variables that are supposed to be included in the equation. The result is shown in Table 5.24. In this case, I choose to detect the (non) stationary characteristic of the sectoral output (y^i), the labor productivity (lp^i) which is measured by the output per unit of labor, and the capital stock per unit of labor (kl^i). All variables are tested in level, 1st difference, and the logarithmic forms[44].

Table 5.24: The ADF Test for the labor productivity (lp^i), the capital stock per unit of labor (kl^i), and the logarithmic form of sectoral output (ln (y^i))

The ADF Test for Labor Productivity Series (lp^i)					
Sector	**Coefficient for (lp^i)**	**Tau (τ) Statistic**	**Sector**	**Coefficient for (lp^i)**	**Tau (τ) Statistic**
1	-0.333	-2.132	4	-0.349	-3.991**
1st diff.	-3.077	-5.108**	1st diff.	-3.337	-3.535*
log	-0.598	-3.391*	log	-0.141	-1.239
2	-0.629	-3.496*	5	-0.186	-1.671
1st diff.	-1.524	-8.925***	1st diff.	-1.417	-7.470***
log	-0.623	-2.006	log	-1.050	-2.675
3	-0.359	-2.388	6	-0.735	-3.541*
1st diff.	-1.514	-4.147**	1st diff.	-1.498	-8.356***
log	-0.690	-3.116	log	-0.596	-2.595

[44] The result of the ADF test on sectoral output in level and 1st difference forms are already shown in Table 5.10 and 5.14.

Table 5.24: (Continued)

The ADF Test for Labor Productivity Series (lp^i)					
Sector	Coefficient for (lp^i)	Tau (τ) Statistic	Sector	Coefficient for (lp^i)	Tau (τ) Statistic
7	-1.131	-5.946***	17	-0.201	-1.879
1st diff.	-2.251	-6.329***	1st diff.	-1.329	-5.227***
log	-0.629	-2.224	log	-0.462	-2.725
8	-0.162	-1.831	18	0.767	1.007
1st diff.	-1.484	-7.899***	1st diff.	-1.357	-4.300**
log	-0.390	-2.335	log	-0.575	-3.370*
9	0.536	2.614	19	-0.166	-1.216
1st diff.	-5.420	-5.766***	1st diff.	-1.116	-5.741***
log	-0.933	-2.822	log	-0.152	-1.287
10	-0.202	-0.366	20	-0.284	-1.936
1st diff.	-12.104	-5.763***	1st diff.	-1.231	-6.346***
log	-0.656	-3.332*	log	-0.280	-1.926
11	0.731	1.930	21	-0.051	-0.437
1st diff.	-4.688	-5.139***	1st diff.	-0.800	-4.038**
log	-1.696	-2.397	log	0.026	0.299
12	-0.784	-4.258**	22	-0.267	-2.370
1st diff.	-2.294	-7.088***	1st diff.	-8.390	-3.302*
log	-0.582	-2.371	log	0.443	2.430
13	-0.378	-2.686	23	-0.556	-3.153
1st diff.	-1.257	-6.610***	1st diff.	-0.662	-3.453**
log	-0.422	-2.467	log	-1.147	-3.249*
14	-0.539	-3.116	24	-1.401	-5.277***
1st diff.	-1.349	-6.241***	1st diff.	-0.779	-4.086**
log	-0.423	-2.305	log	0.002	0.033
15	-0.157	-1.125	25	-0.530	-1.832
1st diff.	-3.401	-6.975***	1st diff.	-1.721	-3.621**
log	0.704	1.312	log	-0.019	-0.206
16	-0.421	-2.770	26	-0.760	-3.121
1st diff.	-1.663	-6.513***	1st diff.	-1.354	-7.382***
log	-0.445	-2.694	log	-0.244	-1.884
The ADF Test for the Capital - Labor Ratio (kl^i)					
Sector	Coefficient for (kl^i)	Tau (τ) Statistic	Sector	Coefficient for (kl^i)	Tau (τ) Statistic
1	-0.006	-0.088	6	-0.125	-1.764
1st diff.	-1.373	-7.468***	1st diff.	-0.974	-4.962***
log	-0.238	-2.267	log	-0.156	-1.190
2	-0.006	-0.087	7	-0.189	-2.149
1st diff.	-1.373	-7.454***	1st diff.	-1.075	-3.679**
log	-0.237	-2.268	log	-0.251	-1.405
3	0.029	0.404	8	-0.153	-1.800
1st diff.	-1.772	-5.236***	1st diff.	-0.964	-4.951***
log	-0.211	-1.685	log	-0.266	-1.291
4	-0.861	-5.189***	9	-0.230	-2.315
1st diff.	-0.777	-3.561**	1st diff.	-0.973	-4.867***
log	-0.194	-1.743	log	-0.172	-1.105
5	-0.232	-1.772	10	-0.245	-2.047
1st diff.	-1.791	-3.935**	1st diff.	-1.073	-3.664**
log	-0.856	-4.264**	log	-0.990	-1.062

Table 5.24: (Continued)

The ADF Test for the Capital - Labor Ratio (kl^i)					
Sector	Coefficient for (kl^i)	Tau (τ) Statistic	Sector	Coefficient for (kl^i)	Tau (τ) Statistic
11	-0.184	-0.740	19	2.273	2.499
1st diff.	-0.974	-4.769***	1st diff.	-0.805	-4.115**
log	-0.157	-1.191	log	-0.514	-2.997
12	-0.184	-0.740	20	-0.201	-1.989
1st diff.	-0.974	-4.867***	1st diff.	-1.207	-6.259***
log	-0.659	-1.898	log	-0.219	-1.835
13	-0.114	-1.664	21	-0.129	-1.521
1st diff.	-0.972	-4.773***	1st diff.	-0.577	-3.312*
log	-0.579	-2.051	log	-0.034	-0.360
14	-0.123	-1.753	22	-0.074	-1.274
1st diff.	-0.951	-4.541***	1st diff.	-1.142	-5.771***
log	-0.156	-1.189	log	-0.321	-2.359
15	-0.121	-1.821	23	-0.231	-1.969
1st diff.	-1.074	-3.676**	1st diff.	-0.926	-4.727***
log	-0.268	-1.290	log	-0.190	-1.764
16	-0.189	-2.149	24	-5.513	-4.615***
1st diff.	-1.035	-3.609**	1st diff.	-11.071	-4.452**
log	-0.969	-2.466	log	-0.532	-2.932
17	-0.123	-1.591	25	-0.303	-2.744
1st diff.	-0.944	-4.782***	1st diff.	-0.904	-4.638***
log	-0.155	-1.186	log	-0.124	-1.112
18	1.703	3.507*	26	-0.755	-4.038**
1st diff.	-5.802	-3.996**	1st diff.	-1.398	-7.765***
log	-0.368	-2.432	log	-0.288	-2.108
The ADF Test for the Logarithmic Form of Sectoral Output (ln (y^i))					
Sector	Coefficient for (ln (y^i))	Tau (τ) Statistic	Sector	Coefficient for (ln (y^i))	Tau (τ) Statistic
1	-0.469	-2.993	14	-0.303	-2.664
2	-0.406	-2.704	15	-0.219	-2.237
3	-0.268	-2.726	16	-0.233	-2.347
4	-0.368	-2.246	17	-0.078	-1.272
5	-0.454	-2.777	18	-0.034	-0.311
6	-0.643	-2.512	19	-0.114	-2.237
7	-0.295	-2.009	20	-0.032	-0.386
8	-0.032	-0.646	21	-0.010	-0.163
9	-0.164	-2.547	22	0.046	0.766
10	-0.362	-2.376	23	-0.139	-2.141
11	-0.277	-1.469	24	-0.058	-0.757
12	-0.377	-2.562	25	-0.107	-1.389
13	-0.103	-1.736	26	-0.216	-1.781

Notes: (1) *, **, *** denoted the significant level at 10%, 5%, and 1%, respectively for testing the null hypothesis that the particular series has a unit root.

According to the ADF test, most series in both the level and the logarithmic forms are non – stationary but all of them are integrated of order 1. The possible functional forms in this case can be separated into two groups. The first group is to estimate the labor productivity function by using the 1st difference form, while the second group is to estimate the equations with the non – stationary data if the cointegration tests confirm the existence of cointegrating vectors among these variables.

Since the productivity equation is estimated by using the logarithmic form due to the use of Cobb – Douglas functional form and the result from Table 5.24 indicates that some series in the level form are stationary (e.g. lp^7, lp^{24}, kl^4, kl^{24}, and kl^{26}), the second task of this section is to detect the existence of cointegrating vectors among these three variables in order to avoid the problem of spurious regression. Otherwise, the experiment on the 1st difference form is conducted to estimate the labor productivity equations. The result of cointegration test is shown in Table 5.25.

Table 5.25: the Cointegration Test on ln(lp^i), ln(kl^i), and ln(y^i)

Sector	Trace Test			Maximum Eigenvalue Test			# of Cointegrating Vector
Vectors	$r = 0$	$r \leq 1$	$r \leq 2$	$r = 0$	$r \leq 1$	$r \leq 2$	
# 1	26.206	4.793	0.464	21.413	4.329	0.464	0, 1
Critical Value	**29.680**	**15.410**	**3.760**	**20.970**	**14.070**	**3.760**	
# 2	30.642	9.990	0.002	20.653	9.987	0.002	1, 0
Critical Value	**29.680**	**15.410**	**3.760**	**20.970**	**14.070**	**3.760**	
# 3	39.353	11.408	1.423	27.945	9.986	1.423	1
Critical Value	**29.680**	**15.410**	**3.760**	**20.970**	**14.070**	**3.760**	
# 4	37.396	18.185	5.189	19.211	12.996	5.189	3, 0
Critical Value	**29.680**	**15.410**	**3.760**	**20.970**	**14.070**	**3.760**	
# 5	27.541	14.541	4.263	13.001	10.278	4.263	0
Critical Value	**29.680**	**15.410**	**3.760**	**20.970**	**14.070**	**3.760**	
# 6	23.616	8.138	2.537	15.477	5.601	2.537	0
Critical Value	**29.680**	**15.410**	**3.760**	**20.970**	**14.070**	**3.760**	
# 7	26.249	10.939	4.822	15.311	6.116	4.822	0
Critical Value	**29.680**	**15.410**	**3.760**	**20.970**	**14.070**	**3.760**	
# 8	26.633	14.633	4.586	12.000	10.047	4.586	0
Critical Value	**29.680**	**15.410**	**3.760**	**20.970**	**14.070**	**3.760**	
# 9	27.129	9.821	2.479	17.308	7.342	2.479	0
Critical Value	**29.680**	**15.410**	**3.760**	**20.970**	**14.070**	**3.760**	
#10	22.037	6.648	3.149	15.389	3.500	3.149	0
Critical Value	**29.680**	**15.410**	**3.760**	**20.970**	**14.070**	**3.760**	
# 11	16.515	6.393	2.417	10.122	3.976	2.417	0
Critical Value	**29.680**	**15.410**	**3.760**	**20.970**	**14.070**	**3.760**	

Table 5.25: (Continued)

Sector	Trace Test			Maximum Eigenvalue Test			# of Cointegrating Vector
Vectors	r =0	r ≤ 1	r ≤ 2	r =0	r ≤ 1	r ≤ 2	
# 12	22.883	8.727	1.890	14.157	6.837	1.890	0
Critical Value	**29.680**	**15.410**	**3.760**	**20.970**	**14.070**	**3.760**	
# 13	33.504	14.055	6.385	19.449	7.670	6.385	1, 0
Critical Value	**29.680**	**15.410**	**3.760**	**20.970**	**14.070**	**3.760**	
# 14	27.026	9.035	2.974	17.991	6.061	2.974	0
Critical Value	**29.680**	**15.410**	**3.760**	**20.970**	**14.070**	**3.760**	
# 15	35.293	12.219	2.741	23.074	9.478	2.741	1
Critical Value	**29.680**	**15.410**	**3.760**	**20.970**	**14.070**	**3.760**	
# 16	21.138	10.778	1.964	10.361	8.814	1.964	0
Critical Value	**29.680**	**15.410**	**3.760**	**20.970**	**14.070**	**3.760**	
# 17	28.990	13.846	5.592	15.144	8.253	5.592	0
Critical Value	**29.680**	**15.410**	**3.760**	**20.970**	**14.070**	**3.760**	
# 18	26.313	7.982	2.491	18.331	5.491	2.491	0
Critical Value	**29.680**	**15.410**	**3.760**	**20.970**	**14.070**	**3.760**	
# 19	39.350	16.590	2.913	22.760	13.677	2.913	2, 1
Critical Value	**29.680**	**15.410**	**3.760**	**20.970**	**14.070**	**3.760**	
# 20	32.370	16.727	4.749	15.643	11.978	4.749	3, 0
Critical Value	**29.680**	**15.410**	**3.760**	**20.970**	**14.070**	**3.760**	
# 21	21.684	5.743	2.162	15.941	3.581	2.162	0
Critical Value	**29.680**	**15.410**	**3.760**	**20.970**	**14.070**	**3.760**	
# 22	46.697	23.606	2.621	23.091	20.984	2.621	2
Critical Value	**29.680**	**15.410**	**3.760**	**20.970**	**14.070**	**3.760**	
# 23	13.697	5.767	0.468	7.930	5.299	0.468	0
Critical Value	**29.680**	**15.410**	**3.760**	**20.970**	**14.070**	**3.760**	
# 24	21.043	7.642	0.201	13.402	7.441	0.201	0
Critical Value	**29.680**	**15.410**	**3.760**	**20.970**	**14.070**	**3.760**	
# 25	15.821	4.355	0.030	11.466	4.324	0.030	0
Critical Value	**29.680**	**15.410**	**3.760**	**20.970**	**14.070**	**3.760**	
# 26	39.397	14.119	3.776	25.278	10.343	3.776	0
Critical Value	**29.680**	**15.410**	**3.760**	**20.970**	**14.070**	**3.760**	

Notes: The bold numbers are the critical value at 5% level of significance

The cointegration tests show that there are cointegrating vectors only in sectors 1, 2, 3, 4, 13, 15, 19, 20, and 22, while the rest do not show the existence of cointegrating vectors. Thus, the use of the logarithmic form to estimate labor productivity equations is not suitable due to the problem of spurious regression.

Since, the logarithmic form by the virtue of its relying on the Cobb – Douglas function is out of the question, the regression on the 1st difference form is used to estimate the sectoral labor productivity equations. However, there are two main problems in estimation. Firstly, the estimated results give low values of adjusted R^2. In most cases, the values of the adjusted R^2 are less than 0.3 and sometimes negative. This is possibly because not only the 1st difference form is unsuitable for the data, but it also lacks the theoretical support in applying the 1st difference form for the labor productivity function. The final problem emerges from the incorrect sign of the estimated parameter of capital – labor ratio (in some cases, the estimated parameter of kl^i is negative), and the sign is sometimes correct but not statistically significant. This is possibly because of the problem of mismeasurement as previously mentioned in Chapter 2.

Due to the defects of both functional forms, the labor productivity equations in this study are estimated by applying the AICc techniques on the 1st difference series of lp^i. The appropriate structures of the *ARIMA* (*p*, *d*, *q*) model for the sectoral labor productivity series are shown in Table 5.26. As usual, the estimated residuals of each equation are tested for whether they are White noise or not, and the results of these tests are shown in Table 5.27. Finally, the appropriate *ARIMA* model are used to forecast the sectoral productivity series for the MUTE model from 2005 – 2020 (See Table 5.28).

Table 5.26: The Estimation Results for Sectoral Labor Productivity by the AICc Method

Sector	ARIMA (p, d, q)	Equation	WN Var.
1	(1, 1, 0)	$D(lp01, 1)_{(t)} = -\underset{(0.192)}{0.281} D(lp01, 1)_{(t-1)} + Z_{(t)}$	6.259
2	(0, 1, 1)	$D(lp02, 1)_{(t)} = Z_{(t)} - \underset{(0.158)}{0.604} Z_{(t-1)}$	11.453
3	(0, 1, 4)	$D(lp03, 1)_{(t)} = Z_{(t)} - \underset{(0.196)}{0.138} Z_{(t-1)} + \underset{(0.001)}{0.298} Z_{(t-2)} - \underset{(0.220)}{0.582} Z_{(t-3)} - \underset{(0.228)}{0.578} Z_{(t-4)}$	4.843
4	(0, 1, 2)	$D(lp04, 1)_{(t)} = Z_{(t)} + \underset{(0.130)}{0.053} Z_{(t-1)} + \underset{(0.142)}{0.722} Z_{(t-2)}$	100.529
5	(1, 1, 0)	$D(lp05, 1)_{(t)} = -\underset{(0.175)}{0.294} D(lp05, 1)_{(t-1)} + Z_{(t)}$	50541.00
6	(0, 1, 1)	$D(lp06, 1)_{(t)} = Z_{(t)} - \underset{(0.153)}{0.635} Z_{(t-1)}$	666.231
7	(0, 1, 2)	$D(lp07, 1)_{(t)} = Z_{(t)} - \underset{(0.192)}{1.108} Z_{(t-1)} + \underset{(0.179)}{.4020} Z_{(t-2)}$	1906.370

Table 5.26: (Continued)

Sector	ARIMA (p, d, q)	Equation	WN Var.
8	(1, 1, 0)	$D(lp08, 1)_{(t)} = -\ 0.242\ D(lp08, 1)_{(t-1)} + Z_{(t)}$ (0.179)	171.984
9	(1, 1, 0)	$D(lp09, 1)_{(t)} = -\ 0.174\ D(lp08, 1)_{(t-1)} + Z_{(t)}$ (0.186)	178.034
10	(0, 1, 1)	$D(lp10, 1)_{(t)} = Z_{(t)} - 0.684\ Z_{(t-1)}$ (0.128)	870.704
11	(1, 1, 2)	$D(lp11, 1)_{(t)} = 0.793D(lp11, 1)_{(t-1)} + Z_{(t)} - 1.736\ Z_{(t-1)} + 0.999\ Z_{(t-2)}$ (0.111) (0.004) (0.004)	1480.460
12	(0, 1, 1)	$D(lp12, 1)_{(t)} = Z_{(t)} - 0.670\ Z_{(t-1)}$ (0.125)	664.928
13	(0, 1, 1)	$D(lp13, 1)_{(t)} = Z_{(t)} - 0.368\ Z_{(t-1)}$ (0.193)	505.027
14	(0, 1, 1)	$D(lp14, 1)_{(t)} = Z_{(t)} - 0.433\ Z_{(t-1)}$ (0.204)	1051.670
15	(2, 1, 4)	$D(lp15, 1)_{(t)} = -0.186\ D(lp15, 1)_{(t-1)} + 0.653\ D(lp15, 1)_{(t-2)} + Z_{(t)}$ (0.138) (0.138) $-0.144\ Z_{(t-1)} - 0.861\ Z_{(t-2)} - 0.145\ Z_{(t-3)} + 0.999\ Z_{(t-4)}$ (0.008) (0.007) (0.007) (0.008)	95.929
16	(0, 1, 2)	$D(lp16, 1)_{(t)} = Z_{(t)} + 0.128\ Z_{(t-1)} - 0.684\ Z_{(t-2)}$ (0.169) (0.165)	500.665
17	(2, 1, 0)	$D(lp17, 1)_{(t)} = 0.200\ D(lp17, 1)_{(t-1)} - 0.335\ D(lp17, 1)_{(t-2)} + Z_{(t)}$ (0.171) (0.167)	284.709
18	(1, 1, 0)	$D(lp18, 1)_{(t)} = 0.051\ D(lp18, 1)_{(t-1)} + Z_{(t)}$ (0.180)	23809.20
19	(1, 1, 0)	$D(lp19, 1)_{(t)} = -\ 0.049\ D(lp19, 1)_{(t-1)} + Z_{(t)}$ (0.180)	183.041
20	(1, 1, 0)	$D(lp20, 1)_{(t)} = -\ 0.223\ D(lp20, 1)_{(t-1)} + Z_{(t)}$ (0.178)	58.545
21	(0, 1, 1)	$D(lp21, 1)_{(t)} = Z_{(t)} + 0.237\ Z_{(t-1)}$ (0.189)	79.813
22	(0, 1, 4)	$D(lp22, 1)_{(t)} = Z_{(t)} - 0.332\ Z_{(t-1)} + 0.783Z_{(t-2)} - 0.506Z_{(t-3)} + 0.796\ Z_{(t-4)}$ (0.110) (0.086) (0.086) (0.110)	93.109
23	(0, 1, 2)	$D(lp23, 1)_{(t)} = Z_{(t)} + 0.694\ Z_{(t-1)} + 0.999\ Z_{(t-2)}$ (0.003) (0.003)	6374.84
24	(0, 1, 4)	$D(lp24, 1)_{(t)} = Z_{(t)} + 0.299Z_{(t-1)} + 0.493Z_{(t-2)} + 0.299Z_{(t-3)} - 0.507\ Z_{(t-4)}$ (0.157) (0.157) (0.157) (0.157)	123.748
25	(1, 1, 0)	$D(lp25, 1)_{(t)} = 0.181D(lp25, 1)_{(t-1)} + Z_{(t)}$ (0.177)	203.570
26	(0, 1, 1)	$D(lp26, 1)_{(t)} = Z_{(t)} - 0.685\ Z_{(t-1)}$ (0.214)	2.92E+08

Notes:
(1) $lp(\#)$ denotes the labor productivity series for sector #, and $D(lp\#, 1)$ is the 1st difference of the particular series.
(2)Each equation is estimated by the maximum likelihood method via the Iterative Time Series Modeling (ITSM) software.
(3) All numbers in the parentheses represent the standard errors of the AR and MA terms.
(4) $Z_{(t)}$ denotes the White noise stochastic error term with zero mean and their variance shown in the last column of Table 5.25.

Table 5.27: The Results of the Randomness Test on the Residuals of the Sectoral Labor Productivity

Sector #	Q_{LB}	Q_{ML}	Z_{TP}	Z_S	Z_P	MAAO
1	10.702	16.100	21.000	16.000	.26100E+03	0
p - value	(0.709)	(0.375)	(0.297)	(0.351)	(0.120)	
2	3.680	14.157	18.000	14.000	26200E+03	0
p - value	(0.997)	(0.514)	(0.766)	(0.756)	(0.112)	
3	9.3066	30.474	20.000	14.000	.26700E+03	0
p - value	(0.594)	(0.010*)	(0.551)	(0.756)	(0.077)	
4	10.032	9.5699	16.000	18.000	.25600E+03	0
p - value	(0.691)	(0.846)	(0.234)	(0.029*)	(0.170)	
5	5.769	16.620	20.000	14.000	.27200E+03	0
p - value	(0.972)	(0.342)	(0.551)	(0.756)	(0.052)	
6	11.674	13.013	21.000	14.000	.28400E+03	0
p - value	(0.632)	(0.601)	(0.297)	(0.756)	(0.018*)	
7	3.859	0.275	19.000	13.000	.26900E+03	0
p - value	(0.997)	(1.000)	(0.882)	(0.351)	(0.066)	
8	13.514	9.2821	20.000	12.000	.28800E+03	0
p - value	(0.486)	(0.862)	(0.551)	(0.120)	(0.012*)	
9	14.920	4.548	22.000	16.000	.29900E+03	0
p - value	(0.384)	(0.995)	(0.136)	(0.351)	(0.003*)	
10	10.847	22.871	16.000	12.000	.27300E+03	0
p - value	(0.698)	(0.087)	(0.234)	(0.120)	(0.048*)	
11	14.973	8.928	15.000	12.000	.26400E+03	0
p - value	(0.309)	(0.916)	(0.101)	(0.120)	(0.097)	
12	13.239	4.074	17.000	13.000	.26300E+03	0
p - value	(0.508)	(0.998)	(0.457)	(0.351)	(0.104)	
13	6.9193	14.423	17.000	17.000	.29600E+03	0
p - value	(0.938)	(0.494)	(0.457)	(0.120)	(0.005*)	
14	6.095	12.053	18.000	14.000	.25700E+03	0
p - value	(0.978)	(0.740)	(0.766)	(0.756)	(0.159)	
15	9.918	8.247	16.000	16.000	.25300E+03	0
p - value	(0.357)	(0.913)	(0.234)	(0.351)	(0.205)	
16	10.280	17.195	20.000	15.000	.26500E+03	0
p - value	(0.741)	(0.373)	(0.551)	(0.756)	(0.090)	
17	9.292	9.964	19.000	17.000	.27600E+03	0
p - value	(0.812)	(0.869)	(0.882)	(0.120)	(0.037*)	
18	4.413	2.679	16.000	14.000	.25300E+03	0
p - value	(0.992)	(0.999)	(0.234)	(0.756)	(0.205)	
19	8.362	18.401	22.000	17.000	.18200E+03	0
p - value	(0.870)	(0.242)	(0.136)	(0.120)	(0.205)	
20	8.136	9.7082	23.000	14.000	.21200E+03	0
p - value	(0.882)	(0.838)	(0.053)	(0.756)	(0.844)	
21	10.293	13.961	16.000	14.000	.21100E+03	0
p - value	(0.741)	(0.528)	(0.234)	(0.756)	(0.817)	
22	14.733	20.608	18.000	16.000	27500E+03	0
p - value	(0.195)	(0.150)	(0.766)	(0.351)	(0.040*)	
23	7.705	9.626	17.000	13.000	.20900E+03	0
p - value	(0.904)	(0.885)	(0.457)	(0.351)	(0.762)	
24	13.750	8.340	19.000	17.000	.20500E+03	0
p - value	(0.247)	(0.909)	(0.882)	(0.120)	(0.656)	

Table 5.27: (Continued)

Sector #	Q_{LB}	Q_{ML}	Z_{TP}	Z_S	Z_P	MAAO
25 p - value	7.697 (0.905)	4.331 (0.996)	19.000 (0.882)	17.000 (0.120)	.21700E+03 (0.986)	0
26 p - value	3.420 (0.998)	0.803 (1.000)	12.000 (0.003*)	20.000 (0.001*)	.27500E+03 (0.040*)	0

Notes: (1) In this study, the assigned value of h for the Ljung – Box and the McLeod – Li portmanteau tests is 15 (Practically, h is equal to $n/2$).

(2) The results are estimated by the Iterative Time Series Modeling (ITSM) software, and * denotes the significance at the 0.05 level

(3) All numbers in the parentheses represent the corresponding p – value of each statistic at the 5% level of significant.

The result of the residual tests from Table 5.27 guarantees the appropriateness of the assigned *ARIMA* (p, d, q) model in estimating the sectoral labor productivity. In most case, the tests confirm the randomness characteristic of the estimated residuals in every equation except for the rank test (Z_P) of sectors 6, 8 – 10, 12, 17, 22, and 26, the difference – sign test of sectors 4 and 26, and the turning point test of sector 26. However, at least 3 from the 6 tests in each equation fail to reject the null hypothesis of the randomness. I will conclude that the estimated ARIMA models in Table 5.26 fit the labor productivity data quite well, and they can be used to forecast the sectoral series from 2005 – 2020.

One thing that should be mentioned here is that the forecasting result of the labor productivity series of sector 26 from 2012 to 2020 are kept at 447.48 millions of baht per thousand persons. This is because the forecasting values from the estimated *ARIMA* equation after 2012 are negative, and it is unreasonable to assume a negative productivity level in this sector. Consequently, after 2012, the productivity level is maintained at the 2012 forecasting level.

Table 5.28: The Forecasting Results for the Sectoral Labor Productivity from 2005 - 2020

(Millions of Baht per Thousand Persons)

Sector	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1	82.62	86.31	88.34	90.84	93.21	95.61	98.00	100.40	102.79	105.19
2	71.73	73.77	75.82	77.87	79.92	81.97	84.01	86.06	88.11	90.16
3	35.33	33.66	33.48	34.72	35.68	36.65	37.62	38.59	39.56	40.52
4	455.54	483.09	497.49	511.87	526.26	540.66	555.06	569.46	583.83	598.23
5	1548.96	1580.52	1631.10	1676.04	1722.66	1768.80	1815.06	1861.26	1907.52	1953.78
6	1239.32	1279.81	1320.26	1360.72	1401.18	1441.67	1482.13	1522.59	1563.08	1603.54
7	1271.13	1316.17	1356.00	1395.87	1435.70	1475.56	1515.43	1555.26	1595.12	1634.95
8	1315.74	1351.05	1390.22	1428.44	1466.88	1505.30	1543.71	1582.12	1620.50	1658.91
9	1362.04	1404.98	1445.30	1486.09	1526.81	1567.53	1608.26	1648.98	1689.70	1730.42
10	1102.27	1131.31	1160.35	1189.39	1218.43	1247.47	1276.51	1305.55	1334.59	1363.63
11	1561.76	1728.41	1872.85	1999.67	2112.50	2214.27	2307.26	2393.29	2473.78	2549.91
12	1149.46	1184.37	1219.25	1254.13	1289.01	1323.89	1358.78	1393.66	1428.54	1463.42
13	1236.31	1273.24	1310.17	1347.09	1384.05	1420.98	1457.91	1494.83	1531.76	1568.69
14	1116.69	1145.96	1175.23	1204.47	1233.74	1263.01	1292.25	1321.52	1350.76	1380.03
15	1251.13	1227.70	1351.88	1288.06	1398.64	1353.92	1452.07	1422.17	1509.42	1491.24
16	1169.29	1192.95	1228.29	1263.60	1298.95	1334.26	1369.57	1404.91	1440.22	1475.56
17	1295.51	1340.49	1384.81	1422.40	1458.86	1497.38	1536.68	1575.42	1613.83	1652.31
18	2356.08	2429.40	2502.72	2576.04	2649.36	2722.68	2796.00	2869.44	2942.76	3016.08
19	86.24	88.07	89.92	91.76	93.61	95.46	97.30	99.15	100.99	102.84
20	372.57	381.57	391.67	401.50	411.40	421.28	431.16	441.03	450.91	460.81
21	292.34	300.26	308.15	316.07	323.97	331.89	339.81	347.71	355.63	363.53
22	1539.37	1561.70	1618.82	1634.99	1679.13	1723.23	1767.36	1811.46	1855.60	1899.70
23	593.45	602.00	621.77	641.55	661.32	681.10	700.87	720.65	740.42	760.20
24	69.17	84.93	87.75	88.85	91.17	93.49	95.81	98.12	100.44	102.76
25	363.50	372.78	382.28	391.80	401.34	410.88	420.42	429.96	439.50	449.04
26	8998.20	7776.60	6555.00	5333.70	4112.10	2890.50	1668.99	447.48	447.48	447.48

Table 5.28: (Continued)

(Millions of Baht per Thousand Persons)

Sector	2015	2016	2017	2018	2019	2020
1	107.58	109.98	112.37	114.77	117.16	119.56
2	92.21	94.26	96.30	98.35	100.40	102.45
3	41.49	42.46	43.43	44.39	45.36	46.33
4	612.63	627.03	641.42	655.82	670.20	684.60
5	1999.98	2046.24	2092.44	2138.70	2184.90	2231.16
6	1643.99	1684.45	1724.94	1765.40	1805.86	1846.35
7	1674.82	1714.68	1754.51	1794.38	1834.21	1874.07
8	1697.32	1735.73	1774.15	1812.56	1850.94	1889.35
9	1771.14	1811.87	1852.59	1893.31	1934.03	1974.75
10	1392.67	1421.71	1450.75	1479.79	1508.83	1537.87
11	2622.54	2692.44	2760.15	2826.15	2890.77	2954.29
12	1498.33	1533.21	1568.09	1602.98	1637.86	1672.74
13	1605.62	1642.54	1679.47	1716.40	1753.32	1790.25
14	1409.30	1438.54	1467.81	1497.08	1526.32	1555.59
15	1569.18	1560.37	1630.50	1629.28	1692.90	1697.82
16	1510.87	1546.18	1581.53	1616.84	1652.15	1687.49
17	1690.95	1729.60	1768.17	1806.75	1845.36	1883.94
18	3089.40	3162.72	3236.04	3309.36	3382.68	3456.12
19	104.69	106.53	108.38	110.22	112.07	113.92
20	470.69	480.57	490.45	500.32	510.22	520.10
21	371.45	379.37	387.27	395.19	403.08	411.00
22	1943.83	1987.93	2032.07	2076.17	2120.27	2164.40
23	779.97	799.75	819.53	839.30	859.08	878.85
24	105.08	107.39	109.71	112.03	114.35	116.66
25	458.58	468.12	477.66	487.20	496.74	506.28
26	447.48	447.48	447.48	447.48	447.48	447.48

5.6 The Summary

In conclusion, the objective of this long Chapter 5 is to find the appropriate equations both in terms of the relevancy to the economic theories, and the proper statistical characteristics of the data for the real side of the MUTE model.

In this study, only 4 components on the real side namely, private consumption expenditure (*pce*), gross fixed capital formation (*gfcf*), inventory change (*inv*), and expenditure on imports (*im*), are represented by the regression equations for all 26 I – O sectors, while the remaining 3 components of aggregate demand (government consumption expenditure, exports and special exports) are left as exogenous variables to the model. Finally, the labor productivity equations are estimated at the end of the chapter as the vehicle of growth for the economy and the linkage between the real side and the price – income side.

Chapter VI

The Estimation for the Price – Income Side

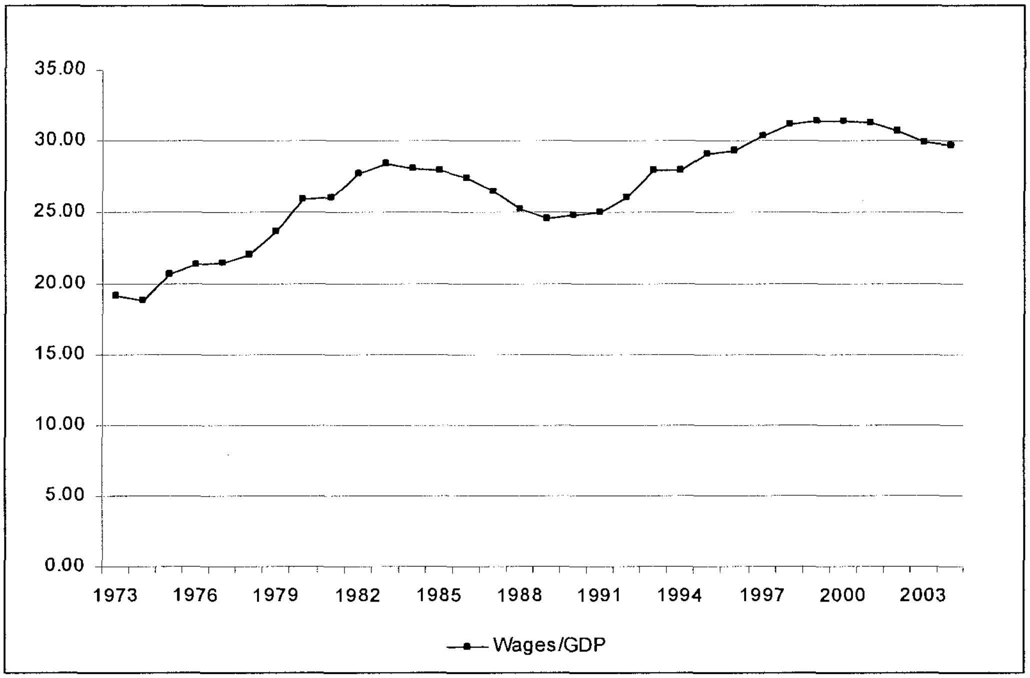
The aim of this chapter is to find the suitable functional forms for the price – income side of the MUTE model by combining the available data in SNA and SIO. The price – income side can be separated into the following 4 components which are 1) the compensation to employees (wages and salaries), 2) operating surplus (profits), 3) depreciation, and 4) Indirect taxes minus subsidies. The summation of these four components is the total amount of value added, which is equal to the country's GDP computing from the income side. The difference of GDP from the real side and from the income side is equal to the statistical discrepancy. Moreover, the accuracy of the estimation of these value - added components are quite important not only in determining the level of GDP but also in computing the sectoral prices.

In this chapter, only 3 value added components (wages, profits, and depreciation) are estimated by the regression technique. The indirect taxes minus subsidies component is treated as the policy variable thus, is exogenous to the MUTE model. The structure of this chapter can be divided into three main parts. Section 6.1 and 6.2 show the importance and the determination of the sectoral wage and profit equations. Finally, the depreciation equations are estimated in section 6.3.

6.1 The Estimation of the Wage Equations (w^i)

Wages and salaries are the main part of the value added components of Thailand. They account for 19 percent of GDP in 1973, and this ratio increases to approximately 30 percent of GDP in 2004 (See Figure 6.1 below).

Figure 6.1: The Proportion of Wages to GDP of Thailand (%)



Source: National Economic and Social Development Board (*NESDB*)

In Thailand, the minimum wage rate has been controlled by the law since 1973. Under current legislation (2005), the basic minimum wage rate is set at 140 Baht (about \$4) per day. The highest controlled rate is found in Bangkok and municipal areas (184 Baht (approximately \$6)/day). In the urban areas, the average rate is about 150 Baht (about \$5) /day, while in the rural area, the average rate is set at the basic minimum rate.

However, the main problems of Thailand in determining the minimum wage rate can be separated into two groups by the affected parties. The first group on one hand is the problem on the employee side. In most cases, employees feel that the predetermined rates do not reflect the true minimum standard of livings. The adjustment by increasing the minimum rate raises the amount of money paid by employers, but not sufficiently to cover the effect of inflation on the purchasing power. Furthermore, the minimum wage law causes the rate of unemployment to rise, since the costs of hiring labors are higher.

Firms will substitute expensive labors with lower - cost machines or hire fewer labors. On the other hands, employers take advantage from the minimum wage law by paying the same wage rate to both high and low potential workers. Consequently, workers lack the incentive to improve themselves. Moreover, the frequent changes of the minimum wage rate will cause firms not only to lose the ability to compete in both domestic and foreign markets due to the higher costs of production, but also to create difficulties in making decision in advance on the sale prices, amounts of production, marketing, and so on.

Besides the institutional factors such as the minimum wage law, the wage contracts, and the bargaining power between firms and workers that determine the level of wage rate, two main economic approaches (*Phillips Curve* and *Wage Curve*) provide the foundation in explaining the wage relation. The dynamic *Phillips curve* exhibits the negative relationship between wage growth and the unemployment rate (in the short run), while the idea of *wage curve* shows the long – run negative relationship between the wage level and the unemployment rate. According to Gunnar, Jurgen, and Jan (2004)[1], the specification of the Phillip curve seems to fit the U.S. data quite well, while the wage curve approach is favored by the European economists in determining the wage equations.

Generally, the simple Phillips curve which relates the change in the inflation rate and the unemployment rate is derived from the following price and wage equations:

$$\Delta \log P_t = \alpha_1 + \alpha_2 \Delta \log W_t + \varepsilon_{1t} \tag{6.1}$$

[1] Gunnar Bårdsen & Jurgen Doornik & Jan Tore Klovland, 2004. "A European-type wage equation from an American-style labor market: Evidence from a panel of Norwegian manufacturing industries in the 1930s," Working Paper 2004/4, Norges Bank.

$$\Delta \log W_t = \beta_1 + \beta_2 \Delta \log P_{t-1} - \beta_3 u_t + \varepsilon_{2t} \qquad (6.2)$$

where P_t is the price index at time t, W_t denotes the nominal wage, u_t is the unemployment rate, α_1, α_2, and β_1 to β_3 are the estimated parameters, ε_{1t} and ε_{2t} are the residuals. Since variables P and W are estimated in term of the difference of the logarithmic form, $\Delta \log P$ and $\Delta \log W$ represents the price inflation and wage inflation, respectively. By substituting equation (6.2) into (6.1), the Phillips curve can be exhibited as:

$$\Delta \log P_t = \gamma_1 + \gamma_2 \Delta \log P_{t-1} - \gamma_3 u_t + \varepsilon_{3t} \qquad (6.3)$$

where $\gamma_1 = \alpha_1 + \alpha_2 \beta_1, \gamma_2 = \alpha_2 \beta_2, \gamma_3 = \alpha_2 \beta_3$, and $\varepsilon_{3t} = \alpha_2 \varepsilon_{2t} + \varepsilon_{1t}$. However, the point of interest here is equation (6.2) which relates the wage inflation with the price inflation and the unemployment rate.

One interesting example of the wage curve is the study by Blanchard and Katz (1997)[2], which tried to find the compromise between the Phillips curve and the wage curve approaches. They argue that the Phillips curve is only one specification of the wage curve. To prove this argument, the wage curve is estimated by the following error correction model:

$$\Delta w_t = c + \Delta pc_t + \alpha \Delta q_t - \delta u_t - \alpha [w - pc - q]_{t-1} + \varepsilon_t \qquad (6.4)$$

where W, PC, Q and U denote the wage rate per hour, retail prices, labor productivity, and the unemployment rate, respectively. The lower case letters represent the logarithmic form of the particular variables, and Δ denotes the difference of the particular series from their previous period value. Due to the derived method, they assumed that:

[2] Blanchard, O. and L. F. Katz (1997). What We Know and Do Not Know About the Natural Rate of Unemployment. Journal of Economic Perspectives, 11, 51–72.

$$\alpha = (1 - \mu\lambda) \qquad \text{and} \qquad 0 \le \mu, \lambda \le 1$$

where $(1-\mu)$ and $(1-\lambda)$ can be interpreted as the direct effect of productivity on reservation wage and the expected real wage, consecutively. If the productivity has no effect on the wage rate (that is $\alpha = 0$, or $\mu = \lambda = 1$), equation (6.4) will turn out to be the Phillips curve.

Moreover, the continued study of Blanchard and Katz (1999)[3] attempted to compare the degree of productivity effect on the wage rates between two continents (Europe and USA). They concluded that the estimated values of parameters μ and λ in Europe are smaller than those in U.S.A, which make the effect of productivity in U.S. lower than that in Europe. This is because of the greater role of labor unions, the higher level of laws and regulation enforcement, and the bigger informal sectors in the European labor markets.

Review of some studies on the wage equation shows that the choices of the explanatory variables for the wage equations in the MUTE model are definitely based on these two approaches. However, the appropriateness of the wage function still depends on the (non)stationary characteristic of the relevant series.

6.1.1 The Functional Forms, Sources of data, and the ADF Test for the Wage Equations

As mentioned in Chapter 4, the connection of sectoral wage and the aggregate wage in the MUTE model can be established by estimating one aggregate wage equation and sectoral wage equations for 26 I – O sectors (See equations 4.20 and 4.21). On one

[3] Blanchard, O. J. and L. Katz. "Wage Dynamics: Reconciling Theory and Evidence," *American Economic Review*, 89(2), 1999, 69–74.

hand, the specification for the aggregate wage function is based on the combination of Phillips curve and wage curve approaches. Thus, the possible explanatory variables in this case include 1) the average rate of labor productivity (ALP_t), 2) the price index (P_t), 3) the unemployment rate (U_t), and 4) time trend variable and dummy variables, which represent the periods of political disorder and financial crisis in Thailand (*poldum* and *cridum*) as shown in equation (6.5):

$$\Delta w_t = \alpha_1 + \alpha_2 \Delta alp_t + \alpha_3 \Delta p_t + \alpha_4 u_t + \alpha_5 t + \alpha_6 poldum + \alpha_7 cridum + \varepsilon_t \qquad (6.5)$$

where the lower letters except, for time trend variable (t) and dummy variables (*poldum*, and *cridum*) represent the logarithmic form of the above series. The aggregate wage (W_t) in this case is computed by dividing the total amount of compensation to employee by the total employment in a particular year (baht/ person/year).The sign for α_2 and α_3 are expected to be positive, since high labor productivity and higher inflation rate will cause wage rate to rise, while the sign for α_4, α_6, and α_7 are expected to be negative, because high unemployment rate, which means higher available supply of labors, and the crises should generate negative impacts on the wage rate. The time trend variable (t) is added to equation (6.5) to represent other effects such as labor contracts, law and regulation, and so on.

On the other hand, in order to maintain the connection between the sectoral wage and the aggregate wage, the sectoral wage rate equations are estimated in the logarithmic form of the share equations. Intuitively, the sectoral wage equations are supposed to include the industry - specific factors. Two variables that use to exhibit the industry – specific factors in this study are the ratio of employment in sector i to the total employment ($\frac{emp_t^i}{temp_t}$) and the labor productivity of each industry (lp_t^i). Thus, the sectoral wage equations (ws_t^i) in this study are estimated by the following form:

$$\Delta \ln\left(\frac{ws_t^i}{W_t}\right) = \beta_1 + \beta_2 \Delta \ln\left(\frac{emp_t^i}{temp_t}\right) + \beta_3 \Delta \ln(lp_t^i) + \beta_4 t + \varepsilon_t \tag{6.6}$$

By the same token, the sectoral wage rate (ws_t^i) series are calculated by dividing the sectoral compensation to employee by the number of employed laborers in that sector. The time trend variable is also added to equation (6.6) to represent other effects on sectoral wage rate. The insertion of the ratio of the sectoral employment to the total employment ($\frac{emp_t^i}{temp_t}$) is aimed at capturing the demand condition in the labor market. The signs of both β_2 and β_3 are expected to be positive, since high demand for labors and high level of productivity in a particular sector will cause the wage in that sector to rise.

All data for the aggregate wage equation are acquired from the published annual NESDB and labor force survey (LFS). In order to avoid the problem of discrepancy between SNA and SIO data, the ratios of the sectoral compensation to employee to its total amount from the RAS IO table are used as the scaling factors in generating the ws_t^i series in this study and the sectoral wage rate are simply computed by dividing these amounts by the number of labor employment in each sector. Before using equations (6.5) and (6.6) in estimating the wage equation for the MUTE model, the (non) stationary characteristic of each variable in the model has to be detected to avoid the problem of spurious regression. The results of the ADF test for each variable in level, logarithmic, and the 1^{st} difference of logarithmic form are shown in Tables 6.1 and 6.2

Table 6.1: The ADF Test for Variables in the Aggregate Wage Rate Equation

The ADF Test for the Aggregate Wage Equation					
	Coefficient for (W_t)	**Tau (τ) Statistic**		**Coefficient for (ALP_t)**	**Tau (τ) Statistic**
level	0.004	0.182	level	-0.635	-3.545**
log	-0.021	-1.064	log	-0.257	-2.025
1^{st} – log	-1.111	-5.653***	1^{st} – log	-1.266	-6.696***
	Coefficient for (U_t)	**Tau (τ) Statistic**		**Coefficient for (P_t)**	**Tau (τ) Statistic**
level	-0.209	-1.943	level	-0.009	-0.594
log	-0.155	-1.772	log	-0.034	-2.384
1^{st} – log	-0.828	-4.293***	1^{st} – log	-0.699	-4.214***

Notes: (1) *, **, *** denoted the significant level at 10%, 5%, and 1%, respectively for testing the null hypothesis that the particular series has a unit root.
(2) The "level", "log", and "1^{st} – log" represent the ADF test on the level, logarithmic, and the 1^{st} difference of the logarithmic forms, respectively.

Table 6.2: The ADF Test for Variables in the Sectoral Wage Rate Equations

The ADF Test for the Sectoral Wage Series (ws^i/W_t)					
Sector	**Coefficient for (ws^i/W_t)**	**Tau (τ) Statistic**	**Sector**	**Coefficient for (ws^i/W_t)**	**Tau (τ) Statistic**
1	-0.153	-1.810	9	-0.098	-1.068
log	-0.151	-1.708	log	-0.047	-0.607
1^{st} – log	-1.178	-6.157***	1^{st} – log	-1.009	-5.145***
2	-0.115	-0.616	10	-0.256	-2.015
log	-0.116	-0.650	log	-0.237	-1.928
1^{st} – log	-2.071	-6.899***	1^{st} – log	-1.105	-5.683***
3	-0.294	-2.531	11	-0.107	-1.118
log	-0.282	-2.267	log	-0.062	-0.763
1^{st} – log	-1.588	-9.527***	1^{st} – log	-0.820	-4.462***
4	-0.415	-2.527	12	-0.076	-0.958
log	-0.413	-2.515	log	-0.043	-0.664
1^{st} – log	-1.544	-5.767***	1^{st} – log	-1.087	-5.989***
5	-0.243	-1.967	13	-0.327	-3.597**
log	-0.229	-1.895	log	-0.362	-3.412**
1^{st} – log	-1.308	-6.989***	1^{st} – log	-1.121	-3.937***
6	-0.073	-0.738	14	-0.175	-1.402
log	-0.063	-0.634	log	-0.174	-1.597
1^{st} – log	-1.720	-12.264***	1^{st} – log	-1.260	-6.573***
7	-0.059	-0.749	15	-0.110	-1.150
log	-0.055	-0.707	log	-0.088	-0.976
1^{st} – log	-1.216	-6.341***	1^{st} – log	-1.247	-6.428***
8	-0.162	-1.711	16	-0.265	-2.008
log	-0.145	-1.609	log	-0.203	-1.720
1^{st} – log	-1.399	-7.773***	1^{st} – log	-1.323	-7.127***

Table 6.2: (Continued)

The ADF Test for Sectoral Wage Series (ws^i/W_t)					
Sector	**Coefficient for (ws^i/W_t)**	**Tau (τ) Statistic**	**Sector**	**Coefficient for (ws^i/W_t)**	**Tau (τ) Statistic**
17	-0.134	-1.380	22	-0.264	-1.991
log	-0.093	-1.153	log	-0.285	-2.091
1st – log	-1.027	-3.210**	1st – log	-1.079	-5.936***
18	-0.236	-2.101	23	-0.197	-1.792
log	-0.241	-2.207	log	-0.197	-1.820
1st – log	-0.814	-4.215***	1st – log	-1.076	-5.643***
19	-0.088	-1.010	24	-0.277	-2.136
log	-0.061	-0.811	log	-0.227	-1.973
1st – log	-1.018	-5.368***	1st – log	-1.073	-5.872***
20	-0.332	-2.274	25	-0.239	-2.587
log	-0.298	-2.119	log	-0.222	-2.296
1st – log	-1.183	-6.135***	1st – log	-1.427	-8.094***
21	-0.462	-2.780*	26	-0.077	-1.348
log	-0.417	-2.579	log	-0.047	-1.593
1st – log	-1.409	-7.751***	1st – log	-1.116	-4.593***
The ADF Test for the ratio of the sectoral employment to the total employment ($emp^i/temp^i$)					
Sector	**Coefficient for ($emp^i/temp^i$)**	**Tau (τ) Statistic**	**Sector**	**Coefficient for ($emp^i/temp^i$)**	**Tau (τ) Statistic**
1	0.006	0.124	11	-0.185	-1.717
log	0.022	0.372	log	-0.541	-3.059
1st – log	-1.591	-10.034***	1st – log	-1.289	-6.710***
2	-0.321	-1.990	12	0.092	0.699
log	-0.294	-1.811	log	-0.718	-3.749**
1st – log	-1.382	-7.174***	1st – log	-1.425	-7.817***
3	-0.014	-0.309	13	-0.157	-1.748
log	0.033	0.997	log	-0.300	-1.718
1st – log	-1.056	-5.339***	1st – log	-1.644	-10.808***
4	0.010	0.186	14	-0.777	-4.141***
log	0.020	0.381	log	-1.035	-5.313***
1st – log	-2.682	-3.641**	1st – log	-1.500	-8.662***
5	-0.597	-3.418**	15	-0.229	-1.929
log	-1.136	-5.693***	log	-0.797	-4.116**
1st – log	-1.752	-11.665***	1st – log	-2.236	-5.550***
6	-0.021	-0.100	16	0.022	0.443
log	-0.159	-0.785	log	-0.333	-2.340
1st – log	-2.112	-5.873***	1st – log	-1.325	-6.995***
7	-0.746	-4.029***	17	-0.066	-1.086
log	-0.766	-4.054**	log	-0.812	-3.078
1st – log	-1.495	-8.607***	1st – log	-0.990	-3.593**
8	-0.209	-1.868	18	-0.238	-1.910
log	-0.176	-0.760	log	-0.190	-1.329
1st – log	-1.183	-3.257**	1st – log	-1.132	-5.710***
9	-0.159	-1.575	19	-0.106	-1.322
log	-0.217	-1.867	log	-0.343	-2.259
1st – log	-1.516	-4.280***	1st – log	-1.380	-7.463***
10	0.052	1.180	20	0.013	0.197
log	-0.006	-1.510	log	-0.576	-2.758
1st – log	-1.163	-3.354**	1st – log	-1.648	-10.832***

Table 6.2: (Continued)

The ADF Test for the ratio of the sectoral employment to the total employment ($emp^i/temp^i$)					
Sector	**Coefficient for ($emp^i/temp^i$)**	**Tau (τ) Statistic**	**Sector**	**Coefficient for ($emp^i/temp^i$)**	**Tau (τ) Statistic**
21	0.141	2.099	24	0.111	1.357
log	-0.499	-2.795	log	-0.596	-2.069
1^{st} – log	-1.623	-10.365^{***}	1^{st} – log	-3.096	-5.557^{***}
22	-0.053	-0.670	25	0.092	1.153
log	-0.584	-3.224^{*}	log	-0.574	-3.163
1^{st} – log	-1.466	-8.309^{***}	1^{st} – log	-2.079	5.474^{***}
23	0.258	2.555	26	-0.604	-3.251^{*}
log	-0.394	-1.644	log	-0.169	-1.081
1^{st} – log	-2.216	-6.049^{***}	1^{st} – log	-1.385	-7.520^{***}
The ADF Test for the Sectoral Productivity (The 1^{st} Difference of the Logarithmic Form $\Delta\ln(lp^i)$)					
Sector	**Coefficient for $\Delta\ln(lp^i)$**	**Tau (τ) Statistic**	**Sector**	**Coefficient for $\Delta\ln(lp^i)$**	**Tau (τ) Statistic**
1	-1.529	-9.105^{***}	14	-1.205	-6.085^{***}
2	-1.397	-8.039^{***}	15	-1.559	-9.409^{***}
3	-1.297	-6.847^{***}	16	-1.525	-5.647^{***}
4	-0.778	-3.696^{**}	17	-1.073	-5.378^{***}
5	-1.642	-5.011^{***}	18	-1.917	-6.141^{***}
6	-2.114	-6.885^{***}	19	-1.390	-7.518^{***}
7	-3.818	-4.885^{***}	20	-1.404	-7.854^{***}
8	-1.323	-6.986^{***}	21	-0.844	-4.277^{**}
9	-5.619	-4.866^{***}	22	-1.504	-8.556^{***}
10	-6.075	-5.370^{***}	23	-0.633	-3.799^{**}
11	-2.259	-7.157^{***}	24	-0.825	-4.220^{**}
12	-1.446	-8.077^{***}	25	-0.794	-4.051^{**}
13	-1.338	-7.109^{***}	26	-1.299	-6.819^{***}

Notes: (1) *, **, *** denoted the significant level at 10%, 5%, and 1%, respectively for testing the null hypothesis that the particular series has a unit root.
(2) The "level", "log", and "1^{st} – log" represent the ADF test on the level, logarithmic, and the 1^{st} difference of the logarithmic forms, respectively.
(3) The results of the ADF test on the level, logarithmic and the 1^{st} difference forms of labor productivity series are already shown in Table 5.24.

The results of the ADF test exhibit the non – stationary characteristic of both the level and the logarithmic forms of most series. However, the 1^{st} – difference transformation of logarithmic form is enough to convert all non – stationary series into the stationary ones. This evidence supports the appropriateness of using both functional forms in (6.5) and (6.6) as the aggregate and sectoral wage equations.

6.1.2 The Estimated Results for Aggregate and Sectoral Wage Equations

Since the labor productivity series are estimated by the ARIMA model, they are all treated as a predetermined variable and the rest of the variables are exogenous to the MUTE model. Thus, the technique of OLS is employed to estimate both the aggregate wage equation (6.5), and the set of sectoral equations (6.6). At first, equation (6.5) is estimated by OLS, but the estimated result gives a low value of R^2 and a negative value of adjusted R^2. Moreover, the DW statistic also shows the evidence of autocorrelation, even if the equation is added with the *AR(1) – AR(5)*. In order to solve this problem, equation (6.5) is estimated again by using only the logarithmic form of each variable.

According to the ADF test on the aggregate wage equation, all series in the logarithmic form are non – stationary. Thus, the cointegration test is necessary. In this case, the number of cointegrating vectors is detected among the 4 variables ($\log(W_t)$, $\log(ALP_t)$, $\log(P_t)$, and $\log(U_t)$). The result is shown in Table 6.3.

Table 6.3: The Cointegration Test on the Aggregate Wage Equation

Trace Test				Maximum Eigenvalue Test				# of Cointeg rating Vector
r =0	**r ≤ 1**	**r ≤ 2**	**r ≤ 3**	**r =0**	**r ≤ 1**	**r ≤ 2**	**r ≤ 3**	
53.489	25.863	8.702	1.689	27.627	17.161	7.013	1.689	1
47.21	**29.68**	**15.41**	**3.76**	**27.07**	**20.97**	**14.07**	**3.76**	

<u>*Notes*</u>: The bold numbers are the critical value at 5% level of significance

Both the trace test and the maximum eigenvalue test indicate 1 cointegrating vectors among these four variables. This evidence confirms that equation (6.5) can be estimated in the logarithmic form. The final result of the estimation for the aggregate equation is shown in the following regression:

$$
\begin{array}{llllll}
\ln(W_t) = & 4.294 + 0.003\ln(ALP_t) & + 1.135\ln(P_t) & - 0.005\ln(U_t) & + 0.046t + & 0.060\text{poldum} \\
 & (1.727) \quad (0.034) & (0.481) & (0.046) & (0.020) & (0.034) \\
t = & (2.486) \quad (0.075) & (2.362) & (-0.100) & (2.273) & (1.765) \\
 & + 0.047\text{cridum} & & & & \\
 & (0.068) & & & & \\
t = & (0.694) & & & &
\end{array}
$$

$$
n = 29 \quad \overline{R}^2 = 0.9915 \quad D.W. = 2.0063 \quad F-Statistic = 466.003
$$

$$
AR(1) \text{ coefficient} = 0.7244 \; (t = 3.947) \tag{6.7}
$$

Most of the estimated parameters except for the parameter of *poldum* and *cridum* variables have the expected sign. Even though the estimated parameters of *poldum* and *cridum* variables give the unexpected positive sign, the impacts of these two variables on the aggregate wage rate are not significant. Only the price level (P_t) and the time trend variables have the significant influence on the aggregate wage rate. Since the equation is estimated in the logarithmic form, the estimated parameters for log(ALP_t), log(P_t), and log(U_t) can be interpreted as the elasticities with respect to the percentage change in the corresponding variables. In this case, the price level has the highest impacts on the aggregate wage.

The estimated results and some important statistics for the sectoral wage rate equations are shown in Table 6.4. The autoregressive components are inserted in the particular equation in order to solve the problem of autocorrelation.

Table 6.4: The Estimated Results for the Sectoral Wage Equations

Sector	C	$\Delta\ln$ (emp^i / $temp^i$)	$\Delta\ln(lp^i)$	*trend*	*AR(1)*	*AR(2)*	R^2	*D.W.*
1	-0.064 **(-2.015)**	0.784 (1.822)	0.343 **(2.293)**	0.002 (1.391)	-0.333 (-1.526)	-	0.260	1.986
2	-0.040 (-1.478)	-0.059 (-0.212)	0.038 (0.195)	0.002 (1.927)	-0.730 **(-3.980)**	-0.557 **(-3.000)**	0.483	1.839
3	-0.068 **(-3.079)**	0.332 **(2.063)**	0.472 **(3.483)**	0.003 (1.928)	-0.977 **(-4.661)**	-0.478 **(-2.093)**	0.591	1.948

Table 6.4: (Continued)

Sector	*C*	Δln (*emp*^{i} /*temp*^{i})	Δln(*lp*^{i})	*trend*	*AR(1)*	*AR(2)*	R^2	*D.W.*
4	-0.012 (-0.310)	-0.070 (-0.186)	0.146 (0.931)	-0.001 (-0.415)	-	-0.431 **(-2.345)**	0.214	1.819
5	-0.004 (-0.057)	0.093 (0.573)	0.014 (0.091)	-0.001 (-0.237)	-0.284 (-1.363)	-	0.117	1.905
6	-0.001 (-0.054)	-0.087 (-0.609)	-0.124 (-1.201)	0.000 (-0.098)	-0.755 (-4.944)	-	0.532	2.174
7	0.020 (0.545)	-0.053 (-0.253)	-0.049 (-0.303)	-0.002 (-0.956)	-0.241 (-1.156)	-	0.183	2.051
8	-0.156 (-1.480)	0.632 (1.621)	0.567 (1.161)	0.005 (1.168)	-	0.134 (0.638)	0.158	2.280
9	0.008 (0.118)	0.168 (1.166)	-0.151 (-0.439)	-0.002 (-0.615)	-	-	0.127	1.757
10	0.007 (0.125)	-0.222 (-0.740)	-0.144 (-0.662)	0.000 (0.057)	-0.150 (-0.679)	-0.130 (-0.586)	0.042	2.104
11	-0.055 (-0.762)	0.281 (1.514)	0.127 (1.006)	0.000 (0.010)	0.164 (0.850)	-0.248 (-1.270)	0.221	2.169
12	-0.012 (-0.180)	-0.104 (-0.551)	0.008 (0.034)	-0.001 (-0.284)	-	-	0.036	2.037
13	-0.047 (-0.599)	0.269 (1.238)	0.041 (0.138)	0.001 (0.226)	-	-	0.065	1.926
14	-0.042 (-0.569)	0.149 (0.473)	0.265 (0.798)	-0.001 (-0.159)	-0.451 (-1.842)	-0.234 (-0.842)	0.134	1.889
15	0.062 (0.819)	-0.202 (-1.177)	-0.304 (-0.811)	-0.003 (-0.917)	-0.306 (-1.123)	0.162 (0.696)	0.146	1.803
16	0.021 (0.337)	0.249 (0.943)	-0.143 (-0.633)	-0.002 (-0.626)	-0.225 (-0.989)	-0.047 (-0.179)	0.212	2.032
17	-0.097 (-0.799)	0.514 (1.710)	0.091 (0.371)	0.004 (0.677)	0.160 (0.6580	0.230 (1.004)	0.162	2.038
18	-0.001 (-0.013)	0.003 (0.011)	-0.028 (-0.135)	0.001 (0.170)	0.222 (1.051)	-0.146 (-0.706)	0.071	2.080
19	0.016 (0.237)	0.053 (0.350)	-0.245 (-1.258)	-0.002 (-0.489)	0.148 (0.707)	-	0.160	1.992
20	0.041 (0.645)	0.422 (1.310)	-0.045 (-0.153)	-0.003 (-0.963)	-	-	0.104	2.070
21	-0.030 (-0.418)	1.124 (2.995)	0.464 (1.183)	-0.002 (-0.610)	-	-	0.290	2.285
22	-0.034 (-0.408)	0.299 (0.867)	0.201 (0.386)	0.000 (0.058)	-	-	0.030	1.825
23	0.077 (1.855)	-0.430 (-1.618)	-0.226 **(-2.367)**	-0.003 (-1.413)	-0.239 (-1.147)	-	0.245	2.037
24	0.102 (1.218)	0.469 (1.610)	0.010 (0.048)	-0.007 (-1.615)	-	-	0.181	2.086
25	-0.032 (-0.675)	0.127 (0.379)	-0.161 (-0.557)	0.001 (0.465)	-0.444 (-2.051)	-	0.243	1.852
26	-0.004 (-0.082)	-0.472 **(-2.255)**	-0.449 **(-2.234)**	-0.003 (-1.074)	-0.535 **(-3.967)**	-	0.407	1.945

Note: (1) The t – statistics are shown in the parenthesis. The Bold numbers represent the significance level at 5%. (2) *C*, *D.W.* and R^2 denote the constant term, the Durbin – Watson Statistics and the correlation coefficients, respectively.

The OLS estimation of sectoral wage rates gives unimpressive results. The low values of R^2 and t – statistics are obtained in every sectors and the estimated parameters have unexpected sign. Although this evidence suggests the need for better specifications for sectoral wage equations, proper functional forms are hardly to find. For instance, the sectoral wage equations are estimated by using both the level and the logarithmic forms for each variable, but the cointegration tests (since they are non - stationary) in both cases confirm the inexistence of cointegrating vectors. Another feasible way is to estimate these equations by the *ARIMA (p, d, q)* model. However, the estimation of these series by the *ARIMA* model will destroy the relationships between the real and the price – income sides, which are linked by the labor productivity through the wage equations. Therefore, the sectoral wage equations are left as shown in Table 6.4, until they can be replaced by better specifications or superior methods in stacking the sectoral wage series are found.

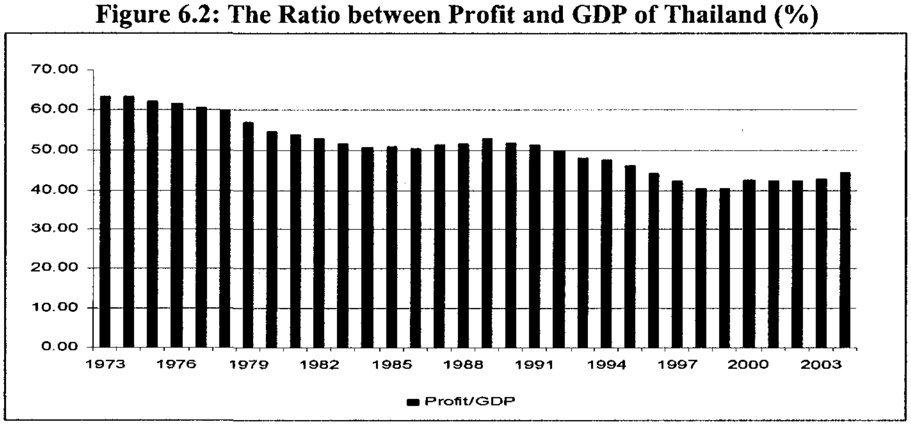
According to the result from Table 6.4, the expected positive sign of estimated parameters for both $\Delta\ln(emp^i/temp^i)$ and $\Delta\ln(lp^i)$ are found only in sectors 1, 3, 5, 8, 11, 13, 14, 17, 21, 22, and 24. For the rest of the sectors, at least one or both of these two parameters have negative values, though in most case, they are statistical insignificant at 5% level. Two possible explanations for the negative value of these parameters are found in the fundamental structures of the labor market in Thailand. First, wage rates in Thailand are quite sticky, since they are basically determined by the institutional factors such as labor contracts, law and regulations, and so on. Consequently, during the boom (slump) period which is represented by the high (low) demand for labor (captured by the high (low) values of $emp^i/temp^i$ variable), wage rates cannot be adjusted immediately with the changing economic situation. Thus, it is possible to see high wage rate during slump period, or otherwise. The second explanation comes from the fact that the movement of sectoral wage rates in Thailand does not reflect the adjustment of labor productivities, and on the average, Thai workers are paid lower than their productivities. As a result, the relationship between labor productivity and wage rate does not exist in most sectors and even worse, there could be negative relationship between these two variables.

Finally, since all sectoral wage equations are estimated in the 1st – difference of the logarithmic form, each estimated parameter can be interpreted in term of the growth rate. For instance, if the growth rate of productivity in sector 1 increases by 1 percent ($\Delta\ln(lp^i)$ in sector 1 increase by 1%), this will cause the growth rate of wage rate in this sector to rise by 0.343 percent.

6.2 The Estimation of the Sectoral Profit Equations (pf^i)

The next task of this chapter is to estimate the sectoral equations for profit. Profit is the largest component on the price – income side of Thailand. It accounted for 63.28 percent of GDP in 1973, and gradually decreased to 44.37 percent in 2004 (see figure 6.2).

Figure 6.2: The Ratio between Profit and GDP of Thailand (%)



Source: National Economic and Social Development Board (*NESDB*)

Moreover, the Real Business Cycle theory (RBC) explains that during the early stage of the recovery, price level rises faster than the factor costs, especially for the wage rate. This will cause the profit margin (price minus cost per unit of goods and services) to rise. Consequently, the rising profit margin will promote more investment and economic expansion[4]. By contrast, the profit margin starts to decrease before GDP when the economy reaches the peak, since the factor costs increase (due to the overuse of the factors) at the rate faster than the price level (that begin to slow down during the initial stage of recession). In other words, the profit margin is strongly procyclical and it can be used as a leading indicator for GDP.

Therefore, the understanding of the variation in profit and the accuracy of estimating the profit function at both aggregate and sectoral levels are quite important in determining GDP and prices for the MUTE model.

6.2.1 Literature Reviews and the Functional Forms of Profit

Most functional forms of profit come from the fundamental economic theory. Generally, firm's profit is defined as the revenue from the sales of goods and services minus the production costs, or:

$$\Pi = p \times f(k,l) - (w \times l) - (r \times k) \tag{6.8}$$

where, Π is the profit, p is the commodities price. k and l denote the amounts of capital and labor used in the firm's production function $f(k, l)$, and the prices of capital and labor are r and k, respectively. By maximizing equation (6.8) with respect to k and l, the input demand functions $k^*(p,w,r)$ and $l^*(p,w,r)$ are obtained, i.e., k^* and l^* are capital and

[4] This is sometimes called the process of "accelerator" in economics.

labor that maximize profit given the price level and the factor prices. Moreover, substituting these input demand functions into the production function *f(k, l)*, yields the firm's supply function, or:

$$q^* = f(k^*, l^*) = f(k^*(p,w,r), l^*(p,w,r)) = q(p,w,r) \tag{6.9}$$

where, $q(p,w,r)$ is the firm's supply function or the optimum amounts of output that the firm should produce in order to maximize its profits. As a result, the profit function is determined by:

$$\max.\Pi = \Pi^*(p,w,r) = p \times q(p,w,r) - w \times l(p,w,r) - r * k(p,w,r) \tag{6.10}$$

where, $\Pi^*(p,w,r)$ is the profit function that shows the maximum profit given the price level and the factor prices. Moreover, the profit function should have suitable properties such as non - decreasing in *p*, non – increasing in *w*, homogenous of degree 1 in *p* and *w*, and convex and continuous in *p* and *w*.

Most studies both related and not related to the INFORUM model use equation (6.10) and its mentioned characteristics to determine the explanatory variables that should be included in the profit equation. However, Chand and Kaul (1986)[5] suggest that proper caution must be taken when estimating the profit function with the Cobb – Douglas form. In this study, the normalized Cobb – Douglas profit function with *m* variable inputs and *n* fixed inputs is:

$$\Pi = a_0 \prod_{i=1}^{m} q_i^{\alpha_i} \prod_{k=m+1}^{n} Z_k^{\beta_k}$$

[5] Ramesh Chand and J. L. Kaul. "A Note on the Use of the Cobb-Douglas Profit Function,"*American Journal of Agricultural Economics*, Vol. 68, No. 1. (Feb., 1986), pp. 162-164.

or, $$\log \Pi = \log a_0 + \sum_i \alpha_i \log q_i + \sum_k \beta_k \log Z_k \tag{6.11}$$

where Π is the restricted profit per farm defined as current revenue minus current variable cost, q_i represents the price of the i^{th} variable inputs, and Z_k is k^{th} factor. Both Π and q_i series are normalized by the price of the output (*P*). Under the profit maximization condition, they prove that the use of the above Cobb – Douglas type profit function lead to five inescapable characteristics, including 1) factor demand is always elastic with respect to own prices changes, 2) all variable factors are complementary to each other, thus this function does not allow for the substitutive relation, 3) there is symmetry in the cross price elasticities of any pairs factors in both magnitude and signs, 4) a change in any fixed factors generates symmetric impact on all variable inputs, and finally, 5) the price elasticity of factor demand with respect to changes in the output price is always greater than 1 and is the same for all factors. Consequently, the estimated results especially the elasticities that are concluded from the Cobb – Douglas profit function might not be consistent with the empirical results, since they are completely controlled by the functional form rather than dictated by the empirical data. Thus, the estimated results from the studies such as Lau and Yotopaulos[6], Sidhu[7], and so on must be used with cautious.

For the study related to the INFORUM model, the TIDY model of Thailand in the study of Manuprasert (2004)[8] used the following functional form for sectoral profits:

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[6] Lau, L. J., and P.A. Yotopaulos. "Profit, Supply, and Factor Demand Functions." *American Journal of Agricultural Economics*. 54(1972):11 – 18.

[7] Sidhu, Surjit S. "Economics of Technical Change in Wheat Production in the Indian Punjab." *American Journal of Agricultural Economics*. 56(1974): 217 – 26.

[8] Manuprasert, op. cit., p.112.

$$profit_{i,t} = \alpha_0 + \alpha_1 q_{i,t} + \alpha_2 \Delta q_{i,t} + \alpha_3 w_{i,t} + \alpha_4 T + \varepsilon_{i,t} \tag{6.12}$$

where $profit_{i,t}$ is the level of profit of sector i at time t, $q_{i,t}$ and $\Delta q_{i,t}$ are the sectoral output and its first difference, respectively, $w_{i,t}$ denotes the sectoral wage, and T is the time trend. All $profit_{i,t}$ and $w_{i,t}$ series are deflated by the GDP deflator. The reason of inserting the sectoral output variable in the equation is to capture the effects of business cycle and demand condition on the profit.

By the same token, in the study of MUDAN[9] the sectoral profit equation is determined by:

$$pmrg_{i,t} = \alpha_0 + \alpha_1 * pcq_{i,t} + \alpha_2 * unsq_t + \alpha_3 * T \tag{6.13}$$

where $pmrg_{i,t}$ is the profit divided by current output, *pcq* is the percentage change of current output, and *unsq* denotes the inverse of the square of unemployment rate ratio. Again, *pcq* is inserted in the equation to represent the procyclical movement of sectoral profit, while *unsq* is added to capture the impact of the overall slackness of the economy.

Recently, Kumbhakar (2001)[10] studies how to estimate the profit function without the profit maximization constraint. A non – linear functional form such as the generalized Leontief restricted profit function is firstly introduced by Diewert (1971)[11], and this function is improved into the CET – CES - generalized Leontief restricted profit function,

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[9] Yu, op. cit., p.171.

[10] Kumbhakar Subal C., "Estimation of Profit Functions When Profits Is Not Maximum," *American Journal of Agricultural Economics*. Vol. 83, No. 1 (Feb., 2001), pp. 1-19.

[11] Diewert, W.E., "An application of the Shepard Duality Theorem: a Generalized Linear Production Function," *Journal of Political Economics* Vol.79 (1971), pp. 482–507.

and is prevalently used in the studies of Thompson and Langworthy (1989)[12], Behrman et al.(1992)[13], and etc. Although there are various studies related to the estimation of profit function, linear profit functions are preferred to the non – linear ones because they entail less complexity in estimation. Thus, the set of sectoral profit equations in this study is initially presented by the following regression:

$$pf_t^i = \alpha_0 + \alpha_1 p_t^i + \alpha_2 ws_t^i + \alpha_3 T + \alpha_4 poldum + \alpha_5 cridum + \varepsilon_t^i \qquad (6.14)$$

where pf_t^i denotes the profit level of sector *i* in period *t*, p_t^i and ws_t^i represent the output price and the wage rate in sector *i* at time *t*, respectively, *T* is the time trend variable, *poldum* and *cridum* are the dummy variables that represents the period of political disorder and financial crisis in Thailand, and $\alpha_0 - \alpha_5$ are the estimated parameters. The expected sign for α_1 is positive (higher output price will generate more profit.), while the expected signs for α_2, α_4, and α_5 are negative (higher cost of production and all the crises should have negative impacts on the profit level). However, the choice of the suitable form (level, 1st difference, or the logarithmic forms) for each variable in equation (6.14) is based on the ADF test in the following section.

6.2.2 Sources of Data, the (Non) Stationary Test and the Estimated Results for Sectoral Profit Equations

The data on total operating surplus (profit) come from the annual published series of NESDB. In order to avoid the discrepancy problem between the SIO and SNA data,

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[12]Thompson, G.D., and Langworthy, M., "Profit Function Approximations and Duality Applications to Agriculture," *American Journal of Agricultural Economics.* Vol.71 (1989), pp. 791–798.

[13]Behrman, J.R., Knox Lovell, C.C., Pollak, R.A., and Sickles, R.C., "The CET-CES-Generalized Leontief Variable Profit Function: An Application to Indian Agriculture," Oxford economic papers. No. 44 (1992), Oxford University Press, New York. pp. 341–354.

the sectoral profit data are generated by using the ratios between the sectoral profits to the total profit from the RAS I – O table as scaling factors for each consecutive year. The sectoral price and wage series are already obtained from section 5.1 and 6.1, respectively. The ADF test for the variables in sectoral profit equations is shown in Table 6.5.

Table 6.5: The ADF Test for the Variables in Sectoral Profit Equations

The ADF Test for the Sectoral Profit Series (pf^{i})					
Sector	**Coefficient of (pf^{i})**	**Tau (τ) Statistic**	**Sector**	**Coefficient of (pf^{i})**	**Tau (τ) Statistic**
1	-0.035	-0.505	14	-0.229	-2.139
log	-0.068	-1.174	log	-0.505	-4.013**
1st diff.	-0.978	-4.862***	1st diff.	-2.101	-3.735**
2	-0.007	-0.113	15	0.078	1.199
log	-0.080	-1.340	log	-0.504	-3.306
1st diff.	-0.949	-4.626***	1st diff.	-1.722	-4.440***
3	-0.470	-3.215	16	-0.116	-1.213
log	-0.418	-3.025	log	-0.159	-1.351
1st diff.	-2.510	-3.772**	1st diff.	-0.864	-4.206**
4	-0.082	-1.061	17	-0.219	-1.985
log	-0.160	-1.569	log	-0.139	-1.302
1st diff.	-1.093	-5.305***	1st diff.	-0.978	-4.060**
5	-0.258	-1.484	18	-0.264	-2.084
log	-0.251	-1.932	log	-0.098	-0.995
1st diff.	-1.138	-5.585***	1st diff.	-0.832	-4.142**
6	0.061	0.578	19	-0.172	-1.523
log	-0.331	-2.528	log	-0.087	-1.098
1st diff.	-1.457	-7.746***	1st diff.	-10.728	-8.708***
7	-0.374	-2.589	20	-0.024	-0.257
log	-0.315	-2.239	log	-0.086	-1.106
1st diff.	-0.989	-4.858***	1st diff.	-0.937	-4.135**
8	-0.320	-2.458	21	-1.070	-3.044
log	-0.178	-1.960	log	-0.136	-1.822
1st diff.	-4.892	-6.610***	1st diff.	-0.645	-3.660**
9	0.039	0.582	22	-0.012	-0.148
log	-0.376	-2.553	log	-0.158	-1.720
1st diff.	-1.513	-8.587***	1st diff.	-1.203	-5.480***
10	0.051	0.800	23	-0.318	-2.918
log	-0.267	-2.002	log	-1.731	-3.803**
1st diff.	-1.469	-8.183***	1st diff.	-0.755	-3.865**
11	-0.806	-2.014	24	-0.271	-2.446
log	-0.077	-0.842	log	-0.158	-1.625
1st diff.	-0.778	-3.960050**	1st diff.	-0.671	-3.743**
12	0.028	0.417	25	-1.623	-3.796**
log	-0.230	-1.841	log	-0.358	-2.834
1st diff.	-1.499	-8.474***	1st diff.	-1.728	-4.857***
13	-0.316	-2.354	26	-0.406	-2.460
log	-0.112	-1.397	log	n.a.	n.a.
1st diff.	-1.027	-4.281**	1st diff.	-1.014	-5.066***

Table 6.5: (Continued)

The ADF Test for the Sectoral Price Series (p^i)					
Sector	**Coefficient of (p^i)**	**Tau (τ) Statistic**	**Sector**	**Coefficient of (p^i)**	**Tau (τ) Statistic**
1	0.134	1.740	14	-0.315	-1.159
1st diff.	-0.782	-3.688**	1st diff.	-4.558	-3.913**
2	-0.826	-2.041	15	-0.237	-1.845
1st diff.	-3.780	-5.317***	1st diff.	-1.261	-6.503***
3	-0.096	-1.345	16	-0.245	-1.689
1st diff.	-0.649	-3.581**	1st diff.	-1.021	-5.045***
4	-0.242	-2.036	17	-1.030	-3.854**
1st diff.	-1.414	-7.611***	1st diff.	-1.111	-5.550***
5	-0.113	-0.630	18	-0.034	-0.275
1st diff.	-1.572	-4.031**	1st diff.	-1.150	-5.618***
6	-0.451	-3.232*	19	-0.171	-1.213
1st diff.	-0.741	-3.776**	1st diff.	-0.942	-4.472***
7	-0.343	-2.417	20	-0.336	-2.121
1st diff.	-0.720	-3.627**	1st diff.	-3.144	-4.526***
8	-0.253	-1.886	21	-0.212	-2.837
1st diff.	-1.048	-5.248***	1st diff.	-0.382	-3.594**
9	-0.231	-2.014	22	-0.187	-1.660
1st diff.	-0.886	-4.480***	1st diff.	-0.718	-3.733**
10	-0.462	-2.278	23	-0.284	-2.042
1st diff.	-1.534	-4.472***	1st diff.	-4.932	-4.424**
11	-0.032	-0.162	24	-0.105	-1.071
1st diff.	-1.126	-3.677**	1st diff.	-1.985	-3.827**
12	-0.150	-1.438	25	-0.289	-2.613
1st diff.	-1.011	-5.116***	1st diff.	-0.435	-3.709**
13	-0.254	-1.968	26	-0.324	-2.523
1st diff.	-0.941	-4.523***	1st diff.	-1.011	-5.002***
The ADF Test for the Sectoral Wage Series (ws^i)					
Sector	**Coefficient of (ws^i)**	**Tau (τ) Statistic**	**Sector**	**Coefficient of (ws^i)**	**Tau (τ) Statistic**
1	-0.209	-1.916	8	-0.323	-2.109
log	-0.319	-1.909	log	-0.436	-2.889
1st diff.	-0.937	-4.681***	1st diff.	-3.697	-4.522***
2	-0.197	-1.835	9	-0.123	-0.972
log	-0.415	-2.650	log	-0.140	-1.284
1st diff.	-5.977	-5.747***	1st diff.	-0.868	-4.377***
3	-0.471	-2.851	10	0.176	0.496
log	-0.351	-2.078	log	-0.477	-1.819
1st diff.	-1.326	-6.605***	1st diff.	-5.897	-5.730***
4	-0.350	-1.938	11	-0.866	-4.492***
log	-0.161	-0.735	log	-0.508	-2.764
1st diff.	-1.556	-6.980***	1st diff.	-3.155	-5.134***
5	-0.610	-3.404*	12	-0.461	-2.780
log	-0.486	-2.904	log	-0.358	-2.688
1st diff.	-1.177	-5.910***	1st diff.	-1.339	-6.990***
6	-0.171	-1.699	13	-0.826	-4.214**
log	-1.252	-5.044***	log	-0.219	-1.820
1st diff.	-0.907	-4.450***	1st diff.	-2.011	-5.677***
7	-0.371	-2.494	14	-5.557	-4.186**
log	-0.234	-2.163	log	-0.364	-2.381
1st diff.	-1.228	-6.239***	1st diff.	-26.989	-4.946***

Table 6.5: (Continued)

The ADF Test for the Sectoral Wage Series (ws^i)					
Sector	**Coefficient of (ws^i)**	**Tau (τ) Statistic**	**Sector**	**Coefficient of (ws^i)**	**Tau (τ) Statistic**
15	-0.435	-2.705	21	-1.572	-3.093
log	-0.184	-1.607	log	-0.198	-1.770
1st diff.	-1.300	-6.129***	1st diff.	-2.069	-3.669**
16	-0.494	-1.659	22	-0.237	-2.324
log	-0.228	-2.318	log	-0.133	-1.127
1st diff.	-1.522	-4.200**	1st diff.	-0.791	-3.978**
17	-0.054	-0.360	23	-0.454	-2.953
log	-0.401	-3.575*	log	-0.172	-1.769
1st diff.	-1.192	-4.275***	1st diff.	-1.596	-5.299***
18	-0.241	-2.058	24	-4.045	-3.974**
log	-0.255	-1.924	log	-0.230	-2.524
1st diff.	-1.756	-6.146***	1st diff.	-1.444	-8.057***
19	-0.342	-2.280	25	-0.212	-2.270
log	-0.329	-3.453*	log	-0.238	-2.062
1st diff.	-1.151	-5.595***	1st diff.	-0.762	-3.900**
20	-0.286	-2.393	26	-0.847	-5.803***
log	-0.209	-1.921	log	-0.816	-7.599***
1st diff.	-0.735	-3.816**	1st diff.	-1.668	-12.572***

Notes: (1) *, **, *** denoted the significant level at 10%, 5%, and 1%, respectively for testing the null hypothesis that the particular series has a unit root.
(2) The "sector #", "log", and "1st diff." represent the ADF test on the level, logarithmic, and the 1st difference forms, respectively.
(3) The results of the ADF test on the logarithmic and the 1st difference of the logarithmic forms of the price series are already shown in Table 5.1.

The result of the ADF test from table 6.4 suggests two possible functional forms for sectoral profit equations. The first one is to estimate equation (6.14) directly in level form[14] but each sectoral equation is required to be checked for the existence of cointegrating vector. The second alternative is to estimate equation (6.14) by transforming pf^i, p^i, and ws^i variables into the 1st difference form, since all of these series are Integrated of order 1.

To check the possibility of the first alternative, the cointegration test is applied to pf^i, p^i, and ws^i variables, and the result is shown in Table (6.6).

[14] In this case, the logarithmic form is out of the question, since profit series of sector 26 in some years have a negative value.

Table 6.6: The Cointegration Test for Profit Function (Level Form)

Sector	Trace Test			Maximum Eigenvalue Test			# of Cointegrating Vector
Vectors	**r =0**	**$r \leq 1$**	**$r \leq 2$**	**r =0**	**$r \leq 1$**	**$r \leq 2$**	
# 1	32.351	9.896	4.068	22.455	5.828	4.068	1
Critical Value	**29.68**	**15.41**	**3.76**	**20.97**	**14.07**	**3.76**	
# 2	33.166	10.438	0.864	22.727	9.574	0.864	1
Critical Value	**29.68**	**15.41**	**3.76**	**20.97**	**14.07**	**3.76**	
# 3	28.186	12.353	3.649	15.833	8.705	3.649	0
Critical Value	**29.68**	**15.41**	**3.76**	**20.97**	**14.07**	**3.76**	
# 4	40.771	13.087	5.556	27.684	7.531	5.556	1
Critical Value	**29.68**	**15.41**	**3.76**	**20.97**	**14.07**	**3.76**	
# 5	24.629	9.411	2.869	15.218	6.541	2.869	0
Critical Value	**29.68**	**15.41**	**3.76**	**20.97**	**14.07**	**3.76**	
# 6	21.829	7.311	2.569	14.118	5.341	2.649	0
Critical Value	**29.68**	**15.41**	**3.76**	**20.97**	**14.07**	**3.76**	
# 7	22.619	7.988	0.837	14.631	7.150	0.837	0
Critical Value	**29.68**	**15.41**	**3.76**	**20.97**	**14.07**	**3.76**	
# 8	36.096	9.723	2.958	26.373	6.765	2.958	1
Critical Value	**29.68**	**15.41**	**3.76**	**20.97**	**14.07**	**3.76**	
# 9	39.440	7.007	0.305	32.433	6.702	0.305	1
Critical Value	**29.68**	**15.41**	**3.76**	**20.97**	**14.07**	**3.76**	
# 10	63.976	13.228	3.018	50.748	10.211	3.018	1
Critical Value	**29.68**	**15.41**	**3.76**	**20.97**	**14.07**	**3.76**	
# 11	16.927	4.868	0.414	12.059	4.454	0.414	0
Critical Value	**29.68**	**15.41**	**3.76**	**20.97**	**14.07**	**3.76**	
# 12	42.066	15.043	1.078	27.023	13.965	1.078	1
Critical Value	**29.68**	**15.41**	**3.76**	**20.97**	**14.07**	**3.76**	
# 13	18.310	9.811	2.910	8.499	6.902	2.910	0
Critical Value	**29.68**	**15.41**	**3.76**	**20.97**	**14.07**	**3.76**	
# 14	24.559	7.857	1.408	16.702	6.449	1.408	0
Critical Value	**29.68**	**15.41**	**3.76**	**20.97**	**14.07**	**3.76**	
# 15	32.114	14.239	0.203	17.875	14.036	0.203	1, 0
Critical Value	**29.68**	**15.41**	**3.76**	**20.97**	**14.07**	**3.76**	
# 16	22.869	7.178	0.076	15.690	7.102	0.076	0
Critical Value	**29.68**	**15.41**	**3.76**	**20.97**	**14.07**	**3.76**	
# 17	36.554	12.298	4.403	24.256	7.895	4.403	1
Critical Value	**29.68**	**15.41**	**3.76**	**20.97**	**14.07**	**3.76**	
# 18	28.974	11.458	2.013	17.516	9.445	2.013	0
Critical Value	**29.68**	**15.41**	**3.76**	**20.97**	**14.07**	**3.76**	
# 19	21.459	5.527	0.001	15.932	5.526	0.001	0
Critical Value	**29.68**	**15.41**	**3.76**	**20.97**	**14.07**	**3.76**	
# 20	42.170	9.975	4.103	32.196	5.872	4.103	1
Critical Value	**29.68**	**15.41**	**3.76**	**20.97**	**14.07**	**3.76**	
# 21	25.520	9.755	0.033	15.764	9.722	0.033	0
Critical Value	**29.68**	**15.41**	**3.76**	**20.97**	**14.07**	**3.76**	
# 22	21.215	7.002	0.733	14.213	6.268	0.733	0
Critical Value	**29.68**	**15.41**	**3.76**	**20.97**	**14.07**	**3.76**	
# 23	23.094	4.814	0.088	18.280	4.726	0.088	0
Critical Value	**29.68**	**15.41**	**3.76**	**20.97**	**14.07**	**3.76**	
# 24	28.675	7.558	0.099	21.117	7.459	0.099	0, 1
Critical Value	**29.68**	**15.41**	**3.76**	**20.97**	**14.07**	**3.76**	

Table 6.6: (Continued)

Sector	Trace Test			Maximum Eigenvalue Test			# of Cointegrating Vector
Vectors	r =0	$r \leq 1$	$r \leq 2$	r =0	$r \leq 1$	$r \leq 2$	
# 25	23.158	8.298	0.275	14.860	8.023	0.275	0
Critical Value	**29.68**	**15.41**	**3.76**	**20.97**	**14.07**	**3.76**	
# 26	27.352	6.291	0.025	21.060	6.266	0.025	0, 1
Critical Value	**29.68**	**15.41**	**3.76**	**20.97**	**14.07**	**3.76**	

Notes: The bold numbers are the critical value at 5% level of significance

The result of the cointegration test confirms the existence of cointegrating vectors in sectors 1, 2, 4, 8, 9, 10, 12, 15, 17, 20, 24, and 26. This evidence suggests that the estimation of profit equations by the level form is not suitable for all sectors. Therefore, the sectoral profit equations in this study are estimated by the 1st difference form. Since, both p^i and ws^i variables are endogenous to the MUTE model, the two stages least square technique (*TSLS*) is employed in order to avoid the problem of simultaneity bias. The structures of *AR(1)* – *AR(3)* are inserted in the particular equation, if the Durbin – Watson statistic indicates the problem of autocorrelation. The estimated result for sectoral profit equations is presented in Table 6.7.

The estimated result is quite unimpressive for sectoral profit equations. Although, the Durbin – Watson statistics (DW) in every sector lie in the suitable range of no – autocorrelation problem, the values of R^2 in each sector are quite low. The highest value of 71 percent is found in sector 23 (Banking and Insurance). This indicates that the assigned functional form is inappropriate for these data.

The unexpected negative signs for the parameter of price variable (p^i) are found in the estimated equations of sectors 5, 8, 10, 15 – 17, 21, 22, and 26. This is possibly because the increase in price level will cause a larger reduction in quantity demanded and then reduce both revenue and profit levels in these sectors. Sectoral prices generate the large positive impacts on the profit level of sectors such as 19 (Construction), 20 (Trade), and 25 (Services).

The unexpected positive signs for the parameter of sectoral wage (ws^i) are found in sectors 1, 2, 4, 7, 18, 22, and 24. One feasible explanation is based on the use of the average sectoral wage rate series to represent the price of labor in these sectors. By not taking into account the distribution of income, it is possible that the average sectoral wage series are larger than the true unit cost of hiring labor. In other words, the average sectoral wage might represent the efficiency wage rate rather than the market – clearing wage rate in these sectors. As a result, higher wage rates mean higher labor contribution (higher productivity) or lower miscellaneous costs such as minimizing the incentive of labors to shirk or to find jobs elsewhere, which cause higher profit in these sectors, even when wage rate is also high.

The parameters of the time trend variable show positive value in most sectors except for sectors 19 (Construction) and 26 (Unclassified). This indicates that the profit level in most sectors is increased over time. The estimated parameters of *poldum*, which represent the impact of political disorder on the profit level, give different results from sector to sector. In most cases, these estimated parameters are not significant at 5 percent level and have the unexpected positive sign. The significant parameters are found only in sectors 1, 17 and 23. Finally, the estimated parameter for *cridum* which represents the financial crisis in Thailand has the expected negative sign in most sectors except for sectors 9, 10, 12, and 15. However, significant impacts are found only in sectors 1, 4, 8, 10, 12, 14, 15, 20, 21 and 23.

Table 6.7: The Estimated Parameter for the Sectoral Profit Equations (1st Difference Form)

Sector	*c*	*Δ(p)*	*Δ(ws)*	*Trend*	*poldum*	*cridum*	*AR(1)*	*AR(2)*	*AR(3)*	R^2	*D.W.*
1	-17117.80 **(-2.700)**	968.305 **(2.916)**	9.992 **(3.153)**	786.787 **(2.541)**	32750.260 **(2.265)**	-47869.86 **(-4.208)**	-0.856 **(-3.173)**	-0.314 (-1.199)	-	0.575	1.963
2	-2240.531 (-1.250)	77.743 (0.701)	0.039 (0.164)	163.199 (1.779)	5027.270 (1.942)	-3307.014 (-1.216)	-0.165 (-0.641)	0.203 (0.813)	-0.140 (-0.557)	0.224	2.014
3	-1371.521 (-1.611)	133.168 (1.038)	-0.111 (-1.448)	44.170 (1.425)	2892.738 (1.836)	-65.443 (-0.068)	-0.655 **(-2.613)**	-0.329 (-1.120)	-0.079 (-0.323)	0.301	1.982
4	-186.190 (-0.084)	293.829 (0.940)	0.154 (0.743)	221.940 **(2.309)**	-7049.719 (-1.381)	-7574.498 **(-2.990)**	-0.597 **(-2.154)**	-0.082 (-0.364)	-	0.311	2.121
5	-1008.512 (-0.472)	-50.094 (-0.187)	-0.087 (-0.670)	191.259 **(2.234)**	4000.130 (0.769)	-1065.427 (-0.484)	-0.318 (-1.224)	-0.469 (-1.684)	-0.161 (-0.566)	0.246	1.949
6	-1967.752 (-1.208)	360.381 (1.656)	-0.244 (-0.972)	311.468 **(4.353)**	1076.258 (0.309)	-2000.386 (-1.013)	-0.872 **(-3.710)**	-0.416 (-1.764)	-	0.467	1.930
7	-2738.059 (-1.260)	370.344 (1.549)	0.497 **(3.158)**	107.419 (1.119)	-687.937 (-0.453)	-3509.932 (-1.854)	-0.143 (-0.568)	-	0.445 (1.820)	0.364	1.866
8	1612.368 (0.523)	-984.374 **(-2.734)**	-0.076 (-0.440)	420.847 **(2.462)**	949.457 (0.374)	-10581.43 **(-2.462)**	0.597 **(2.385)**	-0.731 **(-2.990)**	0.188 (0.713)	0.698	1.918
9	-662.575 (-0.848)	89.448 (0.794)	-0.016 (-0.161)	119.053 **(3.768)**	-635.696 (-0.386)	920.674 (0.937)	-0.786 **(-3.370)**	-0.397 (-1.685)	-	0.617	2.009
10	-290.199 (-0.140)	-18.965 (-0.076)	-0.072 (-0.909)	159.831 **(2.597)**	-2836.097 (-0.702)	2117.693 **(2.191)**	-0.875 **(-2.946)**	-0.397 (-1.146)	-0.107 (-0.310)	0.643	1.944
11	-768.271 (-0.242)	289.558 (1.715)	-0.001 (-0.007)	159.604 (0.753)	2081.075 (0.585)	-19461.21 **(-2.281)**	0.529 **(2.198)**	-0.416 (-1.660)	-	0.318	1.930
12	-462.470 (-0.847)	143.295 (3.016)	-0.200 **(-2.777)**	77.456 **(3.573)**	385.143 (0.298)	1723.963 **(3.596)**	-0.639 **(-2.517)**	-0.823 **(-3.781)**	-0.209 (-0.831)	0.640	1.953
13	-80.450 (-0.087)	21.980 (0.079)	-0.073 (-0.868)	116.827 **(3.048)**	531.889 (0.370)	-3276.827 (-1.457)	0.034 (0.131)	-0.529 **(-2.080)**	-0.260 (-0.965)	0.659	1.912

Note: (1) The t – statistics are shown in the parenthesis. The Bold numbers represent the significance level at 5%. (2) *C*, *D.W.* and *Adj.* R^2 denote the constant term, the Durbin – Watson Statistics and the adjusted correlation coefficients, respectively.

Table 6.7: (Continued)

Sector	*c*	*D(p)*	*D(ws)*	*Trend*	*poldum*	*cridum*	*AR(1)*	*AR(2)*	*AR(3)*	*Adj.* R^2	*D.W.*
14	-202.374 (-0.973)	29.313 (1.635)	-0.011 (-1.611)	28.127 **(2.231)**	421.798 (1.756)	-922.286 **(-3.049)**	0.138 (0.674)	0.202 (0.983)	-0.164 (-0.660)	0.677	2.044
15	357.670 (0.360)	-110.211 (-1.560)	-0.182 (-1.184)	89.670 (1.727)	-1006.980 (-0.885)	3289.971 **(2.419)**	-	-0.267 (-0.986)	0.270 (0.852)	0.404	2.125
16	749.381 (0.087)	-1181.943 (-0.574)	-0.796 (-0.396)	702.682 (1.383)	6036.613 (0.439)	-4543.567 (-0.292)	0.139 (0.397)	-0.345 (-1.292)	-	0.132	2.109
17	2999.106 (0.746)	-740.082 (-1.898)	-0.250 (-0.275)	379.777 (1.466)	-7777.199 **(-2.038)**	-7577.959 (-1.478)	0.146 (0.574)	-0.526 **(-2.533)**	0.337 (1.340)	0.513	1.939
18	-596.666 (-0.250)	78.276 (0.299)	0.258 (1.401)	89.000 (0.582)	2581.428 (0.913)	-8832.473 (-1.781)	0.292 (1.045)	-0.337 (-1.178)	0.103 (0.363)	0.534	1.915
19	6373.348 (0.500)	1410.987 (0.435)	-0.705 (-0.252)	-145.108 (-0.227)	-12465.40 (-0.392)	-26479.46 (-0.959)	-	-0.132 (-0.319)	-0.103 (-0.429)	0.347	1.875
20	-11691.46 (-0.971)	1697.310 (1.665)	-0.387 (-0.572)	1967.187 **(4.528)**	14695.02 (0.502)	-36470.05 **(-4.126)**	-0.690 **(-2.745)**	-0.523 (-1.762)	-0.338 (-1.221)	0.524	2.114
21	5330.249 (0.821)	-219.085 (-0.191)	-0.034 (-0.082)	209.140 (0.905)	-9790.951 (-0.939)	-14742.94 **(-2.758)**	-	-0.470 (-1.809)	-0.036 (-0.165)	0.470	1.960
22	-2943.963 (-0.860)	-33.812 (-0.075)	0.144 (0.206)	621.406 **(4.267)**	2047.754 (0.321)	-7790.962 (-1.899)	-0.431 (-1.679)	-	0.062 (0.249)	0.480	2.021
23	-4734.330 (-0.965)	346.720 (5.177)	-0.427 (-1.918)	675.901 **(2.521)**	8308.507 **(2.171)**	-33859.59 **(-4.717)**	0.632 **(2.566)**	-0.679 (-2.896)	0.190 (0.751)	0.716	2.035
24	-33.019 (-0.024)	28.053 (0.106)	0.059 (1.130)	47.006 (0.942)	-1785.323 (-1.301)	-1044.561 (-0.603)	-	-	0.188 (0.693)	0.244	1.995
25	-3656.190 (-1.137)	1061.827 (1.480)	-0.168 (-0.525)	432.116 **(2.871)**	-3182.808 (-0.484)	-6086.051 (-1.338)	-0.729 **(-2.598)**	-0.409 (-1.123)	-0.054 (-0.183)	0.399	2.025
26	2911.289 (0.288)	-1053.371 (-0.886)	-0.097 (-0.208)	-42.235 (-0.109)	11400.970 (0.454)	-2374.705 (-0.147)	-0.201 (-0.613)	-0.255 (-0.693)	-	0.189	2.036

Note: (1) The t – statistics are shown in the parenthesis. The Bold numbers represent the significance level at 5%. (2) *C*, *D.W.* and *Adj.* R^2 denote the constant term, the Durbin – Watson Statistics and the adjusted correlation coefficients, respectively.

6.3 The Estimation of the Sectoral Depreciation (dep^i)

One interesting economic meaning of depreciation is defined by Hicks (1939)[15] that depreciation is the cost of maintaining the value of capital stock over a specific time period. It is important to note that Hicks' concept emphasizes only on maintaining the value of capital stock rather than the physical number of capital units or any other measurement of production capacity. Thus, depreciation is normally the function of (1) the real interest rate (*rr*), which represents the opportunity cost of capital, (2) the change in price of capital stock (Δpc), which measures the gains and losses of holding this capital, and finally, (3) the physical depreciation (*pd*) such as wear and tear and the remaining life of capital assets as shown in equation (6.15):

$$dep_t^i = f(rr, \Delta pc, pd) \qquad (6.15)$$

where dep_t^i denotes the level of capital depreciation of sector *i* at time *t*. The expected signs for the derivative with respect to *rr*, Δpc, and *pd* are positive, negative and positive, respectively. However, equation (6.15) is not suitable for estimating the sectoral depreciation equations for the MUTE model, since the data on prices of capital stocks by sector are not available and it is quite difficult for measuring the physical depreciation for each sector. Moreover, the general specification of equation (4.23) in chapter 4, which uses the capital stock in period *t-1* as one of the explanatory variables, will make the model more complicated in estimation. This is because not only the capital stock data are endogenous to the MUTE model (since they are used in estimating the sectoral gross fixed capital formation series ($gfcf^i$)), but also the cointegration test confirms the nonexistence of cointegrating vector between dep_t^i and K_{t-1}^i in some sectors.

[15] Hicks, J. R, "Value and Capital: An Inquiry into Some Fundamental Principles of Economic Theory," (Clarendon Press Oxford), 1939.

In order to avoid these problems and to keep the model as simple as possible, the sectoral depreciation equations in this study are estimated by the appropriate *ARIMA (p, d, q)* model.

6.3.1 Source of Data, the ADF Test, and the Estimated Result for the Sectoral Depreciation Equations

Before applying the AICc technique, the ADF test is employed to examine the (non) stationary characteristic of depreciation series for all sectors. In order to avoid the discrepancy between SNA and SIO data, the adjusted depreciation ($Depn_t^i$) series obtained from equation (5.23) are used to represent the level of capital depreciation. The results of the ADF test both in level and 1^{st} difference forms are shown in Table 6.8.

Table 6.8: The ADF Test for Depreciation Series ($Depn^i$)

The ADF Test for Depreciation Series ($Depn^i$)					
Sector	**Coefficient of ($Depn^i$)**	**Tau (τ) Statistic**	**Sector**	**Coefficient of ($Depn^i$)**	**Tau (τ) Statistic**
1	-1.412	-8.050^{***}	12	-2.051	-5.684^{***}
1^{st} diff.	-2.472	-7.380^{***}	1^{st} diff.	-10.202	-6.012^{***}
2	-1.382	-7.692^{***}	13	-0.850	-4.235^{**}
1^{st} diff.	-2.792	-8.824^{***}	1^{st} diff.	-2.984	-4.770^{***}
3	-0.972	-5.046^{***}	14	-2.346	-3.196
1^{st} diff.	-2.280	-7.102^{***}	1^{st} diff.	-2.150	-4.943^{***}
4	-1.833	-4.356^{***}	15	-3.944	-6.806^{***}
1^{st} diff.	-6.062	-6.172^{***}	1^{st} diff.	-21.506	-5.191^{***}
5	21.03	4.269^{***}	16	-11.319	-6.745^{***}
1^{st} diff.	-2.446	-7.805^{***}	1^{st} diff.	-1.840	-5.575^{***}
6	-1.627	-5.093^{***}	17	-1.436	-4.193^{**}
1^{st} diff.	-2.393	-8.174^{***}	1^{st} diff.	-12.920	-3.588^{*}
7	-10.932	-5.051^{***}	18	4.022	0.566
1^{st} diff.	-26.985	-6.463^{***}	1^{st} diff.	-71.267	-5.327^{***}
8	-1.133	-3.744^{**}	19	-0.746	-0.510
1^{st} diff.	-12.105	-5.079^{***}	1^{st} diff.	-13.192	-5.121^{***}
9	-4.095	-3.749^{**}	20	-0.592	-0.250
1^{st} diff.	-13.949	-4.973^{***}	1^{st} diff.	-20.746	-6.271^{***}
10	-1.700	-4.578^{***}	21	-1.359	-5.027^{***}
1^{st} diff.	-2.172	-4.679^{***}	1^{st} diff.	-2.099	-6.942^{***}
11	-9.026	-3.225	22	-13.649	-1.707
1^{st} diff.	-3.545	-4.700^{***}	1^{st} diff.	-46.821	-3.496^{**}

Table 6.8: (Continued)

The ADF Test for Depreciation Series ($Depn^i$)					
Sector	**Coefficient of ($Depn^i$)**	**Tau (τ) Statistic**	**Sector**	**Coefficient of ($Depn^i$)**	**Tau (τ) Statistic**
23	-1.083	-5.529^{***}	25	-10.350	-5.163^{***}
1st diff.	6.769	1.043	1st diff.	-31.526	-4.362^{**}
24	-1.735	-12.913^{***}	26	-7.009	-5.017^{***}
1st diff.	-3.011	-9.445^{***}	1st diff.	-22.232	-5.159^{***}

Notes: (1) *, **, *** denoted the significant level at 10%, 5%, and 1%, respectively for testing the null hypothesis that the particular series has a unit root.

The results of the ADF test from Table 6.8 suggest that most of the depreciation data are stationary except for the data of sectors 11, 14, 18, 19, 20 and 22, which are integrated of order 1. Thus, in order to find the appropriate ARIMA model for these series, the 1st difference transformation has to be applied to the data from these sectors, while the models for the rest of the sectors are simply estimated by using the data in the level form. The results of the estimated *ARIMA (p, d, q)* model for each sector and the randomness tests are shown in Tables 6.9 and 6.10.

Table 6.9: The Estimation Results for Sectoral Depreciation by AICc Method

Sector	**ARIMA (p, d, q)**	**Equation**	**WN Var.**
1	(0, 0, 1)	$Depn(1)_t = Z_{(t)} - \underset{(0.197)}{0.571} Z_{(t-1)}$	.559802E+09
2	(1, 0, 1)	$Depn(2)_t = \underset{(0.182)}{0.321} Depn(2)_{(t-1)} + Z_{(t)} - \underset{(0.109)}{1.000} Z_{(t-1)}$	.867910E+08
3	(2, 0, 5)	$Depn(3)_t = -\underset{(0.007)}{1.273} Depn(3)_{(t-1)} - \underset{(0.006)}{0.999} Depn(3)_{(t-2)} + Z_{(t)} + \underset{(0.173)}{1.655} Z_{(t-1)} + \underset{(0.347)}{2.047} Z_{(t-2)} + \underset{(0.490)}{.7750} Z_{(t-3)} + \underset{(0.347)}{0.117} Z_{(t-4)} - \underset{(0.173)}{0.330} Z_{(t-5)}$	.743438E+06
4	(0, 0, 1)	$Depn(4)_t = Z_{(t)} + \underset{(0.177)}{0.734} Z_{(t-1)}$	.146550E+09
5	(0, 0, 1)	$Depn(5)_t = Z_{(t)} - \underset{(0.159)}{0.250} Z_{(t-1)}$	.286211E+09
6	(0, 0, 3)	$Depn(6)_t = Z_{(t)} - \underset{(0.003)}{0.276} Z_{(t-1)} - \underset{(0.003)}{0.275} Z_{(t-2)} + \underset{(0.003)}{1.000} Z_{(t-3)}$	.281247E+09
7	(0, 0, 1)	$Depn(7)_t = Z_{(t)} - \underset{(0.230)}{0.580} Z_{(t-1)}$	.654416E+09

Table 6.9: (Continued)

Sector	ARIMA (p, d, q)	Equation	WN Var.
8	(0, 0, 3)	$Depn(8)_t = Z_{(t)} + \underset{(0.141)}{0.027} Z_{(t-1)} + \underset{(0.086)}{0.612} Z_{(t-2)} + \underset{(0.141)}{0.636} Z_{(t-3)}$	.303059E+09
9	(0, 0, 3)	$Depn(9)_t = Z_{(t)} + \underset{(0.155)}{0.025} Z_{(t-1)} + \underset{(0.153)}{0.329} Z_{(t-2)} + \underset{(0.172)}{0.503} Z_{(t-3)}$	.132081E+08
10	(2, 0, 0)	$Depn(10)_t = - \underset{(0.222)}{0.121} Depn(10)_{(t-1)} - \underset{(0.211)}{0.384} Depn(10)_{(t-2)} + Z_{(t)}$	.114683E+09
11	(0, 1, 1)	$D(Depn(11), 1)_t = Z_{(t)} - \underset{(0.153)}{0.621} Z_{(t-1)}$	.554425E+09
12	(1, 0, 2)	$Depn(12)_t = \underset{(0.133)}{0.688} Depn(12)_{(t-1)} + Z_{(t)} - \underset{(0.002)}{1.555} Z_{(t-1)} + \underset{(0.002)}{1.000} Z_{(t-2)}$	.136858E+08
13	(1, 0, 0)	$Depn(13)_t = \underset{(0.171)}{.3136} Depn(13)_{(t-1)} + Z_{(t)}$	.132982E+08
14	(4, 1, 0)	$D(Depn(14),1)_t = \underset{(0.199)}{-0.574} D(Depn(14), 1)_{(t-1)} - \underset{(0.199)}{0.343} D(Depn(14), 1)_{(t-2)} - \underset{(0.218)}{0.201} D(Depn(14), 1)_{(t-3)} + \underset{(0.177)}{0.451} D(Depn(14), 1)_{(t-4)} + Z_{(t)}$	.511263E+07
15	(3, 0, 1)	$Depn(15)_t = \underset{(0.150)}{0.484} Depn(15)_{(t-1)} + \underset{(0.211)}{0.143} Depn(15)_{(t-2)} - \underset{(0.179)}{0.631} Depn(15)_{(t-3)} + Z_{(t)} - \underset{(0.197)}{0.951} Z_{(t-1)}$	.677767E+07
16	(0, 0, 1)	$Depn(16)_t = Z_{(t)} + \underset{(0.189)}{0.190} Z_{(t-1)}$	.628415E+09
17	(1, 0, 0)	$Depn(17)_t = \underset{(0.157)}{0.467} Depn(17)_{(t-1)} + Z_{(t)}$	.214101E+09
18	(0, 1, 2)	$D(Depn(18), 1)_t = Z_{(t)} - \underset{(0.229)}{1.462} Z_{(t-1)} + \underset{(0.212)}{0.508} Z_{(t-2)}$	.935052E+09
19	(0, 1, 2)	$D(Depn(19), 1)_t = Z_{(t)} - \underset{(0.004)}{1.792} Z_{(t-1)} + \underset{(0.004)}{1.000} Z_{(t-2)}$	.151533E+09
20	(2, 1, 0)	$D(Depn(20), 1)_t = - \underset{(0.141)}{0.919} D(Depn(20), 1)_{(t-1)} - \underset{(0.136)}{.6414} D(Depn(20), 1)_{(t-2)} + Z_{(t)}$	.870200E+09
21	(1, 0, 1)	$Depn(21)_t = - \underset{(0.160)}{0.483} Depn(21)_{(t-1)} + Z_{(t)} + \underset{(0.002)}{0.999} Z_{(t-1)}$	.137681E+09
22	(0, 1, 5)	$D(Depn(22), 1)_t = Z_{(t)} - \underset{(0.090)}{1.751} Z_{(t-1)} + \underset{(0.226)}{0.914} Z_{(t-2)} + \underset{(0.277)}{0.323} Z_{(t-3)} - \underset{(0.226)}{1.347} Z_{(t-4)} + \underset{(0.090)}{0.875} Z_{(t-5)}$	.350503E+10
23	(0, 0, 2)	$Depn(23)_t = Z_{(t)} + \underset{(0.176)}{0.005} Z_{(t-1)} - \underset{(0.176)}{0.307} Z_{(t-2)}$	.447561E+09
24	(3, 0, 0)	$Depn(24)_t = - \underset{(0.150)}{0.448} Depn(24)_{(t-1)} + \underset{(0.132)}{0.610} Depn(24)_{(t-2)} + \underset{(0.151)}{.4725} Depn(24)_{(t-3)} + Z_{(t)}$	.231336E+08

Table 6.9: (Continued)

Sector	ARIMA (p, d, q)	Equation	WN Var.
25	(0, 0, 1)	$Depn(25)_t = Z_{(t)} - .1624\ Z_{(t-1)}$ (0.177)	.191662E+10
26	(0, 0, 1)	$Depn(26)_t = Z_{(t)} - 0.255\ Z_{(t-1)}$ (0.193)	.368161E+10

Notes: (1) *depn(#)* denotes the depreciation series for sector #, and D(*depn#*, 1) is the 1st difference of the particular series.

(2)Each equation is estimated by the maximum likelihood method via the Iterative Time Series Modeling (ITSM) software.

(3) All numbers in the parentheses represent the standard errors of the AR and MA terms.

(4) $Z_{(t)}$ denotes White noise stochastic error term with zero mean and their variance shown in the last column of Table 6.8.

Table 6.10: The Results of the Randomness Test for the Residuals of the Sectoral Depreciation Equations

Sector #	Q_{LB}	Q_{ML}	Z_{TP}	Z_S	Z_P	MAAO
1 *p* - value	7.864 (0.896)	7.013 (0.957)	17.000 (0.457)	14.000 (0.756)	.26900E+03 (0.066)	0
2 *p* - value	3.593 (0.995)	5.0672 (0.992)	18.000 (0.766)	14.000 (0.756)	.26200E+03 (0.112)	0
3 *p* - value	16.423 (0.037*)	8.337 (0.910)	18.000 (0.766)	17.000 (0.120)	.25900E+03 (0.139)	0
4 *p* - value	11.103 (0.678)	25.756 (0.041*)	19.000 (0.882)	13.000 (0.351)	.22300E+03 (0.844)	0
5 *p* - value	2.562 (0.999)	0.583 (1.000)	18.000 (0.766)	12.000 (0.120)	.33200E+03 (0.000*)	0
6 *p* - value	9.455 (0.664)	8.532 (0.901)	13.000 (0.011*)	13.000 (0.351)	.21600E+03 (0.957)	0
7 *p* - value	2.765 (0.999)	5.868 (0.982)	19.000 (0.882)	13.000 (0.351)	.30100E+03 (0.003*)	0
8 *p* - value	5.858 (0.923)	14.802 (0.465)	17.000 (0.457)	13.000 (0.351)	.27300E+03 (0.048*)	0
9 *p* - value	3.446 (0.991)	3.459 (0.999)	16.000 (0.234)	16.000 (0.351)	.28000E+03 (0.026*)	0
10 *p* - value	2.256 (0.999)	14.860 (0.462)	17.000 (0.457)	16.000 (0.351)	.24800E+03 (0.276)	0
11 *p* - value	10.126 (0.753)	4.751 (0.994)	17.000 (0.649)	10.000 (0.011*)	.20400E+03 (0.970)	0
12 *p* - value	8.294 (0.762)	10.082 (0.815)	15.000 (0.101)	18.000 (0.029*)	.19900E+03 (0.509)	0
13 *p* - value	13.205 (0.510)	10.259 (0.803)	21.000 (0.297)	13.000 (0.351)	.25800E+03 (0.148)	0
14 *p* - value	5.741 (0.890)	10.268 (0.803)	19.000 (0.649)	15.000 (0.527)	.19000E+03 (0.626)	0
15 *p* - value	8.579 (0.661)	8.111 (0.919)	20.000 (0.551)	16.000 (0.351)	.24600E+03 (0.309)	0
16 *p* - value	4.993 (0.986)	9.429 (0.854)	15.000 (0.101)	13.000 (0.351)	.17100E+03 (0.097)	0

Table 6.10: (Continued)

Sector #	Q_{LB}	Q_{ML}	Z_{TP}	Z_S	Z_P	MAAO
17 *p* - value	7.298 (0.923)	17.477 (0.291)	17.000 (0.457)	13.000 (0.351)	.26500E+03 (0.090)	0
18 *p* - value	6.515 (0.925)	1.535 (1.000)	13.000 (0.023*)	16.000 (0.206)	.28700E+03 (0.002*)	0
19 *p* - value	8.872 (0.783)	19.159 (0.207)	13.000 (0.023*)	14.000 (1.000)	.26200E+03 (0.027*)	0
20 *p* - value	6.580 (0.922)	1.101 (1.000)	15.000 (0.172)	13.000 (0.527)	.25100E+03 (0.072)	0
21 *p* - value	4.831 (0.979)	21.213 (0.130)	24.000 (0.017*)	12.000 (0.120)	.25900E+03 (0.139)	0
22 *p* - value	8.788 (0.552)	0.426 (1.000)	12.000 (0.006*)	10.000 (0.011*)	.23500E+03 (0.230)	0
23 *p* - value	0.786 (1.000)	0.324 (1.000)	21.000 (0.297)	14.000 (0.756)	.24800E+03 (0.276)	0
24 *p* - value	5.658 (0.932)	13.509 (0.563)	18.000 (0.766)	14.000 (0.756)	.27800E+03 (0.031*)	0
25 *p* - value	3.753 (0.997)	3.751 (0.998)	19.000 (0.882)	15.000 (0.756)	.33000E+03 (0.000*)	0
26 *p* - value	9.324 (0.810)	1.248 (1.000)	14.000 (0.037*)	13.000 (0.351)	.28000E+03 (0.026*)	0

Notes: (1) In this study, the assigned value of *h* for the Ljung – Box and the McLeod – Li portmanteau tests is 15 (Practically, *h* is equal to *n/2*).

(2) The results are estimated by the Iterative Time Series Modeling (ITSM) software, and * denotes the significance at the 0.05 level

(3) All numbers in the parentheses represent the corresponding *p* – value of each statistic at the 5% level of significant.

Except for the Ljung – Box portmanteau test (Q_{LB}) of sector 1, the McLeod – Li portmanteau test (Q_{ML}) of sector 4, the turning point test (Z_{TP}) of sectors 6, 18, 19, 21, 22, and 26, the Difference – sign test (Z_S) of sectors 11, 12 and 22, the rank test (Z_P) of sectors 5, 7, 8, 9, 18, 19, 24, 25, and 26, the results from Table 6.10 show that at least four from the six tests of randomness in every sector are not significant enough to reject the null hypothesis of the White – noise error term. This evidence concludes that the assigned *ARIMA (p, d, q)* models in Table 6.9 fit the depreciation data quite well, and the models can be used to forecast these series for 2005 – 2020 (Table 6.11).

Table 6.11: The Forecasting Results for the Sectoral Depreciation from 2005 - 2020

(Millions of Baht)

Sector	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1	17602	7110.9	7110.9	7110.9	7110.9	7110.9	7110.9	7110.9	7110.9	7110.9
2	-3604.3	-145.3	965.8	1322.8	1437.4	1474.3	1486.1	1489.9	1491.1	1491.5
3	2774.5	314.6	516.5	2508.2	140.8	1147.4	2231.8	-154.8	1799.8	1696.5
4	3254.8	1957.9	1957.9	1957.9	1957.9	1957.9	1957.9	1957.9	1957.9	1957.9
5	4149.4	4821.1	4821.1	4821.1	4821.1	4821.1	4821.1	4821.1	4821.1	4821.1
6	-24904.0	-9897.2	43472.0	128.9	128.9	128.9	128.9	128.9	128.9	128.9
7	-10032.0	3835.7	3835.7	3835.7	3835.7	3835.7	3835.7	3835.7	3835.7	3835.7
8	21068.0	21350.0	6806.9	10082.0	10082.0	10082.0	10082.0	10082.0	10082.0	10082.0
9	2103.9	3622.6	2576.8	661.3	661.3	661.3	661.3	661.3	661.3	661.3
10	4328.5	11864.0	-6652.8	-7314.6	-119.5	-733.2	-3423.9	-2863.5	-1897.2	-2229.1
11	50176.0	52911.0	55646.0	58381.0	61116.0	63851.0	66586.0	69321.0	72056.0	74791.0
12	3985.8	-4815.2	-3582.3	-2734.6	-2151.8	-1751.0	-1475.5	-1286.1	-1155.9	-1066.3
13	1224.1	1627.1	1753.4	1793.0	1805.5	1809.4	1810.6	1811.0	1811.1	1811.1
14	-2102.5	-2481.8	-185.5	-8525.0	-2305.7	-4098.7	-2934.7	-8453.5	-2969.9	-5717.1
15	-1559.8	-6854.3	2908.3	1642.5	5769.6	1426.4	715.7	-2854.1	-1943.1	-1566.1
16	-10280.0	-4748.1	-4748.1	-4748.1	-4748.1	-4748.1	-4748.1	-4748.1	-4748.1	-4748.1
17	10872.0	8735.7	7737.9	7271.8	7054.1	6952.4	6904.9	6882.7	6872.3	6867.5
18	-11939.0	-6652.7	-7162.9	-7673.1	-8183.2	-8693.4	-9203.5	-9713.7	-10224.0	-10734.0
19	15326.0	27129.0	27575.0	28022.0	28468.0	28914.0	29360.0	29806.0	30252.0	30698.0
20	98200.0	69444.0	66049.0	91565.0	74244.0	77745.0	89588.0	80409.0	85198.0	90635.0
21	867.7	6753.3	3909.5	5283.6	4619.7	4940.4	4785.5	4860.3	4824.2	4841.6
22	18263.0	105700.0	49742.0	53667.0	87938.0	90965.0	93992.0	97019.0	100050.0	103070.0
23	3609.7	3924.4	4797.4	4797.4	4797.4	4797.4	4797.4	4797.4	4797.4	4797.4
24	6452.8	4854.5	5462.1	4928.8	4782.9	4810.2	4457.1	4563.1	4313.3	4323.0
25	9222.9	12890.0	12890.0	12890.0	12890.0	12890.0	12890.0	12890.0	12890.0	12890.0
26	-2887.1	-1442.2	-1442.2	-1442.2	-1442.2	-1442.2	-1442.2	-1442.2	-1442.2	-1442.2

Table 6.11: (Continued)

(Millions of Baht)

Sector	2015	2016	2017	2018	2019	2020
1	7110.9	7110.9	7110.9	7110.9	7110.9	7110.9
2	1491.6	1491.7	1491.7	1491.7	1491.7	1491.7
3	-125.4	2297.4	1033.8	221.2	2518.5	405.9
4	1957.9	1957.9	1957.9	1957.9	1957.9	1957.9
5	4821.1	4821.1	4821.1	4821.1	4821.1	4821.1
6	128.9	128.9	128.9	128.9	128.9	128.9
7	3835.7	3835.7	3835.7	3835.7	3835.7	3835.7
8	10082.0	10082.0	10082.0	10082.0	10082.0	10082.0
9	661.3	661.3	661.3	661.3	661.3	661.3
10	-2560.3	-2392.8	-2285.8	-2363.0	-2394.9	-2361.3
11	77526.0	80261.0	82996.0	85731.0	88466.0	91201.0
12	-1004.7	-962.4	-933.3	-913.3	-899.5	-890.1
13	1811.1	1811.1	1811.1	1811.1	1811.1	1811.1
14	-4833.0	-8443.5	-4098.0	-7220.6	-6242.1	-8687.8
15	998.8	1718.8	2197.0	913.7	-92.7	-1065.1
16	-4748.1	-4748.1	-4748.1	-4748.1	-4748.1	-4748.1
17	6865.2	6864.1	6863.6	6863.4	6863.3	6863.3
18	-11244.0	-11754.0	-12264.0	-12775.0	-13285.0	-13795.0
19	31144.0	31591.0	32037.0	32483.0	32929.0	33375.0
20	86517.0	90764.0	93453.0	92208.0	95578.0	97230.0
21	4833.2	4837.3	4835.3	4836.3	4835.8	4836.0
22	106100.0	109130.0	112150.0	115180.0	118210.0	121230.0
23	4797.4	4797.4	4797.4	4797.4	4797.4	4797.4
24	4216.4	4152.1	4120.5	4045.1	4029.3	3975.5
25	12890.0	12890.0	12890.0	12890.0	12890.0	12890.0
26	-1442.2	-1442.2	-1442.2	-1442.2	-1442.2	-1442.2

6.4 The Miscellaneous Equations for completing the Accountant Block

Before ending this Chapter, the additional 3 aggregate equations have to be estimated in order to complete the accountant block of the MUTE model. These three equations include (1) the equation of aggregate level of inflation (inf_t), (2) the equation for personal income (pi_t), and (3) the equation for personal saving rate (psr_t). The choices of explanatory variables that are supposed to be included in each equation were already determined by the general functional form 4.26 – 4.28:

-The Equation for Aggregate level of Inflation (inf_t)

$$inf_t = \left(\frac{gdpd_t - gdpd_{t-1}}{gdpd_{t-1}} \right) \times 100 = f[u_t, T, Dummy] \tag{4.26}$$

- The Equation for Personal Income (pi_t)

$$pi_t = f[W_t, tpf_t, T, Dummy] \tag{4.27}$$

- The Equation for Personal Saving Rate (psr_t)

$$psr_t = f[psr_{t-1}, u_t, inr_t, gri_t, T, Dummy] \tag{4.28}$$

where inf_t is the inflation rate measured by the growth rate of GDP deflator ($gdpd_t$) and u_t represents total unemployment rate. Thus, equation (4.26) resembles the concept of the Phillips curve. pi_t denotes the personal income, while W_t and tpf_t are the aggregate wage and the level of total profit at time t, respectively. psr_t represents the personal saving rate. inr_t is the nominal interest rate at time t. gri_t denotes the growth rate of real income in period t. T is the time trend variable. Finally, the *Dummy* variables in this case are represented by the *poldum* and *cridum* variables, which capture the impacts of political disorder and financial crisis in Thailand. The time series data on $gdpd_t$, pi_t, W_t, tpf_t, psr_t, and gri_t come from the annual published SNA data of National Economic and Social Development Board (*NESDB*), while u_t and W_t series are obtained from the Labor Force Survey (LFS). Once again, the ADF test is applied to detect both the (non) stationary characteristic of the included variables, and to specify the appropriate functional form for each equation. The results of the ADF test in the level, the logarithmic, and the 1st differences forms of these variables are shown in Table 6.12.

Table 6.12: The ADF Test on All Variables Included in the Aggregate Inflation, Personal Income, and Personal Saving Rate Equations

Variable	Coefficient	Tau (τ) Statistic	Variable	Coefficient	Tau (τ) Statistic
inf_t	-0.443	-2.131	tpf_t	-0.156	-1.893
log	n.a.	n.a.	log	-0.134	-2.363
1st diff.	-1.599	-4.702^{***}	1st diff.	-0.569	-2.878
u_t	-0.209	-1.943	psr_t	-0.379	-2.719
log	-0.155	-1.772	log	-0.343	-2.566
1st diff.	-0.838	-4.329^{***}	1st diff.	-4.086	-3.738^{**}
pi_t	0.013	1.059	inr_t	-0.364	-2.357
log	-0.102	-2.086	log	-0.158	-1.281
1st diff.	-0.171	-1.234	1st diff.	-1.026	-5.144^{***}
W_t	0.004	0.182	gri_t	-0.476	-2.885
log	-0.021	-1.064	log	n.a.	n.a.
1st diff.	-4.553	-4.578^{***}	1st diff.	-1.051	-5.362^{***}

Notes: (1) *, **, *** denoted the significant level at 10%, 5%, and 1%, respectively for testing the null hypothesis that the particular series has a unit root.

The ADF test shows that none of these variables are stationary both in the level and the logarithmic forms. However, only inf_t, u_t, W_t, psr_t, inr_t, and gri_t series are integrated of order 1. The rest of the variables are non – stationary, even after the 1st difference transformation. Therefore, the estimation by using the level form of these variables is feasible for all equations, if the cointegrating vector exists. The 1st difference transformation can be applied only in equations (4.26) and (4.28), while the logarithmic form is out of the question for these two equations, since inf_t and gri_t series contain the negative values. The next step is to check whether the cointegrating vectors exist among these variables. The results of the cointegration tests are shown in Table 6.13.

Table 6.13: The Cointegration Test for the Aggregate Inflation, Personal Income, and Personal Saving Rate Equations

Equation #	Trace Test				Maximum Eigenvalue Test				# of Coint.
Vectors	$r = 0$	$r \leq 1$	$r \leq 2$	$r \leq 3$	$r = 0$	$r \leq 1$	$r \leq 2$	$r \leq 3$	Vector
(4.26)	12.014	5.630	n.a.	n.a.	6.383	5.630	n.a.	n.a.	0
Critical Value									
5%	15.41	3.76	n.a.	n.a.	14.07	3.76	n.a.	n.a.	
1%	20.04	6.65	n.a.	n.a.	18.63	6.65	n.a.	n.a.	

Table 6.13 (Continued)

Equation # Vectors	Trace Test				Maximum Eigenvalue Test				# of Coint. Vector
	r =0	r ≤ 1	r ≤ 2	r ≤ 3	r =0	r ≤ 1	r ≤ 2	r ≤ 3	
(4.27)	42.025	14.478	3.179	n.a.	27.547	11.300	3.179	n.a.	1
Critical Value 5% 1%	 29.68 35.65	 15.41 20.04	 3.76 6.65	 n.a. n.a.	 20.97 25.52	 14.07 18.63	 3.76 6.65	 n.a. n.a.	
(4.28)	40.807	20.230	7.859	0.038	20.577	12.371	7.821	0.038	0
Critical Value 5% 1%	 47.21 54.46	 29.68 35.65	 15.41 20.04	 3.76 6.65	 27.07 32.24	 20.97 25.52	 14.07 18.63	 3.76 6.65	

The cointegration tests indicate that none of the cointegrating vector exists among the variables in equations (4.26) and (4.28) and only one cointegrating vector occurs in equation (4.27) at both 5% and 1% significant levels. This result suggests the suitable model for estimating these data, namely, equations (4.26) and (4.28) should be estimated in the 1st difference form, while the simple level form can be applied to equation (4.27).

The sign of the parameter of u_t in equation (4.26) is expected to be negative due to the concept of the Phillips curve (negative relationship between inflation rate and unemployment rate). The parameters of W_t and tpf_t from equation (4.27) are expected to be positive, since both profit and wage are the main sources of income. The expected sign for the parameter of u_t in equation (4.28) is negative because high level of unemployment will cause people to save less, since they have low level of income. The expected signs for the parameters of inr_t and gri_t from the same equation are positive, because higher level of interest rate means higher opportunity costs of spending money in the current period and higher growth rate of real income reflects a better condition of the economy. Thus, both variables should contribute positive impacts on the saving rate. Moreover, the objective of inserting the lagged value of personal saving rate is to capture the saving behavior of households. However, the expected sign of the parameter for this variable is uncertain (it is possible that people with high saving rate in the previous period will save more in the current period, or if the target amount of saving is reached due to the high saving rate in the previous period, people will save less in the current period).

The time trend variable is added to every equation to represent other effects that can not be explained by the regressors. Finally, the parameters of *poldum* and *cridum* variables in equations (4.27) and (4.28) are expected to have negative value, since during the period of political disorder and financial crisis, the personal income and the saving rate are kept at low level. However the expected signs of the same variables in equation (4.26) are uncertain and depend on the comparison between these impacts on the demand and the supply sides of the economy. In my opinion, if these crises send a larger negative impact on the demand (supply) side, the inflation rate should fall (rise). The estimated results of these three equations are shown by the following regressions:

-The Equation for Aggregate level of Inflation (inf_t)

$$\Delta inf_t = 0.860 - 1.054(\Delta u_t) - 0.042(trend) - 2.075\text{poldum} - 0.468\text{ cridum}$$

$$(1.174)\quad(0.717)\qquad(0.065)\qquad(2.268)\qquad(1.794)$$

$$t = (0.732)\ (-1.470)\qquad(-0.654)\qquad(-0.915)\qquad(-0.261)$$

$$n = 26\qquad R^2 = 0.385\qquad D.W. = 2.085\qquad F-Statistic = 1.615$$

AR(1) coefficient = -0.797 (t = -3.262) *AR(2)* coefficient = -0.426 (t = -1.417)

AR(3) coefficient = -0.030 (t = -0.120) (6.16)

- The Equation for Personal Income (pi_t)

$$pi_t = -17808.43 + 31.81W_t + 0.854tpf_t + 3801.712(trend) - 32978.70(poldum) - 96646.49(cridum)$$

$$(17353.03)\quad(1.878)\quad(0.053)\quad(3832.005)\qquad(27119.24)\qquad(47303.50)$$

$$t = \quad(-1.026)\quad(16.938)\quad(15.998)\qquad(0.992)\qquad(-1.216)\qquad(-2.043)$$

$n = 27 \quad R^2 = 0.998 \quad D.W. = 1.869 \quad F - Statistic = 3213.077$

AR(2) coefficient = 0.155 (t = 0.851) *AR(3)* coefficient = -0.883 (t = -4.813) (6.17)

- The Equation for Personal Saving Rate (psr_t)

Unfortunately, the equation for personal saving rate is failed to estimate by two reasons. First, the estimation by using the 1st - difference form of the included variables gives unexpected results both in the magnitude of the estimated parameters and the sign for each variable. Secondly, the problem of autocorrelation can not be resolved, even after inserting the higher order of autoregressive structure (e.g. *AR(5), AR(6)*). Moreover, the value of adjusted R^2 is quite low and in some cases, negative. Thus, to avoid these problems, the personal saving rate series in this study is estimated by applying the AICc technique on the 1st – difference series of personal saving rate. The appropriate *ARIMA* (*p, d, q*) model for this series, the randomness test on the estimated residuals and the forecasting result are shown in Tables 6.14 - 6.16, respectively.

Table 6.14: The Estimation Results for Personal Saving Rate (psr_t) by the AICc Method

Series	ARIMA (p, d, q)	Equation	WN Var.
psr_t	(0, 1, 1)	$D(psr, 1)_t = Z_{(t)} - 0.239\, Z_{(t-1)}$ (0.211)	4.816

Notes: (1) D(*psr#*, 1) is the 1st difference of the personal saving rate series.
(2) The equation is estimated by the maximum likelihood method via the Iterative Time Series Modeling (ITSM) software.
(3) All numbers in the parentheses represent the standard errors of the MA terms.
(4) $Z_{(t)}$ denotes the White noise stochastic error term with zero mean and their variance shown in the last column of Table 6.12.

Table 6.15: The Randomness Test on the Residuals of Personal Saving Rate

Series	Q_{LB}	Q_{ML}	Z_{TP}	Z_S	Z_P	MAAO
psr_t *p* - value	17.368 (0.237)	22.162 (0.103)	19.000 (0.649)	15.000 (0.527)	.15600E+03 (0.078)	0

Notes: (1) In this study, the assigned value of *h* for the Ljung – Box and the McLeod – Li portmanteau tests is 15 (Practically, *h* is equal to *n/2*). (2) The results are estimated by the Iterative Time Series Modeling (ITSM) software, and * denotes the significance at the 0.05 level (3) All numbers in the parentheses represent the corresponding *p* – value of each statistic at the 5% level of significance.

Table 6.16: The Forecasting Results for the Personal Saving Rate, 2005 – 2020

Year	psr_t	Year	psr_t
2005	7.397	**2013**	6.539
2006	7.289	**2014**	6.431
2007	7.182	**2015**	6.324
2008	7.075	**2016**	6.217
2009	6.968	**2017**	6.110
2010	6.860	**2018**	6.002
2011	6.753	**2019**	5.895
2012	6.646	**2020**	5.788

Equation (6.16) is simply estimated by the OLS method, while equation (6.17) is estimated by the two stages least square (TSLS), since total profit (tpf_t) and the aggregate wage (W_t) are determined within the MUTE model. Both equations (6.16) and (6.17) have the expected signs for all estimated parameters. However, *cridum* only has the significant impact on personal income, while *poldum*, even though it has the expected negative sign, its impact is statistically insignificant at 5% level in both equations. The R^2 value of equation (6.16) is much lower than that of equation (6.17). This is possibly because of the use of the 1st - difference transformation in equation (6.16). Furthermore, the structures of *AR(1) – AR(3)* are inserted into both equations so as to solve the problem of autocorrelation. Finally, the model chosen by the AICc method for personal saving rate series is *ARIMA (0, 1, 1)*. The test of randomness from Table 6.15 confirms that this *ARIMA* model fit the data quite well and the model can be used to forecast the personal saving rate series from 2005 to 2020. One interesting point in this case is that from 2005 – 2020, the predicted value of the saving rate in Thailand is on a declining trend.

6.5 The Conclusion

Chapter 6 attempts to estimate the price – income side of the MUTE model. Three from the four value added components namely, wage (compensation to employees), profit (operating surplus), and depreciation are estimated for 26 sectors by the regression technique, while the indirect taxes less subsidies are left as an exogenous variable to the model. The estimated results of the sectoral equations for wage and profit components are unimpressive due to the low value of R^2 and the signs of each parameter are not consistent with the economic theories in some cases. Moreover, due to the limitation of data and the statistic properties, the sectoral equations for depreciation are simply estimated by the time - series technique. However, these equations are left unchanged until superior functional forms in term of theoretical and statistical relevancy, or better sectoral data are acquired.

Before ending this chapter, 3 additional aggregate equations are estimated in order to complete the accountant block of the MUTE model. These equations include (1) the equation for the aggregate level of inflation, (2) the equation for personal income, and (3) the equation for personal saving rate. The first equation is simply estimated by applying the OLS method on the 1st difference data. TSLS is used to estimate the second equation, since the explanatory variables namely, the aggregate wage rate and the total profit are endogenous to the model. Ultimately, due to the improper statistical properties of the estimated regression, the AICc technique is directly applied to the personal saving rate series. The randomness tests guarantees the appropriateness of the chosen *ARIMA (p, d, q)* model and finally, this model is used to forecast the personal saving rate series from 2005 - 2020.

Chapter VII

The Long - Run Forecasting for the Thai Economy

After completing the estimation of the three main blocks of the MUTE model (the real side, the price – income side and the accountant), the model is ready to forecast the long – term movement of the main economic variables for the Thai economy under various scenarios. However, before using the model for prediction, the model must be tested for its accuracy. One criterion for the good model is that if the model can resemble the past with small error, it can be used to forecast the future.

Therefore, to fulfill the main objectives of this study, the chapter begins with the performance test of the MUTE model. Then, the baseline forecast for the Thai economy from 2008 – 2020 is estimated in section 7.2 as the point of reference. Finally, various scenarios relating to the impacts of the exchange rate appreciation of Baht against U.S. dollar and the political disorder are estimated and reported for 2005 – 2020.

7.1 The Verification and the Validation of the MUTE Model

Practically, to measure the performance of an economic model is a very difficult task, since the real world system consists of much larger details and greater sets of restrictions than the abstract model created by the computer. However, the performance test on the data produced by the simulation is quite necessary to guarantee that our generated model is reasonable and can be used to predict the future with high confidence. According to Kennedy et al. (2005)[1], two processes called verification and validation

[1] R. C. Kennedy, X. Xiang, G. R. Madey, T. F. Cosimano, "Verification and Validation of Scientific and Economic Models", Agent2005, Chicago, October 2005.

play a significant role in this case. The verification process generally refers to whether the factors and the constraints that determine the real world situation are similar or closely matched to those in the abstract model, while the validation process means that the chosen model can explain or correctly represent the empirical situation with small error.

Though, the concept of verification and the validation are quite comprehensible, the effective processes to measure them are diverse and it is impossible to create a general method that fits all simulations with different objectives. Fortunately, Balci (1998)[2] suggests 15 general simulation principles for verification, validation and testing. Among which, the 4 essential principles pertinent to researches in economic field include:

1. Firstly, since the model is only the abstraction, it cannot be used as the perfect representation of the real world phenomenon. As a result, the outcome of verification and validation processes should not be treated as the binary variable. In other words, the result of these tests should not be considered as the decisive decision that the model is absolutely accurate or absolutely inaccurate.
2. Secondly, perfect validation and verification test for all parameters and inputs of the model is impossible. Thus, some important parameters must be chosen before performing the test.
3. Thirdly, the proper test must be planed and well documented.

[2] Balci, O., "Handbook of Simulation: Principles, Methodology, Advances, Applications, and Practice," *Book Chapter: Verification, Validation, and Testing,* John Wiley & Sons, NewYork, 1998.

4. Finally, even though each module of the model works properly, it is possible that they might not work cooperatively when they are combined as one single system. Thus, to prove that each part of the model is successful does not guarantee the credibility of the overall model.

The performance test for the MUTE model in this study uses these principles as the starting point. For the purpose of verification, the MUTE model is claimed without proving that it is correct due to two important reasons. First, the structure of the MUTE model shown in section 4.2 is constructed by relying on the structure of input – output table which is internationally accepted as the appropriate structure for studying the sectoral details of an economy. Finally, both the identities and the estimation of aggregate and sectoral behavioral equations satisfy both economic and statistical theories not only in choosing the included explanatory variables for each equation but also in selecting the suitable functional forms for the whole system.

Therefore, the only task left for this section is to design the validation test for the MUTE model. According to Xiang et al (2005)[3], various validation tests can be separated into the subjective methods and the quantitative methods. The subjective methods largely reckon on the judgment of the professional group. The methods in this category include the face validation, Turing test, internal validity, tracing, black – box testing, and etc. Since most tests are based on the value judgment of the domain experts, they are informal and usually are used as the starting point of the validation process. Due to the defects of the subjective methods, the validation process in this study is mainly focused on the quantitative methods, which heavily rely on statistical techniques in comparing the

[3] Xiang, X., Kennedy, R., Madey, G., "Verification and Validation of Agent-based Scientific Simulation Models," *Agent-Directed Simulation Conference*, San Diego, CA, April 2005.

computed output data of the particular model with the corresponding empirical data or the forecasted output data from other models. Again, there exist various quantitative methods such as docking, historical data validation, sensitivity analysis, predictive validation, and so on. However, only the quantitative method called historical data validation is chosen to measure the performance of the model in this case, since it is corresponding to the main objective of the MUTE model in forecasting the impacts of political disorder and exchange rate fluctuation on the Thai economy.

Conceptually, the historical data validation is to test whether the behaviors of the generated model constructed from the historical data are consistent with those from the real system. The historical data are not only used to construct the model but also used as the reference point for the model outcomes. Thus, this method is quite suitable when historical data exist. However, to compare the model outcomes with the empirical data is not an easy task. According to Balci and Sargent (1984)[4], the comparison can be made by creating a range of accuracy which is the confidence interval of the differences between the model outputs and the empirical data. An acceptable range of accuracy is determined by:

$$L_j \leq \mu_j^m - \mu_j^s \leq U_j \tag{7.1}$$

where L_j and U_j represent the lower and upper limits of the differences between model outputs and the empirical data. μ_j^m and μ_j^s are the population parameters of the corresponding model and system (empirical data), respectively. Equation (7.1) suggests that if the model range of accuracy lies within the boundary of the specified range of accuracy (given a set of experimental conditions and a level of confidence), the

[4] Balci, O., and R. G. Sargent (1984). Validation of simulation models via simultaneous confidence intervals, *American Journal of Mathematical and Management Sciences,* Vol. 4, No.3-4, pp. 375 - 406.

corresponding model is valid; otherwise it is not. Balci and Sargent (1984) also suggest univariate and multivariate approaches in computing the model range of accuracy. However, for the sake of simplicity[5], the univariate approach is employed to calculate the range of accuracy for the MUTE model.

However, the most suitable univariate statistic in this case is based on the two main characteristics of the MUTE model, namely, the (in)dependency and the variances between the model and the real system observations. For the (in)dependency characteristic, there are three reasons to confirm that the MUTE model is independent. First, as mentioned above that the MUTE model is just the abstraction, it cannot represent all aspects of the real economy. For instance, the model can not cover all of the explanatory variables that determine the Thai economy. Second, the model is mainly designed to examine the impacts of political disorder and the fluctuation of the exchange rate on the Thai economy. Thus, the focus of this study is mostly placed on these two variables and it is possible that some impacts are ignored or differ from the real system. Finally, although it is possible to compare the model outcomes one by one with the empirical results, these outcomes are computed by using different sets of assumptions and number of observations from the real world system.

The next task is to examine whether the variances of the model outcomes and the empirical data are different or not. In order to test the differences between two variances from independent observations, the F statistics must be computed as follows:

$$F = S_1^2 / S_2^2 \tag{7.2}$$

[5] Besides its simplicity, the univariate approach has other advantages when comparing with the multivariate approach. For instance, the constructed confidence intervals can be varied by changing the confidence level for each of the model outcomes. Moreover, the univariate technique can be applied to the case when there are unequal sample sizes for each model outcome.

where S_1^2 and S_2^2 are the variances from independent observations with degrees of freedom $n_1 - 1$ and $n_2 - 1$, respectively. n_1 and n_2 are the number of observations of these two groups. Also note that in computing (7.2) the value of S_1^2 is always larger than the value of S_2^2. The computed F in equation (7.2) follows the F distribution with degrees of freedom of the numerator = $n_1 - 1$ and the denominator = $n_2 - 1$. The null hypothesis of equal variances between two groups is rejected when the computed F value exceeds the critical F value at the level of significance α.

Before applying the F test to find the appropriate statistic for computing the range of accuracy, one problem that requires answer is which model outcomes should be tested for the model validation. As indicated by the rule number 2 above that it is impossible to apply the validation test on all outcomes of the model, since in this case, the MUTE model provides a large set of outcomes both at the sectoral and the aggregate levels. The answer to this question is based on the availability of the empirical data as the points of reference. Generally, the SNA system annually reports the corresponding economic data at both aggregate and sectoral levels. However, the annual report on the sectoral data is not consistent with the 26 – sector data of the SIO system. Moreover, the sectoral data used to generate the sectoral equations are constructed by relying on the information from the I – O tables. Put differently, the test on the sectoral details is not feasible due to the lack of empirical data as the point of reference. Consequently, the computation of the range of accuracy in equation (7.2) is only applied to:

1) The Aggregate Level of Private Consumption Expenditures (PCE)
2) The Aggregate Level of Gross Fixed Capital Formation (GFCF)
3) The Aggregate Level of Import Expenditures (IM)

4) Total Wage (W)

5) Total Profit (PF)

6) The Aggregate Level of Inflation (INF)

7) Total Personal Income (PI), and

8) Gross Domestic Product (GDP)

It is worth mentioning here that the validation test applied to items 1 - 7 is the test for each module of the MUTE model, while the test on GDP is treated as the test for the overall model. This is corresponding to rule number 4 above that successful test on the submodels does not guarantee the credibility of the overall model. Furthermore, the rest of the model outcomes are treated as exogenous variables, so it is unnecessary to perform the validation test on these output variables. Back to the point of the calculation of the *F* statistics, the computed F statistics for each of these eight variables and the corresponding critical values are shown in Table 7.1.

Table 7.1: The F Test for the Differences between the Model and the Real System Variances

	1	2	3	4	5	6	7	8
	PCE	**GFCF**	**IM**	**W**	**PF**	**INF**	**PI**	**GDP**
Var(S)	1.19E+12	3.45E+11	1.47E+12	3.01E+08	6.75E+11	1.09E+01	1.61E+12	3.95E+12
Var(M)	1.16E+12	8.54E+11	1.46E+12	2.80E+08	5.61E+11	4.30E+00	1.51E+12	5.28E+12
F Value	1.025	2.475***	1.005	1.074	1.203	2.539***	1.065	1.337
df.num	30	28	30	30	30	30	30	27
df.den	29	30	27	29	29	26	27	30
Critical Value								
0.10	1.616	1.606	1.636	1.616	1.616	1.647	1.636	1.622
0.05	1.854	1.841	1.884	1.854	1.854	1.901	1.884	1.864
0.01	2.412	2.386	2.133	2.412	2.412	2.157	2.133	2.428

Notes: (1) Var(S) and Var(M) represent the variances of the observations from the real system and the model, respectively.

(2) df.num and df.den denote the degrees of freedom of the numerator and denominator, respectively.

(3) *, **, *** denote the significant level at 10%, 5%, and 1%, respectively for testing the null hypothesis that two variances from the model and the real system are equal.

According to the F test, only two model outcomes, namely gross fixed capital formation (GFCF) and the inflation rate (INF), exhibit the evidence of unequal variances between the model and the real system observations. The rest of the variables fail to reject the null hypothesis of equal variances between the two groups. These results together with the independent characteristic of the MUTE model suggest appropriate statistics in computing the range of accuracy for each model outcomes. Let $\bar{x}_j$ and $\bar{y}_j$ be the j sample means of the model and the real system observations, respectively. For the case that the variances between the model and the real system are equal, the range of accuracy can be computed by using the following formula:

$$(\bar{x}_j - \bar{y}_j) \pm t_{\alpha_j/2, n+N-2} S_j^p \sqrt{\frac{1}{n_j} + \frac{1}{N_j}} \qquad ,j = 1, 3, 4, 5, 7, \text{ and } 8 \tag{7.3}$$

For the case of unequal variances, the range of accuracy is determined by

$$(\bar{x}_j - \bar{y}_j) \pm t_{\alpha_j/2, v} \sqrt{\frac{S_{mj}^2}{n_j} + \frac{S_{rj}^2}{N_j}} \qquad ,j = 2 \text{ and } 6 \tag{7.4}$$

where, n and N denote the number of observations of model and the real system of categories j, respectively. $t_{\alpha_j/2}$ is the critical t statistics at the significant level α_j. S_j^p is the pooled standard deviation between these two sets of observations[6]. S_{mj}^2 and S_{rj}^2 represent the sample variances of the model and the real system of categories j, respectively. Finally, v is the degrees of freedom, which can be computed by the following formula:

[6] The pooled standard deviation can be computed by:

$$S_j^p = \sqrt{\frac{(n_j - 1)S_{mj}^2 + (N_j - 1)S_{rj}^2}{n_j + N_j - 2}} \tag{7.5}$$

$$v = \frac{(S_{mj}^2 / n_j) + (S_{rj}^2 / N_j)}{[(S_{mj}^2 / n_j)^2 / (n_j - 1)] + [(S_{rj}^2 / N_j)^2 / (N_j - 1)]} \tag{7.6}$$

Owing to Balci and Sargent (1984), the simultaneous confident interval for these variables in this case will have a confidence level of at least equal to $(1 - \sum_{j=1}^{8} \alpha_j) = (1 - \alpha)$.

The differences between the paired observations on model outputs and the empirical data (x_j - y_j) and the computed ranges of accuracy at 10%, 5%, 1% and 0.001% are shown in Table 7.2 and Table 7.3, respectively.

Table 7.2: the Differences between the Paired Observations on Model Outputs and the Empirical Data (x_j - y_j)

Year	$x_1 - y_1$	$x_2 - y_2$	$x_3 - y_3$	$x_4 - y_4$	$x_5 - y_5$	$x_6 - y_6$	$x_7 - y_7$	$x_8 - y_8$
1976	5722.7	n.a.	n.a.	87.9	n.a.	n.a.	n.a.	n.a.
1977	5907.4	55398.3	n.a.	140.6	n.a.	n.a.	n.a.	n.a.
1978	40048.0	139041.8	-94143.9	10.9	n.a.	n.a.	15082.4	273233.6
1979	58190.7	213428.1	-51664.8	-410.2	-16441.4	-2.0	2907.3	323283.6
1980	62459.8	266645.3	-30985.8	834.6	3115.7	-4.2	-37648.6	360091.0
1981	54964.8	270530.9	46590.6	245.6	40346.8	-0.9	-14757.0	278905.1
1982	99299.7	359956.5	26415.6	817.4	35561.2	-0.2	-9819.9	432840.6
1983	105356.0	431335.4	25624.7	-636.8	47329.1	1.0	40680.5	511066.7
1984	126068.2	517221.9	45265.5	-755.3	66368.8	3.9	41609.9	598024.6
1985	146570.7	558233.1	124682.5	33.9	109656.2	0.7	-8654.4	580121.3
1986	194001.8	679193.4	133347.8	-224.4	137043.1	1.0	17579.6	739847.4
1987	230986.9	735502.2	93635.0	687.7	114198.5	-2.1	-12527.5	872854.1
1988	273423.8	747205.4	-36436.5	985.6	54228.3	-1.4	-8921.5	1057065.8
1989	294054.6	715028.7	-78543.5	1280.7	-15619.2	-0.6	-23329.3	1087626.7
1990	225872.6	624081.3	-98215.2	2112.4	-34646.6	1.4	-27077.3	948169.0
1991	229812.9	556805.8	40130.0	1452.6	-16751.0	-1.5	-26131.6	746488.7
1992	259893.1	680659.9	104142.4	318.9	-39745.8	0.2	-22595.4	836410.6
1993	262603.2	729627.8	105729.0	-1564.5	-25512.1	1.7	-20263.5	886502.0
1994	231153.3	725502.6	62815.7	-4423.6	-96178.8	-0.2	111658.5	893840.2
1995	235413.9	669383.3	-91167.9	-5034.4	-127087	0.3	41339.7	995965.1
1996	199813.3	728311.1	127703.4	-7939.0	-70148	2.0	87895.9	800421.0
1997	120452.3	736864.0	-356521	-6341.8	-115120	1.4	-73728.1	1213838.1
1998	183342.3	930732.3	38664.5	-6001.3	39074.7	-7.4	-108208	1075410.1
1999	149867.6	1001995.6	42397.4	-3320.8	-95470.7	5.4	-113924	1109465.9
2000	99960.2	1112271.8	-110825	-2084.8	-91942.9	0.5	71053.1	1323057.3
2001	29698.5	1173721.7	-172076	-862.7	13381.9	-0.5	82230.0	1375496.6
2002	-21698.1	1500972.2	366726.6	1244.7	51589.1	1.6	100095.8	1112547.5
2003	152.3	1689833.2	224971.3	3777.0	52039.8	0.7	-40461.5	1465014.2
2004	30.5	1841408.4	-201293	6316.8	-33972.1	-1.2	-51780.8	2042732.4

Table 7.2: (Continued)

	x_1-y_1	x_2-y_2	x_3-y_3	x_4-y_4	x_5-y_5	x_6-y_6	x_7-y_7	x_8-y_8
Means	134600.8	728246.1	10628.4	-663.9	-565.5	0.0	455.7	886678.5
S_{mj}	97865.7	432757.2	142013.9	3036.0	72090.2	2.4	57854.0	408794.1
n_j	29	28	27	29	26	26	27	27

Notes: (1) The non – available data are denoted by "n.a". This is because of the use of the lagged terms and the autoregressive structure at higher order in estimating the system equations.
(2) S_d and N denote the standard errors of the differences and the number of observations, respectively.

Table 7.3: the Computed Ranges of Accuracy at 10%, 5%, 1%, and 0.001% Levels

Variable	Formula	df.	α (%)	Ranges of Accuracy
x_1-y_1	Equal Variances	57	10	-460,993.65 : 817,408.03
			5	-583,445.87 : 939,860.25
			1	-822,776.91 : 1,179,191.29
			0.001	-1,100,502.30 : 1,456,916.64
x_2-y_2	Unequal Variances	1	10	-515,802.93 : 2,072,692.46
			5	-1,826,182.42 : 3,383,071.95
			1	-12,270,466.43 : 13,827,355.96
			0.001	-129,721,285.6 : 131,278,175.10
x_3-y_3	Equal Variances	55	10	-576,824.67 : 991,711.64
			5	-713,934.44 : 991,711.64
			1	-981,913.44 : 1,259,690.64
			0.001	-1,292,882.56 : 1,570,659.77
x_4-y_4	Equal Variances	57	10	-6,917.05 : 6,937.78
			5	-8,244.14 : 8,264.87
			1	-10,837.92 : 10,858.64
			0.001	-13,847.80 : 13,868.53
x_5-y_5	Equal Variances	54	10	-319,541.06 : 613,585.43
			5	-408,920.96 : 702,965.32
			1	-583,612.64 : 877,657.00
			0.001	-786,328.96 : 1,080,373.33
x_6-y_6	Unequal Variances	94	10	-1.44 : 0.95
			5	-1.67 : 1.17
			1	-2.12 : 1.63
			0.001	-2.639 : 2.146
x_7-y_7	Equal Variances	55	10	-572,346.21 : 904,736.05
			5	-713,829.13 : 1,046,218.97
			1	-990,355.39 : 1,322,745.23
			0.001	-1,311,242.95 : 1,643,632.792
x_8-y_8	Equal Variances	55	10	-126,781.20 : 2,401,538.46
			5	-368,957.31 : 2,643,714.57
			1	-842,286.93 : 3,117,044.19
			0.001	-1,391,549.73 : 3,666,306.98

Notes: df. and α represent the degrees of freedom and the level of significance used to construct the corresponding ranges of accuracy.

The results show that, the computed ranges of accuracy are quite wide due to the large values of standard error. Consequently, most of the differences data lie within the ranges of accuracy except for the differences data of group 4 (Total Wages) in 1996 that is significant at 10% level, and the differences data of group 6 (Inflation Rate) in 1980, 1998, and 1999, which are significant even at the 0.001%. Though some of the data lie outside the ranges of accuracy, this evidence still confirms the validation of the MUTE model. Finally, the simultaneous confidence interval for these variables will have a confidence level of at least approximately equal to 99.2 percent, or, $(1-\sum_{j=1}^{8}0.001)=(1-0.008)=0.992$.

7.2 The Assumptions under the Baseline Case and the Effects of Political Disorder and the Appreciation of Thai Baht

In order to create the reference point for the performance of the Thai economy under various scenarios, the baseline prediction for the Thai economy is estimated from 2005 – 2020. The assigned values for the exogenous variables are showed in Table 7.4.

The only value of 1 for the dummy variable *Poldum* in year 2006 represents the notorious event of coup d'etat in Bangkok to oust Prime Minister Thaksin Shinawatra, while the *Cridum* variable which represents the financial crisis in Thailand is assumed to have the value of 0 during the 2005 – 2020 periods.

The data on the interest rate (*ir*) and the real interest rate (*r*) variables are available until 2006 at the time of writing. Thus, the values of these variables are forecasted via the AICc method as already mentioned in appendix B. The estimated result is quite consistent with the empirical situation which shows a downward trend of the interest rate.

The value of the exchange rate (er) for the baseline forecast is assumed to appreciate during 2008 – 2010 and will begin to depreciate after 2012 and back to the level of approximately 40 Baht per U.S. Dollar in 2020. Put differently, the baseline model expects that the current Baht appreciation to be finished in 2012.

The unemployment rate is assumed to fluctuate around 1.7% – 2.3% during the forecasting period. Due to the non – stationary characteristic of the unemployment rate series, the data are estimated by applying the AICc method on the 1st difference data of the unemployment rate.

The number of Thai population came from the projection of future Thai population (1995 - 2020). These numbers are readjusted by taking into account the deaths from HIV/AIDS[7]. Since the data are available only every five years (2005, 2010, 2015, and 2020), the data of the intermediary years are simply estimated by assuming the constant increment calculated from two points of the available data.

The growth rates of government consumption expenditures (GCE), exports (EX) special exports (EXS), and the indirect taxes less subsidies series are estimated by applying the AICc technique on the 1st difference data of these growth rate series. The estimated results correspond well with the situation of the Thai economy, especially for the case of exports and special exports. The reduction in the growth rate of the exports and special exports during the forecasting period is the consequence of the appreciation of Thai Baht against U.S. dollar.

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[7] For more details, see Sirikanokwilai N, Wibulpolprasert S. Modified Population – to – Physician Ratio Method to Project Future Physician Requirement in Thailand. *Human Resources for Health Development Journal.* 1998; 3: 55 – 67.

Table 7.4: The Assigned Values of the Exogenous Variables for the Baseline Forecast

Year	*Poldum*	*Cridum*	*ir* (%)	*r* (%)	*er* (Baht /U.S.$)	*u* (%)	*pop* (Million Persons)	*GCE* (Millions of Baht)	*EXP* (Millions of Baht)	*EXS* (Millions of Baht)	Ind. T. less Subsidies (Millions of Baht)	*dtax* (%)
2005	0	0	6.75	3.47	40.27	2.0	65.03	812828.3*	4293740.1*	898174.4*	688210*	4.10
2006	1	0	7.50	3.87	37.93	1.8	65.47	921145.6*	4837094.0*	1000455.9*	711030*	4.30
2007	0	0	7.14*	3.28*	34.56	1.8*	65.91	1037482.9*	5435651.1*	1111581.2*	733860*	4.38
2008	0	0	7.01*	3.00*	34.10*	1.9*	66.35	1148353.8*	6093042.0*	1231934.4*	756690*	4.46
2009	0	0	6.88*	2.77*	35.17*	1.9*	66.79	1238454.5*	6812863.0*	1361866.0*	779510*	4.54
2010	0	0	6.75*	2.58*	35.17*	1.9*	67.23	1295983.7*	7598629.3*	1501684.9*	802340*	4.63
2011	0	0	6.61*	2.42*	35.91*	1.9*	67.60	1317959.9*	8453727.4*	1651650.2*	825160*	4.71
2012	0	0	6.48*	2.27*	36.15*	2.0*	67.97	1312105.0*	9381360.8*	1811963.0*	847990*	4.79
2013	0	0	6.35*	2.14*	36.73*	2.0*	68.34	1293909.9*	10384492.8*	1982758.1*	870820*	4.87
2014	0	0	6.22*	2.01*	37.07*	2.0*	68.71	1281033.5*	11465785.4*	2164095.6*	893640*	4.95
2015	0	0	6.09*	1.89*	37.58*	2.0*	69.08	1288557.3*	12627535.4*	2355952.8*	916470*	5.04
2016	0	0	5.95*	1.77*	37.98*	2.1*	69.36	1326805.8*	13871609.1*	2558216.6*	939300*	5.12
2017	0	0	5.82*	1.65*	38.45*	2.1*	69.65	1400956.7*	15199375.9*	2770675.7*	962120*	5.20
2018	0	0	5.69*	1.53*	38.87*	2.1*	69.93	1510789.9*	16611638.1*	2993014.9*	984950*	5.28
2019	0	0	5.56*	1.42*	39.33*	2.1*	70.22	1649654.0*	18108567.6*	3224808.4*	1007800*	5.37
2020	0	0	5.42*	1.30*	39.76*	2.2*	70.50	1803109.6*	19689641.1*	3465515.5*	1030600*	5.45

<u>Note</u>: (1) * represents the estimation by using the AICc method.

Moreover, such growth rates are expected to decrease from approximately 11% in 2005 to 7% by the end of 2020 due to the higher level of competitiveness in the near future from within the countries and outside in the region such as Vietnam and China. In order to find the consistency between the aggregate and the sectoral data, the sectoral data of these series are simply obtained by using the information from the RAS I – O table as the scaling factors.

Finally, by rearranging equation (4.29), the direct tax rate (*dtax*) in period *t* is equal to 1 minus the ratio between the personal disposable income and the personal income:

$$dtax_t = 1 - \left(\frac{pdi_t}{pi_t} \right) \tag{7.7}$$

Again, these data are forecasted by applying the AICc method on the 1st difference of *dtax* series. The result shows that the direct tax rate has an upward trend and fluctuates in the range of 4% – 5% over the forecasting period.

Moreover, to fulfill the objective of this study, three additional scenarios are assumed to detect the effect of political disorder and the appreciation of Thai Baht. These 3 scenarios include:

7.1.1 The Thai Baht continues to appreciate from 40.27 Baht/U.S. Dollar in 2005 to approximately 31Baht/U.S. Dollar at the end of 2020, but the political situation is back to the stable state after the revolution in 2006.

7.1.2 The movement of the Thai Baht is similar to the base case (back to the level of approximately 40 Baht /Dollar at the end of 2020). However, the political disorder happens again in 2008 and 2009. There are two main reasons to support this scenario. First, the result of the latest election at the end of 2007 would possibly lead to the disunity among the Thai people between the group that supports the Democrat Party (Phak Prachatipat) and the group that supports the People's Power Party (Phak Palang Prachachon), which represents the previous president Taksin Shinawatra. Consequently, if one of these parties is elected to be the new government, another side definitely feels unsatisfied, and if the conflict between these two groups is severe, it possibly leads to the revolution by the military for the 2^{nd} round. Second, the new government is not stable, since it is definitely a coalition government with only slim majority. Thus, the possibility to dissolve the parliament in the following year (2009) is quite high.

7.1.3 The last scenario is the combination of the first two scenarios when both Baht appreciation and the political disorder are expected to happen during the forecasting period.

7.3 The Estimated Results

All of the estimated results for the Thai economy from 2005 – 2020 under scenarios 1 – 3 and the baseline case are shown in Appendix D. In this section, these results are reported both at the macro and at the sectoral levels.

7.3.1 The Macroeconomic Outlook for the Thai Economy

The estimated results show that the performances of the Thai economy during 2005 - 2020 under the baseline case and the scenarios 1 – 3 are in the good condition. On the average, the computed growth rate of the nominal GDP and the real GDP for all scenarios are approximately 13% and 11% per year, respectively.

As expected from the results of Table 7.5, by taking into account the effects of the Baht appreciation and the political disorder, the estimated GDP both in the nominal and real terms will gradually decrease case by case. The lowest growth rate both in the real and nominal term is found under scenario 3 when both political disorder and the Baht appreciation happen at the same time. The Baht appreciation will directly cause net exports to fall due to the lower value of imports and the higher value of exports, while the political disorder erodes both consumer and entrepreneurial confidence, which will adversely affect the level of consumption expenditure and the gross fixed capital formation.

One interesting point revealed from Table 7.5 is that the Baht appreciation from 34.24 Baht per U.S. dollar to 33.94 Baht per U.S. dollar (about 1% during 2008 – 2009) is less harmful to the level of GDP than the two - year continuation of the political disorder. This can be seen from the growth rate of the real GDP during 2008 and 2009. If the political chaos can not be resolved during this period (under scenario 2), it will cause the real growth rate to fall from 12.86% in 2007 to the level of 8.68% and 11.26% in 2008 and 2009 comparing with the case of Baht depreciation (scenario 1), which causes the real growth rate to fall slightly to 10.77% in 2008 and increase to the level of 12.37% in 2009. In nominal term, the political turmoil during 2008 and 2009 by comparing with the base case will cause GDP to fall around 50 billions of Baht, while only 12 billions of baht is the loss due to the Baht appreciation[8].

[8] This is possibly because the degree of the appreciation is quite low under the assumption of scenario 1.

Table 7.5: The Comparison between the Nominal and the Real GDP and Their Growth Rates under the Baseline Case and Scenarios 1 – 3

Nominal GDP (Billions of Baht)															
Year	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Baseline	10188	11665	13330	15198	17221	19460	21917	24667	27763	31271	35247	39747	44849	50632	57190
1	10188	11665	13331	15185	17205	19433	21885	24627	27717	31217	35187	39680	44775	50552	57103
2	10188	11665	13324	15154	17129	19368	21824	24572	27664	31167	35137	39631	44724	50498	57045
3	10188	11665	13325	15141	17113	19342	21792	24531	27618	31113	35077	39563	44650	50418	56959
Growth Rate of the Nominal GDP (%)															
Year	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Baseline	14.47	14.50	14.27	14.02	13.31	13.00	12.63	12.55	12.55	12.63	12.72	12.77	12.83	12.89	12.95
1	14.47	14.50	14.28	13.91	13.30	12.95	12.62	12.53	12.55	12.63	12.72	12.77	12.84	12.90	12.96
2	14.47	14.50	14.22	13.74	13.03	13.07	12.68	12.59	12.59	12.66	12.74	12.79	12.85	12.91	12.97
3	14.47	14.50	14.23	13.63	13.02	13.02	12.67	12.57	12.58	12.66	12.74	12.79	12.86	12.92	12.97
Real GDP (Value in 2000 Prices, Billions of Baht)															
Year	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Baseline	9071	10152	11244	12647	14025	15517	17119	18880	20832	23012	25447	28164	31199	34592	38385
1	9071	10152	11245	12636	14012	15496	17094	18849	20798	22972	25404	28116	31148	34537	38327
2	9320	10518	11432	12719	14075	15482	17077	18815	20769	22951	25425	28281	31330	34737	38484
3	9320	10518	11433	12708	14062	15461	17052	18784	20734	22911	25381	28233	31279	34682	38426
Growth Rate of the Real GDP (%)															
Year	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Baseline	11.79	11.92	10.75	12.48	10.89	10.64	10.32	10.29	10.34	10.46	10.58	10.67	10.78	10.87	10.97
1	11.79	11.92	10.77	12.37	10.88	10.59	10.31	10.27	10.34	10.46	10.59	10.68	10.78	10.88	10.97
2	13.82	12.86	8.68	11.26	10.66	10.00	10.30	10.18	10.39	10.50	10.78	11.23	10.78	10.88	10.79
3	13.82	12.86	8.70	11.15	10.65	9.95	10.29	10.16	10.38	10.50	10.78	11.24	10.79	10.88	10.79

Notes: (1) The real GDP is computed by dividing nominal GDP with the corresponding GDP Deflator and multiply this number with 100. (2) The forecast of GDP Deflator series is obtained from Equation (6.15).

By considering the sources of growth, the forecasting results (See Table 7.6) show that the influences of Baht appreciation and the event of political disorder have no effects on the structure of incomes and expenditures of the Thai economy. On the expenditure side under the baseline and the scenarios 1 – 3, the main source of growth during 2005 – 2008 comes from both personal consumption expenditure and gross fixed capital formation. On the average during this period, both personal consumption and investment expenditure account for 40% and 44% of the nominal GDP. This will leave a small room of 12% for others components (government expenditure, inventory investment, and the net exports). However, this trend will change after 2009. The more important of investment expenditure and the net exports concomitantly with the downward trend of personal consumption will shift the source of growth of the Thai economy to focus only on the investment and foreign trade. The results under these 4 scenarios confirm this evidence. During 2009 - 2020, investment expenditure takes control of 47% of the nominal GDP. The 2nd place of approximately 23% belongs to the net exports, while the share of personal consumption expenditure is reduced to only 17% of GDP by the end of 2020[9].

On the income side, the main sources of income during 2005 – 2011 come from wages and salaries (approximately 41% of nominal GDP) and profit (about 46% of nominal GDP) which leave only 13% of the total income coming from the depreciation and net indirect taxes (See Table 7.7). However, the situation changes after 2011. The share of wages and salaries to the total GDP is raised from 43% in 2012 to about 66% at the end of 2020, while the profit share has the downward trend from approximately 43%

[9] The increasing level of the dependency on the foreign sector is one of the most vulnerable characteristics for the Thai economy in the next decade, since the growth rate of the country will heavily reckon on the situation of the world economy rather than on the strength of the domestic sectors.

Table 7.6: The Expenditure Shares under the Baseline Case and the Scenarios 1 – 3

(Percent)

BASE	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
PCE	44.1	41.9	38.5	36.0	33.7	31.7	29.8	28.1	26.5	25.0	23.5	22.1	20.7	19.4	18.1	17.0
GCE	9.1	9.0	8.9	8.6	8.1	7.5	6.8	6.0	5.2	4.6	4.1	3.8	3.5	3.4	3.3	3.2
GFCF	44.6	43.6	43.2	42.9	42.8	43.0	43.4	44.1	44.9	45.8	46.8	47.9	49.1	50.3	51.7	53.2
INV	0.2	0.0	-0.1	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Net. EX	1.9	5.5	9.5	12.5	15.3	17.7	19.9	21.8	23.3	24.6	25.6	26.3	26.7	26.9	26.8	26.6
GDP	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
SC. #1	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
PCE	44.1	41.9	38.5	36.0	33.7	31.7	29.8	28.1	26.5	25.0	23.5	22.1	20.7	19.4	18.2	17.0
GCE	9.1	9.0	8.9	8.6	8.2	7.5	6.8	6.0	5.3	4.6	4.1	3.8	3.5	3.4	3.3	3.2
GFCF	44.6	43.6	43.2	42.9	42.8	43.0	43.5	44.2	45.0	45.9	46.9	48.0	49.1	50.4	51.8	53.3
INV	0.2	0.0	-0.1	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Net. EX	1.9	5.5	9.5	12.5	15.3	17.6	19.8	21.6	23.2	24.4	25.4	26.1	26.6	26.7	26.7	26.5
GDP	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
SC. #2	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
PCE	44.1	41.9	38.5	36.7	34.5	31.9	30.0	28.3	26.6	25.1	23.6	22.2	20.8	19.5	18.2	17.0
GCE	9.1	9.0	8.9	8.6	8.2	7.6	6.8	6.0	5.3	4.6	4.1	3.8	3.5	3.4	3.3	3.2
GFCF	44.6	43.6	43.2	42.4	42.1	42.6	43.1	43.8	44.6	45.6	46.6	47.7	48.9	50.2	51.6	53.1
INV	0.2	0.0	-0.1	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Net. EX	1.9	5.5	9.5	12.2	15.1	17.8	20.0	21.8	23.4	24.6	25.6	26.3	26.8	26.9	26.9	26.7
GDP	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
SC. #3	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
PCE	44.1	41.9	38.5	36.7	34.5	31.9	30.0	28.3	26.7	25.1	23.6	22.2	20.8	19.5	18.2	17.0
GCE	9.1	9.0	8.9	8.6	8.2	7.6	6.8	6.0	5.3	4.6	4.1	3.8	3.5	3.4	3.3	3.2
GFCF	44.6	43.6	43.2	42.4	42.2	42.7	43.2	43.9	44.7	45.7	46.7	47.8	49.0	50.3	51.7	53.2
INV	0.2	0.0	-0.1	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Net. EX	1.9	5.5	9.5	12.2	15.1	17.7	19.9	21.7	23.3	24.5	25.5	26.2	26.6	26.8	26.8	26.6
GDP	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Note: (1) SC. # denotes the scenario #. (2) Net. EX is the net exports, which is the difference between the export and import expenditures.
(3) The number in each cell represents the expenditure share (%) to its total GDP

Table 7.7: The Income Shares under the Baseline Case and the Scenarios 1 – 3

(Percent)

BASE	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Comp.	39.8	40.5	39.6	40.8	41.6	42.4	43.9	47.3	48.7	50.5	52.6	54.7	57.2	60.0	63.2	66.6
Profits	46.8	45.7	47.2	46.9	46.5	46.1	45.3	42.9	42.0	40.8	39.3	37.8	35.9	33.7	31.2	28.4
Depre.	3.1	4.2	3.7	3.2	3.4	3.2	3.1	2.6	2.6	2.4	2.2	2.0	1.9	1.7	1.5	1.3
Ind. – S.	10.3	9.5	9.5	9.0	8.6	8.2	7.8	7.1	6.7	6.3	5.9	5.5	5.0	4.6	4.1	3.6
VA.	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
SC. #1	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Comp.	39.8	40.5	39.6	40.8	41.6	42.4	43.8	47.3	48.7	50.5	52.6	54.7	57.1	60.0	63.2	66.6
Profits	46.8	45.7	47.2	46.9	46.5	46.2	45.3	43.0	42.0	40.8	39.3	37.8	35.9	33.7	31.2	28.5
Depre.	3.1	4.2	3.7	3.2	3.4	3.2	3.1	2.6	2.6	2.4	2.2	2.0	1.9	1.7	1.5	1.3
Ind. – S.	10.3	9.5	9.5	9.0	8.6	8.2	7.8	7.1	6.7	6.3	5.9	5.5	5.0	4.6	4.1	3.6
VA.	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
SC. #2	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Comp.	39.8	40.5	39.6	42.0	42.5	41.9	43.3	46.8	48.2	50.1	52.2	54.3	56.8	59.7	62.9	66.3
Profits	46.8	45.7	47.2	46.1	46.0	46.8	45.9	43.5	42.5	41.2	39.8	38.2	36.3	34.0	31.5	28.7
Depre.	3.1	4.2	3.7	3.1	3.2	3.1	3.0	2.6	2.5	2.4	2.2	2.0	1.9	1.7	1.5	1.3
Ind. – S.	10.3	9.5	9.5	8.8	8.3	8.2	7.7	7.1	6.7	6.3	5.9	5.4	5.0	4.6	4.1	3.6
VA.	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
SC. #3	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Comp.	39.8	40.5	39.6	42.0	42.5	41.9	43.3	46.8	48.2	50.1	52.2	54.3	56.8	59.7	62.9	66.3
Profits	46.8	45.7	47.2	46.1	46.0	46.8	45.9	43.5	42.5	41.3	39.8	38.2	36.3	34.1	31.5	28.7
Depre.	3.1	4.2	3.7	3.1	3.2	3.1	3.0	2.6	2.5	2.4	2.2	2.0	1.9	1.7	1.5	1.3
Ind. – S.	10.3	9.5	9.5	8.8	8.3	8.2	7.7	7.1	6.7	6.3	5.9	5.5	5.0	4.6	4.1	3.6
VA.	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Note: (1) SC. # denotes the scenario #.

(2) Comp., Depre, and Ind. – S. represents the compensation to employees, depreciation, and the indirect taxes less subsidies.

(3) The number in each cell represents the income share (%) to its total value added (VA).

in 2012 to 29% in 2020. Again, the Baht appreciation and the political disorder under these 4 scenarios have no significant impact on the income structure of the Thai economy.

The inflation rates calculated by the GDP deflator under these 4 scenarios are quite similar. The levels of inflation for all scenarios are quite low and fluctuate around 1.7 % – 3% per year and tend to decline during the forecasting period (See Table 7.6).

Table 7.8: Inflation Rate (%) by GDP Deflator under the Baseline Case and Scenario 1 - 3

Year	Baseline and SC.#1	SC.#2 and SC.#3
2006 -2010	2.28	2.30
2011 -2015	2.05	2.22
2015 - 2020	1.86	1.77

Note: (1) SC. # denotes the scenario #.

The total employment for all scenarios is presented in Table 7.9 but in this case, the labor forces are separated into 3 main sectors: (1) Agriculture, (2) Manufacturing, and (3) Services. The results show the impacts of both political disorder and the Baht depreciation on the employment situation of the Thai economy. Under scenario 1, the labor requirement is reduced by 0.07% in 2009. This is equal to 23,000 persons losing their jobs due to the effect of Baht appreciation. This ratio will increase to 0.17% in 2020, which is equal to 126,000 job losses when comparing with the baseline case. Scenario 2 is more severe than scenario 1. Beginning in 2009, the labor requirement is decreased by 0.13% (approximately 53,000 persons) comparing to the base case and by the end of 2020, the ratio is increased to 0.38% (about 286,000 persons). The severest case is found when both political disorder and the Baht appreciation happen at the same time. By comparing with the base case, the reduction of labor requirement is equal to 0.18% (73,000 persons) in 2009 and will increase to 0.55% (412,000 persons) in 2020. Although, both of these impacts have the influence on the labor requirement in absolute term, the structure of labor requirement is not affected by these two. All of the four scenarios exhibit downward trend of the employment in the agricultural sector from 35% of total employment in 2005 to only 22% by the end of 2020. A constant share of about 35% - 37% belongs to the service sector, while the manufacturing sector exhibits an upward trend of employment share from 28% in 2005 to 42% in 2020.

Finally, the level of labor productivity in this study is estimated by the AICc method. Therefore, it is a predetermined variable for the MUTE model and is the same for all 4 scenarios. The results are already shown in Table D.13 in Appendix D. The report of the labor productivity in table 7.10 resembles that in Table D.13, but in this case, the 26 I – O sectors are grouped into 3 main sectors, namely, agriculture, Manufacturing and service[10].

In nominal term, the lowest labor productivity is found in the agricultural sector. It is equal to 161.3 millions of Baht/thousand persons in 2005 and 238.2 millions of Baht/thousand persons in 2020. The manufacturing sector possesses the highest level of productivity of 1270.8 millions of Baht/thousand persons in 2005 and this value increases to 1877.7 millions of Baht/thousand persons in 2020. The service sector has a moderate level of productivity between these two sectors, at 538.4 millions of Baht/thousand persons in 2005, and 766.2 millions of Baht/thousand persons by the end of 2020.

On the contrary, the growth rates of the productivity in each sector are quite close to one another (2.38% for service sector and 2.64% for both manufacturing and the agricultural sectors). On the average, it grows approximately 2.56% per year during 2005

[10] In this case, sector #26 is excluded from the computation of the productivity level, since sector #26 includes the miscellaneous products that cannot be categorized into the first 25 sectors, and the inclusion of this sector gives an unreasonable result for the overall level of productivity.

Table 7.9: The Estimated Labor Requirement under the Baseline case and Scenario 1 – 3

(Thousand Persons)

BASE	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Agri.	14386	14346	13891	13609	13158	13290	13509	13819	14115	14451	14781	15076	15372	15704	16204	16682
Manu.	10800	11232	11844	12435	13191	14000	14816	15964	17345	18861	20574	22430	24468	26742	29250	32075
Ser.	13362	13500	13818	14847	15491	15828	16715	19086	19693	20694	21761	22393	23232	24483	25479	26769
Total	38549	39080	39552	40890	41841	43118	45042	48867	51154	54005	57115	59897	63073	66929	70935	75525
SC.# 1	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Agri.	14386	14346	13891	13611	13149	13280	13491	13798	14090	14423	14750	15040	15333	15662	16160	16636
Manu.	10800	11232	11844	12434	13187	13991	14803	15949	17328	18840	20554	22404	24441	26715	29221	32043
Ser.	13362	13500	13818	14849	15483	15819	16700	19065	19668	20663	21727	22356	23195	24440	25435	26720
Total	38549	39080	39552	40892	41818	43090	44996	48812	51086	53928	57028	59802	62969	66817	70816	75399
SC.# 2	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Agri.	14386	14346	13891	13710	13240	13245	13459	13762	14055	14385	14710	14997	15288	15613	16107	16577
Manu.	10800	11232	11844	12351	13039	13856	14681	15833	17215	18733	20450	22307	24346	26624	29132	31953
Ser.	13362	13500	13818	14885	15509	15778	16666	19033	19642	20641	21707	22338	23178	24426	25421	26709
Total	38549	39080	39552	40946	41788	42879	44805	48627	50913	53760	56866	59643	62812	66661	70659	75239
SC.# 3	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Agri.	14386	14346	13891	13711	13232	13234	13441	13743	14030	14357	14678	14962	15250	15572	16063	16530
Manu.	10800	11232	11844	12353	13033	13849	14667	15816	17199	18717	20428	22285	24322	26595	29104	31923
Ser.	13362	13500	13818	14886	15502	15768	16650	19013	19617	20610	21674	22303	23137	24383	25374	26659
Total	38549	39080	39552	40949	41768	42851	44759	48573	50845	53684	56779	59548	62708	66550	70540	75113

Notes: (1) Agri., Manu., and Ser. denote the agricultural, manufacturing and service sectors. (2) SC. # denotes the scenario #.

Table 7.10: The Estimated Labor Productivity and its Growth Rate from 2005 - 2020

Labor Productivity (Millions of Baht / Thousand Persons)																
Year	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Agri.	161.3	169.2	173.8	178.8	183.8	188.7	193.7	198.6	203.6	208.5	213.5	218.4	223.4	228.3	233.3	238.2
Manu.	1270.8	1311.6	1362.6	1398.9	1446.0	1482.1	1527.3	1563.3	1606.8	1643.0	1685.4	1721.8	1763.3	1799.9	1840.8	1877.7
Ser.	538.4	550.5	568.4	579.1	594.7	610.3	625.9	641.5	657.1	672.7	688.3	703.9	719.4	735.0	750.6	766.2
Total	917.5	946.2	981.8	1007.0	1039.8	1066.0	1097.6	1123.7	1154.4	1180.6	1210.6	1236.9	1266.4	1292.9	1322.0	1348.6
Growth Rate of the Labor Productivity																
Year	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**Average**
Agri.	4.90	2.70	2.90	2.76	2.70	2.62	2.56	2.49	2.43	2.38	2.32	2.27	2.22	2.17	2.12	2.64
Manu.	3.21	3.88	2.67	3.37	2.50	3.04	2.36	2.78	2.25	2.58	2.16	2.41	2.08	2.27	2.00	2.64
Ser.	2.25	3.25	1.89	2.69	2.62	2.55	2.49	2.43	2.37	2.32	2.26	2.22	2.17	2.12	2.08	2.38
Total	3.13	3.76	2.57	3.26	2.52	2.96	2.39	2.73	2.27	2.54	2.18	2.38	2.09	2.25	2.02	2.60

Notes: (1) Agri., Manu., and Ser. denote the agricultural, manufacturing and service sectors.
(2) The estimated results exclude the productivity of sector #26 (Unclassified).

- 2020. Moreover, the results of the estimation show a constant or slightly downward trend of the labor productivity growth in the Thai economy.

7.3.2 The Sectoral Prediction for the Thai Economy

7.3.2.1 The Sectoral Outputs

By considering the output level of each industry under various scenarios (See Table 7.11), the negative growth rates of output during the forecasting period are found in sectors 2(Livestock), 5(Mining and Quarrying), and 19(Construction). On the average, the sectors that have low growth rate (0% - 5% per year) include sectors 1(Crops), 3(Forestry), 6(Food Manufacturing), 11(Petroleum Refineries), 18(Electricity and Water Works), and 20(Trade), while the high – growth rate group (>10% per year) includes sectors 10(Chemical Industries), 12(Rubber and Plastic Products), 14(Basic Metal), 15(Fabricated Metal Products), 16(Machinery), and 17(Other Manufacturing). The remaining sectors grow only at moderate rate (5% - 10%) during 2005 – 2020.

Table 7.11: The Average Growth Rate (%) of the Sectoral Output under the Baseline Case and Scenarios 1 – 3 during 2005 -2020

Sector	Base	SC.#1	SC.#2	SC.#3	Sector	Base	SC.#1	SC.#2	SC.#3
1	3.85	3.82	3.81	3.78	**14**	20.10	20.31	20.09	20.30
2	-4.08	-4.07	-4.12	-4.13	**15**	43.43	54.99	38.97	60.65
3	0.00	0.00	0.00	0.00	**16**	13.91	13.90	13.91	13.90
4	9.96	10.02	9.94	10.00	**17**	17.00	17.01	16.99	17.00
5	-2.97	-2.97	-2.91	-2.91	**18**	2.75	2.73	2.74	2.72
6	0.60	0.56	0.57	0.53	**19**	-1.88	-1.88	-2.14	-2.14
7	6.43	6.42	6.44	6.43	**20**	4.12	4.12	4.03	4.03
8	5.74	5.74	5.71	5.70	**21**	6.04	6.03	6.04	6.03
9	7.85	7.60	7.86	7.63	**22**	6.64	6.63	6.60	6.59
10	12.72	12.72	12.71	12.71	**23**	7.86	7.86	7.87	7.87
11	3.59	3.47	3.59	3.48	**24**	6.64	6.61	6.66	6.62
12	10.36	10.32	10.35	10.31	**25**	7.13	7.11	7.13	7.11
13	7.77	7.81	7.76	7.79	**26**	8.78	8.77	8.78	8.77

Note: (1) The growth rates under all of these scenarios are computed from tables D.28 – D.31.
(2) SC. # denotes the scenario #.

The Baht appreciation under scenarios 1 causes most of the sectoral output growth rates to fall (comparing with the baseline case) except for sectors 2(Livestock), 4(Fishery), 11(Petroleum Refineries), 13(Non – Metallic Products), 14(Basic Metal), 15(Fabricated Metal Products), and 17(Other Manufacturing). This will make the overall output growth rate at 9.92% comparing with 9.93% under the baseline case, or equal to a loss of 594 billions of Baht in nominal term during the forecasting period. The impact of 2 – year political disorder is presented under scenarios 2. The result shows a negative impact on the output growth in most sectors except for sectors 5(Mining and Quarrying), 7(Beverages and Tobacco Products), 9(Paper Products and Printing), 23(Banking and Insurance), and 24(Real Estate). However, the overall impact under scenario 2 is more severe than that under scenario 1. The overall output growth rate is only 9.91% which is equal to the loss of 1,255 billions of Baht during 2005 – 2020 when comparing with the base case. Finally, the combination of the Baht appreciation and the event of political disorder produce the worst scenario for the output growth in the Thai economy. The reduction in the average growth rate is found in most sectors except for sectors 4(Fishery), 5(Mining and Quarrying), 13(Non – Metallic Products), 14(Basic Metal), 15(Fabricated Metal Products), and 23(Banking and Insurance). Under scenario 3, the growth rate of output grows at an annual rate of 9.90%. This is equivalent to a loss of 1,851 billions of Baht in nominal term during the forecasting period.

The sectoral output shares do not vary with the scenarios. In other words, the impacts of political disorder and the Baht appreciation do not affect the structure of the output shares. The largest output share comes from sectors 16(Machinery) and 17(Other Manufacturing). These two sectors account for approximately 27% of the total output in

2005 and are projected to about 57% of the total output by the end of 2020. The other two sectors that have the upward trend for their output shares are sectors 14(Basic Metal) and 15(Fabricated Metal Products). They account for only 0.3% in 2005 and increase to 1.1% of the total output in 2020. Constant shares are found in sectors 4 (Fishery), 10(Chemical Industries), 12(Rubber and Plastic Products), 24(Real Estate), and 26(Unclassified), while the remaining sectors show a downward trend during the forecasting period.

7.3.2.2 The Sectoral Wage Rates, Productivities and the Labor Requirement

The sectoral wage rates under the baseline case and the scenarios 1 – 3 from 2005 – 2020 are shown in Tables D.14 and D.15. Since the exchange rate variable is not included in the wage rate equations, the computed wage rates under baseline case and scenario 1 (when the event of political disorder does not occur) are the same. By the same reason, the wage rates under scenarios 2 and 3 are similar to each others (when the political disorder happens in 2008 and 2009). Consequently, the differences in wage rates between these two groups can be seen only in 2008 and 2009. According to the results, the wage rates under scenarios 2 and 3 are slightly higher than the wage rates under the baseline case and scenarios 1. This is due to the positive relationships between the dummy variable (*Poldum*) and the aggregate wage rate in equation (6.7).

Under these four scenarios, the group of the highest wage rate (>100,000 Baht/Person/Year) includes sectors 18(Electricity and Water Works), 22(Transportation and Communication), 23(Banking and Insurance), and 24(Real Estate), while the group of the lowest wage rate (<40,000 Baht/Person/Year) is found among the agricultural sectors such as sectors 1(Crops), and 3(Forestry).

In this study, the estimated result of labor productivity under the baseline case and scenarios 1 – 3 is the same, since labor productivity is a predetermined variable of the MUTE model due to the estimation by the AICc technique. According to the results, high labor productivities are found in sector 22 (Transportation and Communication), and the manufacturing sectors such as sectors 6(Food Manufacturing), 7(Beverages and Tobacco Products), 8(Textile Industry), 9(Paper Products and Printing), and so on. The group with low labor productivity consists of the agricultural sectors 1(Crops), 2(Livestock), and 3(Forestry), and sector 24(Real Estate)[11].

In order to compute the total and the sectoral amounts of employee compensations for each sector, the labor requirement for each sector has to be estimated and the amount of compensation to employees for each sector is the products between the labor requirement and its wage rate. In this study, the labor requirement is simply calculated by dividing each sectoral output by the corresponding labor productivity. The results of labor requirements under the baseline case and scenarios 1 – 3 are shown in Tables D.24 – D.27 (See Appendix D), while the corresponding labor shares under these four scenarios are presented in Table 7.12. For all scenarios, the results show that on the average, 24% of Thai laborers work in sector 1(Crops). However, the labor share in this sector has a downward trend from approximately 30% in 2005 to only 19% in 2020. The decreasing share of labor requirement also happens in other agricultural sectors such as sectors 2(Livestock) and 5(Mining and Quarrying). The lowest share of employment is found in sectors 3(Forestry), 5(Mining and Quarrying), and 15(Fabricated Metal

[11] The unexpected result of the high wage rate but the low level of productivity is found in sector 24 (Real Estate). Since theoretically, the wage rate is equal to the value of the marginal product of labor (= $MP_L \times$ Output Price), one explanation is that wage rate in this sector is more responsive to the demand impact (via the output price) than the labor productivity level.

Products). In 2005, these three sectors account for only 0.14% of the total employment, and this ratio increases slightly to 0.21% by the end of 2020.

The reduction of the labor requirement in these sectors is compensated by the increase of the employment share in manufacturing industries such as sectors 16(Machinery) and 17(Other Manufacturing), and the service sector (sector 25). On the average, the employment shares in these sectors increase from 8% of total employment in 2005 to 13.3% in 2020. This evidence confirms that in the near future, the employment structure of Thailand is moving toward more employments in manufacturing and service sectors with or without the impacts of the Baht appreciation and the political disorder.

Nevertheless, both the Baht appreciation and the political disorder affect the sectoral employments in their nominal term. Under scenario 1, the impact of the Baht appreciation reduces the employment by 23,000 persons in 2009. This number increases to 87,000 persons in 2015, 112,000 persons in 2018, and 126,000 persons by the end of 2020 when comparing with the baseline case. 47% of the reduction comes solely from the employment in sector 1(Crops). The situation under scenario 2 is more severe than scenario 1. Beginning in 2009 by comparing with the base case, the overall employment is reduced by 53,000 persons. This will increase to 249,000 persons in 2015, 268,000 persons in 2018, and 286,000 persons in 2020. However, 40% of the reduction in the level of employment comes from sector 19(Construction), and about 23% of the reduction belongs to sector 1(Crops). The combination of the currency appreciation and the occurrence of the political disorder produces the worst scenario. By comparing the situation under scenario 3 and the baseline case, the employments in 2009, 2015, 2018 and 2020 will decrease by 73,000, 336,000, 379,000 and 412,000 persons, respectively.

Again, the most reduction of 31% comes from sector 19(Construction). This is followed by the 28% and 12% of the reduction from sectors 1(Crops) and 20(Trade).

Finally, the compensation to employees for each sector is calculated by multiplying the sectoral wage rates with the employments. The results are presented in Tables D.16 – D.19 (See Appendix D). According to the result, the main focus is still on sectors 1(Crops), 16(Machinery), 17(Other Manufacturing), and 25(Services), since on the average, they account for more than 60% of the total labor income. Moreover, the impacts of both currency appreciation and the event of political disorder have no influence on the structure of the compensation to employees. Sector 1(Crops) generates approximately 12.3% of the total labor income during 2005 – 2008, but this number decreases to only 9.7% in 2015, and 7.4% in 2020. The reduction in the labor income share of sector 1(Crops) is compensated by the increasing shares of sectors 16(Machinery), 17(Other Manufacturing), and 25(Services). These three sectors account for 29% of the total labor income in 2005 and they continue to rise to 51% and 71% in 2014 and 2020, respectively.

By considering the amount of the compensation to employees in nominal term, the results show that the effect of the political disorder under scenario 1 is more severe than the effect of the currency appreciation under scenario 2. Under scenario 1, the currency appreciation causes the total amount of the compensation to employees to reduce by 2,096 millions of Baht in 2010. This amount increases to 8,737 millions of Baht in 2016, and 12,688 millions of Baht in 2020 when comparing with the Baseline case and around 77% of the reduction comes from sectors 1(Crops), 24(Real Estate), and 25(Services).

Table 7.12: The Employment Shares of the Thai Economy from 2005 – 2020

Sector	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
1	30.0	29.8	29.1	27.4	26.0	26.1	25.4	23.8	23.4	22.6	21.7	21.3	20.8	20.0	19.3	18.6
2	5.6	5.1	4.1	3.8	3.3	2.4	2.3	2.2	1.9	1.9	1.8	1.4	1.1	1.0	1.0	1.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	1.7	1.8	2.0	2.0	2.1	2.2	2.3	2.2	2.3	2.3	2.3	2.3	2.4	2.4	2.4	2.5
5	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
6	2.7	2.6	2.5	2.4	2.4	2.3	2.1	1.8	1.6	1.5	1.4	1.3	1.3	1.2	1.1	1.0
7	1.0	1.1	1.0	1.1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.9	0.9	0.9
8	2.2	2.1	2.2	2.2	2.2	2.2	2.2	2.1	2.0	2.0	1.9	1.9	1.9	1.9	1.8	1.8
9	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
10	0.6	0.7	0.8	0.9	1.0	1.1	1.1	1.1	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
11	1.4	1.3	1.2	1.2	1.2	1.1	1.1	1.0	0.9	0.9	0.8	0.8	0.8	0.7	0.7	0.6
12	0.8	0.9	1.0	1.0	1.1	1.1	1.2	1.2	1.2	1.2	1.3	1.3	1.3	1.3	1.3	1.3
13	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.4	0.4
14	0.1	0.1	0.2	0.3	0.3	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.6
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
16	5.6	6.6	7.7	8.6	9.5	10.4	11.1	11.3	11.9	12.3	12.6	13.1	13.4	13.6	13.8	13.9
17	4.9	5.5	6.2	6.7	7.5	8.3	9.0	9.4	10.2	11.0	11.9	13.0	14.2	15.3	16.6	18.0
18	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.2
19	7.4	6.3	5.5	4.7	3.9	3.1	2.3	2.1	2.0	2.1	2.1	2.1	2.0	2.0	2.0	2.0
20	7.1	6.6	6.2	6.4	6.3	6.1	5.9	5.7	5.5	5.4	5.3	5.1	5.0	5.0	4.8	4.7
21	8.0	8.3	8.4	8.6	8.7	8.8	8.7	8.3	8.2	8.1	7.8	7.8	7.6	7.4	7.2	7.0
22	3.4	3.6	3.7	3.8	3.9	4.0	4.0	3.8	3.8	3.7	3.6	3.6	3.5	3.4	3.4	3.3
23	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.7
24	4.8	4.0	3.6	4.0	3.9	3.4	3.6	3.9	3.8	4.1	4.3	4.0	3.8	3.9	3.7	3.7
25	10.4	11.1	12.0	12.5	13.0	13.1	12.9	12.2	11.9	11.5	11.2	11.0	10.9	10.8	10.8	10.7
26	0.1	0.2	0.2	0.3	0.4	0.6	1.1	4.4	4.5	4.8	5.0	5.1	5.1	5.3	5.3	5.3
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Notes: The computed employment shares under the 4 scenarios are quite closely to each others.

Scenario 2 exhibits much worse results. The impact of two – year event of political disorder causes the total amount of the compensation to employees to decrease by 21,006 millions of Baht in 2010. It increases to 29,386 millions of Baht in 2016, and 48,808 millions of Baht by the end of 2020. In this case, about 76% of the reduction comes from sectors 1(Crops), 2(Livestock), 18(Electricity and Water Works), 19(Construction), 20(Trade), and 22(Transportation and Communication). Ultimately, the combination of these two negative effects produces the worst scenario. Under scenario 3, the reductions of the total amount of the compensation to employees in 2010, 2016, and 2020 are equal to 23,102, 38,124, and 61,496 millions of Baht, respectively, and approximately 71% of the reduction emerges from the same sectors under scenario 2.

7.3.2.3 The Sectoral Profit and the Depreciation

Since the exchange rate variable is not the one of the explanatory variables for the system of profit equations, the results of the estimated profit for each sector can be divided into two groups: (1) the results under the baseline case and scenario 1 when there is no appearance of the political disorder in Thailand, and (2) the results under scenarios 2 and 3, when the event of the political disorder is presented in 2008 and 2009. The results show that during 2008 – 2020, the level of profit in nominal term with the presence of the political disorder in 2008 and 2009 is higher in most sectors (except for sectors 24(Real Estate) – 25(Services) than those without it. This is because of the unexpected positive relationship between the dummy variable (*Poldum*) and the profit level, and the unexpected negative sign of the estimated coefficients of the price level in many sectors as mentioned in section 6.2.2. As a result, the average growth rate of the total profit under the baseline case and scenarios 1 (6.36%) is slightly lower than that under scenarios 2 and 3 (6.45%).

Under the baseline case and scenario 1, the highest share (approximately 22.96%) of profit belongs to sector 20(Trade), while the lowest share (about 0.18%) comes from sector 3(Fishery). In term of the growth rate, the highest average profit growth of 10.66% is found in sector 23(Banking and Insurance), while the lowest one of 2.68% is found in sector 17(other Manufacturing).

The results are the same for the situation under scenarios 2 and 3. The highest and lowest ranks for the profit shares still belong to sectors 20(trade) and 3(Fishery) at 23.05% vs. 0.26%, while the highest and lowest ranks for the profit rate of growth belongs to sectors 23(Banking and Insurance) and 17(other Manufacturing) at 11.01% vs. 2.18%. Moreover, the average profit shares under scenario 2 and 3 are slightly higher than those under baseline case and scenario 1.

Because the sectoral depreciations in this study are estimated by the AICc technique, they are a predetermined variable to the MUTE model, and their values are all the same for all 4 scenarios. The result of the sectoral depreciations is presented in Table D.22 in Appendix D. According to the results, the total depreciation is quite unstable during the forecasting period. In 2005, the total depreciation is equal to 206,172 millions of Baht. This amount increases to 311,809 millions of Baht in 2006, but reduces to 310,931 millions of Baht in 2012, and by the end of 2020, the total depreciation is equal to 375,715 millions of Baht. As a result, the average growth rate of this value – added component during 2005 – 2020 is equivalent to 4.78% per year. Under this constructed data, the largest depreciation share of 77% comes from sectors 11(Petroleum Refineries), 20(Trade), and 22(Transformation and Communication). Another 9% of the total share belongs to sector 19(Construction), while the remaining 22 sectors share the rest of 14% of the total depreciation.

7.3.2.4 The Net Export

The net export is simply the difference between the total exports and the total imports. The results of the net export under the baseline case and scenarios 1 – 3 are shown in Table 7.13 – 7.16. For all 4 scenarios, the results show the evidence of the trade surpluses during the forecasting periods with or without the currency appreciation and the event of political disorder. On the average, about 70% of the total surplus comes from sectors 8(Textile Industry), 16(Machinery), and 22(Transportation and Communication)[12]. The Baseline case predicts that the trade surplus is equal to 556,657 millions of Baht in 2006. This amount will increase to 2,330,840 millions of Baht in 2009, and it ends up with 15,228,378 millions of Baht by the end of 2020. Under scenario 1, the Baht appreciation will make the Thai export goods more expensive, while the foreign import goods are cheaper than before. Consequently, the net export in 2009 will reduce to 2,317,864 millions of Baht and by the end of 2020, the net export is equal to 15,141,974 millions of Baht[13].

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[12] The impacts of the currency appreciation and the political disorder have no influence on the structure of the net exports.

[13] The effect of a change in the net export is very small even though the change in the exchange rate (under scenario #1) is fairly large. This is possibly because in this study, the assumed growth rate of the exports and special exports during the forecasting period is too high.

Table 7.13: The Baseline Estimation for the Net Export at Current Market Price

(Millions of Baht)

Sector	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	128456	108597	76995	33928	-19394	-19229	-18063	-15975	-11841	-7562	-3036	788	3910	6486	9489	13544
2	-2793	-3251	-4156	-4789	-4929	-5103	-5251	-5414	-5564	-5721	-5873	-6026	-6176	-6326	-6473	-6620
3	-3620	-3755	-3824	-3913	-3958	-4021	-4072	-4121	-4159	-4201	-4235	-4263	-4256	-4270	-4278	-4280
4	39802	57537	77709	94136	111489	131603	152546	176051	201348	227661	255842	286254	319056	353833	390648	429936
5	-13953	-16020	-14147	-18413	-23142	-29295	-36783	-45835	-56318	-68891	-83360	-99681	-118277	-120841	-123290	-125635
6	141139	117504	109886	71978	45183	-6919	-58864	-131995	-210910	-221959	-230497	-239180	-247836	-256574	-265308	-274101
7	17395	20603	21832	24331	27546	30261	33266	39045	45245	51839	59021	66546	74551	83078	92208	101696
8	184171	228702	279401	329303	389897	453651	522745	596940	677322	758696	845768	938477	1037232	1140537	1249727	1364070
9	-65297	-53519	-72425	-70659	-65320	-57643	-52547	-49671	-44792	-38776	-35662	-27958	-17716	-8091	120	12049
10	-309818	-271871	-231093	-189733	-137678	-80765	-17541	52291	130472	210609	298236	393879	497938	608810	727703	854799
11	107253	108273	122380	153733	193513	214479	249463	290700	329774	366517	411292	459973	509373	560901	617673	677530
12	78338	98684	113708	134471	166798	198143	238178	279777	328625	378096	431540	491357	555536	624280	697787	775871
13	18267	28235	37833	46716	56686	67603	79023	91458	104871	118364	132714	148072	164448	181585	199636	218630
14	-88797	-98543	-59671	-41970	-23621	-2142	19368	43428	69024	94625	121505	150401	181229	213211	246718	282009
15	-154786	-160552	-167370	-189660	-194778	-204753	-191647	-196891	-196018	-204639	-193159	-189594	-179957	-182231	-170652	-162476
16	-367107	-120395	255016	584989	993991	1432437	1915533	2442658	3032066	3634689	4289548	4998865	5766990	6582493	7454003	8381643
17	-48612	-11639	9919	34199	61078	90792	121373	154889	190329	225675	262893	302268	343726	386744	431610	478181
18	-13389	-12305	-15597	-15317	-14740	-14295	-13085	-12013	-10607	-9015	-7327	-5360	-3040	-633	2085	5068
19	49	128	165	199	241	361	413	471	631	698	770	845	1060	1152	1247	1346
20	182154	148715	118108	162755	164336	162957	159278	174411	190098	206263	223294	240794	258894	277716	297295	317246
21	105717	121730	138313	169920	191015	214379	240333	268447	297357	327641	359733	392539	426379	461775	498785	536263
22	219083	249510	286215	321563	366245	410981	461160	514780	570474	628453	690099	753213	818666	887209	959102	1032114
23	2559	2033	1553	-317	-913	-1018	-1094	-1210	-1366	-1577	-1822	-2136	-2511	-2947	-3413	-3990
24	-756	1211	4383	7865	13065	18455	25059	32483	40650	49557	59517	70123	81573	94049	107581	121886
25	34395	39530	46248	54671	67690	79704	94235	109448	125650	142448	160612	179170	198572	218901	240342	262187
26	-20503	-23488	-25752	-27914	-29459	-31564	-33499	-35711	-38033	-40622	-43301	-46297	-49505	-52953	-56608	-60594
Total	169350	555657	1105624	1662070	2330840	3049060	3879527	4768443	5754327	6818870	7994112	9253071	10609858	12047893	13593738	15228378

Table 7.14: The Estimated Result for the Net Export under Scenario 1 at Current Market Price

(Millions of Baht)

Sector	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	128456	108597	76995	34048	-20449	-20524	-20225	-18557	-15127	-11337	-7428	-4118	-1554	507	2969	6518
2	-2793	-3251	-4156	-4784	-4968	-5151	-5330	-5509	-5685	-5860	-6034	-6206	-6377	-6546	-6713	-6879
3	-3620	-3755	-3824	-3912	-3968	-4033	-4092	-4145	-4189	-4236	-4275	-4308	-4306	-4325	-4338	-4345
4	39802	57537	77709	93948	113147	133638	155942	180108	206510	233591	262742	293963	327640	363226	400890	440973
5	-13953	-16020	-14147	-18413	-23145	-29298	-36787	-45841	-56325	-68900	-83370	-99692	-118289	-120855	-123304	-125650
6	141139	117504	109886	72106	44051	-8309	-61184	-134766	-214436	-226009	-235210	-244445	-253699	-262990	-272304	-281640
7	17395	20603	21832	24361	27281	29936	32723	38396	44420	50891	57917	65314	73179	81576	90571	99932
8	184171	228702	279401	329332	389647	453344	522231	596327	676542	757799	844724	937311	1035933	1139116	1248177	1362401
9	-65297	-53519	-72425	-70343	-68096	-61052	-58235	-56464	-53437	-48707	-47219	-40869	-32094	-23823	-17034	-6436
10	-309818	-271871	-231093	-189733	-137678	-80765	-17541	52291	130472	210609	298236	393879	497938	608810	727703	854799
11	107253	108273	122380	154118	190131	210327	242534	282424	319243	354419	397214	444245	491858	541736	596776	655011
12	78338	98684	113708	134636	165348	196364	235209	276230	324112	372912	425507	484617	548030	616067	688832	766221
13	18267	28235	37833	46666	57131	68150	79934	92547	106257	119955	134566	150141	166752	184106	202385	221592
14	-88797	-98543	-59671	-42257	-21104	948	24526	49589	76863	103630	131983	162108	194266	227475	262272	298771
15	-154786	-160552	-167370	-189308	-197872	-208550	-197985	-204462	-205651	-215705	-206036	-203980	-195978	-199761	-189767	-183074
16	-367107	-120395	255016	585270	991521	1429405	1910472	2436613	3024374	3625852	4279265	4987377	5754197	6568494	7438739	8365195
17	-48612	-11639	9919	33967	63117	93295	125550	159879	196677	232968	271380	311750	354285	398298	444208	491757
18	-13389	-12305	-15597	-15277	-15088	-14723	-13799	-12865	-11692	-10262	-8778	-6981	-4845	-2608	-69	2747
19	49	128	165	199	241	361	413	471	631	698	770	845	1060	1152	1247	1346
20	182154	148715	118108	162755	164336	162957	159278	174411	190098	206263	223294	240794	258894	277716	297295	317246
21	105717	121730	138313	169944	190798	214113	239890	267918	296684	326867	358833	391533	425258	460549	497448	534822
22	219083	249510	286215	321681	365200	409698	459018	512222	567220	624714	685748	748352	813253	881286	952643	1025154
23	2559	2033	1553	-312	-959	-1074	-1188	-1323	-1509	-1741	-2013	-2350	-2749	-3207	-3697	-4296
24	-756	1211	4383	7899	12763	18084	24441	31744	39710	48478	58261	68720	80010	92339	105716	119877
25	34395	39530	46248	54823	66349	78058	91488	106167	121475	137652	155030	172935	191628	211303	232057	253259
26	-20503	-23488	-25752	-27867	-29870	-32069	-34341	-36716	-39312	-42092	-45012	-48208	-51633	-55282	-59147	-63330
Total	169350	555657	1105624	1663547	2317864	3033129	3852941	4736688	5713921	6772450	7940097	9192726	10542655	11974360	13513558	15141974

Table 7.15: The Estimated Result for Net Export under Scenario 2 at Current Market Price

(Millions of Baht)

Sector	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	128456	108597	76995	33136	-20186	-19229	-18063	-15975	-11841	-7562	-3036	788	3910	6486	9489	13544
2	-2793	-3251	-4156	-4848	-4988	-5103	-5251	-5414	-5564	-5721	-5873	-6026	-6176	-6326	-6473	-6620
3	-3620	-3755	-3824	-3951	-3996	-4021	-4072	-4121	-4159	-4201	-4235	-4263	-4256	-4270	-4278	-4280
4	39802	57537	77709	93970	111322	131603	152546	176051	201348	227661	255842	286254	319056	353833	390648	429936
5	-13953	-16020	-14147	-22646	-27375	-29295	-36783	-45835	-56318	-68891	-83360	-99681	-118277	-120841	-123290	-125635
6	141139	117504	109886	70004	43210	-6919	-58864	-131995	-210910	-221959	-230497	-239180	-247836	-256574	-265308	-274101
7	17395	20603	21832	25341	28556	30261	33266	39045	45245	51839	59021	66546	74551	83078	92208	101696
8	184171	228702	279401	327278	387872	453651	522745	596940	677322	758696	845768	938477	1037232	1140537	1249727	1364070
9	-65297	-53519	-72425	-56070	-50731	-57643	-52547	-49671	-44792	-38776	-35662	-27958	-17716	-8091	120	12049
10	-309818	-271871	-231093	-190552	-138497	-80765	-17541	52291	130472	210609	298236	393879	497938	608810	727703	854799
11	107253	108273	122380	156102	195882	214479	249463	290700	329774	366517	411292	459973	509373	560901	617673	677530
12	78338	98684	113708	133778	166104	198143	238178	279777	328625	378096	431540	491357	555536	624280	697787	775871
13	18267	28235	37833	47096	57065	67603	79023	91458	104871	118364	132714	148072	164448	181585	199636	218630
14	-88797	-98543	-59671	-43375	-25026	-2142	19368	43428	69024	94625	121505	150401	181229	213211	246718	282009
15	-154786	-160552	-167370	-183869	-188988	-204753	-191647	-196891	-196018	-204639	-193159	-189594	-179957	-182231	-170652	-162476
16	-367107	-120395	255016	530098	939099	1432437	1915533	2442658	3032066	3634689	4289548	4998865	5766990	6582493	7454003	8381643
17	-48612	-11639	9919	42685	69564	90792	121373	154889	190329	225675	262893	302268	343726	386744	431610	478181
18	-13389	-12305	-15597	-13320	-12743	-14295	-13085	-12013	-10607	-9015	-7327	-5360	-3040	-633	2085	5068
19	49	128	165	197	239	361	413	471	631	698	770	845	1060	1152	1247	1346
20	182154	148715	118108	162755	164336	162957	159278	174411	190098	206263	223294	240794	258894	277716	297295	317246
21	105717	121730	138313	168793	189888	214379	240333	268447	297357	327641	359733	392539	426379	461775	498785	536263
22	219083	249510	286215	319266	363948	410981	461160	514780	570474	628453	690099	753213	818666	887209	959102	1032114
23	2559	2033	1553	-351	-946	-1018	-1094	-1210	-1366	-1577	-1822	-2136	-2511	-2947	-3413	-3990
24	-756	1211	4383	7425	12625	18455	25059	32483	40650	49557	59517	70123	81573	94049	107581	121886
25	34395	39530	46248	54253	67272	79704	94235	109448	125650	142448	160612	179170	198572	218901	240342	262187
26	-20503	-23488	-25752	-28521	-30066	-31564	-33499	-35711	-38033	-40622	-43301	-46297	-49505	-52953	-56608	-60594
Total	169350	555657	1105624	1624670	2293440	3049060	3879527	4768443	5754327	6818870	7994112	9253071	10609858	12047893	13593738	15228378

Table 7.16: The Estimated Result for the Net Export under Scenario 3 at Current Market Price

(Millions of Baht)

Sector	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	128456	108597	76995	33256	-21241	-20524	-20225	-18557	-15127	-11337	-7428	-4118	-1554	507	2969	6518
2	-2793	-3251	-4156	-4843	-5027	-5151	-5330	-5509	-5685	-5860	-6034	-6206	-6377	-6546	-6713	-6879
3	-3620	-3755	-3824	-3950	-4006	-4033	-4092	-4145	-4189	-4236	-4275	-4308	-4306	-4325	-4338	-4345
4	39802	57537	77709	93781	112980	133638	155942	180108	206510	233591	262742	293963	327640	363226	400890	440973
5	-13953	-16020	-14147	-22646	-27378	-29298	-36787	-45841	-56325	-68900	-83370	-99692	-118289	-120855	-123304	-125650
6	141139	117504	109886	70133	42078	-8309	-61184	-134766	-214436	-226009	-235210	-244445	-253699	-262990	-272304	-281640
7	17395	20603	21832	25371	28291	29936	32723	38396	44420	50891	57917	65314	73179	81576	90571	99932
8	184171	228702	279401	327306	387621	453344	522231	596327	676542	757799	844724	937311	1035933	1139116	1248177	1362401
9	-65297	-53519	-72425	-55754	-53507	-61052	-58235	-56464	-53437	-48707	-47219	-40869	-32094	-23823	-17034	-6436
10	-309818	-271871	-231093	-190552	-138497	-80765	-17541	52291	130472	210609	298236	393879	497938	608810	727703	854799
11	107253	108273	122380	156487	192500	210327	242534	282424	319243	354419	397214	444245	491858	541736	596776	655011
12	78338	98684	113708	133943	164655	196364	235209	276230	324112	372912	425507	484617	548030	616067	688832	766221
13	18267	28235	37833	47045	57510	68150	79934	92547	106257	119955	134566	150141	166752	184106	202385	221592
14	-88797	-98543	-59671	-43662	-22509	948	24526	49589	76863	103630	131983	162108	194266	227475	262272	298771
15	-154786	-160552	-167370	-183517	-192081	-208550	-197985	-204462	-205651	-215705	-206036	-203980	-195978	-199761	-189767	-183074
16	-367107	-120395	255016	530379	936629	1429405	1910472	2436613	3024374	3625852	4279265	4987377	5754197	6568494	7438739	8365195
17	-48612	-11639	9919	42453	71603	93295	125550	159879	196677	232968	271380	311750	354285	398298	444208	491757
18	-13389	-12305	-15597	-13280	-13091	-14723	-13799	-12865	-11692	-10262	-8778	-6981	-4845	-2608	-69	2747
19	49	128	165	197	239	361	413	471	631	698	770	845	1060	1152	1247	1346
20	182154	148715	118108	162755	164336	162957	159278	174411	190098	206263	223294	240794	258894	277716	297295	317246
21	105717	121730	138313	168817	189671	214113	239890	267918	296684	326867	358833	391533	425258	460549	497448	534822
22	219083	249510	286215	319385	362903	409698	459018	512222	567220	624714	685748	748352	813253	881286	952643	1025154
23	2559	2033	1553	-345	-992	-1074	-1188	-1323	-1509	-1741	-2013	-2350	-2749	-3207	-3697	-4296
24	-756	1211	4383	7459	12324	18084	24441	31744	39710	48478	58261	68720	80010	92339	105716	119877
25	34395	39530	46248	54405	65931	78058	91488	106167	121475	137652	155030	172935	191628	211303	232057	253259
26	-20503	-23488	-25752	-28474	-30477	-32069	-34341	-36716	-39312	-42092	-45012	-48208	-51633	-55282	-59147	-63330
Total	169350	555657	1105624	1626147	2280464	3033129	3852941	4736688	5713921	6772450	7940097	9192726	10542655	11974360	13513558	15141974

The results under scenario 2 differ from the baseline case only in 2008 and 2009. If the event of political disorder appears in 2008 and 2009, it will make the net export in these two years equal to 1,624,670 and 2,293,440 millions of Baht, respectively, or equal to a reduction of approximately 74,800 millions of Baht during these two years.

Finally, scenario 3 combines the impacts of both the currency appreciation and the political disorder. The results under scenario 3 are the same as under scenario 1 except for 2008 and 2009. Comparing with the baseline case, the net export under scenario 3 will reduce by 35,923 millions of Baht in 2008 and by 50,376 millions of Baht at the end of 2009.

7.3.2.5 The Private Consumption Expenditure (PCE)

The private consumption system for the MUTE model is calculated by the Almost Ideal Demand System (AIDS) which generates the results only in the consumption shares of the 26 I – O sectors. Thus, the total private consumption expenditure function has to be estimated, and the nominal results for the sectoral private consumption expenditures are simply calculated by the products between the AIDS and the estimated total PCE. Since the exchange rate variable is not included in the total PCE equation (refer to equation 5.20 in Chapter 5), this will make the results of the estimated sectoral PCE of the baseline case similar to those under scenario 1, and the results of the estimated sectoral PCE under scenario 2 are the same as those under scenario 3. The estimated results for the total and the sectoral PCE under these 4 scenarios are shown in Tables D.1 and D.2 in Appendix D.

According to the results, the impacts of the currency appreciation and the 2 – year events of political disorder have no influence on the structure of the personal consumption expenditure (See Tables 7.17 and 7.18). On the average, the private spending on food items has downward slope. For instance, the spending on the products of sectors 1(Crops), 2(Livestock), 4(Fishery) and 6(Food Manufacturing), which account for 22.5% of the total PCE in 2005, is reduced to approximately 15.9% of the total PCE in 2013, and by the end of 2020, it will be only at 9.9% of the total PCE. The reduction of the spending in the food sector is compensated by the increasing spending in sectors such as 16(Machinery), 17(Other Manufacturing), and 22(Transportation and Communication) which account for 26.0% of the total PCE in 2005. This ratio increases to 32.6% in 2013, and 35.22% in 2020.

However, unexpected results are found when PCE is considered in nominal term. The results show that with the presence of the political disorders in 2008 and 2009 (under scenarios 2 and 3), the level of PCE is larger than those under the baseline case and scenario 1 in every sector. This is possibly because of the unexpected positive relationship between profit and the dummy variable (*Poldum*) in some sectors. Since the level of profit is used to determine the level of personal income and the personal disposable income, the presence of the event of political disorder in the profit function will not only cause the level of profit to rise but also cause the personal income and the personal disposable income to increase. As a results, the higher level of the personal disposable incomes, the higher level of PCE with the presence of the political chaos in the model.

Table 7.17: The Private Consumption Expenditure Shares under the Baseline Case and Scenario 1

(Percent of Total PCE)

Sector	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	12.15	12.27	12.02	11.62	11.30	11.12	10.62	10.11	9.77	9.29	8.79	8.52	8.19	7.74	7.39	6.96
2	2.45	2.15	1.61	1.59	1.33	0.92	0.89	0.91	0.70	0.68	0.66	0.37	0.15	0.06	0.06	0.06
3	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
4	2.76	2.78	2.79	2.62	2.58	2.62	2.44	2.23	2.15	1.97	1.78	1.76	1.69	1.54	1.47	1.34
5	0.04	0.04	0.05	0.01	0.12	0.16	0.15	0.11	0.11	0.09	0.07	0.10	0.12	0.12	0.14	0.15
6	5.10	4.83	4.88	4.47	4.32	4.31	3.95	3.52	3.34	2.95	2.58	2.46	2.28	1.97	1.78	1.49
7	9.53	9.68	9.30	9.47	9.26	9.17	9.19	9.26	9.25	9.29	9.34	9.28	9.25	9.26	9.20	9.19
8	7.42	6.57	6.28	5.90	5.65	5.42	5.13	4.82	4.61	4.37	4.17	4.07	3.97	3.85	3.78	3.70
9	1.54	1.64	1.75	1.64	1.75	1.81	1.76	1.63	1.63	1.53	1.44	1.47	1.48	1.42	1.42	1.37
10	1.22	1.36	1.40	1.25	1.18	1.32	1.18	1.00	0.99	0.84	0.68	0.73	0.72	0.61	0.60	0.51
11	1.51	1.56	1.64	1.65	1.69	1.76	1.77	1.76	1.80	1.81	1.82	1.87	1.91	1.93	1.97	2.00
12	0.59	0.81	1.01	1.25	1.40	1.50	1.66	1.84	1.94	2.07	2.19	2.22	2.26	2.33	2.36	2.40
13	0.46	0.85	0.83	0.72	0.66	0.84	0.69	0.54	0.55	0.43	0.28	0.37	0.40	0.31	0.33	0.26
14	0.04	0.08	0.18	0.13	0.21	0.34	0.31	0.23	0.26	0.20	0.15	0.24	0.31	0.29	0.36	0.36
15	0.42	0.46	0.34	0.34	0.25	0.26	0.22	0.19	0.16	0.12	0.08	0.06	0.03	0.03	0.03	0.03
16	3.42	3.83	4.29	4.64	5.09	5.11	5.35	5.61	5.74	5.98	6.23	6.32	6.46	6.68	6.82	7.02
17	3.99	4.85	5.57	5.33	5.69	6.42	6.15	5.78	5.99	5.73	5.46	5.90	6.15	6.06	6.29	6.27
18	1.40	1.29	1.10	1.30	1.24	1.08	1.23	1.42	1.43	1.59	1.75	1.68	1.67	1.78	1.77	1.85
19	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.06	0.17	0.15	0.15	0.22	0.23	0.28
20	7.82	7.07	6.68	7.00	6.92	6.49	6.74	7.08	7.01	7.26	7.53	7.29	7.18	7.32	7.20	7.27
21	9.05	8.91	8.70	8.56	8.38	8.45	8.30	8.10	8.06	7.90	7.71	7.74	7.73	7.59	7.54	7.42
22	18.58	18.90	19.54	19.52	20.06	20.73	20.75	20.53	20.87	20.76	20.71	21.17	21.53	21.56	21.86	21.93
23	3.63	3.79	3.86	3.96	4.06	4.20	4.26	4.30	4.39	4.45	4.50	4.61	4.72	4.78	4.87	4.94
24	2.77	2.67	2.38	2.58	2.49	1.99	2.13	2.38	2.25	2.42	2.60	2.30	2.11	2.17	1.98	1.98
25	3.32	3.20	3.43	3.69	3.96	3.73	4.04	4.31	4.40	4.64	4.95	4.89	4.96	5.16	5.23	5.40
26	0.72	0.33	0.33	0.72	0.36	0.20	1.04	2.31	2.54	3.54	4.33	4.39	4.56	5.19	5.30	5.79
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Table 7.18: The Private Consumption Expenditure Shares under Scenarios 2 and 3

(Percent of Total PCE)

Sector	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	12.15	12.27	12.02	11.62	11.30	11.12	10.62	10.11	9.77	9.29	8.79	8.52	8.19	7.74	7.39	6.96
2	2.45	2.15	1.61	1.59	1.33	0.92	0.89	0.91	0.70	0.68	0.66	0.37	0.15	0.06	0.06	0.06
3	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
4	2.76	2.78	2.79	2.62	2.58	2.62	2.44	2.23	2.15	1.97	1.78	1.76	1.69	1.54	1.47	1.34
5	0.04	0.04	0.05	0.01	0.12	0.16	0.15	0.11	0.11	0.09	0.07	0.10	0.12	0.12	0.14	0.15
6	5.10	4.83	4.88	4.47	4.32	4.31	3.95	3.52	3.34	2.95	2.58	2.46	2.28	1.97	1.78	1.49
7	9.53	9.68	9.30	9.47	9.26	9.17	9.19	9.26	9.25	9.29	9.34	9.28	9.25	9.26	9.20	9.19
8	7.42	6.57	6.28	5.90	5.65	5.42	5.13	4.82	4.61	4.37	4.17	4.07	3.97	3.85	3.78	3.70
9	1.54	1.64	1.75	1.64	1.75	1.81	1.76	1.63	1.63	1.53	1.44	1.47	1.48	1.42	1.42	1.37
10	1.22	1.36	1.40	1.25	1.18	1.32	1.18	1.00	0.99	0.84	0.68	0.73	0.72	0.61	0.60	0.51
11	1.51	1.56	1.64	1.65	1.69	1.76	1.77	1.76	1.80	1.81	1.82	1.87	1.91	1.93	1.97	2.00
12	0.59	0.81	1.01	1.25	1.40	1.50	1.66	1.84	1.94	2.07	2.19	2.22	2.26	2.33	2.36	2.40
13	0.46	0.85	0.83	0.72	0.66	0.84	0.69	0.54	0.55	0.43	0.28	0.37	0.40	0.31	0.33	0.26
14	0.04	0.08	0.18	0.13	0.21	0.34	0.31	0.23	0.26	0.20	0.15	0.24	0.31	0.29	0.36	0.36
15	0.42	0.46	0.34	0.34	0.25	0.26	0.22	0.19	0.16	0.12	0.08	0.06	0.03	0.03	0.03	0.03
16	3.42	3.83	4.29	4.64	5.09	5.11	5.35	5.61	5.74	5.98	6.23	6.32	6.46	6.68	6.82	7.02
17	3.99	4.85	5.57	5.33	5.69	6.42	6.15	5.78	5.99	5.73	5.46	5.90	6.15	6.06	6.29	6.27
18	1.40	1.29	1.10	1.30	1.24	1.08	1.23	1.42	1.43	1.59	1.75	1.68	1.67	1.78	1.77	1.85
19	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.06	0.17	0.15	0.15	0.22	0.23	0.28
20	7.82	7.07	6.68	7.00	6.92	6.49	6.74	7.08	7.01	7.26	7.53	7.29	7.18	7.32	7.20	7.27
21	9.05	8.91	8.70	8.56	8.38	8.45	8.30	8.10	8.06	7.90	7.71	7.74	7.73	7.59	7.54	7.42
22	18.58	18.90	19.54	19.52	20.06	20.73	20.75	20.53	20.87	20.76	20.71	21.17	21.53	21.56	21.86	21.93
23	3.63	3.79	3.86	3.96	4.06	4.20	4.26	4.30	4.39	4.45	4.50	4.61	4.72	4.78	4.87	4.94
24	2.77	2.67	2.38	2.58	2.49	1.99	2.13	2.38	2.25	2.42	2.60	2.30	2.11	2.17	1.98	1.98
25	3.32	3.20	3.43	3.69	3.96	3.73	4.04	4.31	4.40	4.64	4.95	4.89	4.96	5.16	5.23	5.40
26	0.72	0.33	0.33	0.72	0.36	0.20	1.04	2.31	2.54	3.54	4.33	4.39	4.56	5.19	5.30	5.79
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

7.4 The Conclusion and the Recommendations for Further Studies

The MUTE model is created in order to answer the questions about the impacts of the Baht appreciation and the political disorder on the performances of the Thai economy at both the aggregate and the sectoral levels.

The structure of the MUTE model resembles INFORUM type models originally invented by the University of Maryland. In this study, the MUTE model is divideded into 3 main parts, namely, (1) the real side which estimates all of the final demand components, (2) the price – income side which calculates the value added components, and (3) the accountant which includes the identity equations and some important estimated equation in order to link both the real side and the price - income side, together.

The differences of the MUTE model from the INFORUM models are in the use of time – series technique called AICc in estimating some equations that the explanatory variables are non – stationary, and the cointegration test reports the nonexistence of the cointegrating vector. All equations of the MUTE model are inspected by the unit – root tests called the ADF test in order to avoid the problem of spurious regression. Moreover, the MUTE model includes a dummy variable representing the event of the political disorder, which is widely believed as one of the non – economic factors that determine the performance of the economy. Finally, the RAS technique is applied to estimate the matrices of the direct input requirement for each year during the forecasting period. Consequently, the computed matrices of the direct input requirement still have the structure that is quite close to the initial matrix, even though they are not a constant component.

However, the MUTE model still has some issues that need to be resolved for future studies, including:

(1) The accuracy of the model depends on the availability of the data, especially the information used to stack or scale the SNA data into the SIO data. Moreover, the inconsistency between these two sets of data and the unavailability of the sectoral data are the main problems that future studies have to realize if they want their models to be more reliable.

(2) Despite the advantages of the AICc technique, the estimation by using this method will cause the estimated variables to be predetermined. Thus, the estimated values of these variables will be the same for all scenarios, which in some cases, will give unreasonable results. The best example is the estimation of labor productivities, which yields the constant values for all scenarios.

(3) In order to avoid the problem of spurious regression due to the non – stationary characteristic of the variables, some variables need to be transformed either by using the difference technique or by applying the logarithmic function. These transformations, even though solve the problem of the non – stationary data, may sometimes cause a reduction in the value of the estimated R^2. Moreover, it is quite difficult to find the economic theories to guarantee the existence of the relationships among these transformed variables. One way out of this problem is to find better specifications that are suitable in terms of the precision of both statistics and economics, and data availability.

(4) The use of the dummy variable (*poldum*) is not comprehensive enough to capture the situation of political disorder (In this case, *poldum* takes the value of 1 for the year that has the revolution in Thailand and 0 for otherwise). This can be seen by the unexpected sign or the statistical insignificance (measured by the t - statistics) of the coefficients of this dummy variable in some sets of equations. As a result, this variable may not be a suitable measurement for the year that has political instability but no serious event of revolution. The solution to this problem is to find other dummy variables that are able to measure the political situation in different ways such as the use of multiple dummy variables to capture the periods of the new election, the events of the dissolution of parliament, or the extension of the impact of an event of the political - disorder beyond 1 year.

(5) The MUTE model still has the inconsistency between the data at the sectoral and the aggregate levels, even though it is built on the basis of the bottom – up process. For example, the estimated values of the sectoral productivities by the AICc technique are still not equal to the computed sectoral outputs per unit of labor.

(6) Finally, the model still lacks the determination of the export functions. This will make exports exogenous to the model. As a result, the impact of the currency fluctuation is improperly measured and still relies on the assumption on export expenditures.

All in all, the economic model constructed in this study is a useful tool for the economists to understand, forecast, or simulate the results of policy changes and impacts of other unanticipated economic and non – economic factors. However, the model is just a synthesis of the real world. Thus, there is no universal model that can fit all purposes, and it always has room to improve.

Appendix A: The Converter of Thailand Input – Output Table Classification

16×16 Sector	26×26 Sector	58×58 Sector	180×180 Sector
001 Agriculture	001 Crops (001-007,024)	001 Paddy (001)	001 Paddy
		002 Maize (002)	002 Maize
		003 Cassava (004)	004 Cassava
		004 Beans and Nuts (006)	006 Beans and Nuts
		005 Vegetable and Fruits (007 - 008)	007 Vegetables
			008 Fruits
		006 Sugarcane (009)	009 Sugarcane
		007 Rubber (Latex) (016)	016 Rubber
		008 Other Crops (003, 005, 010 – 015, 017, 024)	003 Other Cereals
			005 Other Root Crops
			010 Coconut
			011 Oil Palm
			012 Kenaf and Jute
			013 Crops for Textile and Matting
			014 Tobacco
			015 Coffee and Tea
			017 Other Agricultural Products
			024 Agricultural Services
	009 Livestock (018 - 023)	009 Livestock (018 – 023)	018 Cattle and Buffalo
			019 Swine
			020 Other Livestock
			021 Poultry
			022 Poultry Products
			023 Silk Worm
	010 Forestry (025 – 027)	010 Forestry (025 – 027)	025 Logging
			026 Charcoal and Firewood
			027 Other Forestry Products
	011 Fishery (028 – 029)	011 Fishery (028 – 029)	028 Ocean and Coastal Fishing
			029 Inland Fishing
002 Mining and Quarrying (030 – 041)	005 Mining and Quarrying (030 – 041)	012 Crude Oil and Coal (030 – 031)	030 Coal and Lignite
			031 Petroleum and Natural Gas

Source: National Economic and Social Development Board

The Converter of Thailand Input – Output Table Classification (Continued)

16×16 Sector	26×26 Sector	58×58 Sector	180×180 Sector
002 Mining and Quarrying (030 – 041)	005 Mining and Quarrying (030 – 041)	013 Metal Ore (032 – 035)	032 Iron Ore
			033 Tin Ore
			034 Tungsten Ore
			035 Other Non-ferrous Metal Ore
		014 Non – Metal Ore (036 – 041)	036 Fluorite
			037 Chemical Fertilizer Minerals
			038 Salt Evaporation
			039 Limestone
			040 Stone Quarrying
(Continued)	(Continued)		041 Other Mining and Quarrying
003 Food Manufacturing (042 – 066)	006 Food Manufacturing (042 – 066)	015 Slaughtering	042 Slaughtering
		016 Processing and Preserving of Food (043 – 048)	043 Canning Preserving of Meat
			044 Dairy Products
			045 Canning of Fruits and Vegetables
			046 Canning Preserving of Fish
			047 Coconut and Palm Oil
			048 Other Vegetable Animal Oils
		017 Rice and Other Grain Milling (049 – 052)	049 Rice Milling
			050 Tapioca Milling
			051 Drying and Grinding of Maize
			052 Flour and Other Grain Milling
		018 Sugar Refineries (055)	055 Sugar
		019 Other Foods (053 – 054, 056 - 060)	053 Bakery Products
			054 Noodles and Similar Products
			056 Confectionery
			057 Ice
			058 Monosodium Glutamate
			059 Coffee and Tea Processing
			060 Other Food Products
		020 Animal Food (061)	061 Animal Feed

Source: National Economic and Social Development Board

The Converter of Thailand Input – Output Table Classification (Continued)

16×16 Sector	26×26 Sector	58×58 Sector	180×180 Sector
003 Food Manufacturing (042 – 066)	007 Beverages and Tobacco Products (062 – 066)	021 Beverages (062 – 064)	062 Distilling Blending Spirits
			063 Breweries
			064 Soft Drinks
		022 Tobacco Processing and Products (065 – 066)	065 Tobacco Processing
(Continued)			066 Tobacco Products
004 Textile Industry (067 – 074)	008 Textile Industry (067 - 074)	023 Spinning, Weaving and Bleaching (067 – 069)	067 Spinning
			068 Weaving
			069 Textile Bleaching and Finishing
		024 Textile Products (070 – 074)	070 Made-up Textile Goods
			071 Knitting
			072 Wearing Apparels Except Footwear
			073 Carpets and Rugs
			074 Cordage Rope and Twine Products
006 Paper Industries and Printing (081 – 083)	009 Paper Industries and Printing (081 – 083)	025 Paper and Paper Products (081 – 082)	081 Pulp Paper and Paperboard
			082 Paper Products
		026 Printing and Publishing (083)	083 Printing and Publishing
007 Rubber, Chemical, and Petroleum Industries (084 – 098)	010 Chemical Industries (084 – 092)	027 Basic Chemical Products (084, 086)	084 Basic Industrial Chemicals
			086 Synthetic Resins and Plastics
		028 Fertilizer and Pesticides (085)	085 Fertilizer and Pesticides
		029 Other Chemical Products (087 – 092)	087 Paints Varnishes and Lacquers
			088 Drugs and Medicines
			089 Soap and Cleaning Preparations
			090 Cosmetics
			091 Matches
			092 Other Chemical Products
	011 Petroleum Refineries (093 – 094)	030 Petroleum Refineries (093 – 094)	093 Petroleum Refineries
			094 Other Petroleum Products

Source: National Economic and Social Development Board

The Converter of Thailand Input – Output Table Classification (Continued)

16×16 Sector	26×26 Sector	58×58 Sector	180×180 Sector
007 Rubber, Chemical, and Petroleum Industries (084 – 098) (Continued)	012 Rubber and Plastic Products (095 – 098)	031 Rubber Products (095 – 097)	095 Rubber Sheets and Block Rubber
			096 Tires and Tubes
			097 Other Rubber Products
		032 Plastic Wares	098 Plastic Wares
008 Non – Metallic Products (099 – 104)	013 Non – Metallic Products (099 – 104)	033 Cement and Concrete Products (102 – 103)	102 Cement
			103 Concrete and Cement Products
		034 Other Non-metallic Products (099 – 101, 104)	099 Ceramic and Earthen Wares
			100 Glass and Glass Products
			101 Structural Clay Products
			104 Other Non-metallic Products
009 Metal, Metal Products and Machinery (105 – 128)	014 Basic Metal (105 – 107)	035 Iron and Steel (105 – 106)	105 Iron and Steel
			106 Secondary Steel Products
		036 Non – Ferrous Metal (107)	107 Non – Ferrous Metal
	015 Fabricated Metal Products (108 – 111)	037 Fabricated Metal Products (108 – 111)	108 Cutlery and Hand Tools
			109 Furniture and Fixtures Metal
			110 Structural Metal Products
			111 Other Fabricated Metal Products
	016 Machinery (112 – 128)	038 Industrial Machinery (112 – 115)	112 Engines and Turbines
			113 Agricultural Machinery
			114 Wood and Metal Working Machinery
			115 Special Industrial Machinery
		039 Electrical Machinery and Apparatus (116 – 122)	116 Office and Household Machinery
			117 Electrical Industrial Machinery
			118 Radio and Television
			119 Household Electrical Appliances
			120 Insulated Wire and Cable
			121 Electric Accumulator & Battery
			122 Other Electrical Apparatuses & Supplies

Source: National Economic and Social Development Board

The Converter of Thailand Input – Output Table Classification (Continued)

16×16 Sector	26×26 Sector	58×58 Sector	180×180 Sector
009 Metal, Metal Products and Machinery (105 – 128)	016 Machinery (112 – 128)	040 Motor Vehicles and Repairing (125 – 127)	125 Motor Vehicle
			126 Motorcycle, Bicycle & Other Carriages
			127 Repairing of Motor Vehicle
		041 Other Transportation Equipment (123 – 124, 128)	123 Ship Building
			124 Railway Equipment
(Continued)	(Continued)		128 Aircraft
010 Other Manufacturing (075 – 077, 129 – 134)	017 Other Manufacturing (075 – 077, 129 – 134)	042 Leather Products (075 – 077)	075 Tanneries Leather Finishing
			076 Leather Products
			077 Footwear Except Rubber
005 Saw Mills and Wood Products (078 – 080)		043 Saw Mills and Woods Products (078 – 080)	078 Saws Mills
			079 Wood and Cork Products
			080 Furniture and Fixtures Wood
010 Other Manufacturing		044 Other Manufacturing Products (129 – 134)	129 Scientific Equipments
			130 Photographic & Optical Goods
			131 Watches and Clocks
			132 Jewelry & Related Articles
			133 Recreational and Athletic Equipment
(Continued)			134 Other Manufacturing Goods
011 Public Utilities (135 – 137)	018 Electricity and Water Works (135 – 137)	045 Electricity and Gas (135 – 136)	135 Electricity
			136 Pipe Line
		046 Water Works and Supply (137)	137 Water Supply System
012 Construction (138 – 144)	019 Construction (138 – 144)	047 Building Construction (138 - 139)	138 Residential Building Construction
			139 Non-Residential Building Construction
		048 Public Works and Other Constructions (140 – 144)	140 Public Works for Agriculture & Forestry
			141 Non-Agricultural Public Works
			142 Construction of Electric Plant
			143 Construction of Communication Facilities
			144 Other Constructions

Source: National Economic and Social Development Board

The Converter of Thailand Input – Output Table Classification (Continued)

16×16 Sector	26×26 Sector	58×58 Sector	180×180 Sector
013 Trade (145 – 146)	020 Trade (145 – 146)	049 Trade (145 – 146)	145 Wholesale Trade
			146 Retail Trade
015 Services (147 – 148, 160 – 178)	021 Restaurants and Hotels (147 – 148)	050 Restaurants and Hotels (147 – 148)	147 Restaurant and Drinking Place
			148 Hotel and Lodging Place
014 Transportation and Communication (149 – 159)	022 Transportation and Communication (149 – 159)	051 Transportation (149 – 158)	149 Railways
			150 Route & Non Route of Road Passenger Trans.
			151 Road Freight Transport
			152 Land Transport Supporting Services
			153 Ocean Transport
			154 Coastal & Inland Water Transport
			155 Water Transport Services
			156 Air Transports
			157 Other Services
			158 Silo and Warehouse
		052 Communication (159)	159 Post and Telecommunication
015 Services	023 Banking and Insurance (160 - 162)	053 Banking and Insurance (160 - 162)	160 Banking Services
			161 Life Insurance Service
			162 Other Insurance Service
	024 Real Estate (163)	054 Real Estate (163)	163 Real Estate
	025 Services (164 – 178)	055 Business Services (164)	164 Business Services
		056 Public Services (165 – 169)	165 Public Administration
			166 Sanitary and Similar Services
			167 Education
			168 Research
			169 Hospital
		057 Other Services (170 – 178)	170 Business and Labor Associations
			171 Other Community Services
(Continued)			172 Motion Picture Production

Source: National Economic and Social Development Board

The Converter of Thailand Input – Output Table Classification (Continued)

16×16 Sector	26×26 Sector	58×58 Sector	180×180 Sector
015 Services	025 Services (164 – 178)	057 Other Services (170 – 178)	173 Movie Theater
			174 Radio, Television and Related Services
			175 Library and Museum
			176 Amusement and Recreation
			177 Repair, Not Elsewhere Classified
(Continued)	(Continued)	(Continued)	178 Personal Services
016 Unclassified (180)	026 Unclassified (180)	058 Unclassified (180)	180 Unclassified (180)
190 Total Intermediate Transaction	190 Total Intermediate Transaction	190 Total Intermediate Transaction	190 Total Intermediate Transaction
201 Wages and Salaries	201 Wages and Salaries	201 Wages and Salaries	201 Wages and Salaries
202 Operating Surplus	202 Operating Surplus	202 Operating Surplus	202 Operating Surplus
203 Depreciation	203 Depreciation	203 Depreciation	203 Depreciation
204 Indirect Taxes less Subsidies	204 Indirect Taxes less Subsidies	204 Indirect Taxes less Subsidies	204 Indirect Taxes less Subsidies
209 Total Value Added	209 Total Value Added	209 Total Value Added	209 Total Value Added
210 Control Total	210 Control Total	210 Control Total	210 Control Total
301 Private Consumption Expenditure	301 Private Consumption Expenditure	301 Private Consumption Expenditure	301 Private Consumption Expenditure
302 Government Consumption Expenditure	302 Government Consumption Expenditure	302 Government Consumption Expenditure	302 Government Consumption Expenditure
303 Gross Fixed Capital Formation	303 Gross Fixed Capital Formation	303 Gross Fixed Capital Formation	303 Gross Fixed Capital Formation
304 Increase in Stock	304 Increase in Stock	304 Increase in Stock	304 Increase in Stock
305 Exports (F.O.B.)	305 Exports (F.O.B.)	305 Exports (F.O.B.)	305 Exports (F.O.B.)
306 Special Exports	306 Special Exports	306 Special Exports	306 Special Exports
309 Total Final Demand	309 Total Final Demand	309 Total Final Demand	309 Total Final Demand
310 Total Demand	310 Total Demand	310 Total Demand	310 Total Demand
401 Imports (C.I.F.)	401 Imports (C.I.F.)	401 Imports (C.I.F.)	401 Imports (C.I.F.)
402 Import Duty	402 Import Duty	402 Import Duty	402 Import Duty
403 Import Tax	403 Import Tax	403 Import Tax	403 Import Tax
404 Special Imports	404 Special Imports	404 Special Imports	404 Special Imports
409 Total Imports	409 Total Imports	409 Total Imports	409 Total Imports
501 Wholesale Trade Margin	501 Wholesale Trade Margin	501 Wholesale Trade Margin	501 Wholesale Trade Margin
502 Retail Trade Margin	502 Retail Trade Margin	502 Retail Trade Margin	502 Retail Trade Margin

Source: National Economic and Social Development Board

The Converter of Thailand Input – Output Table Classification (Continued)

16×16 Sector	26×26 Sector	58×58 Sector	180×180 Sector
503 Transportation Cost	503 Transportation Cost	503 Transportation Cost	503 Transportation Cost
509 Total Margin and Transportation Cost	509 Total Margin and Transportation Cost	509 Total Margin and Transportation Cost	509 Total Margin and Transportation Cost
600 Control Total	600 Control Total	600 Control Total	600 Control Total
700 Total Supply	700 Total Supply	700 Total Supply	700 Total Supply

Source: National Economic and Social Development Board

Appendix B: The Calculation of Input – Output Matrices by the RAS Method

According to the RAS method mentioned in Chapter 4, three categories of data in the target year are required to compute the target matrix $A_{(t+1)}$ including 1) total final demand for each sector 2) total value added for each component, and 3) total intermediate input by sector. The time - series data for the first and the second categories are published by NESDB and BOT and available in monthly, quarterly and annual formats. However, the data for total intermediate input by sector are available every five year via the input – output matrix. Thus, in this study the missing intermediate input data during the intervening period are assumed to adjust by the same proportion in each year. For example, from 1975 to 1980, the intermediate input used by the first sector (Crops) increased by 11765.997 millions of Baht (from 11600.463 to 23366.46 millions of baht), or rose by 2353.1994 millions of Baht per year during this five – year period. As a result, this study assumes that the intermediate input used of this sector in 1976 is equal to 13953.6624 millions of baht (11600.463 plus 2353.1994).

Another problem emerging from the missing data in this case is the estimation of intermediate input used for each sector from the year of 2000. Since, currently the newest version of input – output table from NESDB data is available until the year of 2000, but the time series for final demand and value added components are available till 2004, four observations for intermediate input used by each sector have to be estimated to match up with the SNA data and in order to avert the problem of simultaneity bias when the left hand side of the estimated equations consists of the endogenous variables, the time series technique for forecasting called the Box – Jenkins (BJ) Methodology[1] or ARIMA forecasting are employed to estimate the sectoral equations for intermediate input demand.

The first step under BJ procedure is to test whether the available intermediate demand series are stationary. This task is accomplished by the augmented Dickey - Fuller unit root test (ADF Test)[2]. The results of the DF test are shown in table B.1.

Table B.1: ADF Test on Intermediate Demand Series

Intermediate Demand for Sector	Coefficients	Tau (τ) Statistic	Results
1	-0.040	-0.608	Non - Stationary
After 2^{nd} Difference	-1.021	-4.565^{***}	Stationary
2	-0.158	-1.401	Non - Stationary
After 2^{nd} Difference	-1.116	-4.992^{***}	Stationary
3	-0.080	-0.612	Non - Stationary
After 2^{nd} Difference	-1.058	-4.721^{***}	Stationary
4	-0.025	-0.564	Non - Stationary
After 2^{nd} Difference	-1.028	-4.600^{***}	Stationary
5	0.040	0.755	Non - Stationary
After 2^{nd} Difference	-1.023	-4.577^{***}	Stationary
6	-0.052	-0.923	Non - Stationary
After 2^{nd} Difference	-1.031	-4.611^{***}	Stationary
7	-0.063	-1.223	Non - Stationary
After 2^{nd} Difference	-1.056	-4.724^{***}	Stationary
8	-0.120	-2.234	Non - Stationary
After 2^{nd} Difference	-1.133	-5.102^{***}	Stationary
9	0.029	0.819	Non - Stationary
After 2^{nd} Difference	-1.508	-4.721^{***}	Stationary
10	0.316	5.150^{***}	Stationary
11	0.471	8.853^{***}	Stationary
12	-0.026	-0.548	Non - Stationary
After 2^{nd} Difference	-1.026	-4.582^{***}	Stationary
13	-0.154	-1.561	Non - Stationary
After 2^{nd} Difference	-1.005	-4.493^{***}	Stationary
14	-0.128	-1.116	Non - Stationary
After 2^{nd} Difference	-1.030	-4.602^{***}	Stationary
15	-0.057	-1.997	Non - Stationary
After 2^{nd} Difference	-1.067	-4.783^{***}	Stationary
16	0.084	1.187	Non - Stationary
After 2^{nd} Difference	-1.119	-4.993	Stationary

[1] G.P.E. Box and G.M. Jenkins, *Time Series Analysis: Forecasting and Control*, revised ed., Holden Day, San Francisco, 1978.

[2] D.A. Dickey and W.A. Fuller, "Distribution of the Estimators for Autoregressive Time Series with a Unit Root," *Journal of the American Statistical Association*, vol. 74, 1979, pp. 427 – 431.

Table B.1: (Continued)

Intermediate Demand for Sector	Coefficients	Tau (τ) Statistic	Results
17 After 2nd Difference	-0.121 -1.013	-1.848 -4.526***	Non - Stationary Stationary
18	0.117	4.786***	Stationary
19 After 2nd Difference	-0.009 -1.015	-0.087 -4.537***	Non - Stationary Stationary
20 After 2nd Difference	-0.104 -1.115	-1.688 -4.997***	Non - Stationary Stationary
21 After 2nd Difference	-0.090 -1.046	-2.326 -4.679***	Non - Stationary Stationary
22	0.138	7.837***	Stationary
23 After 2nd Difference	-0.050 -1.175	-0.431 -5.283***	Non - Stationary Stationary
24 After 2nd Difference	0.018 -1.160	0.177 -5.211***	Non - Stationary Stationary
25 After 2nd Difference	0.121 -1.202	2.889 -5.401***	Non - Stationary Stationary
26 After 2nd Difference	0.063 -1.111	0.366 -4.957***	Non - Stationary Stationary

Notes: (1) *, **, and *** denotes the significant level at 10%, 5% and 1%, respectively for testing the null hypothesis that the particular series has a unit root. (2) Time trend and intercept term are included in the estimated equations.

The result from Table B.1 reveals that most of the generated time series data for the sectoral intermediate demands in this study except for sectors 10, 11, 18, and 22 are non - stationary data. However, after the 2nd difference, these non – stationary data become stationary, or they are integrated of order 2. Thus, to find the reliable forecast for the intermediate demand, the second - difference series are employed in most sectors except for sectors 10, 11, and 12 using the level data in the estimation process.

In order to model the structure of time series data, the ARIMA process[3] has to be specified. The methods called autocorrelation functions (ACFs)[4], partial autocorrelation

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[3] ARIMA stands for an Autoregressive Integrated Moving Average process which is the structure of the correlation between current values of residuals and their past values.

[4] The ACFs at lag k (ρ_k) is defined as the ratio between covariance at lag k and its own variances or:

$$\rho_k = \frac{\sum (y_t - \bar{y})(y_{t+k} - \bar{y})/n}{\sum (y_t - \bar{y})^2/n}$$

where n denotes sample size, y is the interested series, and y is the sample mean.

functions (PACFs)[5] and the associated correlogram[6] are quite handful in this case. The results of these analyses are summarized in Table B.2.

Table B.2: The Correlogram and the Partial Correlogram of Intermediate Demand Series

Sector	Integrated Order	ACFs	PACFs
1	2	Significant spike at lag 3	Significant spike at lag 3
2	2	None of all lags is significant	None of all lags is significant
3	2	Significant spike at lag 5	Significant spike at lag 5
4	2	Significant spike at lag 8	Significant spike at lag 8
5	2	None of all lags is significant	None of all lags is significant
6	2	Significant spike at lag 3	Significant spike at lag 3
7	2	None of all lags is significant	None of all lags is significant
8	2	Significant spike at lag 13	None of all lags is significant
9	2	None of all lags is significant	Significant spike at lag 10
10	0	Exponentially decline through lags 9	Significant spike at lag 1
11	0	Exponentially decline through lags 7	Significant spike at lag 1
12	2	None of all lags is significant	None of all lags is significant
13	2	Significant spike at lag 3	Significant spike at lag 3
14	2	Significant spike at lag 3	Significant spike at lag 3
15	2	None of all lags is significant	None of all lags is significant
16	2	None of all lags is significant	None of all lags is significant
17	2	Significant spike at lag 3	Significant spike at lag 3
18	0	None of all lags is significant	None of all lags is significant
19	2	None of all lags is significant	None of all lags is significant
20	2	None of all lags is significant	None of all lags is significant
21	2	None of all lags is significant	Significant spike at lag 10
22	0	Exponentially decline through lags 8	Significant spike at lag 1
23	2	Significant spike at lag 3	Significant spike at lag 3
24	2	Significant spike at lag 10	Significant spike at lag 10
25	2	None of all lags is significant	None of all lags is significant
26	2	None of all lags is significant	None of all lags is significant

The plots of ACFs and PACFs detect some patterns of the time series data. For example, the exponentially decay of ACFs and the significant spike of PACFs in sectors 10, 11, and 22 suggest the structure of AR(1), while the significant spike at particular lag of ACFs implies the structure of MA. However, characteristics in some sectors such as 3,

[5] The PACFs (ρ_{kk}) is the correlation between the time series y_t and y_{t-k} after removing the correlation of the intermediate lags.

[6] The correlogram is basically the plot of ACFs and PACFs against the lag length.

4, 20, and so on are not corresponding with the theoretical patterns of ACFs and PACFs, and it is possible that several specifications of the ARMA (p, q) model will suit these data. According to Brockwell and Davis (1996)[7] there are various order determination criteria such as the final prediction error (FPE), Bayesian estimation criterion (BEC), Schwarz-Rissanen criterion (SIC), Akaike's information criterion (AIC) and so on that are used to specify an optimal model for time series data. However, the most advantageous selection criterion in terms of asymptotic consistency and efficiency[8] called "the corrected Akaike's information criterion (AICc)" is employed in this study.

Owing to Hurvich and Tsai (1989)[9], AICc is the model - selection method that specifies the order of p and q in the ARMA (p, q) model. The method is based on the order selection of p and q so as to minimize a derived statistic which measures the discrepancy between the true and the candidate model:

$$\text{Min. AICc} = \text{Min.}\left[-2\ln L\left(\hat{\phi},\hat{\theta},\hat{\sigma}^2\right)+\left[\frac{2n(p+q+1)}{n-(p+q)-2}\right]\right] \tag{B.1}$$

where, $L\left(\hat{\phi},\hat{\theta},\hat{\sigma}^2\right)$ = likelihood function of the data under the Gaussian ARMA model

$\hat{\phi}$ = a class of autoregressive parameters

$\hat{\theta}$ = a class of moving average parameters

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[7] Brockwell, P. J. and. Davis, R. A. 1996. Introduction to Time Series and Forecasting, Springer, New York.

[8] "Asymptotic consistency" in this sense means that when the sample size is large, the method selects the true model with the probability converging to 1. By the same token, "asymptotic efficiency" implies that the method chooses the model that is closest to the true model as much as possible with the probability converging to 1 as the sample size grows larger toward the infinity.

[9] Hurvich, C.M. and Tsai, C.L. 1989. Regression and Time Series Model Selection in Small Samples. Biometrika 76, 297 – 307

$\hat{\sigma}^2$ = variance of white – noise

n = number of observations, and

p, q = orders of autoregressive and moving average components , consecutively

The estimation results of Sectoral Intermediate Input Equations by AICc Approaches are shown in Table B.3

Table B.3: The Estimated Results of Sectoral Intermediate Input Equations by the AICc Approaches

Sector	ARIMA (p, d, q)	Equation	WN Var.
1	(0, 2, 3)	$D(Y01, 2) = Z_{(t)} + \underset{(.1027)}{.1606} Z_{(t-1)} + \underset{(.1053)}{.1143} Z_{(t-2)} - \underset{(.1027)}{.8642} Z_{(t-3)}$	.444567E+07
2	(1, 2, 0)	$D(Y02, 2) = Z_{(t)} - \underset{(.2001)}{.01789} D(Y02, 2)_{(t-1)}$	.365524E+07
3	(5, 2, 0)	$D(Y03, 2) = - \underset{(.1254)}{.0114} D(Y03, 2)_{(t-1)} + \underset{(.1310)}{.0526} D(Y03, 2)_{(t-2)} + \underset{(.1262)}{.1836} D(Y03, 2)_{(t-3)} - \underset{(.1287)}{.0073} Y03_{(t-4)} - \underset{(.1227)}{.7169} Y03_{(t-5)} + Z_{(t)}$	.703760E+04
4	(0, 2, 1)	$D(Y04, 2) = Z_{(t)} - \underset{(.2002)}{.0003} Z_{(t-1)}$	.121004E+07
5	(1, 2, 1)	$D(Y05, 2) = \underset{(.1608)}{.6953} D(Y05, 2)_{(t-1)} + Z_{(t)} - \underset{(.1124)}{1.000} Z_{(t-1)}$	.502810E+06
6	(3, 2, 0)	$D(Y06, 2) = \underset{(.1374)}{.0036} D(Y16, 2)_{(t-1)} + \underset{(.1797)}{.0079} D(Y16, 2)_{(t-2)} - \underset{(.1356)}{.8252} D(Y16, 2)_{(t-3)} + Z_{(t)}$	.134518E+09
7	(1, 2, 0)	$D(Y07, 2) = -\underset{(.2000)}{.0014} D(Y07, 2)_{(t-1)} + Z_{(t)}$	.312786E+07
8	(1, 2, 0)	$D(Y08, 2) = -\underset{(.2000)}{.0013} D(Y08, 2)_{(t-1)} + Z_{(t)}$	.454509E+08
9	(0, 2, 1)	$D(Y09, 2) = Z_{(t)} - \underset{(.2075)}{.0368} Z_{(t-1)}$	.248665E+07
10	(2, 0, 0)	$Y10 = \underset{(.0728)}{1.921} Y10_{(t-1)} - \underset{(.0728)}{.9285} Y10_{(t-2)} + Z_{(t)}$	.800104E+08
11	(2, 0, 0)	$Y11 = \underset{(.0682)}{1.928} Y11_{(t-1)} - \underset{(.0682)}{.9376} Y11_{(t-2)} + Z_{(t)}$	.145451E+09
12	(1, 2, 1)	$D(Y12, 2) = \underset{(.1785)}{.6357} D(Y12, 2)_{(t-1)} + Z_{(t)} - \underset{(.2160)}{1.000} Z_{(t-1)}$	.123853E+08
13	(0, 2, 3)	$D(Y13, 2) = Z_{(t)} - \underset{(.2318)}{.2037} Z_{(t-1)} - \underset{(.2507)}{.08342} Z_{(t-2)} - \underset{(.2109)}{.7128} Z_{(t-3)}$	.120352E+08

Table B.3: (Continued)

Sector	ARIMA (p, d, q)	Equation	WN Var.
14	(0, 2, 3)	$D(Y14, 2) = Z_{(t)} - .2072\ Z_{(t-1)} - .1438\ Z_{(t-2)}$ (.2025) (.2232) $- .6491\ Z(t-3)$ (.1841)	.823546E+07
15	(0, 2, 1)	$D(Y15, 2) = Z_{(t)} - .0739\ Z_{(t-1)}$ (.2175)	.714032E+06
16	(0, 2, 3)	$D(Y16, 2) = Z_{(t)} + .0135\ Z_{(t-1)} + .0874\ Z_{(t-2)}$ (.0647) (.0623) $- .9484\ Z_{(t-3)}$ (.0647)	.118879E+10
17	(0, 2, 3)	$D(Y17, 2) = Z_{(t)} - .2514\ Z_{(t-1)} - .1099\ Z_{(t-2)}$ (.1983) (.2407) $- .6387\ Z_{(t-3)}$ (.1938)	.117938E+09
18	(2, 0, 0)	$Y18 = 1.967\ Y18_{(t-1)} - .9718\ Y18_{(t-2)} + Z_{(t)}$ (.0024) (.0007)	.665022E+07
19	(0, 2, 1)	$D(Y19, 2) = Z_{(t)} - .0021 Z_{(t-1)}$ (.2006)	.587684E+09
20	(1, 2, 0)	$D(Y20, 2) = -.0069\ D(Y20, 2)_{(t-1)} + Z_{(t)}$ (.2001)	.535045E+08
21	(0, 2, 3)	$D(Y21, 2) = Z_{(t)} - .2979\ Z_{(t-1)} + .0185\ Z_{(t-2)}$ (.2017) (.2726) $- .7206\ Z_{(t-3)}$ (.2244)	.738672E+07
22	(2, 0, 0)	$Y22 = 1.980\ Y22_{(t-1)} - .9824\ Y22_{(t-2)} + Z_{(t)}$ (.0023) (.0007)	.169400E+08
23	(3, 2, 0)	$D(Y23, 2) = -.0183\ D(Y23, 2)_{(t-1)} - .0133\ D(Y23, 2)_{(t-2)}$ (.1699) (.1972) $+ .5235\ D(Y23, 2)_{(t-3)} + Z_{(t)}$ (.1866)	.158694E+08
24	(0, 2, 1)	$D(Y24, 2) = Z_{(t)} - .0180\ Z_{(t-1)}$ (.2006)	.428473E+06
25	(0, 2, 1)	$D(Y25, 2) = Z_{(t)} - .1027\ Z_{(t-1)}$ (.2186)	.210154E+08
26	(0, 2, 1)	$D(Y26, 2) = Z(t) - .0383\ Z(t-1)$ (.2045)	.257814E+08

Notes: (1) Y# denotes the intermediate input series for sector #, and D(Y#, 2) is the 2nd difference of the particular series.
(2)Each equation is estimated by the maximum likelihood method via the Iterative Time Series Modeling (ITSM) software.
(3) All numbers in the parentheses represent the standard errors of the AR and MA terms.
(4) $Z_{(t)}$ denotes White noise stochastic error term with zero mean and their variance shown in the last column of Table B.1.

Before using the model for forecasting purpose, the next step is to check whether the assigned ARIMA models are appropriate for the present data set. One criterion states that if the ARIMA models fit the data reasonably well, the estimated residuals must have the properties corresponding with the White noise sequence, or they must be random. Fortunately, the ITSM software provides six tests[10] for white noise residuals including:

(1) Ljung – Box portmanteau test, which relies on the autocorrelation plot to test the null hypothesis that the residuals are random (independently and identically distributed: iid). The test statistic is:

$$Q_{LB} = \left(n(n+2)\sum_{j=1}^{h} \frac{\rho^2(j)}{n-j} \right) \tag{B.2}$$

where n denotes the sample size, $\rho(j)$ is the autocorrelation at lag j, and h represents the number of lags being tested. The null hypothesis is rejected when:

$$Q_{LB} > \chi^2_{1-\alpha,h}$$

where $\chi^2_{1-\alpha,h}$ is the Chi – Square distribution at the significant level of α.

(2) McLeod – Li portmanteau test, which is the same as the Ljung – Box portmanteau test, but incorporates the assumption of normal distribution of the residuals. The test statistic is in the form:

$$Q_{ML} = n(n+2)\frac{\sum_{j=1}^{h} (\hat{\rho}_j^{WW})^2}{n-j} \tag{B.3}$$

[10] In this study, the tests for randomness of the residuals are based on the six tests, since the increasing number of the test will increase the probability that at least one test rejects the null hypothesis when it is true. Moreover, it is more accuracy by not rejecting the null hypothesis of iid residuals by relying only on one test.

where n, j, and h have the same definition as before and $\hat{\rho}_j^{WW}$ are the sample autocorrelation of the squared residuals[11]. The null hypothesis of iid residuals is rejected when $Q_{ML} > \chi^2_{\alpha,h}$

(3) Turning point test, which is the normality test (based on the Z statistic). The statistic is calculated by reckoning on the number of turning points[12] as follows:

$$Z_{TP} = \frac{|T - \mu_T|}{\sigma_T} \tag{B.4}$$

where T represents the number of observed turning point. The computed T has a standard normal distribution with mean μ_T and variance σ_T^2 [13]. The null hypothesis of iid residuals is rejected when $Z_{TP} > Z_{\alpha/2}$.

(4) Difference – sign test is the method to investigate the appearance of linear trend (one aspect of non – stationary data) in the sequence of residuals. It is also the normality test which relies on the Z statistic. The test statistic is in the form of:

$$Z_S = \frac{|S - \mu_S|}{\sigma_S} \tag{B.5}$$

[11] The idea is that if the particular time series are iid, then the squared of those series are also iid. Thus, $\hat{\rho}_j^{WW}$ can be computed from the formula:

$$\hat{\rho}_j^{WW} = \frac{\sum_{t=1}^{n-|j|}(w_{t-|j|} - \overline{w})(w_t - \overline{w})}{\sum_{t=1}^{n}(w_t - \overline{w})^2} \qquad , -n < j < n$$

where, w_t and $\overline{w}$ are the squared of the time series and their mean, and t is the time period.

[12] A turning point of the particular iid series Y_i at time i (for $1 < i < n$) is defined as (1) $Y_{i-1} < Y_i$ and $Y_i > Y_{i+1}$, or (2) $Y_{i-1} > Y_i$ and $Y_i < Y_{i+1}$

[13] The mean and variance of T can be calculated by the following formula:

$$\mu_T = E(T) = 2(n-2)/3, \text{ and } \sigma_T^2 = Var(T) = (16n-29)/90$$

where S denotes the number of value of time i (e.g. i = $2, \ldots\ldots, n$). S follows a standard normal distribution with mean μ_S, and variance σ_S^2 [14]. The null hypothesis that the residuals is an iid series without trend is rejected when $Z_S > Z_{\alpha/2}$.

(5) The Rank Test which is also employed to detect the linear trend in the particular series. The test statistic is in the form of:

$$Z_P = \frac{|P - \mu_P|}{\sigma_P} \qquad \text{(B.6)}^{15}$$

where P is defined as the number of pairs (i, j) in the particular series such that $Y_j > Y_i$ and $j > i$ for $i = 1, \ldots, n-1$. In large sample, P has a standard normal distribution with mean μ_P, and variance σ_P^2 [16]. By the same token, the null hypothesis that the residuals is an iid series is rejected when $Z_P > Z_{\alpha/2}$.

(6) Minimum – AICc AR order (MAAO) is the criterion in equation (B.1) in choosing the order of autoregressive model by minimizing the AICc statistic. In this case, the White - noise data is represented by a selected order that is equal to 0.

The results of these six tests for randomness and the corresponding computed p – value for the residuals of each sectoral intermediate input series are shown in Table B.4.

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[14] The mean and variance of S can be calculated by the following formula:

$$\mu_S = E(S) = (n-1)/2, \text{ and } \sigma_S^2 = Var(S) = (n+1)/12$$

[15] The idea is that the large positive value of P- μ_P shows the existence of the increasing trend in the data, while the large negative value presents the decreasing trend in the data.

[16] The mean and variance of P can be calculated by the following formula:

$$\mu_P = E(P) = n(n-1)/4, \text{ and } \sigma_P^2 = Var(P) = n(n-1)(2n+5))/72$$

Table B.4: The Randomness Test for the Residuals of the Sectoral Intermediate Inputs

Sector #	Q_{LB}	Q_{ML}	Z_{TP}	Z_S	Z_P	MAAO
1	7.410	5.922	15.00	11.00	.16600E+03	0
p - value	(.6863)	(.9490)	(.8667)	(.7290)	(.1648)	
2	4.339	.5678	11.00	11.00	.14000E+03	0
p - value	(.9765)	(1.000)	(.0649)	(.7290)	(.9210)	
3	11.34	15.65	14.00	12.00	.15200E+03	0
p - value	(.1834)	(.2687)	(.7371)	(.7290)	(.4874)	
4	10.29	7.545	7.00	8.00	.15200E+03	0
p - value	(.5905)	(.8719)	(.0001)*	(.0153)*	(.4874)	
5	5.366	37.36	9.00	5.00	.14000E+03	0
p - value	(.9122)	(.0004)*	(.0043)*	(.0000)*	(.9210)	
6	7.964	8.565	16.00	10.00	.14500E+03	0
p - value	(.6323)	(.8050)	(.5020)	(.2987)	(.7284)	
7	7.853	2.067	9.00	9.00	.13700E+03	0
p - value	(.7965)	(.9997)	(.0043)*	(.0833)	(.9604)	
8	14.83	15.71	12.00	13.00	.11400E+03	0
p - value	(.2508)	(.2650)	(.1794)	(.2987)	(.2338)	
9	9.844	13.91	6.00	9.00	.15000E+03	0
p - value	(.6296)	(.3802)	(.0000)*	(.0833)	(.5516)	
10	1.317	.1262	11.00	19.00	.27000E+03	0
p - value	(.9998)	(1.000)	(.0159)*	(.0000)*	(.0000)*	
11	3.668	.4394	11.00	19.00	.26100E+03	0
p - value	(.9787)	(1.000)	(.0159)*	(.0000)*	(.0000)*	
12	9.154	10.25	10.00	5.00	.14300E+03	0
p - value	(.6077)	(.6736)	(.0188)*	(.0000)*	(.8041)	
13	4.010	.7122	16.00	12.00	.14100E+03	0
p - value	(.9469)	(1.000)	(.5020)	(.7290)	(.8817)	
14	6.151	2.355	14.00	9.00	.14200E+03	0
p - value	(.8024)	(.9994)	(.7371)	(.0833)	(.8427)	
15	10.07	2.417	8.00	6.00	.13100E+03	0
p - value	(.6101)	(.9994)	(.0008)*	(.0001)*	(.7284)	
16	5.832	8.689	16.00	9.00	.12400E+03	0
p - value	(.8292)	(.7960)	(.5020)	(.0833)	(.4874)	
17	6.633	2.648	14.00	9.00	.13500E+03	0
p - value	(.7596)	(.9989)	(.7371)	(.0833)	(.8817)	
18	6.322	1.291	12.00	19.00	.26900E+03	0
p - value	(.8511)	(1.000)	(.0537)	(.0000)*	(.0000)	
19	5.643	1.008	7.00	12.00	.17300E+03	0
p - value	(.9330)	(1.000)	(.0001)*	(.7290)	(.0825)	
20	9.543	3.005	13.00	11.00	.13400E+03	0
p - value	(.6560)	(.9979)	(.4014)	(.7290)	(.8427)	
21	9.030	10.91	16.00	10.00	.13400E+03	0
p - value	(.5293)	(.6186)	(.5020)	(.2987)	(.8427)	
22	11.03	6.065	11.00	19.00	.26700E+03	0
p - value	(.4404)	(.9438)	(.0159)*	(.0000)*	(.0000)	
23	3.964	3.692	12.00	11.00	76.00	0
p - value	(.9489)	(.9941)	(.1794)	(.7290)	(.0021)*	
24	10.50	6.278	8.00	12.00	89.00	0
p - value	(.5722)	(.9355)	(.0008)*	(.7290)	(.0151)*	

Table B.4: (Continued)

Sector #	Q_{LB}	Q_{ML}	Z_{TP}	Z_S	Z_P	MAAO
25 p - value	4.405 (.9750)	.3191 (1.000)	8.00 (.0008)*	6.00 (.0001)*	.12800E+03 (.6198)	0
26 p - value	2.502 (.9982)	.3105 (1.000)	8.00 (.0008)*	9.00 (.0833)	98.00 (.0472)*	0

Notes: (1) In this study, the assigned value of h for the Ljung – Box and the McLeod – Li portmanteau tests is 13 (Practically, h is equal to $n/2$).
(2) The results are estimated by the Iterative Time Series Modeling (ITSM) software.
(3) All numbers in the parentheses represent the corresponding p – value of each statistic at the 5% level of significant.
(4) * denotes the significance at the 0.05 level

From Table B.4, the results show that only 12 sectors (1, 2, 3, 6, 8, 13, 14, 16, 17, 20, 21, and 23) from 26 sectors that have all p – values that satisfy the null hypothesis of the random series (when p – value is larger than the 0.05 level of significant). These results ensure that the assigned models are fitted with the data reasonably well in these sectors. However, in the case when the results from these six tests yield the contradicted conclusion, the rule of thumbs is that if at least 3 from the 6 tests confirm the existence of the White – noise residuals, the assigned model is assumed to be fitted with the data, and the model can be used for predicting the future value of the particular sequence.

The forecasting results for intermediate input requirement from 2001 – 2025 by above assigned models are shown in Table B.5. the value of zero denoted by the mark * in the table are used in order to notify that the estimated values of intermediate input are negative, and are replaced by the 0 number, since the values of the intermediate inputs used by each sector that are recorded in the I – O table never enters the table in negative value. These estimated intermediate input requirements are summed up with the value added by sector from the national income account in order to calculate the series of the total output by sector which are the main element in estimating the I – O coefficient matrix (A_t) for each year by the RAS method.

Table B.5: The Forecasting Results of the Intermediate Input Requirement for 2001 - 2020

(Millions of Baht)

Sector	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1	128,340	134,700	140,040	145,340	150,590	155,800	160,980	166,100	171,190	176,230
2	57,483	52,559	47,379	41,943	36,252	30,305	24,103	17,645	10,931	3,962
3	1,111	1,111	1,111	1,111	1,111	1,111	1,111	1,111	1,111	1,111
4	56,931	58,196	59,479	60,779	62,097	63,433	64,786	66,157	67,546	68,953
5	49,765	53,129	56,620	60,233	63,965	67,816	71,784	75,867	80,066	84,381
6	694,350	753,770	813,060	873,150	887,800	902,090	915,020	965,120	1,015,300	1,066,600
7	82,293	81,899	81,439	80,914	80,323	79,666	78,945	78,157	77,304	76,386
8	495,940	497,120	498,050	498,740	499,190	499,400	499,370	499,100	498,580	497,820
9	116,580	126,250	136,210	146,460	157,010	167,850	178,980	190,410	202,130	214,140
10	310,980	356,610	396,720	431,400	460,770	484,990	504,240	518,740	528,700	534,390
11	421,420	487,750	546,190	596,680	639,260	674,020	701,130	720,800	733,330	739,040
12	186,390	201,570	217,060	232,950	249,290	266,120	283,460	301,320	319,720	338,650
13	105,890	112,620	120,560	128,770	137,260	146,030	155,070	164,390	173,990	183,860
14	97,322	104,580	112,230	120,150	128,360	136,840	145,610	154,660	164,000	173,610
15	86,007	92,063	98,333	104,820	111,520	118,430	125,560	132,900	140,450	148,220
16	1,692,000	1,875,800	2,085,300	2,304,900	2,534,600	2,774,500	3,024,500	3,284,500	3,554,700	3,835,000
17	467,150	501,680	539,970	579,670	620,800	663,360	707,340	752,750	799,580	847,840
18	221,090	239,020	255,650	270,970	284,930	297,510	308,700	318,480	326,860	333,840
19	272,920	251,170	228,320	204,380	179,350	153,230	126,020	97,713	68,317	37,830
20	260,930	248,670	235,800	222,320	208,230	193,540	178,250	162,340	145,840	128,720
21	298,740	318,000	339,200	361,110	383,730	407,060	431,110	455,860	481,320	507,490
22	501,790	543,110	582,880	621,040	657,530	692,300	725,310	756,520	785,890	813,390
23	31,667	6,931	0*	0*	0*	0*	0*	0*	0*	0*
24	18,346	16,442	14,452	12,374	10,209	7,956	5,616	3,189	674	0*
25	285,850	323,260	362,050	402,210	443,760	486,680	530,990	576,670	623,740	672,180
26	122,740	148,270	174,790	202,280	230,760	260,220	290,660	322,080	354,480	387,860

Table B.5: (Continued)

(Millions of Baht)

Sector	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	181,230	186,190	191,110	195,980	200,810	205,600	210,340	215,050	219,710	224,320
2	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*
3	1,111	1,111	1,111	1,111	1,111	1,111	1,111	1,111	1,111	1,111
4	70,377	71,818	73,278	74,754	76,249	77,761	79,291	80,839	82,404	83,987
5	88,810	93,354	98,012	102,780	107,670	112,670	117,790	123,020	128,360	133,820
6	1,086,900	1,106,600	1,124,900	1,168,500	1,212,200	1,257,000	1,280,600	1,303,700	1,325,400	1,364,300
7	75,402	74,353	73,238	72,058	70,812	69,501	68,124	66,682	65,175	63,601
8	496,820	495,570	494,090	492,360	490,390	488,180	485,730	483,030	480,100	476,920
9	226,440	239,040	251,930	265,120	278,590	292,360	306,430	320,780	335,430	350,370
10	536,060	533,980	528,450	519,750	508,170	494,010	477,550	459,100	438,930	417,320
11	738,300	731,530	719,150	701,650	679,490	653,170	623,210	590,100	554,340	516,440
12	358,120	378,130	398,690	419,800	441,440	463,640	486,380	509,670	533,510	557,890
13	194,010	204,440	215,140	226,120	237,380	248,910	260,720	272,800	285,160	297,800
14	183,500	193,680	204,140	214,880	225,900	237,200	248,780	260,650	272,800	285,220
15	156,210	164,410	172,820	181,450	190,290	199,340	208,610	218,100	227,800	237,710
16	4,125,500	4,426,000	4,736,700	5,057,400	5,388,300	5,729,300	6,080,400	6,441,700	6,813,000	7,194,500
17	897,520	948,630	1,001,200	1,055,100	1,110,500	1,167,300	1,225,500	1,285,200	1,346,300	1,408,800
18	339,420	343,620	346,470	347,980	348,180	347,120	344,840	341,370	336,760	331,080
19	6,251	0*	0*	0*	0*	0*	0*	0*	0*	0*
20	111,000	92,674	73,741	54,202	34,057	13,305	0*	0*	0*	0*
21	534,370	561,960	590,260	619,270	649,000	679,430	710,570	742,420	774,980	808,260
22	839,000	862,690	884,440	904,250	922,100	937,990	951,920	963,900	973,930	982,030
23	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*
24	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*
25	722,000	773,200	825,780	879,750	935,090	991,810	1,049,900	1,109,400	1,170,200	1,232,500
26	422,220	457,560	493,880	531,180	569,470	608,730	648,970	690,200	732,400	775,590

Appendix C: The Remedy for the Inconsistency between the Data from the Systems of Input – Output (SIO) and the National Accounting (SNA)

Another problem concerned in this study is the discrepancy between the data from the systems of input – output (SIO) and the national accounts (SNA). The inconsistency emerges not only in the year that the original I – O tables exist, but also for the year that data are generated by the RAS method. According to Li and Yinchu (1997)[1], four different methods employed to solve the discrepancy problem include:

1. Substituting annual SNA statistics only for the I/O report year by the SIO statistics, however this option creates the irregular movement (the jumping or dropping values) of the data in the corrected year which leads to the loss of continuity for the particular adjusted time series.
2. Adjusting the annual SNA statistics for every year of the study period by the ratio between the data from SNA and SIO, although this option preserves the smoothness of the adjusted data, it is certain that the values of the generated time series are lower or higher than the actual value. Consequently, the values of the estimated parameters based on these adjusted data are inappropriate.
3. Transforming the data from SIO according to the SNA statistics by adding the discrepancy column and row in the 2nd and 3rd quadrant of input – output table without adjusting for the technical coefficient matrix (*A*), this option allows the values of final demands, value added components, and the total output from the system of SIO to be consistent with those from the system of SNA,

[1] Zuo Li and Wang Yinchu, "The Treatment of the Discrepancy between the Systems of Input Output and National Accounting", Economic Information Centre of Jiangsu Province, November, 1997.

however the problem is that if "Across the Row" method[2] is used to estimate the input – output coefficient matrix (A) for the year that input – output table does not exist, it is possible that the estimated results might not consistent with the available A matrices from the system of SIO.

4. The final option is the same as the 3rd option except that the existing A matrices from SIO data are adjusted and used as the initial value to estimate other A matrices for the year when there is no input – output table. The matrix A is adjusted in order to solve the inconsistency problem of the 3rd option. However, this option does not preserve the intermediate relationships among the sectors from the system of SIO data, since the method requires the adjustment of the initial technical coefficient matrix.

According to the pros and cons of these four options in dealing with the discrepancy problem, two reasons support the 3rd option to be the best suitable approach for solving the problem of discrepancy in this study. Firstly, the main object for the core of MUTE model is to maintain the relationship of the intermediate transactions among the 26 sectors, thus the adjustment of the existing input – output coefficient matrix (A) will give the distorted results. Finally, since the RAS method rather than the "Across the Row" method is used in this study for updating the A matrix when the input – output table is not available in a given year, thus the inconsistency between the estimated A matrix from RAS method and the existing A matrix from SIO is not the problem anymore.

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[2] Briefly, "Across the Row" approach is the method employed to predict the change in input – output coefficient matrix (A) by using the regression technique to fit a logistic curve to the ratio of actual historical intermediate use to constant coefficient indicated use. For a clear information on "Across the Row" technique, see Buccellato, Claudio, "Input – Output Analysis, Technological Change and Relations between Industry and Services," Economic System Research, Vol. 2, No. 1, 1990.

Therefore, the preparing scheme for the core part of the baseline MUTE model (1975 – 2004) begins with the RAS procedure in estimating the input – output coefficient matrices (A_t) for the year that the input – output table does not exist by relying on the available SIO data. According to equation (4.3), the RAS method is based on the equation:

$$A_{(t+1)} = \hat{r} A_{(t)} \hat{s} \tag{4.3}$$

For each year, the initial matrix (A_t) is chosen from the existing input – output coefficient matrices for the time period that is the closest to the target matrix ($A_{(t+1)}$) as possible. Thus, normally the existing 1975 I – O table is used as the initial matrix to estimate the target matrices for the year 1976, and 1977, while the existing 1980 is employed to estimate the target A matrices for 1978, 1979, 1981, and 1982, and so on. However, in some cases the chosen initial matrix does not give the convergent result for the target year. If these case happens, the estimation of the A matrix in adjacent period is used as the initial matrix instead. The chosen initial matrices and their target year of estimation for the baseline MUTE model are shown in Table C.1.

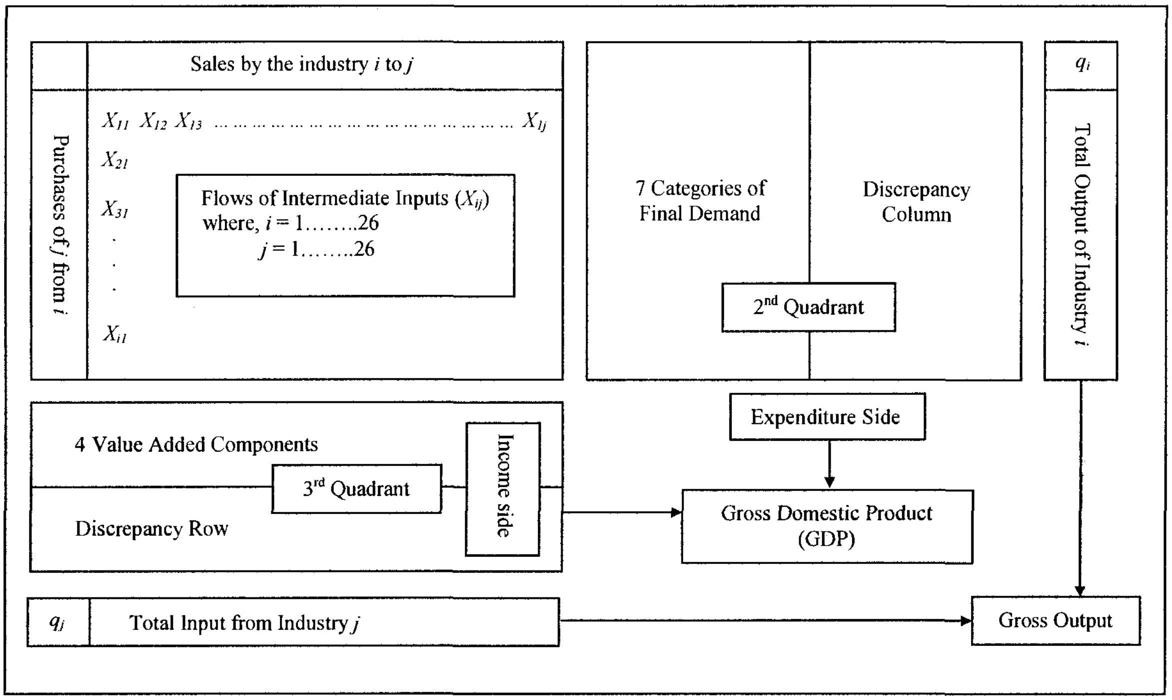
Table C.1: The Chosen Initial Matrices and Their Target Year of Estimation for the MUTE Model

Initial Matrix	Target Year
1975^{o}	1976,1977
1977^{e}	1978,1979
1980^{o}	1981,1982
1985^{o}	1983,1984,1986,1987
1987^{e}	1988,1989
1990^{o}	1991,1992
1995^{o}	1993,1994
1998^{o}	1996,1997
2000^{o}	1999,2001 - 2004

Note: The superscripts e and o denoted the use of the estimated and the original A matrices, respectively.

After all input – output coefficient matrices are estimated by the RAS method, each input – output table is adjusted again by inserting one column and one row in order to represent the discrepancy between the data from SIO and SNA. As a result, in the 2nd and the 3rd quadrant of each year I – O table will consist of 8 columns (7 categories of final demand plus one column of discrepancy), and 5 rows (4 value added components plus one row of discrepancy) as shown in the Figure C.1.

C.1: The Structure of the Input – Output Table after Adding the Discrepancy Column and Row



These additional column and row allow the value of each cell in input – output table to be consistent with the data from SNA system. Each cell in the 2nd and 3rd quadrant is inserted according to the available SNA data, while all values in the intermediate transaction quadrant (X_{ij}), the total input (q_j), the total output (q_i), and the gross output are the results from the RAS method. The discrepancy column (row) is computed from the difference between the total output (input), and the summation of the intermediate demand (input) and the final demands (value added components).

Nevertheless, the problem of inserting the accurate values in each input – output table comes from the fact that the format of SNA data does not relevant with the 26 - sectoral system of input – output table. On expenditure side, the SIO personal consumption expenditures, exports, and imports data for 26 sectors are summed up according to the SNA system of 33 personal consumption expenditures, 44 groups of exports, and 57 categories of merchandise imports[3], respectively by using the converter of input – output table classification shown in Appendix A. However, the current SNA classification for government consumption expenditure, gross fixed capital formation, inventory changes, and special exports do not provide sufficient information to compute the SIO 26 - sectoral data. Since the SNA annually reports the total amounts of these final demands, thus the way out of this problem is to use the information from the corresponding I/O table to stack these total amounts into the SIO 26 – sectoral data.

The problem on the price – income side is similar to the expenditure side. The SNA format reports only the annual total amounts of compensation of employees, operating surplus, indirect taxes less subsidies, and the total value added by 26 sectors. As a result, the total amount of depreciation can be computed as the residual by subtracting these reported 3 value added components from the annual GDP. Again, the SNA formatted tables for the decomposition for each value added components do not support the calculation of value added components by SIO 26 sectors, therefore the relevant SIO information about the proportion of each value added component to its own

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[3] These data are collected from the published economic series of the National Economic and Social Development Board (NESDB) and the Bank of Thailand (BOT).

total amount by 26 sectors (including both the I/O tables that are estimated by the RAS method and the existing tables) is used to stack the data for each year.

In conclusion, the method of adjusting the data by adding one column and one row of discrepancy has an advantage not only in generating the relevancy between the data from SIO and SNA, but also offering the convenient option for correcting the model in the future when the corresponding data are available.

Appendix D: The Forecasting Results under the Baseline Case and Scenarios # 1 – 3

Table D.1: The Baseline Estimation for the Personal Consumption Expenditure at Current Market Price

(Millions of Baht)

Sector	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	476863	524399	540549	558450	578235	606270	615479	622074	638399	643993	645578	662802	673050	673261	678251	674952
2	96040	92057	72230	76463	68245	50237	51409	55729	45807	47037	48280	28555	12150	4993	5260	5551
3	1270	1383	1442	1555	1657	1765	1875	1993	2114	2245	2376	2517	2661	2815	2965	3129
4	108265	118657	125389	125856	131905	142896	141491	137446	140625	136532	130826	136585	138866	134234	135035	130057
5	1640	1786	2134	501	6389	8491	8464	6839	7332	6334	5195	7654	9746	10148	12764	14095
6	200242	206383	219418	214960	221157	235102	228699	216609	217915	204662	189322	191597	187415	171025	163205	144601
7	373897	413677	418148	455022	473727	499919	532627	569934	604137	644433	685287	721825	760262	805012	844709	891148
8	291306	280960	282502	283284	289200	295443	297001	296714	301016	303275	305901	316165	326151	334738	346849	358633
9	60551	70146	78900	79010	89503	98688	101920	100123	106571	105882	106037	114349	121805	123102	130200	132532
10	48006	58282	62890	60156	60605	72198	68151	61452	64428	58054	50044	56712	59311	53242	54859	49180
11	59246	66821	73623	79127	86530	95827	102324	108609	117673	125441	133338	145479	157344	168220	181199	193842
12	23208	34615	45426	60305	71885	81781	96368	112994	126588	143330	160464	172714	185961	202786	216211	232892
13	17967	36337	37424	34363	33751	45790	40204	33024	35890	29502	20745	28848	32644	26901	30136	25633
14	1556	3388	7941	6117	10524	18613	18005	13992	16772	14215	10896	18846	25176	25647	32627	35300
15	16578	19825	15376	16535	12946	14193	13029	11534	10541	8398	5853	4495	2381	2518	2653	2799
16	134308	163809	192786	222992	260286	278561	310003	345561	374960	414802	457663	491587	530782	580903	625797	681221
17	156667	207398	250612	256109	291439	350277	356396	355821	391172	397532	400689	458758	505792	526634	577645	607899
18	54893	55176	49531	62434	63519	59004	70984	87485	93481	110136	128541	130934	137592	154661	162379	179180
19	580	632	658	710	756	806	856	910	965	4268	12388	11356	12260	19080	20845	27355
20	306773	302275	300150	336290	353989	354078	390380	435809	457689	503530	552663	566927	590197	636553	660878	705325
21	355344	380817	391117	411382	428692	460967	481044	498401	526554	547558	566053	602282	635253	660098	692558	720140
22	729301	807570	878643	937833	1026844	1130158	1202025	1264051	1363477	1439744	1520480	1646032	1769574	1875155	2006524	2127174
23	142449	161858	173667	190140	207556	229151	246743	264714	287031	308361	330074	358872	387748	415945	447288	479170
24	108696	114202	106980	124034	127242	108536	123141	146487	146846	167868	190963	178791	173688	188306	182184	192275
25	130347	136902	154115	177333	202607	203139	234309	265450	287656	321792	363246	380624	407815	448986	480179	524069
26	28403	14235	14834	34375	18582	10862	60209	142133	166098	245404	318106	341564	375202	450950	486955	561453
Total	3924395	4273590	4496484	4805335	5117773	5452750	5793135	6155885	6531734	6934328	7341005	7776871	8220826	8695912	9180155	9699606

Notes: The estimated results for consumption expenditure under the baseline case and scenario #1 are identical.

Table D.2: The Estimated Results for the Personal Consumption Expenditure at Current Market Price under Scenarios 2 and 3

(Millions of Baht)

Sector	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	476863	524399	540549	568923	589938	607394	616547	623086	639373	644914	646445	663639	673850	674014	678966	675622
2	96040	92057	72230	77897	69626	50330	51499	55820	45876	47104	48344	28591	12165	4999	5265	5556
3	1270	1383	1442	1585	1690	1768	1878	1996	2117	2248	2379	2520	2664	2818	2968	3132
4	108265	118657	125389	128216	134575	143161	141737	137670	140839	136727	131002	136758	139032	134384	135177	130186
5	1640	1786	2134	510	6518	8507	8478	6850	7343	6343	5202	7663	9758	10159	12778	14109
6	200242	206383	219418	218991	225633	235538	229096	216961	218247	204955	189576	191839	187638	171216	163377	144745
7	373897	413677	418148	463555	483315	500845	533551	570861	605059	645354	686208	722736	761166	805912	845598	892032
8	291306	280960	282502	288596	295053	295990	297517	297196	301475	303709	306312	316564	326538	335113	347215	358989
9	60551	70146	78900	80492	91315	98871	102097	100285	106734	106034	106180	114494	121950	123240	130337	132664
10	48006	58282	62890	61284	61832	72332	68270	61552	64526	58137	50111	56784	59381	53301	54917	49229
11	59246	66821	73623	80611	88282	96004	102501	108785	117852	125621	133517	145663	157531	168408	181390	194035
12	23208	34615	45426	61435	73340	81932	96535	113178	126781	143535	160680	172932	186182	203013	216439	233123
13	17967	36337	37424	35008	34434	45875	40273	33077	35944	29544	20772	28884	32682	26931	30168	25659
14	1556	3388	7941	6231	10737	18647	18036	14015	16798	14235	10910	18870	25206	25676	32662	35335
15	16578	19825	15376	16845	13209	14219	13051	11553	10557	8410	5861	4501	2383	2521	2655	2802
16	134308	163809	192786	227173	265554	279078	310541	346123	375532	415395	458278	492208	531413	581552	626456	681897
17	156667	207398	250612	260911	297338	350926	357015	356399	391769	398101	401227	459337	506393	527223	578254	608502
18	54893	55176	49531	63605	64805	59113	71107	87627	93623	110293	128713	131100	137756	154834	162550	179358
19	580	632	658	723	772	807	858	911	967	4274	12405	11370	12275	19102	20867	27382
20	306773	302275	300150	342597	361154	354734	391058	436517	458387	504250	553406	567643	590898	637265	661574	706025
21	355344	380817	391117	419097	437368	461821	481879	499211	527357	548341	566813	603042	636008	660836	693287	720854
22	729301	807570	878643	955420	1047627	1132253	1204111	1266107	1365556	1441803	1522523	1648110	1771678	1877252	2008638	2129285
23	142449	161858	173667	193706	211757	229576	247171	265144	287469	308802	330518	359325	388208	416410	447759	479645
24	108696	114202	106980	126360	129818	108737	123355	146726	147070	168108	191219	179017	173894	188516	182376	192466
25	130347	136902	154115	180658	206707	203515	234716	265882	288094	322252	363734	381105	408300	449488	480685	524589
26	28403	14235	14834	35019	18958	10882	60314	142364	166351	245755	318533	341995	375648	451454	487468	562010
Total	3924395	4273590	4496484	4895450	5221354	5462854	5803192	6165896	6541698	6944245	7350870	7786689	8230597	8705636	9189827	9709231

Notes: (1) The estimated results for sectoral wage rate and the aggregate wage rate under scenario 2 and scenario 3 are identical.

Table D.3: The Baseline Estimation for the Gross Fixed Capital Formation at Current Market Price

(Millions of Baht)

Sector	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	195515	213131	234347	257458	282631	310051	339919	372452	407890	446491	488537	534336	584224	638564	697755	762229
2	24849	26775	29074	31508	34101	36871	39832	42998	46382	50000	53868	58004	62426	67154	72208	77613
3	1348	1450	1516	1479	1554	1566	1528	1603	1574	1557	1623	1567	1580	1625	1559	1602
4	94964	107355	121953	138480	157192	178378	202364	229520	260267	295077	334489	379110	429630	486827	551585	624903
5	16918	13200	14849	15515	15784	15893	15937	15955	15962	15965	15966	15967	15967	15967	15967	15967
6	75515	80908	81258	87510	94023	100807	107873	115233	122899	130883	139199	147861	156882	166277	176063	186255
7	28277	32593	37518	43129	49523	56809	65111	74570	85349	97630	111625	127571	145740	166443	190034	216914
8	120451	125542	136440	147491	159092	171269	184052	197470	211554	226338	241857	258147	275246	293195	312035	331811
9	8506	8386	8677	9102	9212	9317	9416	9511	9602	9689	9771	9850	9925	9996	10064	10129
10	27585	25992	29355	32992	35060	37346	40346	43319	46169	49198	52411	55697	59074	62587	66231	69996
11	17010	17100	17175	17237	17286	17323	17346	17358	17357	17346	17323	17289	17245	17190	17126	17052
12	20652	23005	25631	28153	30634	33120	35643	38227	40891	43646	46506	49480	52575	55800	59162	62667
13	17506	18528	20189	21866	23556	25256	26967	28689	30421	32165	33919	35684	37460	39248	41046	42856
14	9454	10501	11473	13893	15403	17294	19093	21913	23968	26593	29213	32578	35398	38893	42413	46532
15	30281	33712	36183	39051	41332	44574	48158	52642	57247	62079	66744	71576	76633	82256	88432	95190
16	219835	250599	285235	324229	368130	417555	473200	535846	606375	685779	775175	875819	989127	1116693	1260311	1422001
17	1689823	2009246	2392529	2848943	3392334	4039227	4809311	5726037	6817323	8116405	9662849	11503756	13695196	16303913	19409362	23106129
18	77558	65810	67220	68171	68767	69087	69194	69135	68949	68663	68300	67878	67409	66905	66372	65819
19	62319	62470	68572	74570	80463	86255	91945	97535	103028	108425	113727	118937	124055	129085	134027	138882
20	310673	328080	353410	379173	406854	435839	465909	497838	531242	566175	603043	641657	682162	724788	769486	816420
21	47138	49224	52039	54965	57848	60762	63671	66593	69519	72453	75394	78341	81296	84258	87227	90203
22	409692	443995	477411	512562	556539	602305	649904	699380	750783	804156	859550	917016	976602	1038363	1102353	1168624
23	11308	7232	12033	12052	12052	12052	12052	12052	12052	12052	12052	12052	12052	12052	12052	12052
24	10076	8582	9048	8852	8648	8576	8265	8204	7980	7883	7755	7646	7571	7478	7423	7358
25	172060	187153	203197	220242	238346	257576	278000	299691	322726	347190	373169	400759	430057	461171	494211	529297
26	273921	290080	307106	324126	341140	358148	375150	392146	409135	426119	443097	460068	477033	493993	510946	527893
Total	3973232	4440650	5033438	5712751	6497508	7403257	8450188	9665920	11076644	12719957	14637161	16878645	19502565	22580721	26195451	30446394

Notes: The estimated results for consumption expenditure under the baseline case and scenario #1 are identical.

Table D.4: The Estimated Results for the Gross Fixed Capital Formation at Current Market Price under Scenarios 2 and 3

(Millions of Baht)

Sector	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	195515	213131	234347	255430	278394	305436	334892	366977	401926	439994	481461	526628	575828	629419	687793	751378
2	24849	26775	29074	31189	33442	36166	39079	42192	45520	49079	52884	56951	61300	65950	70922	76237
3	1348	1450	1516	1479	1554	1566	1528	1603	1574	1557	1623	1567	1580	1625	1559	1602
4	94964	107355	121953	137910	155977	177002	200806	227757	258270	292816	331929	376212	426349	483112	547379	620141
5	16918	13200	14849	12364	11359	14104	15214	15663	15844	15917	15947	15959	15964	15966	15966	15967
6	75515	80908	81258	85533	89986	96603	103495	110673	118150	125938	134049	142497	151295	160459	170004	179945
7	28277	32593	37518	43122	49508	56791	65091	74547	85323	97601	111591	127532	145696	166394	189977	216849
8	120451	125542	136440	143660	151239	163026	175399	188387	202021	216331	231353	247121	263673	281047	299284	318427
9	8506	8386	8677	9102	9212	9317	9416	9511	9602	9689	9771	9850	9925	9996	10064	10129
10	27585	25992	29355	32347	33747	35986	38939	41863	44662	47637	50795	54025	57343	60795	64377	68076
11	17010	17100	17175	17237	17286	17323	17346	17358	17357	17346	17323	17289	17245	17190	17126	17052
12	20652	23005	25631	27664	29635	32078	34555	37092	39706	42410	45216	48133	51170	54334	57632	61071
13	17506	18528	20189	21250	22319	24011	25715	27429	29153	30889	32635	34392	36160	37940	39730	41531
14	9454	10501	11473	13641	14886	16749	18519	21308	23330	25921	28504	31831	34610	38063	41538	45610
15	30281	33712	36183	38407	40004	43160	46652	51039	55540	60261	64808	69516	74438	79920	85945	92541
16	219835	250599	285235	324229	368130	417555	473200	535846	606375	685779	775175	875819	989127	1116693	1260311	1422001
17	1689823	2009246	2392529	2846226	3386383	4032143	4800878	5715998	6805373	8102179	9645914	11483597	13671198	16275345	19375355	23065646
18	77558	65810	67220	57518	49860	54439	57845	60342	62136	63384	64210	64709	64954	65003	64899	64677
19	62319	62470	68572	68630	68694	74706	80612	86415	92116	97717	103219	108625	113937	119156	124283	129322
20	310673	328080	353410	372275	392704	420964	450272	481399	513961	548009	583946	621582	661058	702602	746163	791903
21	47138	49224	52039	54026	55967	58876	61781	64698	67620	70549	73485	76429	79379	82336	85300	88272
22	409692	443995	477411	501305	533747	578950	625971	674857	725654	778406	833165	889979	948898	1009974	1073263	1138816
23	11308	7232	12033	7780	7763	12035	12052	12052	12052	12052	12052	12052	12052	12052	12052	12052
24	10076	8582	9048	8169	7640	8096	8037	8096	7928	7859	7743	7640	7569	7477	7423	7357
25	172060	187153	203197	220242	238346	257576	278000	299691	322726	347190	373169	400759	430057	461171	494211	529297
26	273921	290080	307106	323254	339395	356404	373406	390402	407393	424377	441355	458327	475293	492253	509207	526155
Total	3973232	4440650	5033438	5653989	6387179	7301064	8348701	9563196	10971310	12610887	14523323	16759021	19376098	22446272	26051763	30292054

Notes: (1) The estimated results for the sectoral wage rate and the aggregate wage rate under scenario 2 and scenario 3 are identical.

Table D.5: The Estimated Results for the Government Consumption Expenditure at Current Market Price

(Millions of Baht)

Sector	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	969	1098	1245	1375	1468	1533	1543	1519	1495	1464	1457	1484	1548	1649	1778	1919
2	236	286	301	378	407	438	444	442	434	442	443	456	480	530	577	628
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	513	591	664	745	802	850	863	857	856	846	861	885	932	1016	1105	1221
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	2376	2602	2863	3094	3256	3311	3281	3181	3054	2928	2863	2863	2933	3048	3220	3402
7	3	4	6	23	25	26	26	26	26	25	25	26	27	29	32	35
8	33	37	41	46	49	52	52	52	51	50	51	52	55	59	64	70
9	24489	28163	32108	35954	39234	41534	42707	42982	42841	42863	43565	45318	48304	52535	57846	63749
10	15797	16472	18850	21196	23225	24684	25465	25724	25732	25836	26337	27488	29394	32054	35403	39132
11	6478	6718	6857	6794	6475	5900	5098	4181	3258	2360	1507	677	713	766	833	907
12	41	46	52	57	62	64	65	65	64	63	63	65	69	74	80	87
13	285	268	228	172	111	26	26	26	26	25	25	26	27	29	32	35
14	81	102	124	504	555	593	601	610	601	606	608	638	671	736	801	872
15	3028	3525	4067	4606	5069	5424	5634	5727	5762	5819	5967	6260	6728	7377	8186	9090
16	8253	8610	8849	8845	8535	7871	6941	5844	4727	3660	2648	1679	658	707	769	837
17	11964	13426	15146	16785	18143	19015	19373	19310	19063	18907	19040	19640	20747	22366	24429	26693
18	17604	20255	23352	26421	29133	31151	32341	32841	33028	33334	34165	35817	38479	42170	46776	51903
19	1587	1486	1318	1066	728	322	327	325	319	316	317	325	343	368	400	436
20	13217	14709	16235	17587	18562	19002	18890	18388	17709	17115	16798	16880	17362	18214	19335	20534
21	9791	10972	12189	13302	14147	14596	14628	14349	13939	13593	13466	13653	14183	15033	16131	17324
22	14772	16139	17470	18538	19142	19157	18576	17595	16482	15449	14682	14225	14073	14164	14353	14498
23	350	397	446	493	530	554	562	558	549	543	545	560	589	633	689	750
24	1	2	2	2	2	3	3	3	3	3	3	3	3	4	4	4
25	679757	773938	873680	968927	1047327	1098435	1119139	1116228	1102728	1093726	1102146	1136888	1201788	1296419	1416041	1548265
26	1205	1301	1390	1444	1468	1443	1373	1273	1163	1060	975	898	850	810	769	715
Total	812828	921146	1037483	1148354	1238455	1295984	1317960	1312105	1293910	1281034	1288557	1326806	1400957	1510790	1649654	1803110

Table D.6: The Estimated Results for the Inventory Investment at Current Market Price

(Millions of Baht)

Sector	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	1653	1148	1148	1148	1148	1148	1148	1148	1148	1148	1148	1148	1148	1148	1148	1148
2	416	256	140	95	108	148	186	208	212	204	193	185	182	182	185	188
3	68	72	73	74	74	74	74	74	74	74	74	74	74	74	74	74
4	414	-27	-182	-79	133	301	354	308	225	161	143	162	196	220	226	217
5	435	-367	-590	-239	326	702	704	424	104	-47	22	214	379	422	347	230
6	818	-458	-919	-511	305	949	1094	786	321	9	-9	200	457	600	576	443
7	844	221	-134	-147	64	314	467	485	407	307	242	230	258	298	325	332
8	700	-368	4	749	999	778	524	486	589	668	663	621	599	607	623	628
9	125	-209	-259	-66	176	294	242	101	-13	-31	34	115	156	139	91	53
10	23	-559	-510	9	510	612	315	-77	-244	-103	179	358	318	131	-31	-48
11	521	-147	-387	-217	119	374	433	334	188	96	88	140	200	232	228	203
12	154	-253	-323	-91	212	363	297	112	-38	-60	30	144	198	171	100	45
13	267	-91	-61	155	287	262	173	125	140	176	194	186	171	165	169	175
14	103	23	-11	2	37	69	83	79	65	53	47	49	54	58	61	60
15	117	-188	-223	-38	184	283	224	90	-8	-15	51	125	155	133	87	55
16	1601	-1193	-1409	215	1689	1854	1040	265	152	558	965	1038	836	622	577	678
17	616	-443	-228	516	913	770	449	305	386	523	572	530	473	457	478	501
18	421	-609	-781	-241	459	829	733	369	47	-42	90	293	418	409	312	213
19	761	230	341	673	822	750	632	594	630	670	678	662	649	648	655	659
20	4269	415	-1238	-665	1059	2676	3433	3264	2584	1908	1566	1607	1874	2155	2308	2303
21	-70	468	287	266	694	694	694	694	694	694	694	694	694	694	694	694
22	1264	-1226	-1595	-245	1423	2224	1898	998	286	169	544	1017	1249	1163	910	706
23	594	-52	84	461	613	526	406	378	417	453	455	440	430	431	437	439
24	168	6	29	119	163	148	118	107	114	124	126	123	120	120	121	122
25	3915	170	-1400	-722	1046	2571	3121	2746	1974	1359	1175	1369	1703	1948	2005	1909
26	368	189	85	73	118	173	206	211	197	180	170	168	172	177	181	181
Total	20564	-2992	-8059	1292	13680	19885	19048	14612	10650	9237	10134	11892	13161	13405	12886	12208

Notes: (1) The estimated results for depreciation are referred to Table 5.18.

Table D.7: The Estimated Results for the Export Expenditure at Current Market Price

(Millions of Baht)

Sector	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	201993	188793	163430	126288	79250	87741	96635	105967	115925	125643	135829	146502	157697	169185	181087	193390
2	1396	1267	606	183	205	227	250	274	300	325	351	379	407	437	468	500
3	634	731	826	917	1024	1134	1249	1369	1498	1623	1755	1893	2037	2186	2340	2499
4	80611	95883	111798	128062	147306	167849	190191	214399	240836	267952	297162	328461	362255	397971	435794	476062
5	57096	63662	67486	68801	69148	67638	64424	59327	52521	43396	32173	18928	3260	3497	3743	3998
6	272284	261376	263779	235575	217273	175028	132593	69823	1398	1515	1638	1767	1902	2040	2184	2332
7	8712	8238	7706	6850	5597	3854	1665	1825	1997	2164	2340	2524	2717	2914	3120	3331
8	286579	334057	381962	429687	485604	544205	606697	673317	745272	817276	893710	975037	1061501	1151508	1246241	1345401
9	21823	25689	29615	33575	38226	43228	48526	54216	60409	66663	73355	80633	88289	96323	104815	113769
10	302186	359600	418237	478245	548949	624540	706412	794892	891750	990535	1096810	1211131	1333837	1463357	1600928	1746672
11	121128	123669	143779	178210	203621	222640	253033	290612	324908	357233	396723	440262	484093	529851	580383	633972
12	275710	321675	367595	413297	466696	522743	582309	645844	714419	782970	855687	933017	1015048	1100651	1190402	1284602
13	57350	66977	76624	86231	97476	109279	121855	135266	149773	164278	179701	196093	213523	231701	250808	270846
14	194084	192108	205485	229032	256386	284686	314543	345923	379526	412642	447381	483922	522533	562202	603468	646465
15	35569	41775	48110	54429	61912	69754	78157	87257	97053	107029	117578	128962	140990	153738	167049	181230
16	2055201	2438521	2843217	3252066	3737115	4254340	4815287	5421860	6086389	6764601	7494690	8279424	9122932	10013694	10960370	11963523
17	173826	200687	227118	252883	282871	313857	346422	380698	417368	453333	491137	530863	572654	615683	660399	706764
18	8120	9652	11229	12843	14744	16777	18977	21449	24064	26730	29599	32682	35995	39491	43205	47140
19	338	439	495	550	614	756	832	913	1098	1190	1287	1388	1630	1749	1872	1999
20	110343	68878	29670	66110	57680	46100	31130	34136	37343	40474	43755	47193	50800	54501	58335	62298
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	28717	33391	36881	39201	41161	42246	42533	41985	40638	38202	34864	30537	25264	18944	11542	2832
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	1	1	1	1	1	1	1	1	1	1	1	1	2	2
26	39	24	5	5	6	6	7	8	8	9	10	10	11	12	13	14
Total	4293740	4837094	5435651	6093042	6812863	7598629	8453727	9381361	10384493	11465785	12627535	13871609	15199376	16611638	18108568	19689641

Table D.8: The Estimated Results for the Special Export at Current Market Price

(Millions of Baht)

Sector	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	1848	1926	1980	2008	2043	2048	2020	1981	1906	1794	1622	1427	1186	898	528	133
2	34	38	42	47	51	56	62	68	74	81	88	95	102	109	117	125
3	36	41	45	49	68	75	82	90	98	107	116	125	162	174	186	199
4	18	20	23	25	27	30	33	36	39	43	46	50	54	58	62	66
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	10741	10726	10530	10039	9437	8535	7373	5889	4028	1773	1924	2078	2238	2405	2579	2757
7	23166	26886	30916	34909	39683	44677	50248	56351	62792	69682	77114	84907	93154	101930	111291	121013
8	51148	58172	65904	73623	83029	92911	104042	116250	129178	142996	157937	173595	190164	207800	226622	246178
9	8420	9854	12353	14572	16410	22794	24746	25303	26661	29693	29042	32676	38340	43142	45996	52185
10	6	6	7	8	8	9	10	11	12	13	14	15	17	18	19	20
11	38623	42945	47577	52006	57400	62897	69000	75549	82281	89314	96746	104337	112163	120328	128850	137489
12	1429	1592	1778	1946	2152	2362	2594	2845	3104	3375	3685	3981	4287	4607	4941	5282
13	4	4	5	5	6	6	7	8	9	9	10	11	12	13	13	14
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	16558	18958	21600	24278	27536	30985	34878	39170	43734	48641	53959	59568	65518	71855	78659	85769
16	15811	15339	14513	13131	11466	9252	6486	3098	3379	3674	3987	4307	4637	4984	5345	5713
17	40134	44374	48882	53127	58285	63495	69230	75351	81574	88011	94753	101558	108496	115664	123069	130480
18	125	139	155	169	187	206	226	248	270	294	319	344	371	398	427	457
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	71811	79837	88438	96645	106656	116857	128148	140275	152755	165789	179539	193601	208094	223215	238960	254948
21	172632	190463	209692	243018	266382	291768	319845	350047	381052	413437	447620	482525	518456	555950	595053	634629
22	284203	319398	357621	395044	440598	487829	540574	597963	657897	721390	789292	859737	933404	1011245	1093484	1178174
23	8056	8080	8100	6664	6455	6786	7127	7456	7741	7989	8205	8363	8466	8518	8546	8471
24	39551	45428	51942	58559	66592	75139	84781	95431	106801	119028	132325	146353	161261	177262	194363	212296
25	99738	111184	123493	135336	149758	164538	180925	198607	216863	236006	256306	277131	298714	321291	344936	369018
26	14082	15045	15987	16728	17635	18430	19212	19936	20511	20956	21301	21433	21381	21151	20760	20097
Total	898174	1000456	1111581	1231934	1361866	1501685	1651650	1811963	1982758	2164096	2355953	2558217	2770676	2993015	3224808	3465516

Table D.9: The Baseline Estimation for Import Expenditure at Current Market Price

(Millions of Baht)

Sector	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	75385	82122	88415	94368	100687	109018	116718	123923	129672	134999	140487	147141	154973	163597	172126	179979
2	4223	4556	4804	5019	5185	5386	5563	5756	5938	6127	6312	6500	6685	6872	7058	7245
3	4290	4527	4695	4879	5050	5230	5403	5580	5755	5931	6106	6281	6455	6630	6804	6978
4	40827	38366	34112	33951	35844	36276	37678	38384	39527	40334	41366	42257	43253	44196	45208	46192
5	71049	79682	81633	87214	92290	96933	101207	105162	108839	112287	115533	118609	121537	124338	127033	129633
6	141886	154598	164423	173636	181527	190482	198830	207707	216336	225247	234059	243025	251976	261019	270071	279190
7	14483	14521	16790	17428	17734	18270	18647	19131	19544	20007	20433	20885	21320	21766	22203	22648
8	153556	163527	168465	174007	178736	183465	187994	192627	197128	201576	205879	210155	214433	218771	223136	227509
9	95540	89062	114393	118806	119956	123665	125819	129190	131862	135132	138059	141267	144345	147556	150691	153905
10	612010	631477	649337	667986	686635	705314	723963	742612	761290	779939	798588	817267	835916	854565	873244	891893
11	52498	58341	68976	76483	67508	71058	72570	75461	77415	80030	82177	84626	86883	89278	91560	93931
12	198801	224583	255665	280772	302050	326962	346725	368912	388898	408249	427832	445641	463799	480978	497556	514013
13	39087	38746	38796	39520	40796	41682	42839	43816	44911	45923	46997	48032	49087	50129	51185	52230
14	282881	290651	265156	271002	280007	286828	295175	302495	310502	318017	325876	333521	341304	348991	356750	364456
15	206913	221285	237080	268367	284226	305492	304682	323318	336805	360309	364696	378124	386465	407824	416360	429475
16	2438119	2574255	2602714	2680208	2754590	2831155	2906240	2982300	3057702	3133586	3209129	3284866	3360579	3436185	3511712	3587593
17	262572	256700	266081	271811	280078	286560	294279	301160	308613	315669	322997	330153	337424	344603	351858	359063
18	21634	22096	26981	28329	29671	31278	32288	33710	34941	36039	37245	38386	39406	40522	41547	42529
19	289	311	330	351	373	395	419	442	467	492	517	543	570	597	625	653
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	66915	68733	71379	73098	75367	77389	79512	81600	83695	85796	87887	89986	92077	94175	96268	98366
22	93837	103279	108287	112682	115514	119094	121947	125168	128061	131139	134057	137061	140002	142980	145924	148892
23	5497	6047	6547	6981	7368	7804	8221	8666	9107	9566	10027	10499	10977	11465	11959	12461
24	40307	44217	47559	50694	53527	56684	59722	62948	66151	69471	72808	76230	79688	83213	86782	90410
25	65343	71654	77246	80666	82069	84835	86691	89160	91214	93559	95695	97962	100143	102391	104596	106833
26	34624	38557	41744	44647	47100	50000	52718	55655	58552	61587	64612	67740	70897	74116	77381	80705
Total	5022564	5281893	5441608	5662906	5843889	6051254	6225850	6424881	6612924	6811011	6989376	7176755	7360194	7556760	7739638	7926779

Table D.10: Estimated Result for Import Expenditure under Scenario 1 at Current Market Price

(Millions of Baht)

Sector	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	75385	82122	88415	94248	101742	110313	118880	126505	132958	138774	144879	152047	160437	169576	178646	187005
2	4223	4556	4804	5014	5224	5434	5642	5851	6059	6266	6473	6680	6886	7092	7298	7504
3	4290	4527	4695	4878	5060	5242	5423	5604	5785	5966	6146	6326	6505	6685	6864	7043
4	40827	38366	34112	34139	34186	34241	34282	34327	34365	34404	34466	34548	34669	34803	34966	35155
5	71049	79682	81633	87214	92293	96936	101211	105168	108846	112296	115543	118620	121549	124352	127047	129648
6	141886	154598	164423	173508	182659	191872	201150	210478	219862	229297	238772	248290	257839	267435	277067	286729
7	14483	14521	16790	17398	17999	18595	19190	19780	20369	20955	21537	22117	22692	23268	23840	24412
8	153556	163527	168465	173978	178986	183772	188508	193240	197908	202473	206923	211321	215732	220192	224686	229178
9	95540	89062	114393	118490	122732	127074	131507	135983	140507	145063	149616	154178	158723	163288	167845	172390
10	612010	631477	649337	667986	686635	705314	723963	742612	761290	779939	798588	817267	835916	854565	873244	891893
11	52498	58341	68976	76098	70890	75210	79499	83737	87946	92128	96255	100354	104398	108443	112457	116450
12	198801	224583	255665	280607	303500	328741	349694	372459	393411	413433	433865	452381	471305	489191	506511	523663
13	39087	38746	38796	39570	40351	41135	41928	42727	43525	44332	45145	45963	46783	47608	48436	49268
14	282881	290651	265156	271289	277490	283738	290017	296334	302663	309012	315398	321814	328267	334727	341196	347694
15	206913	221285	237080	268015	287320	309289	311020	330889	346438	371375	377573	392510	402486	425354	435475	450073
16	2438119	2574255	2602714	2679927	2757060	2834187	2911301	2988345	3065394	3142423	3219412	3296354	3373372	3450184	3526976	3604041
17	262572	256700	266081	272043	278039	284057	290102	296170	302265	308376	314510	320671	326865	333049	339260	345487
18	21634	22096	26981	28289	30019	31706	33002	34562	36026	37286	38696	40007	41211	42497	43701	44850
19	289	311	330	351	373	395	419	442	467	492	517	543	570	597	625	653
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	66915	68733	71379	73074	75584	77655	79955	82129	84368	86570	88787	90992	93198	95401	97605	99807
22	93837	103279	108287	112564	116559	120377	124089	127726	131315	134878	138408	141922	145415	148903	152383	155852
23	5497	6047	6547	6976	7414	7860	8315	8779	9250	9730	10218	10713	11215	11725	12243	12767
24	40307	44217	47559	50660	53829	57055	60340	63687	67091	70550	74064	77633	81251	84923	88647	92419
25	65343	71654	77246	80514	83410	86481	89438	92441	95389	98355	101277	104197	107087	109989	112881	115761
26	34624	38557	41744	44600	47511	50505	53560	56660	59831	63057	66323	69651	73025	76445	79920	83441
Total	5022564	5281893	5441608	5661429	5856865	6067185	6252436	6456636	6653330	6857431	7043391	7237100	7427397	7630293	7819818	8013183

Table D.11: Estimated Result for Import Expenditure under Scenario 2 at Current Market Price

(Millions of Baht)

Sector	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	75385	82122	88415	95160	101479	109018	116718	123923	129672	134999	140487	147141	154973	163597	172126	179979
2	4223	4556	4804	5078	5244	5386	5563	5756	5938	6127	6312	6500	6685	6872	7058	7245
3	4290	4527	4695	4917	5088	5230	5403	5580	5755	5931	6106	6281	6455	6630	6804	6978
4	40827	38366	34112	34117	36011	36276	37678	38384	39527	40334	41366	42257	43253	44196	45208	46192
5	71049	79682	81633	91447	96523	96933	101207	105162	108839	112287	115533	118609	121537	124338	127033	129633
6	141886	154598	164423	175610	183500	190482	198830	207707	216336	225247	234059	243025	251976	261019	270071	279190
7	14483	14521	16790	16418	16724	18270	18647	19131	19544	20007	20433	20885	21320	21766	22203	22648
8	153556	163527	168465	176032	180761	183465	187994	192627	197128	201576	205879	210155	214433	218771	223136	227509
9	95540	89062	114393	104217	105367	123665	125819	129190	131862	135132	138059	141267	144345	147556	150691	153905
10	612010	631477	649337	668805	687454	705314	723963	742612	761290	779939	798588	817267	835916	854565	873244	891893
11	52498	58341	68976	74114	65139	71058	72570	75461	77415	80030	82177	84626	86883	89278	91560	93931
12	198801	224583	255665	281465	302744	326962	346725	368912	388898	408249	427832	445641	463799	480978	497556	514013
13	39087	38746	38796	39140	40417	41682	42839	43816	44911	45923	46997	48032	49087	50129	51185	52230
14	282881	290651	265156	272407	281412	286828	295175	302495	310502	318017	325876	333521	341304	348991	356750	364456
15	206913	221285	237080	262576	278436	305492	304682	323318	336805	360309	364696	378124	386465	407824	416360	429475
16	2438119	2574255	2602714	2735099	2809482	2831155	2906240	2982300	3057702	3133586	3209129	3284866	3360579	3436185	3511712	3587593
17	262572	256700	266081	263325	271592	286560	294279	301160	308613	315669	322997	330153	337424	344603	351858	359063
18	21634	22096	26981	26332	27674	31278	32288	33710	34941	36039	37245	38386	39406	40522	41547	42529
19	289	311	330	353	375	395	419	442	467	492	517	543	570	597	625	653
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	66915	68733	71379	74225	76494	77389	79512	81600	83695	85796	87887	89986	92077	94175	96268	98366
22	93837	103279	108287	114979	117811	119094	121947	125168	128061	131139	134057	137061	140002	142980	145924	148892
23	5497	6047	6547	7015	7401	7804	8221	8666	9107	9566	10027	10499	10977	11465	11959	12461
24	40307	44217	47559	51134	53967	56684	59722	62948	66151	69471	72808	76230	79688	83213	86782	90410
25	65343	71654	77246	81084	82487	84835	86691	89160	91214	93559	95695	97962	100143	102391	104596	106833
26	34624	38557	41744	45254	47707	50000	52718	55655	58552	61587	64612	67740	70897	74116	77381	80705
Total	5022564	5281893	5441608	5700306	5881289	6051254	6225850	6424881	6612924	6811011	6989376	7176755	7360194	7556760	7739638	7926779

Table D.12: Estimated Result for Import Expenditure under Scenario 3 at Current Market Price

(Millions of Baht)

Sector	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	75385	82122	88415	95040	102534	110313	118880	126505	132958	138774	144879	152047	160437	169576	178646	187005
2	4223	4556	4804	5073	5283	5434	5642	5851	6059	6266	6473	6680	6886	7092	7298	7504
3	4290	4527	4695	4916	5098	5242	5423	5604	5785	5966	6146	6326	6505	6685	6864	7043
4	40827	38366	34112	34306	34353	34241	34282	34327	34365	34404	34466	34548	34669	34803	34966	35155
5	71049	79682	81633	91447	96526	96936	101211	105168	108846	112296	115543	118620	121549	124352	127047	129648
6	141886	154598	164423	175481	184632	191872	201150	210478	219862	229297	238772	248290	257839	267435	277067	286729
7	14483	14521	16790	16388	16989	18595	19190	19780	20369	20955	21537	22117	22692	23268	23840	24412
8	153556	163527	168465	176004	181012	183772	188508	193240	197908	202473	206923	211321	215732	220192	224686	229178
9	95540	89062	114393	103901	108143	127074	131507	135983	140507	145063	149616	154178	158723	163288	167845	172390
10	612010	631477	649337	668805	687454	705314	723963	742612	761290	779939	798588	817267	835916	854565	873244	891893
11	52498	58341	68976	73729	68521	75210	79499	83737	87946	92128	96255	100354	104398	108443	112457	116450
12	198801	224583	255665	281300	304193	328741	349694	372459	393411	413433	433865	452381	471305	489191	506511	523663
13	39087	38746	38796	39191	39972	41135	41928	42727	43525	44332	45145	45963	46783	47608	48436	49268
14	282881	290651	265156	272694	278895	283738	290017	296334	302663	309012	315398	321814	328267	334727	341196	347694
15	206913	221285	237080	262224	281529	309289	311020	330889	346438	371375	377573	392510	402486	425354	435475	450073
16	2438119	2574255	2602714	2734818	2811952	2834187	2911301	2988345	3065394	3142423	3219412	3296354	3373372	3450184	3526976	3604041
17	262572	256700	266081	263557	269553	284057	290102	296170	302265	308376	314510	320671	326865	333049	339260	345487
18	21634	22096	26981	26292	28022	31706	33002	34562	36026	37286	38696	40007	41211	42497	43701	44850
19	289	311	330	353	375	395	419	442	467	492	517	543	570	597	625	653
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	66915	68733	71379	74201	76711	77655	79955	82129	84368	86570	88787	90992	93198	95401	97605	99807
22	93837	103279	108287	114860	118856	120377	124089	127726	131315	134878	138408	141922	145415	148903	152383	155852
23	5497	6047	6547	7009	7447	7860	8315	8779	9250	9730	10218	10713	11215	11725	12243	12767
24	40307	44217	47559	51100	54268	57055	60340	63687	67091	70550	74064	77633	81251	84923	88647	92419
25	65343	71654	77246	80932	83828	86481	89438	92441	95389	98355	101277	104197	107087	109989	112881	115761
26	34624	38557	41744	45207	48118	50505	53560	56660	59831	63057	66323	69651	73025	76445	79920	83441
Total	5022564	5281893	5441608	5698829	5894265	6067185	6252436	6456636	6653330	6857431	7043391	7237100	7427397	7630293	7819818	8013183

Table D.13: The Estimated Results for the Sectoral Productivity at Current Market Price

(Millions of Baht per Thousand Persons)

Sector	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	82.62	86.31	88.34	90.84	93.21	95.61	98.00	100.40	102.79	105.19	107.58	109.98	112.37	114.77	117.16	119.56
2	71.73	73.77	75.82	77.87	79.92	81.97	84.01	86.06	88.11	90.16	92.21	94.26	96.30	98.35	100.40	102.45
3	35.33	33.66	33.48	34.72	35.68	36.65	37.62	38.59	39.56	40.52	41.49	42.46	43.43	44.39	45.36	46.33
4	455.54	483.09	497.49	511.87	526.26	540.66	555.06	569.46	583.83	598.23	612.63	627.03	641.42	655.82	670.20	684.60
5	1548.96	1580.52	1631.10	1676.04	1722.66	1768.80	1815.06	1861.26	1907.52	1953.78	1999.98	2046.24	2092.44	2138.70	2184.90	2231.16
6	1239.32	1279.81	1320.26	1360.72	1401.18	1441.67	1482.13	1522.59	1563.08	1603.54	1643.99	1684.45	1724.94	1765.40	1805.86	1846.35
7	1271.13	1316.17	1356.00	1395.87	1435.70	1475.56	1515.43	1555.26	1595.12	1634.95	1674.82	1714.68	1754.51	1794.38	1834.21	1874.07
8	1315.74	1351.05	1390.22	1428.44	1466.88	1505.30	1543.71	1582.12	1620.50	1658.91	1697.32	1735.73	1774.15	1812.56	1850.94	1889.35
9	1362.04	1404.98	1445.30	1486.09	1526.81	1567.53	1608.26	1648.98	1689.70	1730.42	1771.14	1811.87	1852.59	1893.31	1934.03	1974.75
10	1102.27	1131.31	1160.35	1189.39	1218.43	1247.47	1276.51	1305.55	1334.59	1363.63	1392.67	1421.71	1450.75	1479.79	1508.83	1537.87
11	1561.76	1728.41	1872.85	1999.67	2112.50	2214.27	2307.26	2393.29	2473.78	2549.91	2622.54	2692.44	2760.15	2826.15	2890.77	2954.29
12	1149.46	1184.37	1219.25	1254.13	1289.01	1323.89	1358.78	1393.66	1428.54	1463.42	1498.33	1533.21	1568.09	1602.98	1637.86	1672.74
13	1236.31	1273.24	1310.17	1347.09	1384.05	1420.98	1457.91	1494.83	1531.76	1568.69	1605.62	1642.54	1679.47	1716.40	1753.32	1790.25
14	1116.69	1145.96	1175.23	1204.47	1233.74	1263.01	1292.25	1321.52	1350.76	1380.03	1409.30	1438.54	1467.81	1497.08	1526.32	1555.59
15	1251.13	1227.70	1351.88	1288.06	1398.64	1353.92	1452.07	1422.17	1509.42	1491.24	1569.18	1560.37	1630.50	1629.28	1692.90	1697.82
16	1169.29	1192.95	1228.29	1263.60	1298.95	1334.26	1369.57	1404.91	1440.22	1475.56	1510.87	1546.18	1581.53	1616.84	1652.15	1687.49
17	1295.51	1340.49	1384.81	1422.40	1458.86	1497.38	1536.68	1575.42	1613.83	1652.31	1690.95	1729.60	1768.17	1806.75	1845.36	1883.94
18	2356.08	2429.40	2502.72	2576.04	2649.36	2722.68	2796.00	2869.44	2942.76	3016.08	3089.40	3162.72	3236.04	3309.36	3382.68	3456.12
19	86.24	88.07	89.92	91.76	93.61	95.46	97.30	99.15	100.99	102.84	104.69	106.53	108.38	110.22	112.07	113.92
20	372.57	381.57	391.67	401.50	411.40	421.28	431.16	441.03	450.91	460.81	470.69	480.57	490.45	500.32	510.22	520.10
21	292.34	300.26	308.15	316.07	323.97	331.89	339.81	347.71	355.63	363.53	371.45	379.37	387.27	395.19	403.08	411.00
22	1539.37	1561.70	1618.82	1634.99	1679.13	1723.23	1767.36	1811.46	1855.60	1899.70	1943.83	1987.93	2032.07	2076.17	2120.27	2164.40
23	593.45	602.00	621.77	641.55	661.32	681.10	700.87	720.65	740.42	760.20	779.97	799.75	819.53	839.30	859.08	878.85
24	69.17	84.93	87.75	88.85	91.17	93.49	95.81	98.12	100.44	102.76	105.08	107.39	109.71	112.03	114.35	116.66
25	363.50	372.78	382.28	391.80	401.34	410.88	420.42	429.96	439.50	449.04	458.58	468.12	477.66	487.20	496.74	506.28
26	8998.20	7776.60	6555.00	5333.70	4112.10	2890.50	1668.99	447.48	447.48	447.48	447.48	447.48	447.48	447.48	447.48	447.48
Average	1228.30	1208.89	1196.11	1173.37	1157.92	1136.13	1119.54	1097.73	1127.19	1152.42	1181.22	1206.58	1234.89	1260.39	1288.33	1313.98

Notes: (1) The estimated results for the sectoral productivity are referred to Table 5.26.

Table D.14: The Baseline Forecast for the Sectoral Wage rate and the Aggregate Wage Rate

(Baht/Year/Person)

Sector	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	28625	32730	33488	36070	39156	42333	45986	49857	54241	58957	64279	70051	76556	83540	91372	100063
2	61342	72994	77229	86881	97903	110534	125026	141701	160907	183094	208731	238450	272926	313079	359840	414439
3	36004	33915	24079	26939	28317	29803	31015	31631	31098	35030	39562	44744	50742	57601	65557	74776
4	71013	78673	77125	79931	82864	85640	88506	91230	94006	96657	99311	101851	104369	106789	109162	111406
5	71359	78946	77344	80329	83306	86198	89128	92011	94808	97605	100365	102970	105598	108117	110476	112834
6	66415	75314	75590	80572	85760	91270	97052	103175	109612	116413	123552	131089	138998	147352	156127	165348
7	94779	104321	101698	104970	108081	111042	113813	116401	118788	120960	122891	124596	126035	127237	128173	128833
8	67856	80706	83347	93750	103820	117453	131377	149556	168946	193727	221037	255400	294376	342585	398212	467844
9	77024	83415	80006	81221	82234	83075	83746	84171	84462	84537	84417	84114	83652	82937	82094	81087
10	96987	111180	113125	122132	131807	142259	153435	165551	178547	192562	207598	223853	241204	260088	280327	302033
11	97023	106786	103906	106955	109944	112795	115574	118277	120990	123565	126214	128778	131345	133818	136328	138790
12	62547	68419	66343	68167	69924	71643	73280	74863	76379	77821	79169	80456	81630	82739	83753	84658
13	84772	96295	95764	102212	108028	115214	121874	129914	137651	146703	155608	165892	176225	187819	199658	212996
14	86803	94135	90452	92096	92706	94589	96889	101150	101234	106577	106034	105045	101926	103603	103687	105541
15	81504	91106	87873	91131	91643	95075	96163	98768	98813	100489	100409	101590	100925	101136	100015	99622
16	90446	100045	97782	101141	104385	107437	110347	113026	115554	117812	119904	121708	123317	124579	125623	126406
17	91746	109291	115826	130517	147614	167447	190663	217632	249527	286767	331026	383227	445545	518998	607320	713168
18	213907	249879	259086	285130	313691	345348	380223	418788	461482	508513	560507	618521	682054	753453	831963	918572
19	68416	75071	72930	75022	77004	78864	80605	82203	83673	84987	86153	87153	87996	88658	89152	89476
20	85710	93584	89587	91228	92071	92987	93224	93406	93023	92507	91524	90365	88824	87029	84920	82688
21	65077	70282	66761	67090	67227	67078	66809	66209	65533	64555	63541	62254	60951	59305	57639	55894
22	104972	116920	116926	122362	129439	135786	143454	150340	158641	166152	175165	183357	193136	202002	212507	222282
23	151224	167235	162851	167745	172109	176178	179566	182542	184925	186767	187854	188522	188338	187782	186561	184639
24	127494	133140	119638	113083	106142	98788	91268	83624	76092	68643	61520	54678	48263	42227	36695	31648
25	97481	111095	112359	120631	129570	139208	149656	160931	173191	186441	200862	216477	233496	251902	271977	293844
26	71864	78684	77903	82214	88611	100196	122312	212060	201184	191953	181089	170518	161117	150962	141920	132128
Agg. W	61893	70728	71682	77051	82765	88851	95333	102233	109586	117411	125736	134591	144008	154019	164662	175972

Notes: (1) The estimated results for sectoral wage rate and the aggregate wage rate under the base case and scenario #1 are identical. (2) Agg. W denotes the aggregate wage rate, while the numbers in each row # represent the sectoral wage rate.

Table D.15: The Forecast for the Sectoral Wage rate and the Aggregate Wage Rate under Scenarios 2 and 3

(Baht/Year/Person)

Sector	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	28625	32730	33488	38285	41560	42333	45986	49857	54241	58957	64279	70051	76556	83540	91372	100063
2	61342	72994	77229	92215	103913	110534	125026	141701	160907	183094	208731	238450	272926	313079	359840	414439
3	36004	33915	24079	28593	30055	29803	31015	31631	31098	35030	39562	44744	50742	57601	65557	74776
4	71013	78673	77125	84838	87951	85640	88506	91230	94006	96657	99311	101851	104369	106789	109162	111406
5	71359	78946	77344	85260	88420	86198	89128	92011	94808	97605	100365	102970	105598	108117	110476	112834
6	66415	75314	75590	85518	91025	91270	97052	103175	109612	116413	123552	131089	138998	147352	156127	165348
7	94779	104321	101698	111414	114716	111042	113813	116401	118788	120960	122891	124596	126035	127237	128173	128833
8	67856	80706	83347	99506	110193	117453	131377	149556	168946	193727	221037	255400	294376	342585	398212	467844
9	77024	83415	80006	86207	87283	83075	83746	84171	84462	84537	84417	84114	83652	82937	82094	81087
10	96987	111180	113125	129630	139899	142259	153435	165551	178547	192562	207598	223853	241204	260088	280327	302033
11	97023	106786	103906	113521	116694	112795	115574	118277	120990	123565	126214	128778	131345	133818	136328	138790
12	62547	68419	66343	72351	74217	71643	73280	74863	76379	77821	79169	80456	81630	82739	83753	84658
13	84772	96295	95764	108487	114660	115214	121874	129914	137651	146703	155608	165892	176225	187819	199658	212996
14	86803	94135	90452	97749	98397	94589	96889	101150	101234	106577	106034	105045	101926	103603	103687	105541
15	81504	91106	87873	96726	97269	95075	96163	98768	98813	100489	100409	101590	100925	101136	100015	99622
16	90446	100045	97782	107350	110794	107437	110347	113026	115554	117812	119904	121708	123317	124579	125623	126406
17	91746	109291	115826	138529	156676	167447	190663	217632	249527	286767	331026	383227	445545	518998	607320	713168
18	213907	249879	259086	302635	332949	345348	380223	418788	461482	508513	560507	618521	682054	753453	831963	918572
19	68416	75071	72930	79628	81732	78864	80605	82203	83673	84987	86153	87153	87996	88658	89152	89476
20	85710	93584	89587	96828	97723	92987	93224	93406	93023	92507	91524	90365	88824	87029	84920	82688
21	65077	70282	66761	71209	71354	67078	66809	66209	65533	64555	63541	62254	60951	59305	57639	55894
22	104972	116920	116926	129874	137386	135786	143454	150340	158641	166152	175165	183357	193136	202002	212507	222282
23	151224	167235	162851	178043	182675	176178	179566	182542	184925	186767	187854	188522	188338	187782	186561	184639
24	127494	133140	119638	120025	112658	98788	91268	83624	76092	68643	61520	54678	48263	42227	36695	31648
25	97481	111095	112359	128036	137524	139208	149656	160931	173191	186441	200862	216477	233496	251902	271977	293844
26	71864	78684	77903	87261	94051	100196	122312	212060	201184	191953	181089	170518	161117	150962	141920	132128
Agg. W	61893	70728	71682	81781	87846	88851	95333	102233	109586	117411	125736	134591	144008	154019	164662	175972

Notes: (1) The estimated results for sectoral wage rate and the aggregate wage rate under scenario 2 and scenario 3 are identical. (2) Agg. W denotes the aggregate wage rate, while the numbers in each row # represent the sectoral wage rate.

Table D.16: The Baseline Estimation for the Compensation of Employees at Current Market Price

(Millions of Baht)

Sector	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	330551	380782	384853	404397	426512	476416	526131	579719	648078	718280	797336	895648	1004318	1118156	1254130	1404472
2	132557	144880	123947	135335	133361	116719	128905	154706	159373	186751	219380	205354	195722	211797	257183	312950
3	181	263	228	238	347	402	425	540	561	679	905	1060	1367	1758	2068	2639
4	47710	56599	60510	66412	73858	82840	90568	98687	108943	118760	129427	143066	157502	172110	189105	206723
5	3179	3317	3510	3510	3841	3907	3788	3497	3235	2805	2283	1853	1292	1452	1727	1946
6	70090	77034	76006	79472	84416	88622	89643	88798	88231	93290	98682	105865	111238	115858	121311	127605
7	37337	43337	41722	45159	47291	49947	53090	56762	60201	64092	68020	71625	75352	79527	83330	87562
8	56516	67757	71808	82694	94685	110720	127759	150039	175631	208029	245430	294527	352594	425673	514056	627012
9	10484	13110	12509	13322	14808	16235	17089	17462	18302	18796	19176	20150	21173	21835	22656	23359
10	21325	30791	37411	45526	55216	67108	78466	90881	106360	121916	139432	161885	186809	213712	245820	280923
11	51549	53923	51085	52281	53984	54656	55750	56967	58074	58800	59823	61065	62246	63326	64675	66052
12	20225	24391	25463	28493	31968	35290	39298	43473	47843	52373	57067	61784	66670	71890	77054	82467
13	13134	17342	18323	20309	22509	26173	28456	31093	34732	38002	41187	46633	51989	56981	63334	69616
14	3945	4297	8117	10185	12541	15580	18043	20949	23576	27105	29205	32109	34117	37314	40449	44100
15	439	1095	883	240	341	558	2093	2605	3296	3578	4847	6003	7090	7955	9246	10701
16	195813	257958	299723	354245	416862	480981	550479	623992	702441	782208	866164	952316	1042409	1134431	1228328	1324435
17	172176	234917	282313	358711	461753	598041	769813	995312	1301801	1703297	2242766	2980620	3979129	5321493	7171170	9701609
18	38315	43800	44765	50910	56123	60835	67938	76103	83329	92908	103768	112780	123446	137716	151180	168310
19	194088	185973	159845	143018	124485	104367	83192	82773	87472	94521	105237	108093	112344	120924	125033	132485
20	235873	242254	220708	240278	244083	243521	248412	258888	262632	270848	278334	278517	280807	288650	291148	296000
21	200717	227116	222077	234697	243555	254432	262418	268569	276102	280789	284708	289952	294059	294774	296055	295497
22	138541	165329	172154	190599	212459	234676	257513	278818	306574	331677	361126	393796	430749	465070	506864	546888
23	40073	47634	49184	53033	57213	62407	66272	70036	74598	78577	82202	87168	91536	95337	99255	102613
24	236657	206865	171867	183352	174395	143408	149162	159616	148179	150590	151262	130692	115678	109293	95408	87257
25	392674	484091	531068	614889	704041	783859	872410	960722	1050776	1156855	1285749	1429226	1608182	1828677	2082220	2378601
26	4106	5489	6992	10084	14790	25198	60508	453811	464177	499023	521445	520200	523059	534100	531118	533037
Total	2648257	3020344	3077073	3421391	3765437	4136897	4647622	5624818	6294516	7154549	8194963	9391988	10930878	12929810	15523924	18914858

Notes: (1) The sectoral compensation of employees is the product between the labor requirement in the particular sector and its corresponding wage rate.

Table D.17: Estimated Result for the Compensation of Employees under Scenario 1 at Current Market Price

(Millions of Baht)

Sector	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	330551	380782	384853	404445	426069	475842	525117	578437	646344	716165	794712	892523	1000595	1113804	1249046	1398592
2	132557	144880	123947	135340	133313	116655	128786	154550	159152	186469	219014	204897	195153	211097	256323	311904
3	181	263	228	239	340	393	409	521	538	649	867	1013	1309	1687	1982	2535
4	47710	56599	60510	66383	74119	83162	91110	99337	109774	119718	130546	144318	158899	173639	190774	208519
5	3179	3317	3510	3510	3841	3907	3787	3497	3235	2804	2282	1852	1292	1451	1726	1945
6	70090	77034	76006	79480	84347	88534	89491	88610	87984	92996	98328	105456	110766	115322	120706	126930
7	37337	43337	41722	45161	47271	49923	53049	56714	60140	64022	67939	71536	75253	79421	83215	87441
8	56516	67757	71808	82695	94667	110696	127715	149981	175550	207925	245294	294355	352378	425405	513723	626598
9	10484	13110	12509	13339	14659	16054	16793	17115	17870	18311	18625	19550	20524	21146	21928	22600
10	21325	30791	37411	45526	55216	67108	78466	90881	106360	121916	139432	161885	186809	213712	245820	280923
11	51549	53923	51085	52302	53808	54445	55403	56558	57559	58214	59146	60313	61413	62419	63690	64994
12	20225	24391	25463	28502	31889	35193	39138	43283	47601	52098	56749	61431	66279	71466	76596	81978
13	13134	17342	18323	20305	22543	26217	28532	31187	34856	38151	41366	46842	52231	57257	63647	69969
14	3945	4297	8117	10163	12730	15812	18430	21421	24163	27800	29994	32964	35022	38302	41505	45237
15	439	1095	883	265	138	291	1674	2079	2665	2832	4023	5066	6099	6867	8117	9492
16	195813	257958	299723	354268	416663	480737	550071	623506	701824	781502	865348	951412	1041411	1133352	1227168	1323202
17	172176	234917	282313	358689	461960	598320	770332	996001	1302782	1704563	2244428	2982720	3981790	5324812	7175316	9706748
18	38315	43800	44765	50914	56082	60781	67841	75978	83159	92698	103505	112463	123066	137266	150651	167693
19	194088	185973	159845	143018	124485	104367	83192	82773	87472	94521	105237	108093	112344	120924	125033	132485
20	235873	242254	220708	240278	244083	243521	248412	258888	262632	270848	278334	278517	280807	288650	291148	296000
21	200717	227116	222077	234702	243511	254378	262330	268468	275978	280651	284554	289787	293882	294590	295864	295301
22	138541	165329	172154	190608	212379	234575	257339	278606	306296	331350	360734	393348	430234	464494	506216	546173
23	40073	47634	49184	53035	57201	62393	66248	70007	74562	78537	82156	87118	91481	95279	99194	102549
24	236657	206865	171867	183396	174043	143017	148573	158987	147467	149869	150527	129977	114990	108648	94810	86712
25	392674	484091	531068	614936	703608	783301	871432	959494	1049131	1154864	1283304	1426342	1604787	1824749	2077684	2373420
26	4106	5489	6992	10084	14781	25181	60447	453334	463602	498393	520753	519472	522293	533314	530313	532229
Total	2648257	3020344	3077073	3421585	3763745	4134801	4644117	5620212	6288695	7147864	8187196	9383251	10921107	12919072	15512193	18902170

Notes: (1) The sectoral compensation of employees is the product between the labor requirement in the particular sector and its corresponding wage rate.

Table D.18: Estimated Result for the Compensation of Employees under Scenario 2 at Current Market Price

(Millions of Baht)

Sector	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	330551	380782	384853	432449	455673	474870	524274	577502	645444	715155	793626	891272	999143	1112048	1246918	1395951
2	132557	144880	123947	144894	142410	115894	127916	153529	157927	185017	217297	202781	192573	207984	252591	307407
3	181	263	228	246	365	405	428	543	564	682	908	1064	1371	1762	2073	2644
4	47710	56599	60510	70759	78607	82664	90359	98440	108656	118426	129041	142623	156995	171529	188444	205969
5	3179	3317	3510	3350	3639	3821	3753	3483	3230	2803	2282	1853	1293	1452	1727	1947
6	70090	77034	76006	84356	89499	88383	89383	88513	87921	92952	98314	105467	110806	115388	120802	127053
7	37337	43337	41722	48693	51040	50015	53158	56830	60268	64158	68085	71689	75414	79587	83388	87619
8	56516	67757	71808	87732	100196	110120	127066	149226	174685	206912	244116	292963	350738	423448	511392	623786
9	10484	13110	12509	15072	16655	16244	17098	17470	18310	18804	19183	20156	21180	21841	22662	23365
10	21325	30791	37411	48285	58502	66968	78311	90709	106171	121707	139201	161633	186533	213407	245486	280556
11	51549	53923	51085	55710	57525	54665	55759	56976	58083	58809	59832	61074	62255	63335	64684	66061
12	20225	24391	25463	30239	33917	35242	39249	43422	47790	52318	57011	61725	66608	71826	76987	82398
13	13134	17342	18323	21589	23876	26079	28357	30988	34622	37886	41065	46506	51857	56841	63188	69462
14	3945	4297	8117	10685	13175	15542	18003	20905	23530	27055	29153	32056	34064	37259	40391	44040
15	439	1095	883	665	690	460	1995	2495	3185	3456	4723	5869	6955	7810	9099	10546
16	195813	257958	299723	371685	438221	481023	550522	624037	702487	782255	866213	952365	1042458	1134481	1228378	1324485
17	172176	234917	282313	381762	491006	597321	768844	994005	1300045	1700927	2239557	2976281	3973234	5313456	7160178	9686513
18	38315	43800	44765	53156	57605	58991	66411	74840	82283	92045	103057	112192	122963	137322	150860	168053
19	194088	185973	159845	146653	121863	94827	73805	73554	78431	85677	96603	99669	104141	112954	117300	124997
20	235873	242254	220708	254887	257408	240382	245177	255556	259211	267346	274765	274876	277112	284915	287382	292214
21	200717	227116	222077	250377	259756	254224	262210	268363	275900	280590	284512	289763	293876	294596	295884	295332
22	138541	165329	172154	202621	225150	233001	255740	276954	304604	329605	358932	391494	428315	462512	504160	544043
23	40073	47634	49184	56084	60692	62513	66382	70145	74707	78685	82309	87275	91642	95441	99358	102713
24	236657	206865	171867	196234	186494	143114	149148	159727	148309	150734	151405	130804	115767	109372	95469	87309
25	392674	484091	531068	653588	748525	783987	872555	960884	1050949	1157046	1285963	1429448	1608419	1828937	2082497	2378903
26	4106	5489	6992	10689	15652	25138	60388	453094	463508	498426	520913	519701	522593	533683	530729	532688
Total	2648257	3020344	3077073	3632456	3988139	4115891	4626291	5602188	6270822	7129476	8168068	9362602	10898304	12893188	15482028	18866050

Notes: (1) The sectoral compensation of employees is the product between the labor requirement in the particular sector and its corresponding wage rate.

Table D.19: Estimated Result for the Compensation of Employees under Scenario 3 at Current Market Price

(Millions of Baht)

Sector	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	330551	380782	384853	432499	455202	474297	523260	576220	643711	713040	791002	888146	995420	1107696	1241834	1390071
2	132557	144880	123947	144899	142360	115830	127798	153372	157706	184735	216932	202325	192003	207283	251731	306361
3	181	263	228	247	356	395	411	523	540	652	870	1016	1312	1691	1986	2540
4	47710	56599	60510	70727	78884	82986	90901	99090	109487	119384	130159	143876	158392	173059	190112	207765
5	3179	3317	3510	3350	3639	3820	3753	3483	3230	2802	2282	1853	1292	1452	1727	1946
6	70090	77034	76006	84364	89425	88295	89231	88325	87674	92658	97960	105057	110334	114853	120197	126378
7	37337	43337	41722	48695	51018	49991	53117	56781	60206	64088	68004	71599	75315	79481	83273	87497
8	56516	67757	71808	87734	100177	110096	127022	149168	174604	206807	243980	292792	350522	423180	511058	623372
9	10484	13110	12509	15090	16496	16064	16802	17123	17878	18318	18632	19557	20530	21152	21934	22606
10	21325	30791	37411	48285	58502	66968	78311	90709	106171	121707	139201	161633	186533	213407	245486	280556
11	51549	53923	51085	55732	57338	54454	55412	56567	57568	58223	59154	60322	61422	62428	63699	65003
12	20225	24391	25463	30249	33833	35145	39088	43232	47548	52043	56692	61371	66218	71402	76529	81909
13	13134	17342	18323	21585	23913	26123	28433	31082	34747	38035	41244	46715	52099	57117	63501	69814
14	3945	4297	8117	10662	13375	15773	18389	21376	24117	27750	29942	32911	34969	38246	41448	45177
15	439	1095	883	691	475	193	1575	1969	2554	2710	3899	4933	5963	6722	7970	9337
16	195813	257958	299723	371709	438010	480779	550114	623551	701870	781549	865397	951461	1041460	1133402	1227218	1323253
17	172176	234917	282313	381739	491225	597601	769362	994694	1301027	1702193	2241218	2978382	3975894	5316775	7164325	9691652
18	38315	43800	44765	53160	57561	58937	66314	74715	82113	91835	102794	111875	122583	136872	150330	167437
19	194088	185973	159845	146653	121863	94827	73805	73554	78431	85677	96603	99669	104141	112954	117300	124997
20	235873	242254	220708	254887	257408	240382	245177	255556	259211	267346	274765	274876	277112	284915	287382	292214
21	200717	227116	222077	250383	259708	254170	262123	268262	275776	280452	284358	289598	293699	294412	295693	295136
22	138541	165329	172154	202630	225064	232900	255566	276741	304326	329278	358540	391046	427801	461936	503513	543328
23	40073	47634	49184	56085	60680	62498	66358	70116	74672	78645	82263	87225	91587	95383	99296	102649
24	236657	206865	171867	196280	186121	142722	148559	159097	147597	150013	150670	130089	115080	108727	94871	86763
25	392674	484091	531068	653638	748065	783429	871577	959656	1049304	1155055	1283518	1426565	1605024	1825009	2077961	2373721
26	4106	5489	6992	10690	15643	25121	60326	452617	462933	497796	520221	518973	521827	532897	529924	531880
Total	2648257	3020344	3077073	3632663	3986343	4113795	4622786	5597582	6265001	7122790	8160301	9353864	10888534	12882451	15470298	18853362

Notes: (1) The sectoral compensation of employees is the product between the labor requirement in the particular sector and its corresponding wage rate.

Table D.20: The Baseline Forecast for the Sectoral Profit

(Millions of Baht)

Sector	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	328018	414248	435076	474918	520576	567929	620821	676684	738459	804349	877067	955079	1041178	1132867	1233825	1344138
2	46115	53877	58032	61722	64514	69364	74740	79244	84975	91041	95823	101345	107942	114195	121433	130096
3	3252	6658	8117	8228	8557	8923	9366	9918	10644	10918	11170	11393	11572	11697	11745	11697
4	98329	100104	107971	116643	125587	134719	144090	153659	163460	173461	183687	194118	204764	215621	226689	237962
5	69981	78357	83604	88631	93924	99353	104990	110836	116857	123085	129505	136124	142938	149951	157168	164578
6	114927	122833	131743	139786	148219	157044	166215	175655	185314	195164	205219	215469	225937	236615	247509	258610
7	40900	46651	47157	50696	54263	57865	61478	65107	68747	72385	76009	79633	83228	86814	90378	93909
8	170111	183022	196182	209165	222608	236194	250175	264263	278671	293102	307752	322286	336901	351228	365423	378965
9	46846	49482	53031	56626	60343	64181	68142	72226	76431	80758	85208	89779	94471	99287	104225	109284
10	61424	62351	67152	71606	76172	80843	85621	90491	95459	100513	105654	110867	116161	121506	126913	132374
11	42914	50512	56198	62037	68040	74199	80518	86996	93637	100435	107393	114513	121789	129226	136825	144580
12	33314	34945	37849	40044	42337	44718	47186	49744	52397	55139	57976	60904	63934	67051	70266	73581
13	45170	48579	52455	55937	59579	63238	67054	70887	74858	78849	82967	87103	91352	95625	99997	104377
14	11339	12501	13391	14251	15150	16063	17000	17943	18961	19948	21029	22143	23308	24448	25634	26829
15	40659	40762	44337	46810	49876	52498	55637	58590	62098	65400	69111	72682	76679	80606	84865	89082
16	239980	259036	282198	301578	321751	342791	364636	387379	410933	435404	460722	486960	514068	542143	571093	600966
17	160630	161505	173238	183309	193200	202774	211861	220411	228114	234850	240217	243983	245602	244814	240704	232594
18	71055	85438	90416	99830	109982	121023	132984	145987	160144	175510	192246	210625	230519	252532	276469	302587
19	83352	72493	80174	84709	89191	93600	97962	102265	106528	110742	114929	119074	123184	127292	131358	135414
20	735131	800774	860790	917775	979515	1043176	1109084	1176981	1247046	1319147	1393378	1469662	1548060	1628507	1711059	1795610
21	168448	169914	181680	193525	205583	217860	230351	243062	255984	269127	282479	296050	309831	323833	338045	352468
22	229461	250065	267523	286387	306108	326345	347395	368953	391336	414228	437956	462188	487271	512843	539273	566219
23	79421	98083	117841	134307	151675	169846	188984	208974	229893	251719	274544	298224	322944	348499	375014	402505
24	24381	24443	25257	26503	27786	29085	30424	31802	33233	34717	36267	37880	39566	41321	43153	45061
25	156554	163678	176639	188929	201593	214593	227911	241532	255420	269574	283963	298594	313422	328439	343618	358918
26	9632	18646	16963	14744	12271	9262	5180	-5491	-6448	-7618	-8661	-9774	-11054	-12293	-13692	-15050
Total	3111345	3408957	3665014	3928696	4208398	4497489	4799804	5104097	5433152	5771945	6123610	6486905	6865569	7254667	7658988	8077352

Notes: The estimated results for the sectoral profit under the baseline case and scenario #1 are identical.

Table D.21: The Estimated Results for the Sectoral Profit under Scenario 2 and 3

(Millions of Baht)

Sector	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	328018	414248	435076	529794	610096	633430	686321	742185	803960	869849	942567	1020579	1106679	1198368	1299325	1409639
2	46115	53877	58032	66957	74803	79418	84795	89298	95029	101096	105877	111399	117997	124250	131487	140150
3	3252	6658	8117	10937	14149	14709	15151	15704	16430	16704	16955	17179	17357	17483	17531	17482
4	98329	100104	107971	110348	112269	120620	129991	139559	149360	159361	169588	180019	190665	201521	212589	223862
5	69981	78357	83604	92202	101479	107353	112990	118836	124857	131085	137505	144124	150939	157951	165168	172579
6	114927	122833	131743	139657	149089	159197	168368	177807	187467	197317	207371	217622	228089	238767	249662	260762
7	40900	46651	47157	53208	56182	56490	60102	63731	67371	71009	74633	78257	81853	85438	89002	92533
8	170111	183022	196182	209678	224024	238093	252074	266161	280569	295001	309650	324185	338800	353127	367322	380864
9	46846	49482	53031	55911	58991	62910	66871	70954	75159	79487	83936	88508	93200	98016	102953	108012
10	61424	62351	67152	68232	69920	75170	79949	84819	89787	94841	99982	105195	110489	115833	121241	126702
11	42914	50512	56198	64113	72196	78361	84680	91159	97800	104597	111555	118675	125951	133388	140987	148742
12	33314	34945	37849	39593	42249	45489	47956	50514	53167	55909	58747	61674	64704	67821	71037	74351
13	45170	48579	52455	56011	60159	64301	68118	71951	75922	79912	84031	88167	92416	96689	101061	105441
14	11339	12501	13391	14611	15931	16907	17844	18787	19804	20792	21873	22986	24151	25292	26478	27673
15	40659	40762	44337	44784	46837	50484	53623	56576	60085	63386	67097	70668	74665	78592	82851	87068
16	239980	259036	282198	302673	328724	354865	376709	399452	423006	447477	472796	499034	526141	554216	583166	613040
17	160630	161505	173238	173531	175383	187220	196307	204857	212559	219295	224663	228429	230048	229260	225150	217040
18	71055	85438	90416	106930	120117	126186	138147	151150	165307	180673	197409	215788	235681	257694	281632	307750
19	83352	72493	80174	68995	60925	68669	73031	77335	81597	85811	89998	94143	98253	102361	106427	110483
20	735131	800774	860790	930306	1006720	1072566	1138474	1206371	1276436	1348537	1422768	1499052	1577450	1657897	1740449	1825000
21	168448	169914	181680	183592	185859	198278	210769	223480	236402	249545	262897	276469	290249	304251	318463	332886
22	229461	250065	267523	289517	311349	330441	351491	373048	395432	418323	442052	466284	491366	516939	543368	570314
23	79421	98083	117841	138213	163775	186463	205601	225591	246510	268336	291161	314841	339561	365116	391631	419122
24	24381	24443	25257	25128	24600	25514	26854	28231	29663	31146	32696	34310	35995	37750	39583	41490
25	156554	163678	176639	184503	193892	208228	221545	235166	249054	263208	277597	292229	307057	322073	337252	352552
26	9632	18646	16963	25656	34545	32064	27982	17311	16354	15184	14141	13027	11748	10509	9110	7752
Total	3111345	3408957	3665014	3985080	4314264	4593425	4895741	5200033	5529088	5867882	6219546	6582841	6961506	7350604	7754924	8173288

Notes: (1) The estimated results for the sectoral profit under scenario 2 and scenario 3 are identical.

Table D.22: The Estimated Results for Depreciation (Replacement Investment) at Current Market Price

(Millions of Baht)

Sector	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	17602	7111	7111	7111	7111	7111	7111	7111	7111	7111	7111	7111	7111	7111	7111	7111
2	-3604	-145	966	1323	1437	1474	1486	1490	1491	1492	1492	1492	1492	1492	1492	1492
3	2775	315	517	2508	141	1147	2232	-155	1800	1697	-125	2297	1034	221	2519	406
4	3255	1958	1958	1958	1958	1958	1958	1958	1958	1958	1958	1958	1958	1958	1958	1958
5	4149	4821	4821	4821	4821	4821	4821	4821	4821	4821	4821	4821	4821	4821	4821	4821
6	-24904	-9897	43472	129	129	129	129	129	129	129	129	129	129	129	129	129
7	-10032	3836	3836	3836	3836	3836	3836	3836	3836	3836	3836	3836	3836	3836	3836	3836
8	21068	21350	6807	10082	10082	10082	10082	10082	10082	10082	10082	10082	10082	10082	10082	10082
9	2104	3623	2577	661	661	661	661	661	661	661	661	661	661	661	661	661
10	4329	11864	-6653	-7315	-120	-733	-3424	-2864	-1897	-2229	-2560	-2393	-2286	-2363	-2395	-2361
11	50176	52911	55646	58381	61116	63851	66586	69321	72056	74791	77526	80261	82996	85731	88466	91201
12	3986	-4815	-3582	-2735	-2152	-1751	-1476	-1286	-1156	-1066	-1005	-962	-933	-913	-900	-890
13	1224	1627	1753	1793	1806	1809	1811	1811	1811	1811	1811	1811	1811	1811	1811	1811
14	-2103	-2482	-186	-8525	-2306	-4099	-2935	-8454	-2970	-5717	-4833	-8444	-4098	-7221	-6242	-8688
15	-1560	-6854	2908	1643	5770	1426	716	-2854	-1943	-1566	999	1719	2197	914	-93	-1065
16	-10280	-4748	-4748	-4748	-4748	-4748	-4748	-4748	-4748	-4748	-4748	-4748	-4748	-4748	-4748	-4748
17	10872	8736	7738	7272	7054	6952	6905	6883	6872	6868	6865	6864	6864	6863	6863	6863
18	-11939	-6653	-7163	-7673	-8183	-8693	-9204	-9714	-10224	-10734	-11244	-11754	-12264	-12775	-13285	-13795
19	15326	27129	27575	28022	28468	28914	29360	29806	30252	30698	31144	31591	32037	32483	32929	33375
20	98200	69444	66049	91565	74244	77745	89588	80409	85198	90635	86517	90764	93453	92208	95578	97230
21	868	6753	3910	5284	4620	4940	4786	4860	4824	4842	4833	4837	4835	4836	4836	4836
22	18263	105700	49742	53667	87938	90965	93992	97019	100050	103070	106100	109130	112150	115180	118210	121230
23	3610	3924	4797	4797	4797	4797	4797	4797	4797	4797	4797	4797	4797	4797	4797	4797
24	6453	4855	5462	4929	4783	4810	4457	4563	4313	4323	4216	4152	4121	4045	4029	3976
25	9223	12890	12890	12890	12890	12890	12890	12890	12890	12890	12890	12890	12890	12890	12890	12890
26	-2887	-1442	-1442	-1442	-1442	-1442	-1442	-1442	-1442	-1442	-1442	-1442	-1442	-1442	-1442	-1442
Total	206172	311809	286760	270233	304711	308854	324975	310931	330573	339008	341831	351461	363503	362608	373913	375715

Notes: (1) The estimated results for depreciation are referred to Table 6.9.

Table D.23: The Estimated Results for Indirect Taxes less Subsidies at Current Market Price

(Millions of Baht)

Sector	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	427	440	454	466	478	490	501	511	521	531	541	549	558	567	575	584
2	7	7	7	7	8	8	8	8	8	9	9	9	9	9	9	9
3	116	120	124	127	130	133	137	139	142	145	147	150	152	154	157	159
4	40	41	42	44	45	46	47	48	49	50	51	51	52	53	54	55
5	25519	26209	26912	27540	28149	28752	29335	29834	30317	30778	31237	31630	32024	32410	32787	33162
6	7036	6240	5425	4591	3751	1923	80	82	84	85	87	88	89	91	92	94
7	111542	115051	118642	121934	125165	128437	131605	134426	137195	139890	142601	145070	147523	149958	152368	154794
8	14482	14922	15372	15782	16183	16589	16981	17327	17665	17994	18322	18620	18916	19208	19497	19787
9	2816	2767	2712	2635	2557	2472	2370	2262	2139	2017	1889	1744	1602	1445	1291	1133
10	3179	3063	2938	2792	2633	2464	2281	2082	1872	1651	1421	1180	931	672	406	131
11	119037	126281	133818	141217	148744	156498	164314	171866	179520	187224	195090	202790	210597	218513	226527	234709
12	1932	1645	1331	1000	651	283	289	295	301	306	312	317	322	327	332	337
13	1658	1496	1323	1135	934	714	490	254	8	8	8	8	8	8	9	9
14	623	233	240	246	253	259	265	270	276	281	286	291	295	300	304	309
15	712	656	604	538	467	392	313	238	150	60	61	62	63	64	65	66
16	51551	54367	57198	59881	62567	64458	66357	68225	70177	72137	74703	77124	79439	81694	83945	85858
17	12893	13200	13503	13774	14025	14282	14523	14712	14899	15074	15237	15379	15507	15637	15762	15874
18	28752	30557	32438	34289	36172	38114	40074	41973	43896	45836	47817	49757	51737	53736	55760	57825
19	12996	13073	13132	13147	13129	13105	13053	12942	12819	12665	12507	12305	12098	11876	11630	11382
20	145110	150027	155073	159747	164361	169046	173615	177743	181818	185811	189820	193541	197256	200959	204642	208360
21	58265	58983	58921	60433	62154	64207	66228	68094	69951	71788	73645	75406	77166	78931	80698	82489
22	8036	6939	5766	4502	3146	2849	2514	2147	1788	1413	95	97	98	100	101	103
23	17092	17739	18412	19037	19659	20293	20917	21499	22069	22633	23202	23738	24284	24823	25362	25908
24	41556	43263	45033	46712	48382	50097	51786	53366	54943	56501	58088	59596	61105	62631	64153	65706
25	16750	17075	17394	17663	17906	18151	18370	18523	18668	18785	18903	18982	19041	19099	19146	19178
26	6083	6635	7046	7451	7862	8279	8707	9122	9543	9967	10392	10816	11247	11685	12128	12580
Total	688210	711030	733860	756690	779510	802340	825160	847990	870820	893640	916470	939300	962120	984950	1007800	1030600

Table D.24: The Baseline Forecast for the Sectoral Labor Requirement

(Thousand Persons)

Sector	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	11548	11634	11492	11211	10893	11254	11441	11628	11948	12183	12404	12786	13119	13385	13725	14036
2	2161	1985	1605	1558	1362	1056	1031	1092	990	1020	1051	861	717	676	715	755
3	5	8	9	9	12	13	14	17	18	19	23	24	27	31	32	35
4	672	719	785	831	891	967	1023	1082	1159	1229	1303	1405	1509	1612	1732	1856
5	45	42	45	44	46	45	42	38	34	29	23	18	12	13	16	17
6	1055	1023	1006	986	984	971	924	861	805	801	799	808	800	786	777	772
7	394	415	410	430	438	450	466	488	507	530	554	575	598	625	650	680
8	833	840	862	882	912	943	972	1003	1040	1074	1110	1153	1198	1243	1291	1340
9	136	157	156	164	180	195	204	207	217	222	227	240	253	263	276	288
10	220	277	331	373	419	472	511	549	596	633	672	723	774	822	877	930
11	531	505	492	489	491	485	482	482	480	476	474	474	474	473	474	476
12	323	356	384	418	457	493	536	581	626	673	721	768	817	869	920	974
13	155	180	191	199	208	227	233	239	252	259	265	281	295	303	317	327
14	45	46	90	111	135	165	186	207	233	254	275	306	335	360	390	418
15	5	12	10	3	4	6	22	26	33	36	48	59	70	79	92	107
16	2165	2578	3065	3503	3993	4477	4989	5521	6079	6639	7224	7825	8453	9106	9778	10478
17	1877	2149	2437	2748	3128	3572	4038	4573	5217	5940	6775	7778	8931	10253	11808	13604
18	179	175	173	179	179	176	179	182	181	183	185	182	181	183	182	183
19	2837	2477	2192	1906	1617	1323	1032	1007	1045	1112	1222	1240	1277	1364	1402	1481
20	2752	2589	2464	2634	2651	2619	2665	2772	2823	2928	3041	3082	3161	3317	3428	3580
21	3084	3231	3326	3498	3623	3793	3928	4056	4213	4350	4481	4658	4825	4971	5136	5287
22	1320	1414	1472	1558	1641	1728	1795	1855	1933	1996	2062	2148	2230	2302	2385	2460
23	265	285	302	316	332	354	369	384	403	421	438	462	486	508	532	556
24	1856	1554	1437	1621	1643	1452	1634	1909	1947	2194	2459	2390	2397	2588	2600	2757
25	4028	4357	4727	5097	5434	5631	5829	5970	6067	6205	6401	6602	6887	7259	7656	8095
26	57	70	90	123	167	251	495	2140	2307	2600	2879	3051	3246	3538	3742	4034
Total	38549	39080	39552	40890	41841	43118	45042	48867	51154	54005	57115	59897	63073	66929	70935	75525

Notes: (1) The sectoral labor requirement is simply the ratio between sectoral output and its corresponding labor productivity.

Table D.25: The Estimated Results of the Sectoral Labor Requirement under Scenario 1

(Thousand Persons)

Sector	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	11548	11634	11492	11213	10881	11241	11419	11602	11916	12147	12364	12741	13070	13333	13670	13977
2	2161	1985	1605	1558	1362	1055	1030	1091	989	1018	1049	859	715	674	712	753
3	5	8	9	9	12	13	13	16	17	19	22	23	26	29	30	34
4	672	719	785	831	894	971	1029	1089	1168	1239	1315	1417	1522	1626	1748	1872
5	45	42	45	44	46	45	42	38	34	29	23	18	12	13	16	17
6	1055	1023	1006	986	984	970	922	859	803	799	796	804	797	783	773	768
7	394	415	410	430	437	450	466	487	506	529	553	574	597	624	649	679
8	833	840	862	882	912	942	972	1003	1039	1073	1110	1153	1197	1242	1290	1339
9	136	157	156	164	178	193	201	203	212	217	221	232	245	255	267	279
10	220	277	331	373	419	472	511	549	596	633	672	723	774	822	877	930
11	531	505	492	489	489	483	479	478	476	471	469	468	468	466	467	468
12	323	356	384	418	456	491	534	578	623	669	717	764	812	864	915	968
13	155	180	191	199	209	228	234	240	253	260	266	282	296	305	319	328
14	45	46	90	110	137	167	190	212	239	261	283	314	344	370	400	429
15	5	12	10	3	2	3	17	21	27	28	40	50	60	68	81	95
16	2165	2578	3065	3503	3992	4475	4985	5516	6074	6633	7217	7817	8445	9097	9769	10468
17	1877	2149	2437	2748	3130	3573	4040	4577	5221	5944	6780	7783	8937	10260	11815	13611
18	179	175	173	179	179	176	178	181	180	182	185	182	180	182	181	183
19	2837	2477	2192	1906	1617	1323	1032	1007	1045	1112	1222	1240	1277	1364	1402	1481
20	2752	2589	2464	2634	2651	2619	2665	2772	2823	2928	3041	3082	3161	3317	3428	3580
21	3084	3231	3326	3498	3622	3792	3927	4055	4211	4347	4478	4655	4822	4967	5133	5283
22	1320	1414	1472	1558	1641	1728	1794	1853	1931	1994	2059	2145	2228	2299	2382	2457
23	265	285	302	316	332	354	369	384	403	421	437	462	486	507	532	555
24	1856	1554	1437	1622	1640	1448	1628	1901	1938	2183	2447	2377	2383	2573	2584	2740
25	4028	4357	4727	5098	5430	5627	5823	5962	6058	6194	6389	6589	6873	7244	7639	8077
26	57	70	90	123	167	251	494	2138	2304	2596	2876	3046	3242	3533	3737	4028
Total	38549	39080	39552	40892	41818	43090	44996	48812	51086	53928	57028	59802	62969	66817	70816	75399

Notes: (1) The sectoral labor requirement is simply the ratio between sectoral output and its corresponding labor productivity

Table D.26: The Estimated Results of the Sectoral Labor Requirement under Scenario 2

(Thousand Persons)

Sector	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	11548	11634	11492	11296	10964	11218	11401	11583	11900	12130	12347	12723	13051	13312	13647	13951
2	2161	1985	1605	1571	1370	1048	1023	1083	981	1011	1041	850	706	664	702	742
3	5	8	9	9	12	14	14	17	18	19	23	24	27	31	32	35
4	672	719	785	834	894	965	1021	1079	1156	1225	1299	1400	1504	1606	1726	1849
5	45	42	45	39	41	44	42	38	34	29	23	18	12	13	16	17
6	1055	1023	1006	986	983	968	921	858	802	798	796	805	797	783	774	768
7	394	415	410	437	445	450	467	488	507	530	554	575	598	626	651	680
8	833	840	862	882	909	938	967	998	1034	1068	1104	1147	1191	1236	1284	1333
9	136	157	156	175	191	196	204	208	217	222	227	240	253	263	276	288
10	220	277	331	372	418	471	510	548	595	632	671	722	773	821	876	929
11	531	505	492	491	493	485	482	482	480	476	474	474	474	473	474	476
12	323	356	384	418	457	492	536	580	626	672	720	767	816	868	919	973
13	155	180	191	199	208	226	233	239	252	258	264	280	294	303	316	326
14	45	46	90	109	134	164	186	207	232	254	275	305	334	360	390	417
15	5	12	10	7	7	5	21	25	32	34	47	58	69	77	91	106
16	2165	2578	3065	3462	3955	4477	4989	5521	6079	6640	7224	7825	8454	9107	9778	10478
17	1877	2149	2437	2756	3134	3567	4032	4567	5210	5931	6766	7766	8918	10238	11790	13582
18	179	175	173	176	173	171	175	179	178	181	184	181	180	182	181	183
19	2837	2477	2192	1842	1491	1202	916	895	937	1008	1121	1144	1183	1274	1316	1397
20	2752	2589	2464	2632	2634	2585	2630	2736	2787	2890	3002	3042	3120	3274	3384	3534
21	3084	3231	3326	3516	3640	3790	3925	4053	4210	4347	4478	4655	4822	4968	5133	5284
22	1320	1414	1472	1560	1639	1716	1783	1842	1920	1984	2049	2135	2218	2290	2372	2448
23	265	285	302	315	332	355	370	384	404	421	438	463	487	508	533	556
24	1856	1554	1437	1635	1655	1449	1634	1910	1949	2196	2461	2392	2399	2590	2602	2759
25	4028	4357	4727	5105	5443	5632	5830	5971	6068	6206	6402	6603	6888	7261	7657	8096
26	57	70	90	122	166	251	494	2137	2304	2597	2877	3048	3244	3535	3740	4032
Total	38549	39080	39552	40946	41788	42879	44805	48627	50913	53760	56866	59643	62812	66661	70659	75239

Notes: (1) The sectoral labor requirement is simply the ratio between sectoral output and its corresponding labor productivity.

Table D.27: The Estimated Results of the Sectoral Labor Requirement under Scenario 3

(Thousand Persons)

Sector	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	11548	11634	11492	11297	10953	11204	11379	11558	11868	12094	12306	12678	13003	13260	13591	13892
2	2161	1985	1605	1571	1370	1048	1022	1082	980	1009	1039	848	703	662	700	739
3	5	8	9	9	12	13	13	17	17	19	22	23	26	29	30	34
4	672	719	785	834	897	969	1027	1086	1165	1235	1311	1413	1518	1621	1742	1865
5	45	42	45	39	41	44	42	38	34	29	23	18	12	13	16	17
6	1055	1023	1006	987	982	967	919	856	800	796	793	801	794	779	770	764
7	394	415	410	437	445	450	467	488	507	530	553	575	598	625	650	679
8	833	840	862	882	909	937	967	997	1033	1068	1104	1146	1191	1235	1283	1332
9	136	157	156	175	189	193	201	203	212	217	221	233	245	255	267	279
10	220	277	331	372	418	471	510	548	595	632	671	722	773	821	876	929
11	531	505	492	491	491	483	479	478	476	471	469	468	468	467	467	468
12	323	356	384	418	456	491	533	577	623	669	716	763	811	863	914	968
13	155	180	191	199	209	227	233	239	252	259	265	282	296	304	318	328
14	45	46	90	109	136	167	190	211	238	260	282	313	343	369	400	428
15	5	12	10	7	5	2	16	20	26	27	39	49	59	66	80	94
16	2165	2578	3065	3463	3953	4475	4985	5517	6074	6634	7217	7818	8445	9098	9769	10468
17	1877	2149	2437	2756	3135	3569	4035	4571	5214	5936	6771	7772	8924	10244	11797	13590
18	179	175	173	176	173	171	174	178	178	181	183	181	180	182	181	182
19	2837	2477	2192	1842	1491	1202	916	895	937	1008	1121	1144	1183	1274	1316	1397
20	2752	2589	2464	2632	2634	2585	2630	2736	2787	2890	3002	3042	3120	3274	3384	3534
21	3084	3231	3326	3516	3640	3789	3923	4052	4208	4344	4475	4652	4819	4964	5130	5280
22	1320	1414	1472	1560	1638	1715	1782	1841	1918	1982	2047	2133	2215	2287	2369	2444
23	265	285	302	315	332	355	370	384	404	421	438	463	486	508	532	556
24	1856	1554	1437	1635	1652	1445	1628	1903	1940	2185	2449	2379	2384	2575	2585	2742
25	4028	4357	4727	5105	5440	5628	5824	5963	6059	6195	6390	6590	6874	7245	7640	8078
26	57	70	90	123	166	251	493	2134	2301	2593	2873	3044	3239	3530	3734	4025
Total	38549	39080	39552	40949	41768	42851	44759	48573	50845	53684	56779	59548	62708	66550	70540	75113

Notes: (1) The sectoral labor requirement is simply the ratio between sectoral output and its corresponding labor productivity

Table D.28: The Baseline Forecast for the Sectoral Gross Output at Current Market Price

(Billions of Baht)

Sector	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	954	1004	1015	1018	1015	1076	1121	1167	1228	1282	1334	1406	1474	1536	1608	1678
2	155	146	122	121	109	87	87	94	87	92	97	81	69	67	72	77
3	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	2
4	306	348	390	425	469	523	568	616	677	735	798	881	968	1057	1161	1270
5	69	66	74	73	79	80	77	71	65	56	45	37	26	29	34	38
6	1308	1309	1328	1342	1379	1400	1369	1310	1258	1285	1313	1360	1380	1388	1403	1425
7	501	547	556	601	628	664	707	758	808	866	927	986	1049	1122	1192	1274
8	1096	1134	1198	1260	1338	1419	1501	1587	1685	1781	1885	2002	2125	2252	2389	2532
9	185	221	226	244	275	306	328	342	366	385	402	434	469	498	534	569
10	242	313	384	443	510	588	653	717	795	863	935	1028	1124	1216	1323	1430
11	830	873	921	977	1037	1073	1113	1153	1187	1213	1243	1277	1308	1337	1371	1406
12	372	422	468	524	589	652	729	809	895	985	1080	1177	1281	1393	1507	1629
13	192	229	251	268	288	323	340	358	386	406	425	462	495	521	556	585
14	51	52	105	133	167	208	241	274	315	351	388	440	491	539	595	650
15	7	15	14	3	5	8	32	38	50	53	76	92	115	128	157	182
16	2531	3076	3765	4426	5187	5973	6832	7756	8755	9797	10914	12098	13369	14723	16154	17681
17	2431	2881	3375	3909	4563	5348	6204	7205	8419	9814	11457	13452	15791	18525	21790	25628
18	422	426	432	460	474	480	500	521	531	551	572	577	586	605	615	633
19	245	218	197	175	151	126	100	100	106	114	128	132	138	150	157	169
20	1025	988	965	1057	1091	1103	1149	1222	1273	1349	1431	1481	1550	1659	1749	1862
21	902	970	1025	1106	1174	1259	1335	1410	1498	1581	1664	1767	1868	1964	2070	2173
22	2032	2208	2383	2547	2756	2978	3173	3359	3586	3792	4007	4269	4532	4780	5057	5325
23	157	171	188	203	220	241	259	276	299	320	341	370	398	426	457	488
24	128	132	126	144	150	136	157	187	196	225	258	257	263	290	297	322
25	1464	1624	1807	1997	2181	2314	2451	2567	2667	2786	2935	3091	3290	3537	3803	4098
26	514	543	588	654	686	727	826	958	1032	1163	1289	1365	1453	1583	1675	1805
Total	18119	19918	21904	24112	26524	29092	31850	34858	38166	41849	45948	50523	55614	61328	67730	74933

Notes: (1) The sectoral gross output is the summation between the intermediate inputs used in that sector and their corresponding final demand components.

Table D.29: The Estimated Result for the Sectoral Gross Output under Scenario 1 at Current Market Price

(Billions of Baht)

Sector	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	954	1004	1015	1019	1014	1075	1119	1165	1225	1278	1330	1401	1469	1530	1602	1671
2	155	146	122	121	109	87	87	94	87	92	97	81	69	66	72	77
3	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	2
4	306	348	390	425	471	525	571	620	682	741	805	888	977	1066	1171	1281
5	69	66	74	73	79	80	77	71	65	56	45	37	26	29	34	38
6	1308	1309	1328	1342	1378	1398	1367	1308	1255	1281	1308	1355	1375	1382	1396	1417
7	501	547	556	601	628	663	706	758	808	865	926	984	1048	1120	1191	1272
8	1096	1134	1198	1260	1338	1419	1501	1587	1684	1780	1884	2000	2124	2251	2388	2530
9	185	221	226	244	272	303	322	335	357	375	391	421	455	483	517	550
10	242	313	384	443	510	588	653	717	795	863	935	1028	1124	1216	1323	1430
11	830	873	921	978	1034	1069	1106	1144	1177	1201	1229	1261	1291	1318	1351	1383
12	372	422	468	524	588	650	726	806	890	980	1074	1171	1273	1385	1498	1620
13	192	229	251	268	289	323	341	359	388	408	427	464	498	523	559	588
14	51	52	105	133	169	211	246	280	322	360	399	451	504	553	611	667
15	7	15	14	4	2	4	25	30	41	42	63	78	99	111	137	162
16	2531	3076	3765	4426	5185	5970	6827	7750	8747	9788	10904	12087	13356	14709	16139	17664
17	2431	2881	3375	3909	4566	5350	6209	7210	8426	9821	11465	13462	15802	18537	21802	25642
18	422	426	432	460	474	479	499	521	530	550	570	575	584	603	613	631
19	245	218	197	175	151	126	100	100	106	114	128	132	138	150	157	169
20	1025	988	965	1057	1091	1103	1149	1222	1273	1349	1431	1481	1550	1659	1749	1862
21	902	970	1025	1106	1174	1259	1334	1410	1498	1580	1663	1766	1867	1963	2069	2171
22	2032	2208	2383	2547	2755	2977	3170	3357	3583	3788	4003	4265	4527	4774	5051	5318
23	157	171	188	203	220	241	259	276	299	320	341	370	398	426	457	488
24	128	132	126	144	149	135	156	187	195	224	257	255	261	288	295	320
25	1464	1624	1807	1997	2179	2312	2448	2563	2662	2781	2930	3084	3283	3529	3795	4089
26	514	543	588	654	686	726	825	957	1031	1162	1287	1363	1451	1581	1672	1803
Total	18119	19918	21904	24114	26511	29077	31824	34826	38125	41802	45894	50462	55547	61254	67650	74847

Notes: (1) The sectoral gross output is the summation between the intermediate inputs used in that sector and their corresponding final demand components.

Table D.30: The Estimated Result for the Sectoral Gross Output under Scenario 2 at Current Market Price

(Billions of Baht)

Sector	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	954	1004	1015	1026	1022	1073	1117	1163	1223	1276	1328	1399	1467	1528	1599	1668
2	155	146	122	122	110	86	86	93	86	91	96	80	68	65	70	76
3	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	2
4	306	348	390	427	470	522	567	614	675	733	796	878	965	1053	1157	1266
5	69	66	74	66	71	78	76	70	65	56	45	37	26	29	34	38
6	1308	1309	1328	1342	1378	1396	1365	1306	1254	1280	1308	1355	1375	1382	1397	1419
7	501	547	556	610	639	665	708	759	809	867	928	987	1050	1122	1193	1275
8	1096	1134	1198	1259	1334	1411	1493	1579	1676	1772	1875	1991	2114	2240	2377	2519
9	185	221	226	260	291	307	328	342	366	385	402	434	469	499	534	569
10	242	313	384	443	510	587	652	715	794	862	934	1027	1122	1214	1321	1429
11	830	873	921	981	1041	1073	1113	1153	1188	1214	1243	1277	1308	1338	1372	1406
12	372	422	468	524	589	651	728	808	894	984	1079	1176	1280	1392	1506	1628
13	192	229	251	268	288	322	339	357	385	405	424	460	494	519	555	584
14	51	52	105	132	165	208	240	273	314	350	387	439	491	538	595	649
15	7	15	14	9	10	7	30	36	49	51	74	90	112	126	154	180
16	2531	3076	3765	4375	5138	5974	6833	7757	8756	9797	10915	12099	13369	14724	16155	17682
17	2431	2881	3375	3920	4572	5341	6197	7196	8408	9800	11440	13433	15768	18497	21756	25588
18	422	426	432	452	458	465	488	513	525	546	568	574	583	603	613	632
19	245	218	197	169	140	115	89	89	95	104	117	122	128	140	147	159
20	1025	988	965	1057	1084	1089	1134	1207	1256	1332	1413	1462	1530	1638	1727	1838
21	902	970	1025	1111	1179	1258	1334	1409	1497	1580	1663	1766	1867	1963	2069	2172
22	2032	2208	2383	2551	2752	2957	3151	3337	3563	3769	3983	4245	4506	4754	5030	5297
23	157	171	188	202	220	242	259	277	299	320	342	370	399	427	458	489
24	128	132	126	145	151	135	157	187	196	226	259	257	263	290	298	322
25	1464	1624	1807	2000	2184	2314	2451	2567	2667	2787	2936	3091	3290	3537	3803	4099
26	514	543	588	653	684	725	824	956	1031	1162	1287	1364	1451	1582	1673	1804
Total	18119	19918	21904	24106	26480	29000	31759	34765	38070	41750	45844	50413	55497	61203	67596	74789

Notes: (1) The sectoral gross output is the summation between the intermediate inputs used in that sector and their corresponding final demand components.

Table D.31: The Estimated Result for the Sectoral Gross Output under Scenario 3 at Current Market Price

(Billions of Baht)

Sector	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	954	1004	1015	1026	1021	1071	1115	1160	1220	1272	1324	1394	1461	1522	1592	1661
2	155	146	122	122	109	86	86	93	86	91	96	80	68	65	70	76
3	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	2
4	306	348	390	427	472	524	570	619	680	739	803	886	973	1063	1167	1277
5	69	66	74	66	71	78	76	70	65	56	45	37	26	29	34	38
6	1308	1309	1328	1342	1377	1395	1363	1303	1250	1276	1303	1350	1369	1376	1390	1411
7	501	547	556	610	639	664	707	759	808	866	927	985	1048	1121	1192	1273
8	1096	1134	1198	1259	1334	1411	1493	1578	1675	1771	1873	1990	2113	2239	2375	2517
9	185	221	226	260	289	303	323	335	358	375	391	421	455	483	517	551
10	242	313	384	443	510	587	652	715	794	862	934	1027	1122	1214	1321	1429
11	830	873	921	982	1038	1069	1106	1145	1177	1201	1229	1261	1291	1318	1351	1384
12	372	422	468	524	588	649	725	805	889	979	1073	1170	1272	1383	1497	1618
13	192	229	251	268	289	322	340	358	387	407	426	463	497	522	558	587
14	51	52	105	131	168	211	245	279	322	359	398	451	504	553	610	666
15	7	15	14	9	7	3	24	28	39	40	61	76	96	108	135	159
16	2531	3076	3765	4375	5135	5971	6828	7751	8748	9789	10905	12087	13357	14710	16140	17665
17	2431	2881	3375	3920	4574	5344	6201	7201	8414	9808	11449	13442	15779	18509	21769	25602
18	422	426	432	453	458	465	488	512	524	545	567	572	582	601	611	630
19	245	218	197	169	140	115	89	89	95	104	117	122	128	140	147	159
20	1025	988	965	1057	1084	1089	1134	1207	1256	1332	1413	1462	1530	1638	1727	1838
21	902	970	1025	1111	1179	1258	1333	1409	1497	1579	1662	1765	1866	1962	2068	2170
22	2032	2208	2383	2551	2751	2956	3149	3334	3560	3765	3979	4240	4501	4748	5024	5290
23	157	171	188	202	220	242	259	277	299	320	342	370	399	426	457	489
24	128	132	126	145	151	135	156	187	195	225	257	256	262	288	296	320
25	1464	1624	1807	2000	2183	2312	2448	2564	2663	2782	2930	3085	3283	3530	3795	4090
26	514	543	588	653	684	725	823	955	1030	1160	1285	1362	1449	1580	1671	1801
Total	18119	19918	21904	24108	26467	28984	31732	34733	38030	41703	45790	50353	55430	61129	67515	74702

Notes: (1) The sectoral gross output is the summation between the intermediate inputs used in that sector and their corresponding final demand components.

Table D.32: The Baseline Forecast for the Output Price Index

(2000 =100)

Sector	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	117.1	137.1	143.2	151.7	162.9	177.9	194.5	216.9	237.3	259.8	284.8	312.6	344.0	378.4	419.2	465.7
2	153.4	174.3	168.7	178.6	182.1	176.8	192.3	220.4	231.6	260.2	292.3	293.3	299.4	325.4	375.5	437.9
3	89.5	103.2	116.3	135.0	141.2	163.8	190.7	214.6	259.9	244.4	286.9	313.3	384.0	411.6	531.4	568.4
4	123.5	133.7	144.4	152.9	164.9	177.5	190.5	206.5	221.4	237.8	255.3	273.7	293.6	315.6	341.7	370.9
5	93.8	105.5	109.3	116.4	125.5	134.0	143.5	157.5	169.2	182.1	196.6	212.6	231.5	253.7	280.7	313.7
6	82.3	93.8	106.8	103.8	109.5	114.4	121.3	134.2	141.5	152.5	164.7	174.9	186.8	202.6	224.0	250.5
7	117.8	135.3	137.0	144.1	150.3	157.1	164.4	176.3	183.4	191.0	198.7	206.0	213.6	221.8	230.2	239.5
8	85.3	94.3	96.3	105.7	115.2	126.1	138.3	157.0	173.0	192.3	214.6	242.1	275.2	316.6	368.1	434.2
9	79.7	90.1	94.2	100.7	109.5	118.4	128.2	144.2	155.5	168.5	183.1	199.9	220.2	244.7	274.8	312.3
10	83.2	95.6	98.7	107.8	120.1	132.3	146.1	172.2	190.4	211.5	236.0	265.0	300.5	344.0	398.8	468.2
11	111.7	126.6	130.3	139.1	150.4	160.6	171.9	187.7	201.1	215.6	231.7	249.4	269.7	293.2	321.3	354.9
12	84.3	92.2	98.3	107.3	118.0	129.3	143.9	183.4	200.3	221.3	244.8	271.0	303.4	344.2	395.1	461.0
13	92.4	99.4	101.7	105.8	110.3	115.8	121.2	135.4	145.6	157.2	170.1	184.6	201.5	221.3	245.1	274.5
14	65.5	73.2	81.1	86.1	97.7	107.1	119.7	139.0	158.3	178.9	205.1	235.6	276.6	326.6	393.6	481.1
15	89.1	95.5	107.2	112.7	123.8	130.0	141.2	160.7	175.0	190.9	210.9	231.4	255.8	284.2	320.0	365.0
16	93.1	109.8	118.9	131.2	145.8	160.1	176.0	199.7	217.8	237.2	257.9	279.4	303.0	328.7	357.1	388.9
17	97.9	114.2	128.6	150.3	178.3	214.2	258.7	320.3	340.9	346.6	375.8	401.8	469.1	476.8	540.4	576.1
18	66.2	76.0	79.5	86.6	94.6	102.5	112.0	125.8	137.4	150.8	166.1	182.9	203.1	227.7	257.4	294.3
19	161.7	158.3	149.2	143.4	136.7	129.1	121.0	124.1	129.3	135.9	144.5	148.9	154.3	162.1	167.9	175.8
20	78.7	84.4	87.8	95.0	100.6	107.1	115.0	125.9	135.0	145.6	157.1	170.0	185.4	204.1	227.2	256.2
21	136.2	147.7	149.7	159.1	167.0	176.1	184.8	195.3	204.5	213.7	223.3	234.0	245.6	257.9	272.5	289.5
22	90.4	112.9	110.0	118.4	132.1	141.9	152.7	168.8	181.8	195.6	211.1	228.1	247.9	270.1	296.8	328.0
23	74.5	85.4	92.0	100.6	109.7	119.2	130.2	148.2	160.7	174.8	190.2	206.9	226.3	248.8	275.7	308.4
24	119.2	110.0	99.3	105.2	104.2	95.5	99.9	107.8	106.5	110.5	114.1	110.5	109.5	112.3	113.5	118.2
25	70.5	82.3	88.6	99.2	110.5	121.0	132.6	145.8	158.1	172.2	189.0	207.5	230.2	257.8	289.8	327.6
26	79.1	99.6	102.7	109.6	118.5	132.8	173.4	198.9	205.4	221.0	232.7	236.4	242.4	252.4	259.0	269.2

Table D.33: The Estimated Result for the Output Price Index under Scenario 1

(2000 =100)

Sector	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	117.1	137.1	143.2	151.7	162.8	177.8	194.3	216.7	237.1	259.5	284.4	312.2	343.4	377.8	418.5	464.9
2	153.4	174.3	168.7	178.6	182.1	176.8	192.2	220.3	231.4	260.0	292.1	292.9	299.0	324.9	374.9	437.1
3	89.5	103.2	116.3	135.0	141.2	163.7	190.7	214.5	259.8	244.4	286.9	313.3	384.0	411.6	531.4	568.4
4	123.5	133.7	144.4	152.9	165.0	177.7	190.8	206.8	221.9	238.3	255.9	274.4	294.3	316.4	342.6	371.8
5	93.8	105.5	109.3	116.4	125.5	133.9	143.4	157.4	169.1	182.0	196.5	212.5	231.3	253.6	280.6	313.6
6	82.3	93.8	106.8	103.8	109.5	114.3	121.2	134.2	141.4	152.4	164.6	174.7	186.7	202.5	223.8	250.3
7	117.8	135.3	137.0	144.1	150.3	157.1	164.3	176.3	183.4	191.0	198.6	205.9	213.5	221.7	230.1	239.4
8	85.3	94.3	96.3	105.7	115.2	126.1	138.3	157.0	173.0	192.3	214.6	242.0	275.2	316.5	368.0	434.1
9	79.7	90.1	94.2	100.7	109.4	118.3	128.0	144.0	155.2	168.1	182.8	199.5	219.8	244.3	274.3	311.8
10	83.2	95.6	98.7	107.8	120.1	132.3	146.0	172.1	190.3	211.4	235.9	264.9	300.4	343.8	398.6	468.0
11	111.7	126.6	130.3	139.1	150.3	160.5	171.8	187.6	201.0	215.5	231.6	249.2	269.5	292.9	321.0	354.6
12	84.3	92.2	98.3	107.3	118.0	129.3	143.8	183.3	200.2	221.1	244.6	270.8	303.2	343.9	394.9	460.8
13	92.4	99.4	101.7	105.8	110.3	115.8	121.2	135.5	145.7	157.2	170.2	184.8	201.6	221.4	245.3	274.7
14	65.5	73.2	81.1	86.1	97.7	107.1	119.8	139.1	158.4	179.0	205.2	235.7	276.7	326.8	393.8	481.3
15	89.1	95.5	107.2	112.7	123.6	129.9	140.9	160.3	174.5	190.3	210.3	230.7	255.1	283.4	319.2	364.2
16	93.1	109.8	118.9	131.2	145.7	160.0	175.9	199.6	217.7	237.0	257.7	279.2	302.8	328.5	356.9	388.6
17	97.9	114.2	128.6	150.3	178.4	214.2	258.9	320.5	341.1	346.8	376.0	402.1	469.3	477.0	540.6	576.4
18	66.2	76.0	79.5	86.6	94.5	102.5	112.0	125.8	137.3	150.7	166.0	182.8	203.0	227.6	257.2	294.2
19	161.7	158.3	149.2	143.4	136.7	129.1	121.0	124.0	129.3	135.9	144.5	148.9	154.3	162.1	167.9	175.8
20	78.7	84.4	87.8	95.0	100.6	107.0	115.0	125.9	135.0	145.6	157.1	170.0	185.4	204.1	227.2	256.1
21	136.2	147.7	149.7	159.1	167.0	176.1	184.8	195.2	204.5	213.7	223.3	233.9	245.5	257.8	272.5	289.5
22	90.4	112.9	110.0	118.4	132.1	141.8	152.6	168.7	181.7	195.6	211.0	228.0	247.8	269.9	296.6	327.9
23	74.5	85.4	92.0	100.6	109.6	119.2	130.1	148.1	160.6	174.8	190.1	206.9	226.2	248.8	275.6	308.3
24	119.2	110.0	99.3	105.2	104.0	95.3	99.7	107.6	106.2	110.2	113.8	110.2	109.3	112.1	113.3	117.9
25	70.5	82.3	88.6	99.2	110.5	120.9	132.5	145.7	157.9	172.0	188.8	207.2	229.9	257.4	289.4	327.1
26	79.1	99.6	102.7	109.6	118.5	132.8	173.3	198.7	205.2	220.8	232.4	236.1	242.1	252.1	258.7	268.9

Table D.34: The Estimated Result for the Output Price Index under Scenario 2

(2000 =100)

Sector	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	117.1	137.1	143.2	163.5	179.6	186.4	203.0	225.3	245.7	268.1	292.9	320.7	351.9	386.2	426.9	473.2
2	153.4	174.3	168.7	189.9	196.6	183.1	198.5	226.4	237.4	265.8	297.7	298.3	304.0	329.5	379.1	440.7
3	89.5	103.2	116.3	147.8	165.1	184.6	211.5	235.4	280.6	261.0	303.4	327.6	398.2	423.7	543.3	578.1
4	123.5	133.7	144.4	153.1	161.3	169.2	182.2	198.1	213.0	229.3	246.8	265.2	285.0	306.9	333.0	362.0
5	93.8	105.5	109.3	119.2	129.2	135.2	144.8	158.8	170.5	183.3	197.9	213.9	232.7	254.9	281.9	314.9
6	82.3	93.8	106.8	106.7	112.6	114.6	121.5	134.4	141.6	152.6	164.7	174.9	186.7	202.5	223.8	250.2
7	117.8	135.3	137.0	147.8	153.7	155.9	163.2	175.1	182.2	189.8	197.5	204.8	212.4	220.6	229.0	238.3
8	85.3	94.3	96.3	107.9	117.9	126.6	138.7	157.4	173.4	192.6	214.8	242.2	275.3	316.5	367.9	433.8
9	79.7	90.1	94.2	103.2	112.1	118.1	127.9	143.9	155.2	168.1	182.8	199.6	219.9	244.3	274.4	311.8
10	83.2	95.6	98.7	111.0	123.9	132.5	146.2	172.3	190.5	211.5	236.0	265.0	300.4	343.8	398.5	467.8
11	111.7	126.6	130.3	142.4	154.4	161.4	172.8	188.6	201.9	216.4	232.5	250.2	270.5	293.9	321.9	355.5
12	84.3	92.2	98.3	110.5	122.6	131.1	145.7	185.1	202.0	223.0	246.5	272.6	305.0	345.7	396.6	462.4
13	92.4	99.4	101.7	105.9	108.9	112.7	118.1	132.3	142.5	154.1	167.0	181.6	198.4	218.2	242.1	271.4
14	65.5	73.2	81.1	87.7	99.5	106.5	119.1	138.4	157.6	178.2	204.4	234.8	275.8	325.8	392.6	480.0
15	89.1	95.5	107.2	114.3	125.2	129.2	140.4	159.9	174.1	190.0	210.0	230.5	254.9	283.2	318.9	363.9
16	93.1	109.8	118.9	134.7	150.7	161.8	177.7	201.4	219.5	238.9	259.6	281.1	304.6	330.4	358.7	390.5
17	97.9	114.2	128.6	153.9	181.7	210.6	255.1	316.6	337.6	343.9	373.3	399.6	466.9	474.9	538.6	574.4
18	66.2	76.0	79.5	89.6	98.1	103.0	112.6	126.5	138.0	151.4	166.8	183.6	203.8	228.4	258.0	294.9
19	161.7	158.3	149.2	137.3	120.9	111.3	103.3	106.4	111.8	118.5	127.2	131.7	137.2	145.1	151.1	159.1
20	78.7	84.4	87.8	97.2	103.5	108.3	116.2	127.1	136.2	146.8	158.3	171.2	186.6	205.2	228.3	257.2
21	136.2	147.7	149.7	161.4	167.0	171.1	179.8	190.2	199.5	208.7	218.3	228.9	240.5	252.8	267.5	284.5
22	90.4	112.9	110.0	121.6	135.8	142.2	153.0	169.1	182.1	195.9	211.4	228.4	248.1	270.2	296.9	328.1
23	74.5	85.4	92.0	103.8	115.3	123.6	134.5	152.5	165.0	179.1	194.5	211.2	230.5	253.1	279.9	312.5
24	119.2	110.0	99.3	109.7	107.8	94.3	98.8	106.8	105.4	109.4	113.1	109.5	108.5	111.3	112.5	117.1
25	70.5	82.3	88.6	102.9	114.7	120.6	132.2	145.4	157.6	171.8	188.6	207.1	229.8	257.4	289.4	327.1
26	79.1	99.6	102.7	123.8	145.3	157.3	197.7	207.0	213.5	229.1	240.8	244.5	250.5	260.5	267.1	277.4

Table D.35: The Estimated Result for the Output Price Index under Scenario 3

(2000 =100)

Sector	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	117.1	137.1	143.2	163.6	179.5	186.3	202.8	225.1	245.4	267.7	292.6	320.3	351.4	385.6	426.1	472.3
2	153.4	174.3	168.7	189.9	196.5	183.1	198.4	226.3	237.3	265.6	297.4	297.9	303.6	329.0	378.5	440.0
3	89.5	103.2	116.3	147.8	165.1	184.6	211.5	235.3	280.6	261.0	303.4	327.6	398.2	423.7	543.3	578.1
4	123.5	133.7	144.4	153.1	161.4	169.4	182.5	198.5	213.5	229.9	247.4	265.8	285.8	307.8	333.9	362.9
5	93.8	105.5	109.3	119.2	129.2	135.2	144.7	158.7	170.4	183.3	197.8	213.8	232.6	254.8	281.7	314.7
6	82.3	93.8	106.8	106.7	112.6	114.5	121.4	134.3	141.5	152.5	164.6	174.7	186.6	202.3	223.6	250.0
7	117.8	135.3	137.0	147.8	153.7	155.9	163.1	175.1	182.2	189.8	197.4	204.7	212.3	220.5	228.9	238.2
8	85.3	94.3	96.3	107.9	117.9	126.6	138.7	157.4	173.3	192.6	214.8	242.2	275.2	316.5	367.8	433.7
9	79.7	90.1	94.2	103.2	112.0	118.0	127.7	143.7	154.9	167.8	182.4	199.2	219.4	243.9	273.9	311.3
10	83.2	95.6	98.7	111.0	123.8	132.5	146.1	172.2	190.4	211.4	235.9	264.9	300.3	343.7	398.4	467.6
11	111.7	126.6	130.3	142.4	154.3	161.4	172.7	188.5	201.8	216.3	232.4	250.0	270.3	293.7	321.7	355.3
12	84.3	92.2	98.3	110.5	122.5	131.0	145.6	185.0	201.9	222.8	246.3	272.4	304.8	345.5	396.3	462.1
13	92.4	99.4	101.7	105.9	108.9	112.7	118.1	132.4	142.6	154.2	167.1	181.7	198.6	218.4	242.3	271.7
14	65.5	73.2	81.1	87.7	99.5	106.5	119.2	138.4	157.7	178.3	204.6	235.0	275.9	325.9	392.8	480.2
15	89.1	95.5	107.2	114.3	125.1	129.1	140.1	159.5	173.7	189.5	209.4	229.8	254.2	282.4	318.1	363.0
16	93.1	109.8	118.9	134.7	150.7	161.8	177.7	201.4	219.4	238.8	259.4	280.9	304.5	330.2	358.5	390.3
17	97.9	114.2	128.6	153.9	181.8	210.6	255.2	316.8	337.8	344.0	373.5	399.8	467.2	475.2	538.8	574.7
18	66.2	76.0	79.5	89.6	98.1	103.0	112.6	126.4	138.0	151.4	166.7	183.5	203.7	228.3	257.9	294.8
19	161.7	158.3	149.2	137.3	120.9	111.3	103.3	106.4	111.8	118.5	127.2	131.7	137.2	145.1	151.1	159.1
20	78.7	84.4	87.8	97.2	103.5	108.3	116.2	127.1	136.2	146.8	158.3	171.2	186.5	205.2	228.3	257.2
21	136.2	147.7	149.7	161.4	167.0	171.0	179.7	190.2	199.4	208.6	218.2	228.9	240.5	252.8	267.4	284.4
22	90.4	112.9	110.0	121.6	135.8	142.2	153.0	169.0	182.0	195.9	211.3	228.3	248.0	270.1	296.8	328.0
23	74.5	85.4	92.0	103.8	115.3	123.6	134.5	152.5	164.9	179.1	194.4	211.2	230.5	253.0	279.9	312.4
24	119.2	110.0	99.3	109.7	107.7	94.1	98.6	106.6	105.2	109.2	112.8	109.2	108.2	111.0	112.2	116.9
25	70.5	82.3	88.6	102.9	114.6	120.5	132.1	145.3	157.5	171.6	188.3	206.8	229.5	257.0	288.9	326.6
26	79.1	99.6	102.7	123.8	145.3	157.2	197.6	206.8	213.2	228.9	240.6	244.2	250.2	260.2	266.8	277.0

References

Abel, Andrew B., "Empirical Investment Equations: An Integrative Framework," Brunner, Karl and Allan Meltzer, editors, On the State of Macroeconomics, volume 12 of the Carnegie-Rochester Conference Series on Public Policy, 1980, pp. 39-91.

Almon, Clopper Jr., "The American Economy to 1975: An Interindustry Forecast," New York: Harper and Row, 1966.

Almon Clopper Jr., "Matrix Methods in Economics," Addison-Wesley Publishing Company, Reading, Mass, 1967.

Ammar Siamwalla and Orapin Sobchokchai, "Responding to the Thai Economic Crisis," Bangkok: UNDP, 1998.

Bank of Thailand, various years, *Economic and Financial Statistics*.

Balci, O., "Handbook of Simulation: Principles, Methodology, Advances, Applications, and Practice," *Book Chapter: Verification, Validation, and Testing,* John Wiley & Sons, NewYork, 1998.

Balci, O., and R. G. Sargent, "Validation of simulation models via simultaneous confidence intervals," *American Journal of Mathematical and Management Sciences,* Vol. 4, No.3-4, 1984, pp. 375 - 406.

Behrman, J.R., Knox Lovell, C.C., Pollak, R.A., and Sickles, R.C., "The CET-CES-Generalized Leontief Variable Profit Function: An Application to Indian Agriculture," Oxford economic papers. No. 44, 1992, Oxford University Press, New York. pp. 341–354.

Blanchard, O. and L. F. Katz, "What We Know and Do Not Know About the Natural Rate of Unemployment. Journal of Economic Perspectives," 11, 1997, pp. 51–72.

Blanchard, O. J. and L. Katz, "Wage Dynamics: Reconciling Theory and Evidence," *American Economic Review*, 89(2), 1999, pp.69–74.

Brockwell, P. J. and. Davis, R. A, "Introduction to Time Series and Forecasting," Springer, New York, 1996

Buccellato, Claudio, "Input – Output Analysis, Technological Change and Relations between Industry and Services," Economic System Research, Vol. 2, No. 1, 1990.

Buse, A., "Evaluating the Linear Almost Ideal Demand System," American Journal of Agricultural Economic 76 (November, 1994): pp. 781 – 793.

Catinat, Michel and Alexander Italianer, "Completing the Internal Market. Primary Microeconomic Effects and Their Complementation in Macro – econometric Models," Repot II/140/88, Commission of the European Communities (Brussels: Directorate General for Economic and Financial Affairs), 1988.

Catinat, Michel, Eric and Alexander Italianer, "The Completion of the Internal Market: Results of Macroeconomic Model Simulations," In Commission of the European Communities, Research on the "Cost of Non – Europe" Studies on the Economics of Integration, Volume 2(Brussels), 1988.

Cecchini, Paolo and others, "The European Challenge 1992: The Benefits of a Single Market,"(Aldershot, England: Wildwood House for the EE Commission), 1988.

Chalongphob Sussangkarn and Charles N. Myers, "Educational Options for the Future of Thailand," Chai Pattana Foundation/TDRI 1991 Year-End Conference.

D.A. Dickey and W.A. Fuller, "Distribution of the Estimators for Autoregressive Time Series with a Unit Root," *Journal of the American Statistical Association*, vol. 74, 1979, pp. 427 – 431.

Deaton, A.S. and Muellbauer, J., (1980a) "An almost ideal demand system," *American Economic Review,* 70, 1980, pp. 312 – 326.

Diewert, W.E., "An application of the Shepard Duality Theorem: a Generalized Linear Production Function," *Journal of Political Economics* Vol.79 (1971), pp. 482–507.

G. L. Perry, "Potential Output and Productivity," Brookings Papers, Washington 1977, 1, pp. 11-47.

G.P.E. Box and G.M. Jenkins, "Time Series Analysis: Forecasting and Control," revised ed., Holden Day, San Francisco, 1978.

Grassini, Maurizio, "The Core of the Multisectoral INFORUM Model," paper presented on the twelfth International Conference on Input – Output Techniques, New York. May, 2005.

Grassini, Maurizio, "CGE Versus Inforum Modeling Approach," paper presented on the fifteenth International Conference on Input – Output Techniques, RUC Beijing, P.R. China. June 27 – July 1, 2005.

Gunnar Bårdsen & Jurgen Doornik & Jan Tore Klovland, 2004. "A European-type wage equation from an American-style labor market: Evidence from a panel of Norwegian manufacturing industries in the 1930s," Working Paper 2004/4, Norges Bank.

Hayashi, Fumio, "Tobin's Marginal and Average q: A Neoclassical Interpretation," *Econometrica*, 50(1), January 1982, pp. 213-224.

Henri Theil, "Principles of Econometrics," John Wiley & Sons, New York, 1971, p. 201.

Hicks, J. R, "Value and Capital: An Inquiry into Some Fundamental Principles of Economic Theory," (Clarendon Press Oxford), 1939.

Hurvich, C.M. and Tsai, C.L., "Regression and Time Series Model Selection in Small Samples," *Biometrika* 76, 1989, pp.297 – 307.

J. Durbin, "Testing for Serial Correlation in Least – Squares Regression When Some of the Regressors Are Lagged Dependent Variables," *Economatrica*, vol. 38, 1970, pp. 410 – 421.

Jehle and Reny, "Advanced Microeconomic theory," 2nd. (Addison – Wesley – Longman, 2001).

Kumbhakar Subal C., "Estimation of Profit Functions When Profits Is Not Maximum," *American Journal of Agricultural Economics*. Vol. 83, No. 1 (Feb., 2001), pp. 1-19.

Lau, L. J., and P.A. Yotopaulos, "Profit, Supply, and Factor Demand Functions," *American Journal of Agricultural Economics*. 54, 1972, pp.11 – 18.

Lucas, Robert E., Jr., *Econometric Policy Evaluation: A Critique*. Amsterdam: North - Holland, 1976.

Manuprasert, Somprawin, "A Thai Interindustry Dynamic Model with Optimization," Ph.D. dissertation, University of Maryland, College Park, 2004.

McCarthy, Margaret, "LIFT: INFORUM's Model of U.S. Economy," *Economic Systems Research*, 3, 1, 1991, pp. 15 – 36.

Meade, Douglas S., "The JIDEA Model of Japan: Building Macroeconomic Stabilizers and Developing the Accountant." *INFORUM Working Paper*, Department of Economics, University of Maryland, 1996.

Meade, Douglas S. "Deregulation and its Aftermath: The Likely Response of the Japanese Economy to Deflation." *INFORUM Working Paper*, Department of Economics, University of Maryland, 1996.

Medhi Krongkaew (2001a), "A Tale of an Economic Crisis", in Chu Yun-Peng and Hal Hill (eds.), *Social Impacts of Economic Crisis in East Asia*, London: Edward Elgar, 2001.

M. Ishaq Nadiri, "Sectoral Productivity Slowdown," *The American Economic Review*, Vol. 70, No. 2, Papers and Proceedings of the Ninety-Second Annual Meeting of the American Economic Association. (May, 1980), pp. 349-352.

Monaco, Ralph, "A Brief Review of Alternative Approaches to Inter – Sectoral Policy Analysis and Forecasting." *mimeo*, Dept. of Economics, University of Maryland, 1997.

National Economic and Social Development Board, Office of the Prime Ministry, *The Seventh Development Plan (1992-1996),* Bangkok: United Production Ltd. Part 1992.

National Economic and Social Development Board, various years, *National Income of Thailand.*

National Statistical Office (NSO), various years, *Socio-Economic Surveys (SES).*

Nyhus, D.E. "The INFORUM International System." *Economic Systems Research*, vol. 3, no.1, 1991, pp. 55 – 64.

Oi, Walter Y., "Labor as a Quasi-Fixed Factor," *Journal of Political Economy,* December 1962, 70, pp. 538-55.

Pratten, Cliff, "A Survey of Economies of Scale," In Commission of the European Communities, *Research on the "Cost of Non – Europe" Studies on the Economies of Integration*, Volume 2 (Brussels), 1988.

Ramesh Chand and J. L. Kaul. "A Note on the Use of the Cobb-Douglas Profit Function,"*American Journal of Agricultural Economics*, Vol. 68, No. 1. (Feb., 1986), pp. 162-164.

R. C. Kennedy, X. Xiang, G. R. Madey, T. F. Cosimano, "Verification and Validation of Scientific and Economic Models", Agent2005, Chicago, October 2005.

Shoven, John B. and Whalley, John, "Applied General Equilibrium Models of Taxation and International Trade: An introduction and Survey," *Journal of Economic Literature*, vol.22, no.3, 1984, pp.1007 – 51.

Sidhu, Surjit S., "Economics of Technical Change in Wheat Production in the Indian Punjab," *American Journal of Agricultural Economics*, vol.56, 1974, pp. 217 – 26.

Sirikanokwilai N, Wibulpolprasert S., "Modified Population – to – Physician Ratio Method to Project Future Physician Requirement in Thailand," *Human Resources for Health Development Journal,* 1998, vol.3, pp. 55 – 67.

Stone, Richard., "*Input-Output and National Accounts*," Paris: Organization for European Economic Cooperation, 1961.

Stone, Richard., "Multiple Classification in Social Accounting," *Bulletin de l'Institut International de Statistique*, vol.39, 1962, pp. 215-33.

Stone, Richard and A. Brown., "A Computable Model of Economic Growth," vol. 1, *A Programme for Growth*. London, Chapman and Hall, 1962.

Summers, Lawrence, "Taxation and Corporate Investment: A q-Theory Approach," Brookings Papers on Economic Activity, 1981, pp. 67-127.

Thompson, G.D., and Langworthy, M., "Profit Function Approximations and Duality Applications to Agriculture," *American Journal of Agricultural Economics.* Vol.71 (1989), pp. 791–798.

Tobin, James, "A General Equilibrium Approach to Monetary Theory," Journal of Money, Credit, and Banking, 1, February 1969, pp. 15-29.

W. D. Nordhaus, "The Recent Productivity Slowdown," Brookings Papers, Washington 1972, 3, pp. 493-546.

Werling, Jeffrey F. "MIDE: A Macroeconomic Multisectoral Model of the Spanish Economy," Ph.D. dissertation, University of Maryland, College Park, 1992.

Wilson, Daniel J., "Embodying Embodiment in a Structural, Macroeconomic Input - output Model," (October 2001). FRB of San Francisco Working Paper No. 2001-18.

Wilson, Daniel J., "Capital-Embodied Technological Change: Measurement and Productivity Effects," Ph.D. Dissertation, University of Maryland, 2000a.

Xiang, X., Kennedy, R., Madey, G., "Verification and Validation of Agent-based Scientific Simulation Models," *Agent-Directed Simulation Conference*, San Diego, CA, April 2005.

Yu, Qisheng, "MUDAN – A China Model for Multisectoral Development Analysis," Ph.D. dissertation, University of Maryland, College Park, 1999.

Zellner, Arnold, "Estimators for Seemingly Unrelated Regression Equations: Some Exact Finite Sample Results," Journal of the American Statistical Association, 58, 1963, pp. 977-992.

Zuo Li and Wang Yinchu, "The Treatment of the Discrepancy between the Systems of Input Output and National Accounting," Economic Information Centre of Jiangsu Province, November, 1997.