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**Fiscal Policy
and Macroeconomic Variables:
The Case of Thailand**

A thesis
submitted in partial fulfilment
of the requirements for the Degree of
Doctor of Philosophy

at
Lincoln University
by
Krittin Mahaphan

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Abstract of a thesis submitted in partial fulfilment of the requirements for the Degree of Doctor of Philosophy

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Fiscal policy in Thailand was expansionary after the 1997 financial crisis until 2002. The public debt rapidly increased from just below 15% of gross domestic product (GDP) in 1996 to 58% in 2000, which is only just below the fiscal sustainability framework target of 60%. Although debt had been reduced to 34% by 2006, since 2007 the government has again run budget deficits and spending has grown twice as fast as revenue. The public debt has exceeded 40% of GDP again. This indicates that the effectiveness of current fiscal policy needs to be questioned. This study investigates the effect of changes in tax and government spending on GDP, price level, the interest rate, private consumption and private investment.

Previous studies on the effects of fiscal policy in Thailand have employed macroeconomic models with Simultaneous Equation Methodology (SEM). This has the advantage of having no limit on the number of variables to be explained, but, because of its size, many restrictions are required that may be theoretically controversial or even contradictory. Moreover, SEM is unsuitable for policy evaluation because the structure it describes may change as a result of policy changes. The present study employs the less restrictive Vector Auto-Regression (VAR) modelling framework, which uses the Vector Error Correction Model (VECM) to account for non-stationarity in data and also employs impulse response functions (IRFs) to examine the dynamic properties.

In this study, a VECM is run for the period 1988:1–2009:4, and the IRFs for a shock from government expenditure and from taxation are examined. According to the model, a positive shock of 1 baht of total government spending and of capital spending increases GDP by a

maximum of 0.17 and 0.60 baht, respectively. The effects on both the interest rate and the price level are also positive. In terms of current spending, an expansionary shock has a brief positive (though insignificant) impact on output, before a negative impact occurs after three quarters.

A total tax increase has a positive impact on output in the first five quarters, but the impact then becomes negative. An increase in personal income tax has a positive impact on output, an indirect tax increase has a negative impact on output, and the impact of corporate income tax on output is insignificant.

If the government of Thailand wishes to increase the effectiveness of its expansionary fiscal policy, it should focus on increasing the ratio of capital spending to total government spending, which is just 20% at present, because the multiplier of capital spending is larger than the multiplier of current spending.

Keywords: Fiscal policy, government spending, tax, VECM, VAR, Thailand, output, impulse response functions, cointegration

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Chapter 1

Introduction

1.1 Introduction

The government of Thailand has mostly employed a budget deficit since 1997. Ongoing deficits increase the level of public debt, which can affect economic stability. The Euro zone PIIGS countries (Portugal, Ireland, Italy, Greece and Spain) show how high public debt can lead to crisis. In Thailand, fiscal policy has been one of the most important tools used by the government to stimulate the economy, especially since 1996. It is likely that an expansionary fiscal policy will continue to be employed, because it is a populist policy, adopted by many political parties (Nilbai, n.d., own translation).

1.2 Background

Before the financial crisis in 1997, Thailand had over 40 years of fast economic growth. The average growth in real GDP was about 6.5% per year from 1951 to 1988 (Warr, 2005) and 9.4% per year from 1988 to 1996 (Bank of Thailand [BOT], 2010). Ahuja, Peungchanchaikul and Piyagarn (2004, own translation) state that from 1988 to 1996 the Thai government aimed to enhance growth through capital inflows, fiscal policy was not heavily used to stimulate the economy, and the average ratio of government spending to GDP was just 15% (Office of the National Economic and Social Development Board [NESDB], 2010). Because the Bangkok International Banking Facilities borrowed money from overseas to supply loans to the private sector during this period, business could find money for investment by paying low interest rates from overseas (Thaicharoen, Yutidhammadamrong & Mahuttikarn, 2005, own translation).

However, the high growth rate after 1988 resulted in instability. During the boom period (1988–1997), trade deficits resulted in large current account deficits and rapidly growing external debt, and the weakness of the financial system led to a collapse of the currency and the ensuing financial crisis (Jansen, 2004). The crisis expanded to other Asian countries. Before this, Thailand's economy relied heavily on short-run international borrowing. During the crisis most financial institutions suffered a lack of credit and liquidity problems, so monetary policy (see Appendix D) was not a good option. As a result, fiscal policy has been more important since the financial crisis in 1997 (Sirismatthakarn, 2003, own translation). The ratio of government spending to GDP increased from an average of 15% during 1988 to

1996 to 20% in 1997 (NESDB, 2010). Because of the financial crisis, the growth rate of Thailand in 1998 was -10.2% , private sector expenditure fell, and the unemployment rate jumped to over 4% in 1998 from just 1.5% in 1997 (BOT, 1998).

The Thai government used an expansionary fiscal policy to get the economy to recover from the crisis. Budget surpluses were run after 1988, and the role of fiscal policy can be seen from the budget deficits that were employed during the crisis in 1997 until 2002 (BOT, 2010). Consequently, the public debt rapidly increased from just below 15% of GDP in 1996 to 58% of GDP in 2000. Although it was reduced to 34% in 2006, since 2007 the government has run budget deficits, and the level of public debt has exceeded 40% of GDP again (BOT, 2010).

In Thailand the level of public debt in 2009, at just over 40% of GDP, was still very low compared to Greece (over 100% of GDP), and it was also lower than the fiscal sustainability framework (60% of GDP; the fiscal sustainability is explained in Appendix A). The BOT warns that there is a risk of a debt crisis: the average growth rate of government spending has been two times higher than revenue since 2007 (as can be seen in Table 1.1). An increase in government spending resulting from this populist policy, combined with the risk of a downturn in the world economy, could result in a decrease in revenue but an expansion in spending by the government to support the economy (BOT, 2011, own translation).

Table 1.1: Growth rate of government spending and government revenue, Thailand

Annual growth rate (%)	1997–2006	2007–2010
Government spending	4.9	8.8
Government revenue	4.7	4.2

Source: BOT, 2011, own translation, Economic Conditions.

1.3 Statement of the problem

Fatas and Mihov (2001) argue that fiscal policy research can be divided into three categories: studies that focus on the impact of large reductions in the budget deficit; studies that analyse the stabilising capability of fiscal policy variables (i.e. the research focuses on automatic fiscal stabilisers); and studies that examine the effect of discretionary fiscal policy on macroeconomic variables (e.g. to study the effect of changes in government spending and taxation on output, as found in Blanchard & Perotti, 2002).

There is an extensive literature that focuses on the effect of government spending and taxation on output and other macroeconomic variables. Some studies find that an increase in

government spending has little effect on output, while others find a positive effect on the economy from an expansionary fiscal policy, which supports Keynesian ideas. Most studies use data from developed countries such as the United States of America, Japan and countries in Europe, but developing countries seem to have received less attention.

There are both theoretical and empirical controversies regarding the effect of fiscal policy. Fiscal policy is a demand management policy. Changes in aggregate demand will affect variables in the product and money markets. Knowing the impact of fiscal policy on these variables will have benefits in terms of planning fiscal policy. One approach is to use a fiscal multiplier, which Spilimbergo, Symansky and Schindler (2009) define as the ratio of a change in output to a change in the fiscal variable.

1.4 Issues identified in previous literature

In Thailand many studies have investigated the effect of fiscal policy on the economy, especially on output. Most previous literature has employed macroeconomic models with Simultaneous Equation Methodology (SEM), such as Kukangwan (1996), Sriboonma (1999), Charoenkittayawut (2001), Thirak (2005) and Yimsiriwattana (2003). Sims (1980) explains the SEM method as follows:

Because existing large models contain too many incredible restrictions, empirical research aimed at testing competing macroeconomic theories too often proceeds in a single- or few-equation framework. For this reason alone, it appears worthwhile to investigate the possibility of building large models in a style which does not tend to accumulate restrictions so haphazardly. ... It should be feasible to estimate large-scale macromodels as unrestricted reduced forms, treating all variables as endogenous. (pp. 14–15)

Sims therefore introduced the Vector Auto-Regression (VAR) model in 1980. As Enders (1995, p. 320) notes, “Sims’s (1980) VAR approach has the desirable property that all variables are treated symmetrically, so that the econometrician does not rely on any incredible identification restrictions”.

A number of studies have used VAR to investigate the effect of fiscal policy in Thailand. Some examine the effect of only one kind of government spending on the economy, such as the effect of public investment on private investment (Atukeren, 2004) and the effect of total government spending on private investment (Fakthong, 2006). Some studies focus on the effect of government spending, by type, on output and its components without considering the

effect of taxation shock (e.g. Vorasangasil, 2008). Some investigate the effect of total government spending and total tax on output without considering spending and taxation by type (e.g. Chang, Liu & Thompson, 2002; Hsing, 2003). Some study the effect of government spending, by type, and total tax on output and its components (e.g. Tubtimtong, Kotrajaras & Chaivichayachat, 2009).

This study not only investigates the effect of government spending, by type, and total tax on GDP and its components, as found in Tubtimtong et al., 2009, but also the effect of taxation, by type, and the effect of fiscal policy on the price level and interest rate. Moreover, some of the previous literature employs VAR with level data without testing for stationarity (e.g. Vorasangasil, 2008; Tubtimtong et al., 2009). The problem with using non-stationary variables is the potential to encounter a spurious regression. Some studies use VAR with first difference data without testing for cointegration relations (e.g. Fakthong, 2006). However, a VAR model with first difference may not be the correct specification when non-stationary data are cointegrated (Enders, 1995). Instead of using a VAR model with first difference, this study will employ the Vector Error Correction Model (VECM) when data are non-stationary and there is at least one cointegration relation between the non-stationary variables.

1.5 Objectives

The objectives are to investigate:

1. the effect of changes in total tax and total government spending on output (and its components: private consumption and private investment) through fiscal multipliers, and the effects on the interest rate and price level
2. the effect of changes in government spending, by type, and taxation, by type, on output through fiscal multipliers, and the effects on the interest rate and price level
3. the duration of the effect of changes in taxation and government spending on the economy.

1.6 Research contribution

This study contributes to an understanding of the effectiveness of using fiscal policy in Thailand. If the outcome from each tool (e.g. government spending by type, and taxation by type) is known, one can choose the appropriate tool to stimulate or stabilise the economy. For example, if policy makers know that an increase in capital spending results in a larger expansion of output than does an increase in current spending, capital spending should be

given more importance by policy makers to increase the effectiveness of expansionary fiscal policy. Thus, this study will provide a useful empirical framework for Thailand's economic reformers and regulators, who are striving to improve the effectiveness of fiscal policy. Compared to previous studies, this thesis uses a more inclusive model and a better data set covering a longer period. Furthermore, this thesis includes data and results from many previous studies of the Thai economy not otherwise available in English.

1.7 Data

This research will use the following variables: output, as measured by real GDP (Y); the price level (P), as measured by the consumer price index (CPI); the interest rate (R), as measured by the inter-bank offered rate (IBOR); real total tax revenue (T); total real government expenditure (G); real private consumption (C_p); and real private investment (I). Real variables are deflated using CPI (1988 constant price) because the GDP deflator is not available.

Total government expenditure (G) can be separated into capital budget (G_i) and current budget (G_c). Total tax will be divided into three categories: personal income tax (T_p), corporate income tax (T_c) and indirect tax (T_i). These kinds of tax are chosen because personal income tax and corporate income tax are the important taxes in direct tax, while indirect tax makes up a high proportion of tax in Thailand, so these three taxes are the most important in terms of total tax revenue. The CPI is used as the price index because the GDP deflator is not available.

Finally, this study will use IBOR to represent the interest rate in Thailand. According to Teerapol (1992, as cited in Charoenkittayawut, 2001, p. 46, own translation), IBOR is a good index to measure the change in interest rate because IBOR easily responds to changes in the liquidity of the commercial bank system in Thailand. IBOR is therefore a better index than either the deposit rate or the loan rate.

Table 1.2: Variables

Variables	Definitions
Real tax (1988 prices)	Total taxes
Personal income taxes	Direct taxes on households
Corporate income taxes	Direct taxes on business
Indirect taxes	Import duties, export duties, business taxes, value-added taxes, selective business taxes, excise taxes, and other taxes
Real government expenditures (1988 prices)	Total government expenditures
Capital budget	Acquisition of fixed capital assets, capital transfers, lending, wages and salaries, expenditures on goods and services, interest payments, subsidies and current transfer
Current budget	
Real GDP (1988 price)	GDP of the country at 1988 prices
Real components of GDP (1988 price)	
C _p	Private consumption expenditure
I	Gross fixed capital formation
Nominal interest rate	Inter-bank rate
CPI	Consumer Price Index

The baseline model consists of G, T, Y, P and R. In order to obtain the effect of different kinds of fiscal spending, the total government spending will be replaced sequentially with one of the different kinds of fiscal spending while the other variables are preserved in the model. As a result, the model will consist of the variables Y, P, R, T and G_x. G_x is one of the components of government spending. Likewise, the real total taxes will be replaced sequentially with one of the different kinds of taxes while the other variables are preserved in the model. As a result, the model will consist of these variables: Y, P, R, G, and T_x. T_x is one of the components of total tax.

In order to obtain the impact of fiscal policy on the components of GDP, output will be replaced by private consumption or private investment. The sources of these variables is discussed below.

Fiscal variables

Data can be received from two sources. The first source is the BOT, which collected data using the Government Finance Statistics (GFS) method established by the International Monetary Fund (IMF). GFS is designed to support fiscal analysis, such as for analysing the impact of fiscal policy on the economy (International Monetary Fund [IMF], 2001). Fiscal

data was the responsibility of the BOT until 2001, and since then the Minister of Finance. After the data are obtained, they will be converted to constant price using CPI.

(a) Government expenditure

The data used are total expenditure, divided into current and capital spending. In the GFS method, government expenditure can be classified by either economic or functional classifications. Economic classification is used here rather than functional classification, for which fewer data are available. In economic classification, government expenditure can be classified into current and capital spending. Data for government expenditure are from the BOT (1988:1 to 2001:4) and the Minister of Finance (2002:1 to 2009:4).

(b) Taxes

Data on taxation (total tax, indirect tax, personal income tax and corporate income tax) are also derived from two sources. Data from 1988:1 to 1989:4 are from the BOT. After this, both the BOT and the Minister of Finance published tax data jointly, but the BOT had responsibility until just after 2000. Since then the Minister of Finance has been the only one responsible for publishing data, and so data from the Minister of Finance is more up to date. As a result, this research employs tax data from the Minister of Finance since 1990.

Macroeconomic variables

(a) GDP, private consumption and private investment

In Thailand the NESDB publishes GDP data using the System of National Accounts (SNA) system. Thailand has had GDP data since 1951 but no quarterly data until 1999. The NESDB cooperated with the BOT and other concerned agencies to set up a project called the Quarterly Gross Domestic Product (QGDP) Compilation Program in 1996. The NESDB started to publish QGDP in 1998. The quarterly national accounts of Thailand consist of production and expenditure, but not income. The detailed components in each item in the quarterly national accounts are the same as in the annual one. The quarterly national accounts in both production and expenditure approaches are given in both current market and constant 1988 prices (CPI).

This research will use data from the QGDP and on quarterly private consumption and investment from the NESDB. However, the QGDP and quarterly private consumption have been calculated backwards only to the first quarter of 1993, and to the first quarter of 1996 for private investment. Earlier quarterly series such as 1988:1 to 1992:4 for GDP and private

consumption and 1988:1 to 1995:4 for private investment were not available. These data were interpolated by Nidhiprabha from the Thailand Development Research Institute Foundation (TDRI) in 1999 (Charoenkittayawut, 2001). There are many popular interpolation procedures (Serju, 2004), but according to Mohanty and Klau (2005), Ginsburg interpolation seems to suit Asian countries. The annual data on the national account from the NESDB between 1987 and 1996 were changed to quarterly in both production and expenditure approaches using Ginsburg's (1973) procedure. These quarterly data were published in both current and 1988 constant prices.

For quarterly GDP, the data from Abeysinghe and Rajaguru (2004) will be employed. A quarterly real GDP estimate is derived by applying the Chow-Lin related series technique to the annual real GDP series. Due to lack of quarterly GDP in Asian countries, Abeysinghe and Rajaguru provide quarterly GDP estimates for countries, including Thailand. The data were tested before they were published in order to make sure they were reliable. Quarterly GDP data from Abeysinghe and Rajaguru (2004) is used here in place of data from the Thailand Development Research Institute (TDRI) (1999) since they are more recent than the data from TDRI. However, private consumption and private investment data from TDRI (1999) will be used where they were unavailable from Abeysinghe and Rajaguru.

(b) Interest rates

The interbank rate, representative of interest rates in this research, from 1988:1 to 2009:4, comes from the BOT.

(c) Price level

The CPI between 1988:1 and 2009:4 comes from the BOT.

1.8 Outline of the thesis

Following this introduction, Chapter 2 outlines a theoretical framework for the effect of fiscal policy, VAR and VECM, and provides empirical results from previous studies on the effect of fiscal policy. In Chapter 3 Thailand's economy and fiscal policy are described. The results will be shown in Chapter 4, and will be presented by type of government spending and tax. Chapter 5 summarises the thesis, the results, some policy implications and limitations of the study, and makes some suggestions for further study.

Chapter 2

Literature Review

2.1 Introduction

This chapter reviews research on the impact of fiscal policy in three parts: theories on the impact of fiscal policy, the methodologies of the research, and the empirical results from research on the impact of fiscal policy in many countries, including Thailand.

2.2 Theories of fiscal policy

The effect of fiscal policy can be investigated via fiscal multipliers, indicators of the impact of fiscal expansions, or contractions on output (Hemming, Kell, & Mahfouz, 2002). Theoretically, fiscal multipliers can have a positive, negative or zero impact on output. A larger absolute value of the multiplier implies that change in fiscal policy has a larger effect on output (i.e. it is more effective). Fiscal multipliers can be derived from the equilibrium condition for income.

Crowding out is defined by Hemming et al. (2002) as a situation where goods and services provided by the government substitute for those provided by the private sector. If there is no crowding out, multipliers can be shown as in (2.1) and (2.2).

$$\text{Multiplier of government expenditure: } \frac{1}{1 - b(1 - t) - i + m} \quad (2.1)$$

$$\text{Multiplier of income taxes: } \frac{-b}{1 - b(1 - t) - i + m} \quad (2.2)$$

where $b = \text{MPC} = \text{marginal propensity to consume}$

$i = \text{MPI} = \text{marginal propensity to invest}$

$m = \text{MPM} = \text{marginal propensity to import}$

$t = \text{marginal tax rate.}$

For the multiplier I will take the case for an increase in government spending; the multiplier for an increase in taxation has the opposite sign.

In the Keynesian view, an increase in government spending will expand the economy, while an increase in taxes will contract the economy. However, the effect of an increase in spending is larger.

In (2.1) and (2.2) the tax multiplier is opposite in sign to the government spending multiplier and smaller in absolute value, since $-b$ (b being between 0 and 1 rather than 1) appears in the numerator. Therefore, when the government increases spending at the same rate as an increase in tax, GDP is still higher (Keiser, 1967). Moreover, “the Keynesian multiplier exceeds one, it increases with the responsiveness of consumption to current income, and it is larger for a spending increase than for a tax cut” (Hemming et al., 2002, p. 4).

Theories of fiscal policy can be divided into demand-side (i.e. the short-term effect of fiscal policy) and supply-side (i.e. the longer-term effect of fiscal policy). In this section, the theory of the demand-side effect of fiscal policy will be reviewed first, followed by the theory of the supply-side effect of fiscal policy. In terms of the duration of the effect, according to Blanchard (2003), ‘short-term effect’ refers to the effect of fiscal policy on output that remains for a year or a few years, but less than 10 years.

The demand-side effect of fiscal policy focuses on how fiscal policy affects output via aggregate demand, or the short-term effect of fiscal policy. Aggregate demand consists of private consumption, private investment and government expenditure in a closed economy, while in an open economy net exports will be added. Short-term effects of fiscal policy will be divided into three parts: positive, zero and negative multipliers. I will illustrate this using the IS-LM and AD-AS diagrams, which are discussed in the following text.

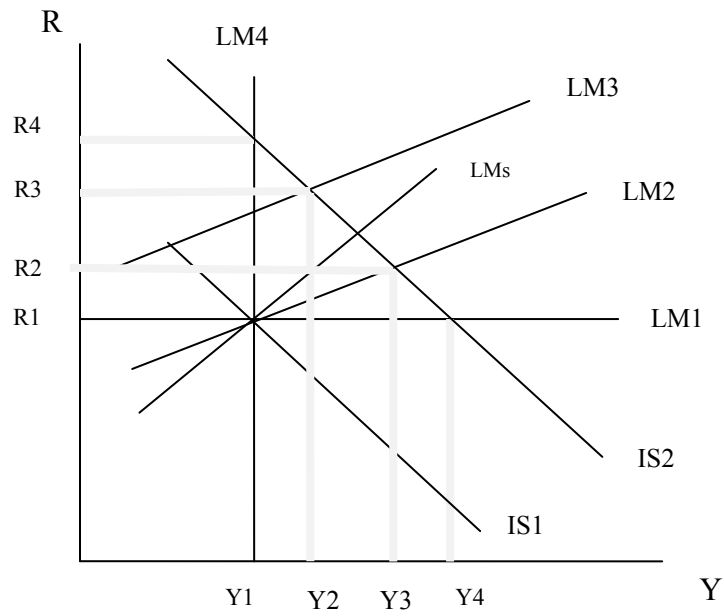


Figure 2.1: IS-LM model in different situations.

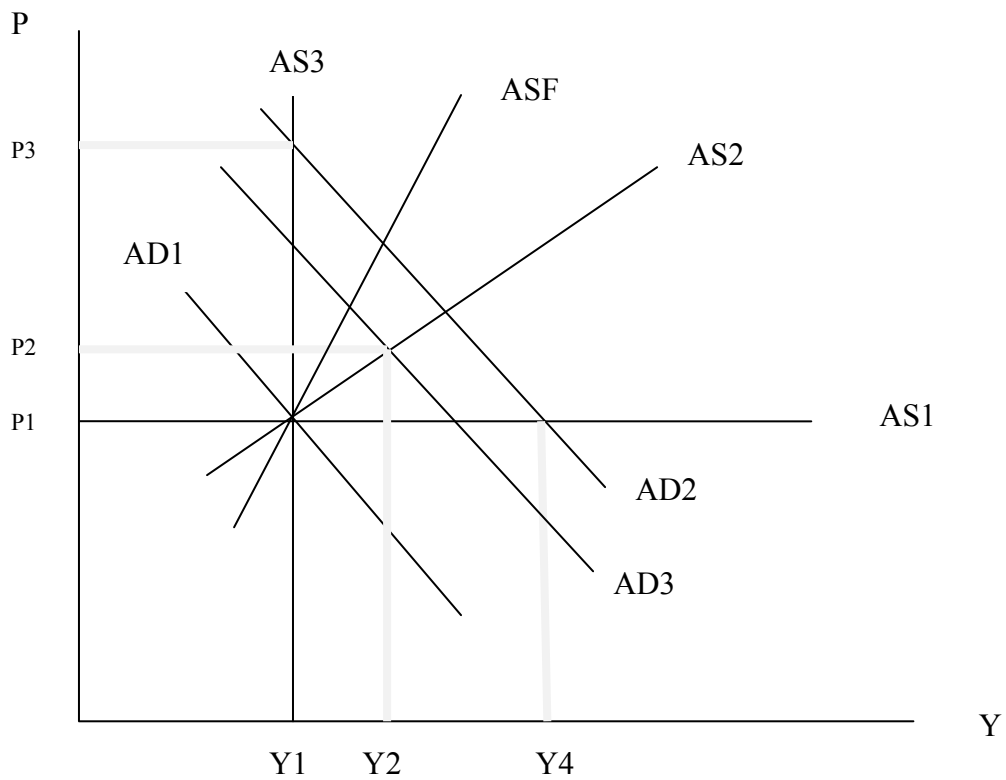


Figure 2.2: Explaining fiscal policy in each case

2.2.1 Short-term positive multiplier

The idea of a positive multiplier corresponds to Keynesian and new classical theories, where the change in fiscal policy is unanticipated. The positive effect may be reduced by partial crowding out.

2.2.1.1 *No crowding out*

In this case, the multipliers are the largest. This corresponds to the Keynesian liquidity trap, when interest rates are extremely low and cannot fall further (Hillier, 1986) or the level of saving is high (Devereux, 2009). This can be explained by the IS-LM model. The IS curve shows the combination of output and interest rate corresponding to equilibrium in the commodity market, and the slope of the IS curve is negative because if interest rates decrease, output will be raised due to an increase in private investment. An increase in government spending or a decrease in taxes shifts the IS curve out (Froyen & Low, 2001).

The LM curve shows the combination of interest rates and output corresponding to equilibrium in the money market. The slope of the LM curve is positive when, as is generally assumed, an increase in demand for money from an increase in disposable income causes an increase in the interest rate (Meyer, 1980). An increase in money supply or a decrease in demand for money shifts the LM curve to the right. In the liquidity trap, which is a situation caused by people hoarding cash, the LM curve is not positively sloped but horizontal (LM1 in Figure 2.1), since an increase in money supply cannot lower the interest rate further and the interest rate does not depend on the money demand (Feldstein, 1986, cited in Ozturk-Degirmen, 2004, p. 6).

In Figure 2.1, an expansionary fiscal policy moves the IS curve to the right, from IS1 to IS2, without an increase in interest rates, in which case output increases from Y_1 to Y_4 with no crowding out from higher interest rates. There is also no crowding out effect from the price level due to assumptions that the price level and money wages are fixed. This can be explained by a horizontal aggregate supply, when the level of output is far below the capacity of the economy or when there is a high level of unemployment; thus, an increase in output will not put pressure on money wages. Accordingly, the cost of an additional unit of output will remain constant with an increase in output.

Turning to Figure 2.2, in the Keynesian view, with AS1, an expansionary fiscal policy will push AD to the right (AD1 to AD2) without an increase in price level. Thus, output can be at Y_4 without a change in price level.

To summarise, since there are a lot of resources remaining in the economy, using expansionary fiscal policy will not cause an increase in price level or interest rates. Therefore, output can be raised by the full amount of fiscal multipliers. This supports the argument of Perotti (2007) that fiscal policy is good in a recession period.

2.2.1.2 *Partial crowding out*

This idea corresponds to the Keynesian and new classical theories when change in fiscal policy is unanticipated. In the Keynesian view, people are interested in money wages (Froyen & Low, 2001). Moreover, the level of output may not have reached its potential level – that level of output with fixed capital stock and full employment (Meyer, 1980) – because money wages are assumed to be rigid, or ‘sticky’, possibly because of contracts (Caldentey, 2003). An expansionary fiscal policy can increase aggregate demand in order to ensure that previously unemployed resources will be utilised to boost output (Matlanyane, 2005). Based on these assumptions, when the price level is increased due to rising aggregate demand, producers want to extend production, resulting in an increase in labour demand. Because of sticky wages, employment will increase, which brings about an expansion in output. For this reason, aggregate supply may have a positive slope, as with AS2 in Figure 2.2.

Alternatively, in the case of flexible wages, Froyen and Low (2001) have argued as follows:

Because the labor bargain is in terms of the money wage, we can assume that workers know the money wage but not the price level. ... Keynesians believe that decisions about labor supply depend on the current money wage and the expectation of the aggregate price level. Further, the Keynesian view has been that workers' expectations about the price level depend for the most part on the past behavior of prices. ... Price expectations are essentially backward-looking. ... Moreover, in the Keynesian view there is considerable inertia in this adjustment process; price expectations adjust only slowly to the past behavior of the price level. If this is the case, then price expectations do not change as a result of current economic conditions. (pp. 190–192)

However, Froyen and Low (2001, p. 192) claim that “firms are assumed to know the price level at which they will be able to sell their individual products”. As a result, due to an increase in the price level, firms want to expand production. Because of workers' imperfect information about prices, although the increase in wages is less than the increase in price, employment and output still increase. Thus, aggregate supply also has a positive slope, but is

steeper than with sticky wages, as in ASF (compared to AS2). In the Keynesian case, the slope of aggregate supply is positive for both sticky and flexible wages, and this positive slope is the cause of a partial crowding out that will decrease fiscal multipliers. However, it does not change the sign of these multipliers in the Keynesian model (Hemming et al., 2002).

Assuming price to be sticky, partial crowding out can happen with an increase in interest rates. This can be explained by the IS-LM diagram in Figure 2.1. From Figure 2.1, because of the crowding out effect, output cannot increase to Y_4 . When the government uses expansionary fiscal policy, on LM2, the IS curve will shift from IS1 to IS2, resulting in an increase in interest rates from R_1 to R_2 . Thus, output can be expanded only at Y_3 . The size of crowding out will depend on the slope of the IS and LM curves (Meyer, 1980).

Private investment will be reduced by higher interest rates. The level of crowding out from interest rates depends on two factors (Arestis & Sawyer, 2003): the responsiveness of private investment to interest rates, and money demand, which is a function of income and interest rates. If the slope of the IS curve is steeper (private investment is quite interest-inelastic), crowding out will be small because private investment does not respond negatively to an increase in the interest rate from an expansionary fiscal policy as much as in the case of a less steep IS curve (Levacic & Rebmann, 1982). Crowding out will be larger if the LM curve is steeper or the interest rate is highly elastic to money demand. Because interest rates can increase more along the steeper LM curve (LMs in Figure 2.1) than the moderate LM curve (LM2), an expansionary fiscal policy causes a greater crowding out effect on private investment. However, interest rates will not expand in two cases: when money demand is infinitely elastic with respect to interest rates, and when it is inelastic with respect to income, as in LM1 (Feldstein, 1986, as cited in Ozturk-Degirmen, 2004, p. 6).

In the case of flexible prices, due to an expansionary fiscal policy aggregate demand will shift from AD1 to AD2 (Figure 2.2). Because of the positive slope of aggregate supply, the price level is also increased. The higher price level shifts the LM curve from LM2 to LM3 (Figure 2.1). Consequently, interest rates will be increased from R_2 to R_3 , reducing private investment, so AD shifts from AD2 to AD3, and finally output will be Y_2 with R_3 and P_2 .

In terms of the effect of an expansionary fiscal policy on private consumption and private investment, in the Keynesian view an expansionary fiscal policy increases disposable income, resulting in an expansion in private consumption (Matlanyane, 2005). The effect on private investment depends on both the effects of any increase in GDP, which has a positive effect on private investment, and any increase in interest rates, which has a negative effect on private

investment (Froyen & Low, 2001). If the effect of an increase in GDP is stronger, private investment will be raised.

To summarise, in the Keynesian view, because of sticky wages in the labour market or workers' imperfect information about prices, aggregate supply in the product market will have a positive slope. As a result, an expansionary fiscal policy can have a positive effect on output via aggregate demand, with an increase in price and interest rates. It can also raise private consumption while leaving uncertain effects on private investment.

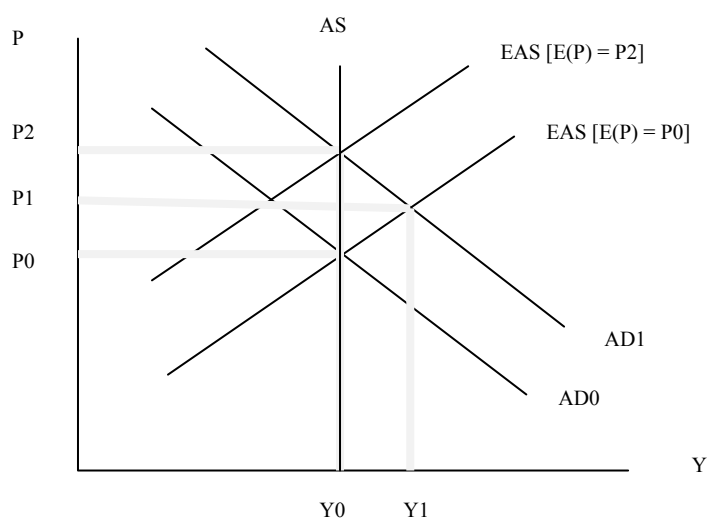


Figure 2.3: Effect of fiscal policy in the new classical case with unanticipated policy

In the new classical case, fiscal policy can affect output via aggregate demand if policy is unanticipated (Froyen & Low, 2001). The new classical theory employs rational expectations instead of the Keynesian backward-looking expectations: “Rational expectations tend to bring forward adjustments in variables that would occur more progressively with adaptive expectations” (Hemming et al., 2003, p. 6). When price level is increased from P_0 to P_1 due to an increase in aggregate demand resulting from an unanticipated shock due to an expansionary fiscal policy (Figure 2.3), labour demand will increase.

Although the speed of adjustment of price expectations is quicker with rational than with backward-looking expectations, if policy is unanticipated, labour cannot immediately predict the price. In this case, labour supply can be increased by an expansion in wages from W_0 to W_1 , although W_1/P_1 is less than W_0/P_0 since workers still expect the price to be P_0 . Consequently, employment and output can increase as the result of a demand shock, and so aggregate supply will have a positive slope, as in $EAS [E(P) = P_0]$ (Figure 2.3). Moreover, in the product market in Figure 2.3, when aggregate demand shifts to the right from AD_0 to

AD1, output can increase to Y_1 with P_1 . The important factor determining private consumption in new classical theory is permanent income, rather than disposable income as in the Keynesian view (Froyen & Low, 2001). Thus, changes in private consumption depend on whether the policy affects permanent income or not.

In the long-run adjustment, although fiscal policy can affect output in both the Keynesian and new classical views, this effect can remain only in the short run. In the Keynesian view (in the long run), sticky wages and price misperception are less important. When the expected price adjusts to the actual price, labour supply will decrease because workers want increased wages. Finally, output and employment will decline to their initial levels (Elmendorf & Mankiw, 2002). In terms of timing, the duration of the effects from fiscal policy shocks varies in each study (De Castro & De Cos, 2006).

In the same way, in the new classical view, although unanticipated fiscal policy can affect output, once workers know the policy they can expect the price level will rise to P_2 eventually. At this point they will want to increase their wages, and labour supply shifts to the left, and so employment returns to its initial level. Thus, in the product market, aggregate supply will shift to the left, from $EAS(P_0)$ to $EAS(P_2)$. Finally, output will return to its initial or Y_0 level, but the price level will increase. The long-run aggregate supply will be vertical. However, because of rational expectation, the speed of adjustment in the new classical case is quicker than in the Keynesian case, because price adjustment is quite slow in backward expectation.

2.2.2 No short-term effect from fiscal policy

This idea corresponds to the assumptions of classical and new classical theories, which are discussed below.

2.2.2.1 Classical theory

Classical theory assumes perfect information about prices and wages, which results in complete flexibility of price and wages (Froyen & Low, 2001). Moreover, employment can be determined from real wages (W/P). In the labour market, when the price level is increased due to an extension in aggregate demand, producers want to expand production, so labour demand will increase. However, because of perfect information about prices, the labour supply recognises that the price level is increased, resulting in a reduction in real wages. As a result, the labour supply decreases until real wages are the same as the initial level. Finally, employment is unchanged: as Meyer (1980) argues, employment is always at the full level. A situation where there is equilibrium in the labour market and unemployment is just frictional

unemployment: not a lack of jobs, but of matching the job with the appropriate worker. When employment is the same and capital is assumed to be constant in the short run, output is not changed either.

As can be seen in Figure 2.2, due to completely flexible prices and wages, aggregate supply is vertical, as with AS3 (Hillier, 1986). Accordingly, a fiscal policy shock via aggregate demand cannot affect GDP (i.e. complete crowding out).

Carlson and Spencer note that “If an increase in Government demand, financed by either taxes or debt issuance to the public, fails to stimulate total economic activity, the private sector is said to have been crowded out by the Government action” (1975, p. 2). Complete crowding out can be explained by the IS-LM model (Buitier, 1977). The LM curve in the classical case is vertical because the demand for money does not respond to changes in interest rates (Hillier, 1986).

In Figure 2.1, when the government uses an expansionary fiscal policy financed by loanable funds, the IS curve will shift from IS1 to IS2. However, with LM4, fiscal policy cannot increase output. The effect is just an increase in interest rate to R_4 . An increase in public consumption is the cause of reductions in saving (Matlanyane, 2005). Because the demand for loanable funds is more than the supply of loanable funds, interest rates are pressured to be higher.

Interest rates are the main factor playing a stabilising role in the classical case (Froyen & Low, 2001). Higher interest rates will decrease private consumption and private investment, which offsets the increase in government spending, leaving aggregate demand unchanged. The result is an increase in interest rates and a decrease in both private consumption and private investment, while leaving output and price levels unaffected. However, if the government increases spending by encouraging the central bank to supply more money, interest rates will not be affected because demand and supply in the loanable funds market are unaffected.

In Figure 2.2, an increase in government spending along with an increase in money supply will shift AD to the right (AD1 to AD2). However, with AS3, the result is that only price levels will be boosted to P_3 , while output is at the same level (Y_1). This can be classified as indirect crowding out. According to Buitier (1977), indirect crowding out is crowding out from interest rates or prices. Crowding out from rational expectations in the new classical case is also classified as indirect crowding out (Vane & Thompson, 1992).

In conclusion, in the classical view a fiscal policy shock cannot change output via aggregate demand because of perfect information about prices and wages in the labour market, which brings about full employment and causes a vertical slope for aggregate supply in the product market. Complete crowding out from using fiscal policy via aggregate demand can happen, with only price levels or interest rates changing. Actual output always equals potential output, even in the short run, in the classical view (Froyen & Low, 2001). As a result, fiscal policy aiming to change aggregate demand to move the economy closer to its potential output is not necessary (Zagler & Durnecker, 2003). In this view, output is determined by aggregate supply, not aggregate demand (Froyen & Low, 2001).

2.2.2.2 *New classical economics with anticipated policy*

This subsection looks at assumptions about rational expectations and anticipated policy. In this case, information about price no longer needs to be perfect, and employment can be determined from real wages (W/P). It is believed by new classical economists that output and employment will not be changed by a policy shock via aggregate demand (Froyen & Low, 2001).

When fiscal policy is anticipated with rational expectations, people will know that an increase in aggregate demand will cause an increase in price level. When prices increase, producers increase production, resulting in an expansion in labour demand. However, labour also expects price increases and wants to increase nominal wages to maintain real wages, resulting in unchanged employment. Thus, aggregate supply is vertical, as in the classical case, because at any price employment and output are constant. So fiscal policy can affect price level, but not output, via change in aggregate demand. Private consumption is also unaffected by anticipated fiscal policy because households have already accounted for their estimates of permanent income. Therefore, households will not revise again when anticipated fiscal policy occurs (Levacic & Rebmann, 1982).

In conclusion, in the new classical case with anticipated policy, aggregate supply is vertical, as in the classical case, not because of perfect information about prices in the labour market but because of zero random error in expectations (Hillier, 1986). Therefore, fiscal policy cannot affect output.

Besides complete indirect crowding out from interest rates and price levels, as in the classical model, or from expectations, as in the new classical view, there is also direct crowding out where fiscal policy cannot shift the IS curve (Buiter, 1977). This has been called the

“ultrarational case” (Carlson & Spencer, 1975). “The notion of ultrarationality is based on the assumption that households regard the corporate and the Government sectors as extension of themselves (Carlson & Spencer, 1975). As Buiter (1977, p. 8) notes, “An extra dollar of government deficit displaces a dollar of private investment expenditure and substitutes for private investment in that households tend to classify both in terms of future benefit”. As a result, changes in private investment compensate for changes in fiscal deficit, so the IS curve will not shift due to a shock from fiscal policy. Therefore, policy cannot affect output, interest rates or price level.

2.2.2.3 Ricardian equivalence

Although this theory was developed by David Ricardo in the 19th century, in the 1970s Barro adapted Ricardo’s views into more complex versions of the same concept. Ricardian equivalence is different from the new classical view in terms of the effect of policy on aggregate demand: “Fiscal effects involving changes in the relative amounts of tax and debt finance for a given amount of public expenditure would have no effect on aggregate demand, interest rates, and capital formation” (Barro, 1974, p. 1116). The reason is that the private sector will save its excess money for paying the future tax expected in order to pay off the debt from the increase in government spending (Tsoufidis, 2006). Thus, an increase in private saving can compensate for the public deficit. As a result, interest rates remain constant, and so private investment remains stable. Moreover, because households reduce private consumption to save more money, a decrease in private consumption will offset an increase in government spending. Thus, output is unchanged.

If there is a reduction in income tax, people expect that taxes will be increased in the future so they save the reduction in taxes. The reduction of public saving from the policy can therefore be offset by an increase in private saving, which means interest rates are unchanged (Arestis & Sawyer, 2003). Because private consumption is unchanged by tax policy, aggregate demand is also unchanged, and so output and price level will not be changed by the policy shock.

In conclusion, fiscal policy has no effect on output, prices, interest rates, private investment or private consumption because of rational expectations.

2.2.3 Negative short-term multiplier

Another view is that contractionary fiscal policy increases output, a phenomenon now labelled a “Keynesian effect of non-Keynesian fiscal policy” (Canale, Foresti, Marani, & Napolitano,

2008). Non-Keynesian fiscal policy is based on a combination of Modigliani life-cycle theory and Ricardian equivalence theory (Canale et al., 2008).

A positive effect of contractionary fiscal policy on output is possible if consumption increases because of the wealth effect (Alesina & Perotti, 1997). This idea is known as the German view of expansionary fiscal contraction (EFC), primarily proposed by the German treasury in the early 1980s (e.g. Fels & Froelich, 1986). It asserts that when the government uses contractionary fiscal policy, such as a permanent decrease in government expenditure, people will expect that there must be a permanent reduction of taxes in the future, and with the wealth effect the increase in private spending could be greater than the fiscal contraction (Giorgioni & Holden, 2003). Thus, the decrease in government expenditure causes an increase in output, and the fiscal multiplier is negative rather than positive. However, if the fiscal contraction does not lead to the expectation of a permanent reduction in taxes, then a positive multiplier can be seen (Bergman & Hutchison, 2010).

Moreover, Alesina and Perotti (1997) argue that the wealth effect can be caused by interest rates. They also say that “lower interest rates imply a higher market value of private wealth” (p. 214). Giavazzi and Pagano (1990) argue that effects on interest rates are also important for contractionary fiscal policy. A permanent contraction in government spending is the cause of falling interest rates, and then an increase in employment and GDP in the short run. In the long run there is a permanently lower interest rate, which causes a higher capital stock, and higher employment and output.

Another possibility is a life-cycle saving effect (Barry & Devereux, 2003). A permanent decrease in government spending can reduce the tax burden on people, which means they can increase their saving (Barry & Devereux, 2003). So a decrease in government consumption can result in an increase in national saving. Thus there is a fall in interest rates, a rise in investment and a permanent rise in output.

In summary, Keynesian effects of non-Keynesian fiscal policy can happen via an increase in either private consumption or saving, and also a decrease in interest rates. Moreover, the Keynesian effects of non-Keynesian fiscal policy depend on the following (Canale et al., 2008): there are rational expectations; policy must be unanticipated; fiscal contraction must have positive effects on the real value of a private asset; and there must be changes in interest rates.

2.2.4 Supply-side (long-term) effect of fiscal policy

While the demand-side effects of fiscal policy theories focus on the short run, supply-side effects can explain the effect of fiscal policy in the longer term (Hemming et al., 2002). In the long term, output depends on factors that determine aggregate supply (Blanchard, 2003). These factors are: saving, capital accumulation, labour input, and productivity and technology (e.g. education expenditure can have long-term effects on output) (Zagler & Durnecker, 2003).

An increase in saving is essential for the kind of capital accumulation that can raise productivity and finally affect output in the long run (Matlanyane, 2005). How fiscal policy affects saving can be explained in three different ways (Akhtar & Harris, 1992). First, it can be explained by Ricardian equivalence. Because of rational expectations, budget deficits will increase private saving, so an expansion in private saving can compensate for the decrease in public saving. Therefore the level of saving remains stable. Second, although an increase in private saving due to higher interest rates from a budget deficit can compensate for a reduction in public saving, the level of total saving will still decrease if the elasticity of private saving to the interest rate is low, since private saving will increase by less than the fall in public saving (Elmendorf & Mankiw, 2002). Third, a decrease in public saving may be offset by foreign saving that flows from overseas because of higher interest rates. In addition, budget deficits can increase total saving by an expansion in output and investment from an expansionary fiscal policy (Arestis & Sawyer, 2003).

Capital accumulation is essential for long-term growth. If it is low, it may be an obstacle for economic growth. Large and long-term budget deficits may reduce the saving levels of the country. Capital accumulation may then decline and growth may decrease in the long run (Blanchard, 2003). Budget deficits can depress investment via an increase in interest rates, but a rise in deficit may also encourage more investment in productive capacity (Akhtar & Harris, 1992). A decrease in corporate income taxes or other business taxes can stimulate an increase in capital investment (Geoff, 2006).

When it comes to the effect of fiscal policy on labour input, tax policies can affect incentives to work. In the classical case, although fiscal policy cannot affect output via aggregate demand, it can affect output via aggregate supply (Froyen & Low, 2001). Labour supply depends on after-tax real wages: when income taxes decrease, after-tax real wages $(1 - t^y) W/P$ increase (where t^y refers to the marginal income tax rate). Therefore, the incentive to work increases (Figure 2.4), so the labour supply increases, and finally employment increases

(from N_0 to N_1). Lastly, the aggregate supply shifts to the right and potential output increases (from Y_0 to Y_1), although capital (K) is unchanged.

However, whether labour supply increases depends on the relative strength of the substitution and income effect (Akhtar & Harris, 1992). On the one hand, labour supply can expand due to high after-tax returns. On the other hand, workers want to work less and earn the same return. In relation to government spending, an increase in government transfers (such as the unemployment benefit) may decrease the incentive to work (Akhtar & Harris, 1992), and labour supply will decrease accordingly.

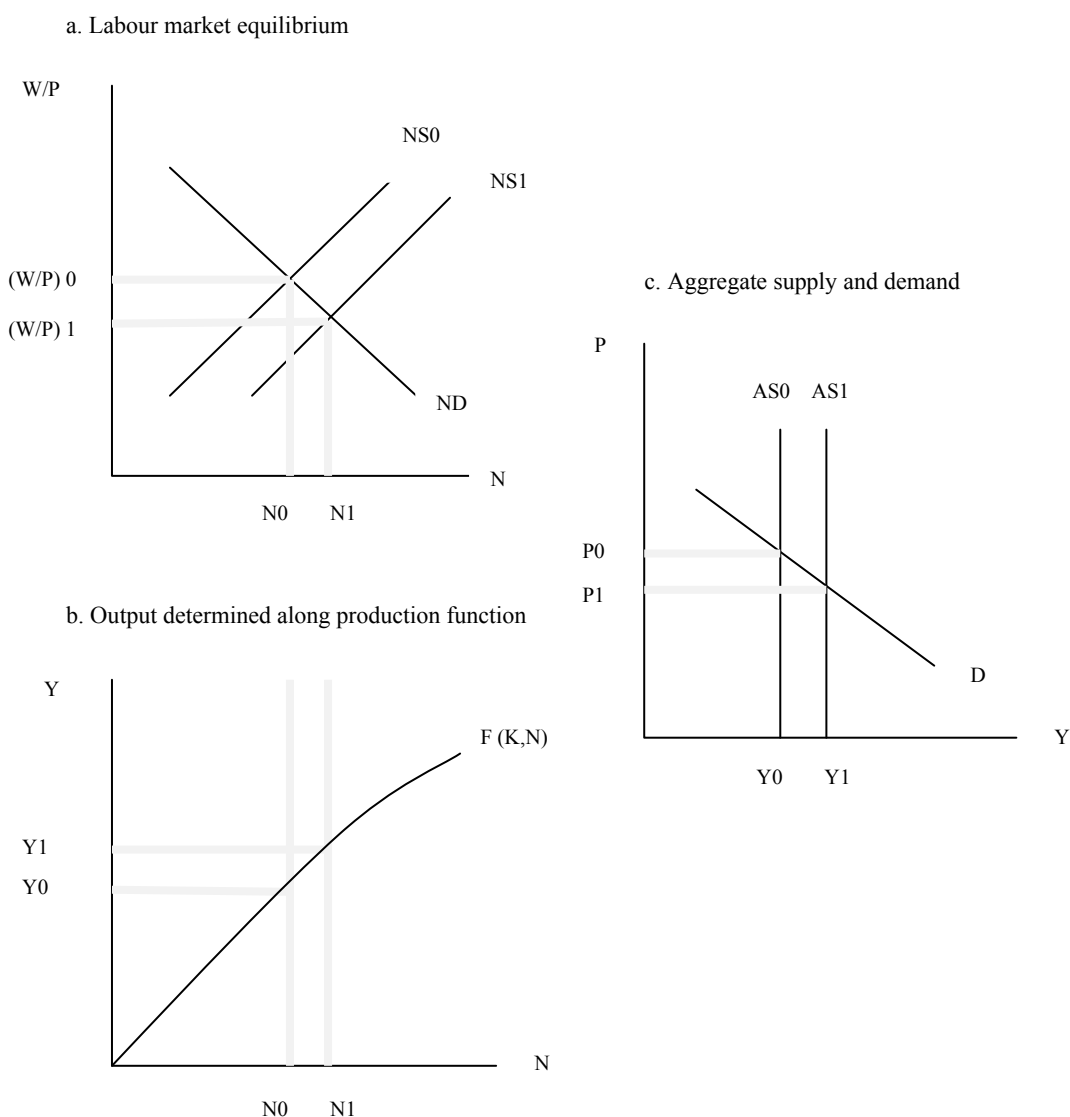


Figure 2.4: A decrease in personal income taxes in the classical case

In terms of the effect of fiscal policy on productivity and technology, government spending on education can affect the quality of labour supply (Geoff, 2006). This has an effect on labour productivity and can affect potential output. Public investment in infrastructure also affects

productivity and competitiveness. An increase in research and development spending from the government can have an impact on long-run output because it can affect technology and productivity (Akhtar & Harris, 1992).

To summarise, after reviewing the theories on the effect of fiscal policy, the response of output to an expansionary fiscal policy can be positive in Keynesian theory, zero in classical theory, or negative in the German view of expansionary fiscal contraction (EFC). Theories also refer to the effect of an expansionary fiscal policy on crowding out variables: prices and interest rates. For example, both Keynesian and classical theories state that an increase in government spending results in a positive response of either prices or interest rates. It would therefore be interesting to see how output and crowding out variables respond to an expansionary fiscal policy in terms of empirical data, and this will be examined in section 2.4.

2.3 Methodology

2.3.1 Pre-VAR models

There are four tasks for macroeconometricians: describe and summarise macroeconomic data; make forecasts; quantify the structure of the macroeconomy; and undertake policy analysis (Stock & Watson, 2001). Before the 1970s these four tasks were done using a variety of approaches, from single-equation models to large models with hundreds of equations.. Simultaneous Equation Methodology (SEM) was conceived at the Cowles Commission (Malinvaud, 1983).

Gujarati (2003) said about the SEM:

In such models there is more than one equation – one for each of the mutually, or jointly, dependent or endogenous variables. And unlike the single-equation models, in the simultaneous-equation models one may not estimate the parameters of a single equation without taking into account information provided by other equations in the system. (pp. 717–718)

As a result, in this model variables are divided into endogenous variables, whose values are determined within the model, and exogenous variables, whose values are determined outside the model (Gujarati, 2003). An independent variable is a variable that influences other variables, while a dependent variable is expressed as a linear function of one or more explanatory or independent variables. In SEM, exogenous variables are not determined by any variables in the model, but other variables are determined by them, so they can be considered

only as independent variables. However, endogenous variables can be considered to be either dependent or independent variables, because an independent variable in one equation may be a dependent variable in other equations.

SEM evolved through economists in the Cowles Commission (Malinvaud, 1983; Tinbergen, 1939), who focused on the statistical testing and measurement of business-cycle theories: Dresch (1940), who studied the impact of several taxation devices using a 15-equation model, and Haavelmo (1940), who considered the problem of solving a set of structural equations in a general simultaneous-equation setting. According to Karayiannis (2004), Klein constructed a new method for estimating econometric relationships called two-stage least squares (2SLS), which was considered by Kang (1995) to be unbiased when the sample size is infinitely large but substantially biased for a typical sample size used in practice.

A large number of studies employed SEM during the late 1960s and early 1970s (Malinvaud, 1983). Many employed SEM to study the effect of fiscal policy. Grossman (1988) used U.S. data to study the relationship between the size of government and economic growth. He expected that the provision of public goods should raise the productivity of the private sector and bring about growth in output; however, a problematic public decision-making process results in an inefficient quantity of public goods and an increase in taxes. These problems become bigger when the size of the government is larger.

Karikari (1995) also who found a negative effect from an expansionary fiscal policy in Ghana. However, Croushore (1989) and Croushore, Koot and Walker (1990) found a positive effect from an expansionary fiscal policy on private consumption in the U.S. In the studies that focus on taxes, Modigliani, Steindel, Hymans and Juster (1977), using U.S. data, discovered that a decrease in taxes temporarily increases private consumption. Jha (1999), employing Indian and Chinese data, found that an increase in taxes can be an obstacle to economic growth. Some studies compare the effect of fiscal policy and monetary policy. Morishima and Saito (1964) found that the effect of fiscal policy is more important during high unemployment. Moroney and Mason (1971) also argued that fiscal policy is more effective than monetary policy.

However, Lucas (1976) criticised SEM for not representing theory and for being ineffective in policy analysis, as pointed out by Sims (2002, p. 1):

[O]ne way to describe the Lucas critique of econometric policy advice is to say that he pointed out that parameters characterizing policy behavior are likely to

appear, via expectations, in many equations of the model, not just in the “policy equations”. Thus an attempt to predict the effects of a policy change by changing only the policy equation, holding other equations in the model fixed as in SEM, will fail, because the other equations will in fact change when the policy changes.

Sargent (1979) claimed that using structural econometric models such as SEM involves employing a large number of restrictions. In the same vein, Sims (1980) claimed that:

Because existing large models contain too many incredible restrictions, empirical research aimed at testing competing macroeconomic theories too often proceeds in a single- or few-equation framework. For this reason alone, it appears worthwhile to investigate the possibility of building large models in a style which does not tend to accumulate restrictions so haphazardly. (pp. 14–15)

Moreover, in SEM, identification can be obtained without the assumption of the orthogonality of structural disturbances. If the component is correlated with other components, an isolated change in a single component residual is unlikely to occur (Lutkepohl, 2006). Further, no variable can be considered to be exogenous in a world of rational, forward-looking agents (Bjornland, 2006). As a result, the model is not good for policy analysis if the policy variables that are assumed to be exogenous variables react endogenously to macroeconomic variables.

After the Lucas critique, the Dynamic Stochastic General Equilibrium (DSGE) approach was developed (Cogley & Yagihashi, 2010). However, Lui and Theodoridis (2010) criticised the DSGE as follows:

Economic theory is used to define all the linkages between variables. The tight economic structure solves the identification problem, but at a cost. As theory is never able to fully explain the data, an agnostic VAR will almost certainly ‘fit’ the data better. (p. 3)

Dungey and Pagan (2008) explained this as follows:

Investigation of this feature shows that the way many DSGE models are implemented on such data fails to adequately reflect this feature. ...When implemented on data it is often the case that DSGE models are simply estimated using data that has been transformed to $I(0)$ form through some filtering operation, which generally does not reproduce the model-consistent estimate of the permanent component. (pp. 1–2)

2.3.2 VAR and fiscal policy

Sims introduced Vector Auto-Regression (VAR) in 1980 and structural VAR (SVAR) in 1986. “VARs are still regarded as the best way to discover what dynamic relations exist between multivariate series” (Dungey & Pagan, 2008, p. 1). This is especially so in the case of non-stationary variables. For non-stationary but cointegrated variables, VAR can be transformed to VECM to deal with this kind of data. As a result, VAR was chosen for this study.

At first, the VAR approach was used in a number of studies to find the effects of monetary policy. Mountford and Uhlig (2005) claimed that

A large literature has therefore successfully applied vector autoregressions in particular to analyse the effects of monetary policy shocks. Leeper, Sims and Zha (1996), Christiano, Eichenbaum and Evans (1997) and Favero (2001) provide excellent surveys. (p. 1)

However, VAR has also been used widely to assess the effect of fiscal policy. According to Arin (2003), while most studies had focused on the effect of government spending, few attempted to investigate the effects of tax policy shocks. Blanchard and Perotti (2002) carried out the first major study that incorporated an aggregate tax revenue variable into the VAR models. However, Auerbach and Gorodnichenko argued that “we would expect the effects of tax policy to work through the structure of taxation (e.g. marginal tax rates) rather than simply through the level of tax revenues” (2010, p. 7).

VAR models have several virtues: all variables are endogenous, the OLS method can be applied for estimation, and their ability to forecast is better than with SEM (Gujarati, 2003). The structural VAR (SVAR) model, provided by Christopher Sims (Enders, 1995), is an n-equation, n-variable linear model where each variable is in turn explained by its own lag, plus current and past values of the remaining n-1 variables (Stock & Watson, 2001). VAR models are different from SVAR models in that VAR models do not employ current values, as in SVAR models. In SVAR models, because of the contemporaneous effect between each variable, OLS cannot be used for estimation. Transforming the system of equations to reduced form (VAR) in order to be estimated by OLS is necessary.

For example, the vector X_t (see below) consists of variables y_t and z_t , and the model has only one lag. Moreover, both variables must be stationary:

$$y_t = b_{10} - b_{12}z_t + \gamma_{11}y_{t-1} + \gamma_{12}z_{t-1} + \varepsilon_{yt} \quad (2.3a)$$

$$z_t = b_{20} - b_{21}y_t + \gamma_{21}y_{t-1} + \gamma_{22}z_{t-1} + \varepsilon_{zt} \quad (2.3b)$$

According to Enders (1995), using matrix algebra, the system in the compact form can be written as:

$$\begin{bmatrix} 1 & b_{12} \\ b_{21} & 1 \end{bmatrix} \begin{bmatrix} y_t \\ z_t \end{bmatrix} = \begin{bmatrix} b_{10} \\ b_{20} \end{bmatrix} + \begin{bmatrix} \gamma_{11} & \gamma_{12} \\ \gamma_{21} & \gamma_{22} \end{bmatrix} \begin{bmatrix} y_{t-1} \\ z_{t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{yt} \\ \varepsilon_{zt} \end{bmatrix} \quad (2.4)$$

or

$$BX_t = \Gamma_0 + \Gamma_1 X_{t-1} + \varepsilon_t. \quad (2.5)$$

Both ε_{yt} and ε_{zt} are white-noise disturbances and are uncorrelated. Because of the contemporaneous effect between y_t and z_t , OLS cannot be used. Thus, this structural VAR (SVAR) can be transformed to the reduced form (VAR):

$$y_t = a_{10} + a_{11}y_{t-1} + a_{12}z_{t-1} + \mu_{1t} \quad (2.6a)$$

$$z_t = a_{20} + a_{21}y_{t-1} + a_{22}z_{t-1} + \mu_{2t}. \quad (2.6b)$$

The reduced form equations above can be written in vector form as:

$$X_t = A_0 + A_1 X_{t-1} + \mu_t. \quad (2.7)$$

Comparing the compact form of the reduced form of VAR, as in equation (2.5) and the structural form, as in equation (2.7), the relationship of reduced form VAR and structural form VAR can be shown as:

$$A_0 = B^{-1}\Gamma_0, A_1 = B^{-1}\Gamma_1, \mu_t = B^{-1}\varepsilon_t.$$

Nevertheless, all information in an SVAR cannot be recovered from the reduced form (VAR) because the number of parameters in the reduced form (VAR) and structural form (SVAR) are not equal (Enders, 1995). This is because SVAR consists of both lagged and contemporaneous variables on the right side of the system, while VAR is composed of only lagged variables. Thus, the number of parameters in SVAR is larger than in VAR.

The SVAR (i.e. primitive systems) are under identified. Imposing restrictions is necessary. Also, the impulse response function that is the hallmark of the VAR cannot be conducted from the reduced form (Keating, 1992). Identification is needed, and the popular method is a recursive system (i.e. Cholesky decomposition) (Uhlig 2005). Cholesky decomposition, which involves a set of contemporaneous restrictions, decomposes the residuals in a triangular fashion (Enders, 1995, p. 303). Arin (2003) explains this as follows:

It is assumed that variables in the VAR model are ordered in a particular fashion, and changes in variables higher in the ordering are assumed to cause contemporaneous changes in variables lower in the ordering. However, variables lower in the ordering are assumed to affect variables higher in the ordering with a lag. (p. 10)

The first variable of the system is assumed to have a contemporaneous effect on all variables in the model, while the last variable has no contemporaneous effect on any variable in the system. However, this technique is atheoretical (Cooley & Leroy, 1985), so changing the order of variables will affect the results.

As a result, Sims (1986) and Bernanke (1986) developed structural decomposition as an alternative means of identification. The purpose of structural decomposition is to use more economic theory than in a recursive system. According to Keating (1992), a third method for identification is the long-run restriction, which is not based on contemporaneous interactions among the variables, unlike both recursive and structural decomposition. This alternative method has a long-run restriction, as developed by Blanchard and Quah (1989). As Keating (1992, p. 42) noted, this approach “allowed the data to determine short-run dynamics based conditionally on a particular long-run model. If each shock has a permanent effect on at least one of the variables, VAR can be estimated.”

According to Fisher, Fackler and Orden (1995):

With the recent attention to non-stationarity and cointegration, issues of identification have focused on restrictions on the long-run effects of the structural shocks rather than on restrictions on the contemporaneous interactions among the variables. In particular, procedures that use the reduced rank of the matrix of long-run impacts for a VECM model to at least partly identify the structural relationships have been suggested recently by Blanchard and Quah (1989), Park (1990), King et al. (KPSW, 1991) and Gonzalo and Granger (1993). They propose

that structural shocks with permanent effects on the levels of the variables be distinguished from those with only transitory effects, a distinction that is not made if the structural relationships are identified by contemporaneous restrictions of the type proposed by Sims or Bernanke. (p. 128)

For the long-run restriction, the King, Plosser, Stock and Watson (or KPSW) method identifies shocks with permanent effects independently of those with only transitory effects, under the assumption that the structural shocks are orthogonal. This is different to the other methods in that it can be used for a model that has more than one common trend, while the others cannot (Fisher et al., 1995).

However, according to Heppke-Falk, Tenhofen and Wolff (2006), VAR for studying the effect of fiscal policy often uses the following four methods for identification. First, there is the narrative approach, or event study. The event study was begun by Ramey and Shapiro (1997), who captured government spending unrelated to the state of the U.S. economy by setting dummies for identified military build-up. The second method, Cholesky decomposition, was first used by Fatas and Mihov (2001), who studied the impact of fiscal policy using U.S. data. The third method is sign restriction, used by Mountford and Uhlig (2005), who used U.S. data to study the effect of fiscal policy. The last is the Blanchard and Perotti (2002) (BP) method, used to study the impact of fiscal policy on the U.S. economy. In this method it is assumed that the discretionary effect of macroeconomic variables on fiscal policy variables is zero because policy planning must take time: the government cannot set fiscal policy to respond to macroeconomic variables within a single quarter. As a result, the impact of macroeconomic variables to fiscal variables will have only an automatic effect. The approach of Blanchard and Perotti (2002) was state of the art at the time for fiscal policy (Tenhofen & Wolff, 2007).

Perotti (2004) notes that the narrative approach is about tracing the effects of a dummy variable capturing fiscal episodes (military build-up). Then, if there are other substantial fiscal shocks occurring around the same time, it will pollute the identification of the military build-up shocks. For sign restriction, Perotti (2004) describes

An approach that consists in identifying fiscal shocks by sign restrictions on the impulse responses, following a methodology originally applied by Canova and De Nicolò (2002), Faust (1998) and Uhlig (1999) to monetary policy analysis. For instance, “revenue” shocks are identified by the condition that tax revenues

increase while government spending does not, and that all responses such that both tax revenues and GDP increase identify a business cycle shock. (p. 6)

However, Perotti (2004) argues that the sign restriction assumptions may be too strong. For example, assuming that output does not respond positively to a shock of taxes excludes the possibility of any Keynesian effect of non-Keynesian fiscal policy.

2.3.3 VECM

2.3.3.1 *Non-stationary time series*

It is possible that variables in the system will contain unit roots (i.e. they are non-stationary). Supposing x_t is stationary, the conditions of stationary variables are as follows.

1. The mean of x_t will be the same in each period; i.e. $E(x_t) = E(x_{t-s}) = \mu$.
2. The variance of x_t will be the same in each period; i.e. $E[(x_t - \mu)^2] = E[(x_{t-s} - \mu)^2] = \sigma_x^2$.
3. The value of the covariance between the two time periods depends only on the distance or gap or lag between the two time periods and not the actual time when the covariance is computed; i.e. $\text{cov}(x_t, x_{t-s}) = \text{cov}(x_{t-j}, x_{t-j-s})$:
 $E[(x_t - \mu)(x_{t-s} - \mu)] = E[(x_{t-j} - \mu)(x_{t-j-s} - \mu)] = \gamma_s$.

It must be said that all $\mu, \sigma_x^2, \gamma_s$ have to be constant. However, if $\mu, \sigma_x^2, \gamma_s$ are not constant over time, the variable will not be stationary. The problem with non-stationary variables is spurious regression; i.e. a fake relationship between variables. When variables are not stationary, the relationship between variables will appear to be related, although it is not the real relationship between the variables. As a result, some people solve this problem by transforming non-stationary variables to stationary variables or I(0) by differentiating these variables. If a non-stationary variable can be stationary by a first difference, this variable will be called I(1). If a variable can be stationary by a second difference, this variable will be called I(2).

2.3.3.2 *Cointegration*

If there is at least one cointegration relation among these variables, a Vector Error Correction Model (VECM) will be an alternative to difference variables. In this case, VAR will be replaced by VECM. The concept of cointegration is that it is a linear combination of non-stationary variables moving closely together over time.

Harris (1995, p. 6) argued as follows:

Alongside the economic interpretation of cointegration, which states that if two (or more) series are linked to form an equilibrium relationship spanning the long-run, then even though the series themselves may contain stochastic trends (i.e. be non-stationary) they will nevertheless move closely together overtime and the difference between them will be stable (i.e. stationary).

As a result, variables cannot move independently of each other. The linkage among the stochastic trend implies that variables are cointegrated, so Enders (1995) argues that first difference can make the long-run relationship disappear. That is why VECM should replace VAR if there is at least one cointegration relation in the model, although VAR can solve the problem of non-stationary data by taking first differences.

Suppose there are three variables in the system; i.e. $X_t = [y_t, z_t, g_t]$, and all three variables are non-stationary I(1) and have only one lag. If one chooses to take the first difference and run variables in VAR, the reduced form VAR can be written as follows.

$$\Delta X_t = A_1 \Delta X_{t-1} + \mu_t \quad (2.8)$$

or

$$\Delta y_t = a_{11} \Delta y_{t-1} + a_{12} \Delta z_{t-1} + a_{13} \Delta g_{t-1} + \mu_{yt} \quad (2.9)$$

$$\Delta z_t = a_{21} \Delta y_{t-1} + a_{22} \Delta z_{t-1} + a_{23} \Delta g_{t-1} + \mu_{zt} \quad (2.10)$$

$$\Delta g_t = a_{31} \Delta y_{t-1} + a_{32} \Delta z_{t-1} + a_{33} \Delta g_{t-1} + \mu_{gt} \quad (2.11)$$

From the equations above it can be seen that all variables are first differences, but the long-run relationship between variables will not exist.

2.3.3.3 Cointegration in VECM

If one chooses to run VECM in place of VARs with first differences, it can be written as:

$$\Delta X_t = \Gamma_1 \Delta X_{t-1} + \alpha \beta X_{t-1} + \mu_t \quad (2.12)$$

This equation consists of difference variables that are stationary I(0), and also $\alpha \beta X_{t-1}$, which represent the long-run relationships (cointegration relations) between variables moving together. The difference between variables is constant, so it can be said that $\alpha \beta X_{t-1}$ is also

stationary $I(0)$. Thus, all terms in VECM are stationary and the long-run relationship remains in the system.

According to Harris (1995, p. 1), modelling long-run relationships when variables are non-stationary has hardly been seen since the mid-1980s, although early forms of the Error-Correction Model (ECM) have occurred since 1964. The concept of cointegration was developed by Engle and Granger (1987). Harris (1995, p. 2) explains that if two variables are cointegrated, there must exist an ECM. According to Burke and Hunter (2005), in the single equation case a Dickey–Fuller test can be used to determine whether such series contain a cointegration relation. Nevertheless, beyond the single equation case, there is an alternative model having the property of cointegration. Burke and Hunter (2005) argue as follows:

An alternative mechanism of decomposing the VAR into an error correction form derives from Engle and Granger (1987), but beyond the single equation case inference about non-stationary processes, estimation of the long-run parameters and testing hypotheses about the long run all derive from the maximum likelihood theory developed by Johansen. (pp. 70–71)

Although there are different approaches, the Johansen methodology, which will be used in this study, dominates empirical work (Burke & Hunter, 2005).

2.4 Empirical results for the impact of fiscal policy

After reviewing the theories of fiscal policy's effects, it can be concluded that an expansionary fiscal policy can yield a positive, negative or zero effect on output, and this can be seen from the fiscal multipliers (see Appendix C). In this section the empirical effect of fiscal policy on output will be examined. This section will begin by looking at the empirical results of fiscal policy on output, which will be separated into the effect from government expenditure and the effect from taxes. The results will also be separated into results from VAR and other methodologies. Then, the effect of fiscal policy on interest rate and on prices will be reviewed. Finally, results from VECM and results from studies of fiscal policy in Thailand will be presented.

2.4.1 Effects of fiscal policy on output

2.4.1.1 *Effects of government spending from VAR*

In the U.S. there have been many studies on the effect of total government spending on output. Blanchard and Perotti (2002), Burriel et al. (2009), Canzoneri, Cumby and Diba

(2002), Carstensen, Kamps and Rothert (2005), Favero and Giavazzi (2007) and Perotti (2002), all employing VAR with the BP method for identification, found that an expansion of total government spending had positive effects on output. Their impact multipliers (see Appendix C) were less than 1; e.g. 0.8 for Blanchard and Perotti (2002), 0.76 for Burriel et al. (2009), 0.98 for Canzoneri et al. (2002) and 0.4 for Perotti (2002). Further, their peak multipliers (see Appendix C) were mostly nearly 1; e.g. 1.3 for Blanchard and Perotti (2002) at the 15th quarter, 0.76 for Burriel et al. (2009) at the 1st quarter, 1 for Canzoneri et al. (2002) at the 3rd quarter, and 1.1 for Perotti (2002) at the 5th quarter. After the peak point, the multipliers declined consistently, with crowding out from either interest rates or prices, except for Blanchard & Perotti, 2002, where interest rates and prices were not included.

Edelberg, Eichenbaum and Fisher (1999) also employed VAR to study the effect of total government spending on output in the U.S. from 1948:1 to 1996:1, but they used the narrative approach for identification. They found that output responded positively to an increase in total government spending. Fatas and Mihov (2001) used VAR with Cholesky decomposition for U.S. data from 1960:1 to 1996:4 and found that the impact multiplier was 0.1. The multiplier then peaked at the 16th quarter at 0.3.

Caldara and Kamps (2008) studied the effect of fiscal policy in the U.S. from 1995:1 to 2006:4 using three identification methods: BP, sign restriction and recursive method. They found that a positive shock of total government expenditure had a positive effect on output in all three approaches, with the impact multiplier at nearly 1 for the BP and recursive methods, but only 0.2 for sign restriction. The peak multipliers for all three methods were at the 10th quarter and nearly 2 in magnitude. The multipliers then started to decline, in line with higher prices and interest rates. Kim (2003), using VAR with long-run restriction for the U.S. from 1947:1 to 2000:4, also found a positive response in output to an increase in total government spending.

Other studies in the U.S. economy found that government expenditure had little effect on output. Using VAR with long-run restriction, Arin and Koray (2005) found that output did not change statistically significantly after an expansionary total government spending shock. Mountford and Uhlig (2005), using VAR with sign restriction, analysed the effect of fiscal policy from three types of policy shocks (pair-wise) instead of a pure government spending shock: a deficit-financed spending increase, a balanced budget spending, and a deficit finance tax cut. For the deficit-financed spending increase, they said that although an increase in government spending of 2% may raise GDP by 3%, the deficit must be repaid by an increase

in tax of more than 2%, which can cause a 7% drop in GDP later. In the same vein, Fu, Taylor and Yucel (2003) also studied the impact of pair-wise combinations of fiscal indicators on economic growth in the U.S. by using three types of shock, as in Mountford and Uhlig (2005), but using VAR with Cholesky decomposition. The result was consistent with Mountford and Uhlig's (2005) findings in that the positive effect of government spending would be diminished by the effect of taxes.

There are many studies on this topic outside the U.S. De Castro (2003) used VAR with Cholesky decomposition for Spain from 1980:1 to 2001:2 and found that the response of output from an expansionary total government spending was positive in the short run and peaked at the fourth quarter, before it was crowded out by an increase in interest rates. The response then turned negative after the 10th quarter. Similarly, Badinger (2006), Burriel et al. (2009), De Castro and De Cos (2006), Giordano, Momigliano, Neri and Perotti (2007), Heppke-Falk et al. (2006) and Perotti (2002) studied the effect of fiscal policy in Austria, the Euro area, Spain, Italy, Germany, and five OECD countries, respectively. All employed VAR with the BP method and found that an increase in total government spending had a positive effect on output, although this was insignificant in the case of Heppke-Falk et al. (2006). Most of their impact multipliers were less than 1; e.g. 0.53 for Badinger (2006), 0.75 for Burriel et al. (2009) and 0.2 for Giordano et al. (2007); and they ranged from low multipliers in the U.K. and Australia, at 0.3, to a high multiplier of 1.3 in Germany for Perotti (2002). In addition, their peak multipliers were mostly less than 1, and by the fourth quarter the multipliers declined consistently with crowding out from interest rates and prices.

There is also research studying the effects of fiscal policy in developed countries in Asia. Kuttner and Posen (2002) and Walker (2002) studied the impact of government spending in Japan by VAR with the BP method and with non-linear VAR, respectively. Both found a positive multiplier; i.e. the peak multiplier found by Walker (2002) was 1.67 in the second quarter, while the cumulative multiplier over 4 years found by Kuttner & Posen (2002) was 3.5.

Many studies that did not employ U.S. data found that the positive effect of an increase in total government spending remained statistically significantly for up to 3 years. Badinger (2006), with Austrian data, claimed that the positive multiplier remained statistically significant only for two quarters after the shock. Burriel et al. (2009) found that the positive multiplier remained statistically significant until the fifth quarter, consistent with higher interest rates and prices. De Castro (2003) and De Castro and De Cos (2006) found that the

positive response of GDP became insignificant after the seventh quarter and the 12th quarter, respectively, associated with higher interest rates and prices. Giordano et al. (2007) also found that the significantly positive multiplier ended at the seventh quarter. Perotti (2002) found that the significantly positive multipliers of total government spending persisted until the third quarter in Australia, the U.K. and Canada.

However, the positive effect of total government spending on output in the U.S. seemed to be more persistent than in the Euro area. Many studies in the U.S. found that the multipliers were hump-shaped. For example, Blanchard and Perotti (2002), Caldara and Kamps (2008), Fatas and Mihov (2001), Favero and Giavazzi (2007) and Perotti (2002) found that the positive multiplier remained significant for at least 20 quarters. This was consistent with the finding that the response of total government spending to its own shock seemed to be more persistent in the U.S. than in the Euro area, as found by Burriel et al. (2009).

In terms of the effect of government spending by type, in the U.S. Burriel et al. (2009) and Carstensen et al. (2005) found that a positive shock of public investment (capital spending) increased output more than a positive shock of public consumption (part of current spending); for example, the impact multipliers of public investment and public consumption were 2 and 0.49, respectively, in Burriel et al., 2009. Defence spending was also found by Arin and Koray (2005) to have a positive effect on output in the U.S., employing VAR with long-run restriction, and by Garcia-Mila (1989), employing VAR with the narrative approach (e.g. the impact multiplier was 1.5 in Garcia-Mila, 1989). In contrast, a negative effect on output from an increase in government wages (part of current spending) in the U.S. was found by Arin and Koray (2005).

In other countries, Burriel et al. (2009) discovered that the multiplier of public investment was higher than the multiplier of public consumption in the Euro area: the impact multipliers of public investment and public consumption were 1.56 and 0.86, respectively. However, they found that the positive effect on output stayed statistically significant longer for an increase in public consumption than for public investment. They argued that the reason for this may be that an increase in public investment raised interest rates longer than an increase in public consumption. Ramos and Roca-Sagales (2008), employing VAR with long-run restriction for U.K. data from 1970 to 2005, found that an increase in public investment yielded a significantly positive effect on output, while a positive shock of public consumption had an insignificant effect on output. In contrast, in Spain, De Castro (2003) and De Castro and De Cos (2006) found that an increase in public consumption increased output more than an

increase in public investment. Although an increase in both public investment and public consumption was mostly found to have a positive effect on output, an increase in government wages decreased output in Spain (De Cos & De Castro, 2006) and had an insignificant effect on output in Italy (Giordano et al., 2007).

Some studies only investigated the effect of public investment. Afonso and Aubyn (2008), using VAR with Cholesky decomposition for 14 Euro countries plus Canada and Japan, found that an increase in public investment raised output in all countries except the Netherlands, the U.K., Italy and Canada. Although the persistence varied in each country, the effect was short run and lasted no more than 10 quarters after the shock. Creel and Pilon (2008) also used VAR for 12 OECD countries and found that an increase in public investment increased output in all countries except Italy. The effect remained statistically significantly for no more than 3 years after the shock.

In terms of the effect of an increase in total government spending on the components of GDP, most studies found statistically significantly positive effects of total government spending on private consumption. Badinger (2006) for Austria, Burriel et al. (2009) for the Euro area, De Castro (2003) and De Castro and De Cos (2006) for Spain found that an increase in government spending boosted private consumption in the short run: responses remained significantly positive for 1, 4 and 12 quarters in Badinger, 2006, Burriel et al., 2009 and De Castro & De Cos, 2006, respectively. In addition, Perotti (2002) discovered that the positive responses of private consumption in the U.K., Australia and Canada remained significant until the fourth quarter.

In the U.S., although Burriel et al. (2009) and Edelberg et al. (1999) found that the positive response of private consumption in the U.S. remained significant only for six and two quarters, respectively, some studies using U.S. data found that the positive effect on private consumption from government spending was quite persistent, which is consistent with the effect of government expenditure on output in that country. Bouakez and Rebei (2007) discovered that the positive response of private consumption remained for 20 quarters before disappearing, and Caldara and Kamps (2008) and Fatas and Mihov (2001) found that the positive responses of private consumption remained statistically significantly for 25 quarters and 35 quarters, respectively. Blanchard and Perotti (2002) and Perotti (2002) found that the positive responses of private consumption remained significant for at least 20 quarters.

Although standard VAR usually reports a positive response for both GDP and private consumption, Tenhofen and Wolff (2007) investigated using VAR to see whether anticipation

of the fiscal shock (total government expenditure) reversed the sign of this dynamic response to a negative one by modelling expectation formation within a VAR framework using U.S. data. They found a positive private consumption response for standard VAR, but when the VAR was extended to allow for one-period-ahead anticipation of the shock, they found a negative response of private consumption instead, because people expected reductions in future income.

In terms of the impact of government spending on private investment, some studies found a positive response of private investment to an increase in total government spending. Fatas and Mihov (2001) found that an increase in total government spending raised private investment in the U.S., and the effect remained significant until the 12th quarter. Perotti (2002) found a positive response of private investment in the U.S., although the effect became insignificant after the fifth quarter. However, Perotti found that an increase in total government spending had an insignificant effect on private investment in Australia, Canada, the U.K. and Germany. The positive effect of an increase in total government spending on private investment was also found by Badinger (2006) for Austria, and by De Castro (2003) and De Castro and De Cos (2006) for Spain. However, many studies found that an increase in total government spending crowded out private investment (e.g. Afonso & Aubyn, 2008, for the U.S., France, Japan and Italy; Bouakez & Rebei, 2007; Mountford & Uhlig, 2005; Blanchard & Perotti, 2002, for the U.S.; and Alesina, Ardagna, Perotti, & Schiantarelli, 2002, for 18 OECD countries).

In conclusion, in the U.S. most studies found that output positively responded to an increase in total government spending, and this trend was also found in other countries (e.g. in the Euro area). Moreover, the responses depended on the type of spending. Negative responses of output to an increase in government wages were found in both the U.S. and Euro areas (e.g. Arin & Koray, 2005; De Castro & De Cos, 2006), while an increase in public investment and public consumption increased output in both the U.S. and Euro areas (e.g. Burriel et al., 2009; Carstensen et al., 2005; De Castro & De Cos, 2006).

However, the effect of government spending was different in each country. For example, in the U.S., public investment shock was found to have a more positive impact than public consumption shock on output by Burriel et al. (2009) and Carstensen et al. (2005), while in Spain, De Castro and De Cos (2006) discovered that output increased more after an increase in public consumption than after an increase in public investment. It also seemed that the positive effect of output in the U.S. remained statistically significant longer than in the Euro

area, and that the positive response of private consumption in the U.S. also remained statistically significant longer than in the Euro area.

2.4.1.2 *Effects of taxes from VAR*

In the U.S. most studies have found negative output responses to positive total tax shocks. Blanchard and Perotti (2002), Burriel et al. (2009), Canzoneri et al. (2002), Carstensen et al. (2005) and Perotti (2002) employed VAR with the BP method for identification, and all found that an increase in taxes decreased output. Their impact multipliers were greater than -1 (e.g. -0.7 in Blanchard & Perotti, 2002; -0.6 in Canzoneri et al., 2002; and -0.3 in Perotti, 2002). Caldara and Kamps (2008) used VAR with three identification methods (BP, sign restriction and recursive method) with U.S. data. Using VAR with sign restriction, they found that output responded negatively to a positive total tax shock; however, using VAR with a recursive method and VAR with the BP method, they found the response of output to a positive total tax shock was insignificant. They thought this was due to the automatic elasticity of taxes to output that was just below 2, and so they tested this by changing the automatic elasticity of taxes to output. When this was set to more than 2, a negative effect of taxes on output was found. In contrast, when it was set to near zero, the effect of taxes on output was positive. They concluded that the BP method was quite sensitive to the elasticity of taxes to output. Fu et al. (2003) and Mountford and Uhlig (2005) used VAR with Cholesky decomposition and VAR with sign restriction, respectively, for U.S. data and both found that a decrease in total tax raised output.

In contrast, some studies in the U.S. found a positive effect on output from an increase in total tax. Favero and Giavazzi (2007, 2009) used VAR with the BP and narrative approaches, respectively, for the periods before and after 1980 (i.e. 1950:1–1980:4 and 1981:1–2006:2). According to Favero and Giavazzi (2009), the motivation for splitting the sample was concern about the stability of the results across periods, since the variance of output declined considerably after about 1980. Thus, investigating this issue would seem to be important for promoting understanding of the transmission mechanism of fiscal policy. Both studies found that an increase in taxes had a small positive effect on output (though insignificant) for the period after 1980 (e.g. the peak multiplier was 0.2 in the 10th quarter in Favero & Giavazzi, 2009). However, both studies found that the response of output was statistically significantly negative for the period before 1980.

In other countries, De Castro (2003) and De Castro and De Cos (2006), using data from Spain, found that an increase in total tax had a delayed negative effect on output (e.g. after 2

years). Before that the effect was statistically significantly positive. They found that an increase in total tax also boosted total government spending, and that the GDP response to the tax shock was positive at the beginning due to the parallel increase of government expenditure (an increase in total government expenditure was high enough to offset the rise in total taxes). Badinger (2006) with Austrian data, Burriel et al. (2009) with Euro-area data, Ramos and Roca-Sagales (2008) with U.K. data, Kuttner and Posen (2002) and Walker (2002) with Japanese data, and Perotti (2002) with Canadian data found that output responded negatively to a positive total tax shock. Most of their impact multipliers were more than -1 (e.g. -0.8 for Badinger (2006), -0.79 for Burriel et al. (2009), -0.16 for Kuttner and Posen (2002), and -0.14 for Perotti (2002)).

However, a positive response of output to total tax shock outside the U.S. can also be found. Perotti (2002) found a positive response on output in the U.K., and said that the reason might be due to the elasticity of taxes on output in this country being low (i.e. nearly zero). A positive response of output to an increase in total tax was also found by Giordano et al. (2007) in Italy, though it was only small.

Some studies have considered the effect of taxation by type. Arin and Koray (2005), using VAR with long-run restrictions for the U.S. economy, found that while an increase in total tax, corporate income tax or indirect tax had a significantly negative effect on output, an increase in personal income tax had a positive (though insignificant) effect on output. They said that “personal income taxes include taxes on all sorts of income, which may have different response patterns... we do not have the measures to estimate the response of output to changes in the components of personal income taxes” (p. 13).

Looking at Canada, Arin and Koray (2006), using VAR with Cholesky decomposition, divided taxes into four categories: personal income tax, social security tax, indirect tax and corporate income tax. They found that while an increase in the first three taxes statistically significantly decreased output, an increase in corporate income tax increased output, since an increase in corporate income tax led firms to shift from equity to bond financing, as interest payments were tax deductible. If firms thought that an increase in this tax was permanent, they tried to cover the future expected interest payments by increasing output.

Arin (2003) studied the effect of taxation by type in G-7 countries by VAR with Cholesky decomposition and found that the effect of tax shocks was different in each country. In the case of personal income taxes, it cannot be concluded that an increase in this tax raised output; although a positive response was found in Japan in the first two quarters, the response

then became negative. In the case of an increase in corporate income taxes, it cannot be surmised that an increase in this tax diminished output because it raised output after the second quarter of the shock in Canada, Germany and Italy and after the first quarter of the shock in the U.S. and France. Taxes were divided into direct and indirect taxes in De Castro and De Cos (2006), who employed data from Spain and found that the effect of a direct tax shock had a delayed negative effect on output (i.e. the response of output became negative after the eighth quarter). Nevertheless, they discovered that indirect taxes had a negative, though insignificant, impact on output.

In terms of persistence, many studies have found that the effect of total tax remains significant for no more than 4 years. This was found by Badinger (2006) for Austria, and by Burriel et al. (2009) for the Euro area: the negative response remained statistically significant for only four quarters in Badinger (2006) for Austria, and for Burriel et al. (2009) for the Euro area. Perotti (2002) found that the negative response remained significant for 14 quarters after the shock in Canada. However, and De Castro (2003) and De Castro and De Cos (2006) found that the effect of total taxes on output remained significantly negative for 38 quarters after the shock in Spain.

The effect of tax in the U.S. was found by Blanchard and Perotti (2002), Canzoneri et al. (2002) and Carstensen et al. (2005): the negative responses in these studies remained significant for 5 years after the shock. Further, Burriel et al. (2009) and Perotti (2002) found that the negative responses remained significant for 15 and 20 quarters, respectively. Burriel et al. noted that output, price level and interest rate in the U.S. did not respond suddenly to the shock, as happened in the Euro area. This might be due to lower demand pressure in the U.S. However, the negative response of output, which happened more slowly in the U.S., also disappeared more slowly than in the Euro area.

In terms of the effect of total tax on private consumption, studies have found that an increase in total tax decreases private consumption (e.g. Blanchard & Perotti, 2002; Caldara & Kamps, 2008; and Tenhofen & Wolff, 2007, with U.S. data; Burriel et al., 2009, with both U.S. and Euro area data; Badinger, 2006, with Austria data, and De Castro & De Cos, 2006, with Spanish data). Although Badinger (2006) found that the significantly negative response disappeared within 12 quarters, Burriel et al. (2009) and De Castro and De Cos (2006) found that the negative responses remained significant for four quarters in the Euro area and for 38 quarters in Spain, respectively. Blanchard and Perotti (2002) and Tenhofen and Wolff (2007)

discovered that the negative responses remained significant for 20 and 12 quarters in the U.S., respectively.

In terms of the effect of an increase in taxes on private investment, Burriel et al. (2009) with U.S. and Euro area data, Badinger (2006) with Austrian data, Blanchard and Perotti (2002) and Caldara and Kamps (2008) with U.S. data, and De Castro and De Cos (2006) with Spanish data found negative responses of output to a positive total tax shock.

In conclusion, in the U.S., most studies found negative responses on output and its components to a positive shock of total tax. In other countries, the effect of total tax on output varied. For example, Perotti (2002) found a positive response of output to an increase in total tax in the U.K., De Castro and De Cos (2006) discovered that output in Spain initially responded positively to a positive shock of total tax but the response later became negative. Badinger (2006) and Burriel et al. (2009) found that an increase in total tax yielded a negative effect on output in Austria and in the Euro area, respectively. Besides the different effect of total tax in each country, the effect from different kind of taxes also yielded different results, as found by Arin and Koray (2005, 2006) and De Castro and De Cos (2006). The effect from the different period of the data also resulted in different results, as found by Favero and Giavazzi (2007, 2009).

2.4.1.3 *Effects of government spending measured using other methods*

After reviewing the literature using the VAR method, it was found that most studies discovered a positive effect from a government spending shock on output. In this section, the impact of government spending on output will be examined using other methods.

Baldacci, Cangiano, Mahfouz and Schimmelpfennig (2001) studied the effectiveness of fiscal policy for stimulating the economy from recession in 168 countries between 1970 and 1989 using three different approaches: descriptive analysis, multidimensional statistical analysis, and standard regression analysis. They defined the recession period as a single year or consecutive years in which real GDP growth was more than one standard deviation below trend growth. The effectiveness of fiscal policy was measured by the difference in growth outcomes during recession episodes accompanied by an expansionary fiscal policy and episodes accompanied by a contractionary fiscal policy. They concluded that an increase in government spending raised growth.

Some studies found that the effect of an increase in government spending depended on how it was financed. Baxter and King (1993), using a quantitative, restricted, neo-classical model

(one sector neo-classical model) for U.S. data from 1930 to 1985, studied the pair-wise combinations and found that an increase in government spending financed by an increase in lump-sum tax raised output, with a multiplier of more than 1. However, the effect from an increase in government spending financed by personal income tax was the opposite. Since an increase in personal income tax reduced individual incentives to work, it could not then promote employment, as when spending came from a lump-sum tax. As a result, output would decrease from an increase in spending financed by personal income tax. In the same way, Ludvigson (1996), using a standard general equilibrium growth model with U.S. data, also studied the pair-wise combinations and found that output, private investment and private consumption responded negatively to an increase in government spending financed by distortionary tax, defined as a tax where changes affect the investment decisions of agents (e.g. taxation on income and profit). Nevertheless, when government expenditure increased, financed by an increase in deficit, output and private consumption increased.

Another study claimed that the effect of an increase in government spending depended on the sticky price. Gali, López-Salido and Vallés (2004), using a stochastic dynamic general equilibrium model for U.S. data from 1945:1 to 1998:2, found that the impact of government spending on output and private consumption depended on sticky prices; that is, the multipliers were nearly 2 in the case of sticky prices and nearly 1 in the case of non-sticky prices. If the price level does not change when the government increases spending, real wages and private consumption will both increase.

The different types of government spending also yielded different effects on the economy. To examine the effect of public consumption and public employment, Ardagna (2001) studied the effect of change in government expenditure using a dynamic general equilibrium model with data from 10 European countries from 1965 to 1995 and found that an increase in public consumption (part of current spending) led to an increase in output: output was raised 0.07% from a 1% increase in public consumption. Because the shock reduced the resources available and had a negative wealth effect, private consumption decreased and workers desired to work more. Employment therefore increased with the same level of capital stock. Consequently, the ratio of capital stock to labour decreased, resulting in a reduction in wages. However, in the long run, the capital stock increased until the ratio of capital and labour was back to the same level. At the new equilibrium, output, capital stock and employment increased with the lowering of private consumption.

Nevertheless, the effect of a positive shock involving public employment (part of current spending) was the opposite. Output fell after an increase in government employment because the shock did not raise private investment, as in the case of an increase in public consumption. Not only did a positive shock to public employment generate a negative wealth effect and decrease private consumption, but it also reduced employment in the private sector because of the movement of labour to the public sector. Due to a constant capital stock, the ratio of capital stock per labourer would increase, resulting in an increase in wages. As a result, private investment and output declined. However, Ardagna (2001) have argued that the effect of an increase in government employment would be the opposite if it could raise productivity.

In the same way, Finn (1998) studied the effect of government spending in the framework of qualitative real business cycles (RBC) using U.S. data from 1950:1 to 1993:4, with calibration and simulation qualitative analysis, and found that a positive shock of public consumption reduced private consumption but raised private investment, while an increase in public employment decreased both private consumption and private investment.

In terms of defence spending, Cavallo (2005), using a neo-classical growth model, studied the impact of fiscal policy on private consumption in the U.S. and found that military build-ups generated a negative wealth effect, resulting in a reduction in private consumption.

In the case of productive and non-productive government spending, Kneller, Bleaney and Gemmell (1999), studying the impact of fiscal policy on growth using an endogenous growth model in 22 OECD countries from 1970 to 1995, also found a positive response of output growth to an increase in productive government spending (that spending which is included as arguments in the private production function, e.g. general public services expenditure): an increase in productive spending of 1% boosted growth 0.2%. However, he found that an increase in non-productive government spending (spending that is not included as arguments in the private production function, such as social security and welfare expenditure) had no effect on growth. Easterly and Rebelo (1993), using regression analysis for data from 28 countries, found that an increase in public investment in transport and communication raised growth rates.

In the case of spending on health, Rivera and Currais (2004), studying the effect of government spending on health in Spain using a model that was developed from the Solow growth model, found that government investment in health did not affect GDP because health infrastructure took a long time to affect productivity, while government consumption in health

increased GDP (e.g. an increase in government consumption of 1% resulted in an increase in output of 0.16%, because it could affect productivity).

In the case of Asian countries, Ducanes, Cagas, Qin, Quising and Razzaque (2006), using macroeconometric model simulation where behavioural equations were estimated by LSE, studied the effect of fiscal policy in four Asian countries from 1990 to 2005. They found that the positive effect on output from a decrease in tax rate was less than that from an increase in government spending. They also discovered that an increase in fiscal spending increased output in China and the Philippines, with multipliers of 1.5 and 0.74, respectively; here it also stabilised the economy, as automatic stabilisers dampened the business cycle. On the other hand, in Indonesia and Bangladesh, while fiscal policy had a positive effect on the economy (the multipliers were 0.76 and 0.59, respectively), it could not stabilise the economy. Anaman (2004), using a regression model, studied the optimal level of government spending (defined as the size of government spending that maximises economic growth) in Brunei from 1971 to 2001 and estimated that the optimal size of government (the total government expenditure:GDP ratio) was about 27.5%.

Some studies found a negative effect from an expansionary fiscal policy on output. Barro (1981), using regression analysis for U.S. data from 1932 to 1978, found a negative response in output to a positive government spending shock. Similar results were found by Alesina and Perotti (1997) for Denmark and Ireland using “Blanchard fiscal impulse”; by Barry and Devereux (2003) employing CGE for Denmark and Ireland from 1983 to 1986; by Folster and Henrekson (2001) using regression analysis for OECD countries from 1970 to 1995; by Giavazzi and Pagano (1990) using regression analysis for Denmark and Ireland from 1961 to 1987; and by Mendoza, Milesi-Ferretti and Asea (1997) for 18 OECD countries from 1965 to 1991. The results from these studies supported the German view of expansionary fiscal contraction (EFC). However, Alesina and Perotti (1997) argued that cuts in transfer and government wages could expand the economy, while an increase in taxes and cuts in public investment could contract the economy.

In conclusion, although many studies discovered positive effects of an increase in government spending on output, as in the VAR method, a negative response of output to an increase in government spending can also be found, especially in Denmark and Ireland. The response of output to the shock also depended on the type of spending; for example, public employment was found to have a negative effect on the economy by Ardagna (2001) and Finn (1998), while public consumption was found to have positive effect on the economy by Ardagna

(2001) and Finn (1998). The effect varied for different countries and for different kinds of spending shock, as found with the VAR method. The effect also depended on other factors, such as how the spending was financed (Baxter & King, 1993; Ludvigson, 1996), sticky prices (Gali et al., 2004), and productivity (Ardagna, 2001; Rivera & Currais (2004).

2.4.1.4 *Effects of taxes measured using other methods*

The effect of taxation shock on output measured using the VAR method varied in different countries and also with different kinds of taxation shock. In this section, the impact of changes in taxation on output measured using other methods will be reviewed.

Looking at the U.S. economy, Ludvigson (1996), using CGE, found a negative effect from a distortionary taxes shock on output. He argued that a decrease in distortionary tax, which changes the investment decisions of agents (e.g. taxation on income and profit), could promote output and private investment, but it also depended on the elasticity of the labour supply. Braun (1994), using the Real Business Cycle (RBC) model with impulse response functions (IRFs), discovered that an increase in personal income tax of 1% would decrease output by 0.2% in the first quarter. Moreover, private investment and private consumption also responded negatively to the shock, and the effect remained for at least 24 quarters, at which point the data ended. An increase in capital income tax had no effect on output, private consumption and private investment.

Ohanian (1997), using CGE with data from 1941 to 1953, found that if the government used the policy from the Korean War (an increase in government spending financed by taxation), instead of an increase in government spending financed by debt (as during World War 2), output would be lower. Engen and Skinner (1996), examining the historical record and micro-level of studies of labour supply and investment demand for the U.S. from 1959 to 1995, found that a 5 percentage point cut in marginal tax rates promoted the growth rate by about 0.2%. Further, Perotti (2001), using an endogenous growth model for the U.S., found that the growth rate was boosted by a decrease in corporate income tax, tax on household assets, tax on consumption and tax on labour.

In contrast, Dotsey (1994) used a one-sector, neo-classical dynamic general equilibrium model to study the effect of a reduction in distortionary tax rate (e.g. taxation on income and profit) in the U.S. from 1970 to 1988, and found that a lower tax rate could result in lower economic growth because of an expectation of future tax burdens.

In other countries, Ardagna (2001), using data from 10 European countries from 1965 to 1995 with the CGE model, found that output decreased by 0.33% from a 1% positive shock of capital tax rate. The shock also decreased private consumption. Folster and Henrekson (2001), employing regression analysis for OECD countries from 1970 to 1995, found a negative effect on output with an increase in total tax. De Hek (2006) studied the effect of taxes on growth rate in 21 OECD countries using an endogenous growth model and found that an increase in labour income tax diminished growth. Widmalm (2001), using regression analysis with 2SLS for 23 OECD countries from 1965 to 1990, found an increase in total tax or personal income tax had a negative effect on growth. However, Mendoza et al. (1997) also studied the effect of changes in tax rate on the growth rate in 18 OECD countries with an endogenous growth model and discovered that changes in tax rates had a small effect on growth rate, especially in the case of an inelastic labour supply (e.g. a decrease of 10% in taxes on physical capital, human capital or consumption raised the growth rate by no more than 0.04%). Kneller et al. (1999), using an endogenous growth model for 22 OECD countries between 1970 and 1995, found a negative effect on output growth with an increase in distortionary taxes.

On the contrary, De Hek (2006) found a positive response in growth to an increase in capital income tax in 21 OECD countries, because the shock resulted in higher attractiveness in education, but the effect also depended on the flexibility of the labour supply. Widmalm (2001) found that an increase in tax on consumption had a positive effect on economic growth, while the effect from other taxes was the opposite. However, he did not conclude that an increase in consumption tax could promote growth; rather, that it was less harmful than other taxes because it left GDP growth unaffected.

In conclusion, in the U.S., the effect of taxes on output in this section corresponded to the results found in the studies using the VAR method in that most studies discovered a negative response of output to taxation shocks. In other countries, the response of output differed in each kind of taxation shock, as found in the studies using the VAR method; e.g. as found by De Hek (2006) and Widmalm (2001). Elasticity of labour supply was also found to be important (e.g. De Hek, 2006; Ludvigson, 1996; Mendoza et al., 1997).

2.4.2 Effects of fiscal policy on interest rates

Changes in fiscal policy can affect other variables in the money and product markets, such as interest rates and prices. This section will look at how changes in either spending or taxation

policy affect the interest rate. The section can be divided into the effect of fiscal policy on interest rate as measured using VAR, and using other methods.

2.4.2.1 *Effects measured using VAR*

In this section, the effect of a government spending shock on interest rates will be mentioned first, followed by the effect of a taxation shock on interest rates.

In the U.S. economy, the effect of changes in government spending on interest rates has not been consistent. Some studies have found a positive effect on interest rates from changes in government spending. Fatas and Mihov (2001), using VAR with Cholesky decomposition from 1960:1 to 2005:4, found that the positive response of interest rates to an increase in total government spending remained statistically significant for two quarters. Canzoneri et al. (2002) discovered a significantly positive response of interest rates to an increase in total government spending until the fourth quarter. Burriel et al. (2009) found that an increase in public investment had a significantly positive effect on interest rates for two quarters.

Some studies in the U.S. economy discovered a delayed positive response of interest rates to a spending shock. Caldara and Kamps (2008) used three methods (VAR with BP method, VAR with recursive identification and VAR with sign restriction) on data from 1995:1 to 2006:4. They found that an increase in total government spending raised interest rates, and the effect was statistically significantly between the 10th quarter and the 20th quarter in all three methods, although interest rates fell (not significantly) from the shock at the beginning. Using data from before 1981, Favero and Giavazzi (2007), using the VAR with BP method, also found that interest rates responded significantly positively to an increase in total government spending between the 12th and 18th quarters, although interest rates insignificantly declined in response to the total government expenditure shock at the beginning. This trend was also found by Edelberg et al. (1999) for the case of a total government spending shock, and by Carstensen et al. (2005) in the case of a public consumption shock.

Some studies found that interest rates fell from an increase in government spending in the U.S. economy. Perotti (2002), using VAR with the BP method, found that a statistically significantly negative effect of government spending on interest rates remained until the 12th quarter. Burriel et al. (2009), using VAR with the BP method from 1981:1 to 2007:4, found that an increase in total government spending and public consumption had a significantly negative effect on interest rates until the fifth quarter and the sixth quarter, respectively. This

trend was also found by Favero and Giavazzi (2007) using VAR with the BP method from 1981 onwards, and by Arin and Koray (2005) using VAR with long-run restriction.

In the case of the effect from tax shock in the U.S., the studies of Burriel et al. (2009), and (for the post-1980 period) by Favero and Giavazzi (2007), discovered that interest rates increased as the result of an increase in total tax; for example, the significantly positive effect of total tax on interest rates remained for two and 16 quarters, respectively, although interest rates were non-significantly positive before the sixth quarter in the case of Favero and Giavazzi (2007). Favero and Giavazzi also found that the positive effect of an increase in total tax on interest rates would be reversed if data before 1981 were employed. Perotti (2002) and Canzoneri et al. (2002), using VAR with the BP method, also discovered that an increase in total tax had a significantly positive effect on interest rates until the fourth quarter. Arin and Koray (2005) found that a positive shock of personal income tax increased interest rates, consistent with the positive output multiplier from the shock.

In other countries, Burriel et al. (2009) discovered that the effect of an increase in government spending on interest rates was positive in the Euro area, and that the effect remained significant for 10, 15 and 6 quarters for total government spending, capital spending and current spending, respectively. In Spain, De Castro (2003) and De Castro and De Cos (2006), using VAR with Cholesky decomposition and BP approaches, respectively, found that an increase in total government spending raised interest rates, and the effect remained significant for about 15 quarters. In New Zealand, Dungey and Fry (2009), using VECM, found that interest rates increased from an increase in government spending after five quarters, and the effect remained until the 20th quarter. In Italy, Giordano et al. (2007), using the VAR with BP method, separated current spending into government spending on consumption and public wages and found that an increase in both types boosted interest rates, though not significantly. In Turkey, Ozturk-Degirmen (2004), using VAR with Cholesky decomposition, also found a positive response of interest rates to an increase in total government spending. Finally, Perotti (2002) found significantly positive responses of interest rates to a positive shock in total government spending in Australia, Canada, Germany and the U.K. after the fourth quarter.

In terms of the effects of taxes in other countries besides the U.S., Arin and Koray (2006) used VAR with Cholesky decomposition in Canada and divided taxes into four categories: personal income taxes, indirect taxes, social security taxes and corporate income taxes. They found a negative effect of an increase in these taxes (except corporate income tax) on interest rates, and the effect remained significant until the 15th quarter. This negative interest rate

response to an increase in total tax was found by Burriel et al. (2009) in the Euro area, and the effect remained significant for two quarters. In New Zealand, Dungey and Fry (2009) found that interest rates fell after the second quarter after an increase in total tax, and the response remained until the 20th quarter. A decline in interest rates in response to an increase in total tax was also found in Canada and Germany by Perotti (2002), and the response remained significant for 12 quarters.

In contrast, some studies found a positive effect on interest rates from an increase in taxes. Arin and Koray (2006) found that an increase in corporate income tax raised interest rates in Canada, consistent with the positive multiplier from this tax shock, and the response remained statistically significantly for 15 quarters. They argued that an increase in corporate income tax could lead firms to shift from equity to bond financing, because interest payments were tax deductible. In Spain, De Castro (2003) and De Castro and De Cos (2006) found that interest rates increased from an increase in total tax, and the effect remained significant for 22 quarters. Perotti (2002) found a positive response of interest rates to an increase in total tax in the U.K. and Australia, and the effect remained significant until the 4th quarter and the 20th quarter, respectively.

Besides the effect from government spending and taxes, some studies used VAR and focused on the effect of budget deficit. Baharumshah, Lau and Khalid (2006) found that an increase in the budget deficit caused higher interest rates in Asian countries. Hartman (2007), using VAR with Cholesky decomposition for the U.S., also discovered that an increase in the budget deficit resulted in higher interest rates. Miller and Russek (1996) also employed U.S. data and found that an increase in the budget deficit raised interest rates. In Turkey, Ozturk-Degirmen (2004) found that interest rates responded positively to an increase in the budget deficit. A positive relationship between the interest rate and the budget deficit was also found in Greece by Vamvoukas (1997), using VECM.

To sum up, in the U.S. it was found that the effect of an increase in government spending on interest rates was inconsistent: some studies found interest rates fell from an increase in government spending, while some found the opposite. Most studies discovered a positive effect on interest rates from a positive tax shock. In other countries, most studies found a positive effect on interest rates from an increase in government spending, while the effect of taxation shock on interest rates could be either positive or negative. The effect of fiscal policy varied in different countries, and may be different for each kind of government spending or tax, as found by Arin and Koray (2006).

2.4.2.2 *Effects measured using other methods*

In the U.S. economy, Plosser (1982) employed regression analysis and found that interest rates increased as a result of an increase in government expenditure. This effect was also found by Blanchard (1984). Some studies employed methods that examined news announcements. Kitchen (1996) and Knot and De Haan (1999) using U.S. data found that interest rates increased when there was news of a budget deficit occurring. In the same way, Thorbecke (1993), using German data, discovered that news of a budget deficit raised interest rates. Moreover, in Denmark and Ireland, Barry and Devereux (2003), using a CGE model, found that interest rates fell with a decrease in government spending.

Looking at the effect of taxes using U.S. data, Braun (1994) employed a real business cycle (RBC) model and discovered that interest rates fell from an increase in both corporate income tax and personal income tax. Evans (1987), using U.S. data with regression analysis, discovered no evidence that a decrease in taxes produced higher interest rates; possible reasons were Ricardian equivalence based on accurate foresight, or increased saving from an altruistic intergenerational transfer compensating for the decrease in taxes.

Dai and Philippon (2005), employing an asset pricing approach with U.S. data, found that interest rates rose following an increase in budget deficit. Feldstein (1986) and Hoelscher (1986), using regression analysis with U.S. data, found that increasing budget deficits increased interest rates. However, Evans (1985), using regression analysis with U.S. data, discovered no evidence that budget deficits produced higher interest rates

In summary, while the effect of government spending shock in the U.S. from studies employing VAR method was inconsistent, a positive interest rate response from an increase in government spending was found in most studies. In contrast, there have been some controversies about the effect of budget deficits on interest rates. For example, although Dai and Philippon (2005), Feldstein (1986) and Hoelscher (1986) found an increase in interest rates resulting from expanding budget deficits, Evans (1985) claimed that budget deficits had never been associated with higher interest rates.

2.4.3 *Effects of fiscal policy on prices*

This section focuses on the effect of changes in fiscal policy on price, for both government expenditure and taxes. The effect from government spending will be discussed first.

2.4.3.1 *Effects of government spending*

In the U.S. many studies have found the response of prices is negative to an increase in government spending, at least at the beginning of the shock. Burriel et al. (2009), using a VAR with BP method, found that prices would decline after an increase in both public consumption and public investment, and the effect remained significant for two and eight quarters, respectively. Perotti (2002), using a VAR with BP method, also found the response of prices was negative to an increase in total government spending, and the effect remained significantly for 20 quarters. Fatas and Mihov (2001), using a VAR with Cholesky decomposition, also found that prices responded significantly negatively until the 10th quarter from the positive shock of total government spending. A negative response of prices to an increase in government spending in the U.S. was found by Mountford and Uhlig (2005) for 25 quarters using VAR with sign restriction, and by Favero and Giavazzi (2007) using a VAR with BP method. Favero and Giavazzi divided the time period into two parts: up to 1980 and 1981 onwards, and predicted that, for the period since 1981, prices would decline until the 10th quarter from an increase in total government spending. In contrast, Edelberg et al., using VAR with narrative approach, discovered price responded positively to an increase in total government spending, and the effect remained significantly for seven quarters.

For other countries, Burriel et al. (2009), using a VAR model with BP method in the Euro area, separated spending into public consumption (a part of current spending) and public investment, and found a positive response of prices to public investment shock; the effect remained statistically significant for 18 quarters, while an increase in public consumption significantly raised prices until the 13th quarter. De Castro (2003), employing VAR with Cholesky decomposition in Spain, found a positive effect from total government spending on prices after the second quarter, and the effect remained significant for 28 quarters. De Castro and De Cos (2006), using a VAR with BP method in Spain, also discovered a positive effect from total government spending on prices. They divided government spending into three categories: public consumption, public wages and public investment, and found that an increase in all categories raised prices. However, the effect from public consumption, which remained statistically significantly for 28 quarters, was the most persistent.

In Italy, Giordano et al. (2007), using a VAR with BP method, found a significant positive effect from an increase in total government spending on prices until the second quarter. They also classified government spending into public consumption and public investment, and found that the positive effect from both on prices remained significant for only two quarters. In the same way, Perotti (2002), with four OECD countries and using a VAR with BP

method, found that prices increased from an increase in total government expenditure in all countries. However, a negative response of inflation from an expansion in government spending was found in New Zealand by Dungey and Fry (2009) using VECM. These authors found that inflation would fall for about 10 quarters after the shock before starting to increase between the 10th and 20th quarter.

In summary, in the U.S. most studies found that the response of prices was negative to the positive shock of government spending, while in other countries most studies discovered a positive effect on prices from the positive shock of government spending. Different kinds of spending shock yielded different results.

2.4.3.2 *Effects of taxes*

In the U.S., a negative response of prices from an increase in taxes was found (e.g. Perotti, 2002; Canzoneri et al., 2002; Burriel et al., 2009). However, the impact in the U.S. had a time lag. Burriel et al. (2009) found that the negative response started after six quarters and the effect remained significant from the 12th quarter to the 36th quarter. Canzoneri et al. (2002) found the response of prices was significantly negative to an increase in total tax from the 13th quarter to the 20th quarter. Perotti (2002) also found prices would decline after an increase in total tax from the 12th quarter to the 20th quarter.

For other countries, Burriel et al. (2009) found that prices would fall from an increase in total taxes in Euro areas. De Castro (2003) found a negative response of prices to an increase in total tax in Spain. Dungey and Fry (2009) founded that inflation would fall from a positive shock of total tax in New Zealand.

Perotti (2002) stated that prices would decline from a positive shock of total taxes in the U.K., Canada and Australia. De Castro (2003) and Dungey and Fry (2009) found that the effect persisted until 9 and 14 quarters, respectively but Burriel et al. (2009) found that the response remained significant for 12 quarters.

Some studies divided total tax into different kinds of tax. Arin and Koray (2006), using a VAR with BP method, found that the price level would fall as the result of an increase in personal income tax, indirect tax and social security tax in Canada, and the effect remained significant for 15 quarters. However, an increase in corporate income tax raised prices, which is consistent with the positive multiplier from the shock. De Castro and De Cos (2006) argued that prices would fall from an increase in direct tax and social security tax in Spain, but the effect of social security tax remained significantly longer than the effect of direct tax (5 and

25 quarters, respectively). However, they found a positive effect on prices from an increase in indirect tax.

Some studies considered the effect of budget deficits on prices. Agha and Khan (2006), using a VECM model, found that prices were increased by an increase in budget deficit in Pakistan. Thams (2006), using VAR with sign restriction, found that an increase in budget deficit raised prices in Germany. Tkacevs (2006), using a VAR model, found that prices in Latvia were raised as the result of an increase in budget deficit.

In conclusion, many studies in both the U.S. and in other countries found a negative response of prices to a positive taxation shock. However, it appears that the effect of taxation in the U.S. had a time lag. Further, different kinds of taxation shock yielded different effects on prices.

2.4.4 Effects of fiscal policy in VECM

If data are non-stationary and at least one cointegration relation is found, VAR can be replaced by VECM. In this section, some studies employing VECM to analyse the effect of fiscal policy on output are discussed, and its components are reviewed.

Giorgioni and Holden (2003), using VECM with Cholesky decomposition for G7 countries from 1950 to 1997, found that an increase in total government spending had a positive effect on private consumption, corresponding to the Keynesian view, except in Italy. However, the effect of an increase in taxes supports the German view of expansionary fiscal contraction (EFC), except in Canada and Italy, where an increase in tax raised private consumption. The effect in all countries except Germany and Italy lasted at least 5 years, at which point the data ended. Krusec (2003), using VECM with long-run restriction of KPSW to study the effect of fiscal policy in eight developed countries from 1960:1 to 2001:4, found that an increase in total government spending had a positive effect on output, while an increase in total tax had no effect on output. From the impulse response functions (IRFs), a positive total government spending shock of 1% increased output at most by 0.5% at the time of impact in Finland, 0.5% after eight quarters in Austria, 0.3% after four quarters in Italy, 0.21% at the time of impact in the U.S., 0.7% at the time of impact in Australia, 0.5% two years after impact in Canada, and 0.5% one year after impact in the U.K. The persistence of the effect was different in each country, but the positive effects in most countries became insignificant after the 10th quarter.

Dungey and Fry (2009), using VECM by employing a method of separating permanent and transitory shocks for New Zealand from 1983:2 to 2006:4, discovered that an increase in both government spending and taxation had a temporary positive effect on output. From the IRFs, output increased by 0.14% at the time of impact, and the impact peaked at 0.24% in the fifth quarter, from an increase in government spending of 1%. The positive response remained for 10 quarters before it turned negative, consistent with higher prices and interest rates, and the negative effect remained until the 40th quarter. Since tax shocks also increased government spending, output responded positively to an increase in tax of 1% and the response peaked at 0.3% before disappearing after 28 quarters. Restrepo and Rincon (2006) studied the effect of fiscal policy in Chile and Colombia from 1990:1 to 2005:2 using VECM with long-run restriction of KPSW and translated results from IRFs. They found no cointegration relation in data from Chile. In Colombia, an increase in government spending of 1 peso raised output by 1.2 pesos at the time of impact, and the effect remained statistically significant for three quarters.

However, a negative response of output to an expansionary fiscal policy can also be found. Konuki (2000) used VECM for Switzerland from 1975:4 to 1996:4 and found the impact multiplier of government spending to be -0.2 . The response remained for 18 quarters. Mariotti (2002) found a negative long-run relationship between government spending and growth rate in South Africa.

In the U.S., Becker (1997), using VECM with long-run restriction from 1960:1 to 1993:1, found that an increase in total government spending decreased private consumption. However, he could not discriminate between the Ricardian and Keynesian models because total tax was also increased with the positive shock of total government spending. The Ricardian view is that private consumption would decrease in response to increases in government consumption, but a Keynesian model would make the same prediction for private consumption due to an increase in tax. Zestos and Geary (2008), using data from 1955 to 2006, found a negative long-run relationship between the deficit to nominal GDP ratio and nominal national income since large deficits increased interest rates and private investments then decreased. Mohammadi and Skaggs (1996) studied the effect of budget deficits on trade deficits in the U.S. (i.e. twin deficits) and analysed the effect from the IRFs derived by Cholesky decomposition. They found that budget deficit had a modest positive effect on trade deficit, and the effect remained for 16 quarters.

Some studies only examined the effect of public investment. Pereira and Andr az (2007), using VECM for Portugal from 1976 to 1998, found that an increase in public investment in transport raised output and private investment. Ramirez (2004), also employing VECM but in Mexico from 1955 to 1999, discovered a positive effect of an increase in public investment on growth rate. However, Acosta and Loza (2005), using a cointegration relation, found a negative long-run relationship between public investment and private investment in Argentina from 1970 to 2000. Ghali (1998), using VECM for Tunisian data from 1963 to 1993, discovered a negative relationship between public investment and private investment. Finally, Rossiter (2002) using U.S. data, discovered a negative long-run relationship between government spending and private investment.

Some studies considered the effect of fiscal policy on fiscal sustainability (i.e. whether the government can maintain a given spending, taxation and borrowing pattern indefinitely). In Spain, Rubio, Roldan and Esteve (2006), using VECM, concluded that huge budget deficits may be dangerous in terms of sustainability. Tshiswaka-Kashalala (2006) also studied the sustainability of fiscal policy by using South African data and found that fiscal policy in that country is sustainable.

To sum up, in this section a positive effect on output from the positive shock of government spending was found in most studies, consistent with the results from studies employing the VAR method, but a negative response of output to an increase in government spending was also found. Many studies found a negative effect on private investment from an increase in government spending. Some studies found that an increase in tax could have positive effects on the economy, which supports the EFC idea.

2.4.5 Effects of fiscal policy in Thailand

After reviewing the effect of a fiscal policy shock on the economy in many countries, in this section the effect of fiscal policy in Thailand will be the focus. Studies in this section were divided into the following methods: macroeconomic model or simultaneous equation (SEM), general equilibrium (CGE), the VAR model, the production function, and other models.

In a study employing SEM, Sriboonma (1999) used data from 1980 to 1996 and found that an increase in government investment caused an increase in GDP, private consumption and private investment in Thailand. Charoenkittayawut (2001), using data from 1988:1 to 1998:2, found that an increase in total government expenditure raised GDP, with a multiplier of 1.02. The shock also raised private consumption, private investment and prices, but decreased

interest rates. Kukangwan (1996), using data that spanned 1971 to 1993, found that the multiplier of total government spending was 1.55. Yongpitayapong (2004), using data from 1993:1 to 2002:4, divided government expenditure into current and capital spending and found that both had positive effects on GDP, with a multiplier of 1.33. Yimsiriwattana (2003) used data from 1972 to 2001 and found that the multiplier of an increase in total government spending was 2.26. Thirak (2005), with data spanning 1988 to 2003, discovered that an increase in total government spending of 5% increased private consumption, private investment and output by 0.74%, 0.67% and 0.75%, respectively. Srisuksai (2005) studied the impact of government spending on private consumption from 1993:1 to 2003:4 and found that an increase in government expenditure slightly boosted private consumption. For example, an increase in government expenditure of 5% led to an increase in private consumption of about 0.03%.

Sangsubhan and Basri (2012) reviewed the impact of the recent global financial crisis on the Thai economy using a structural macroeconomic model and checked whether the fiscal stimulus packages (SP1, which is 117 billion baht, and SP2, which is 350 billion baht, and also 40 billion baht for tax reduction) could counter the negative effect of the crisis during 2008 to 2010. They found that SP1, which was mainly employed in 2009, for about 100 billion baht could increase output about 1%. Moreover, in this year, tax reduction of about 10 billion could increase GDP about 0.06 %. For SP2, in 2010 about 230 billion baht could lift GDP growth from the base case of 6.80–7.8 %. Thus, they concluded that the fiscal stimulus package in Thailand focused on the spending package was effective. They also argued that the recent stimulus packages would not be dangerous to fiscal sustainability in Thailand because the ratio of public debt in Thailand was still not very high.

However, Sussangkarn (2012) argued that the ratio of public debt to GDP in Thailand was expected to expand in the future due to the populist fiscal policy. Moreover, the fiscal sustainability framework, which sets a percentage of public debt to GDP of not over 60%, was not a legal limit and could easily be pushed up when politically convenient. Nemoto (2012) also claimed that the medium-term plan for fiscal sustainability in Thailand was important to ensure ample fiscal space for counter-cyclical policy to respond to future shocks. In addition, the transparency of using public finance in Thailand should be monitored. For the study employing SEM in Thailand, the studies cited above used models that were quite compact for SEM (i.e. not covering variables in all sectors), so they might not explain the behaviour of the economy with a high level of precision. According to Jansen (2004), if a model is too large, simultaneity cannot be treated in a satisfactory way.

Turning now to the CGE approach, Chainakul (2002) used data from 2002 and found positive responses of output, private consumption and prices to an increase in government expenditure. However, the limitation of this study was that it focused on short-run analysis, and could not include variables (such as private investment) which take time to change. Songtragoolsak (2002), using data from 2002, discovered that an increase in government expenditure increased GDP with a multiplier of 1.04, but the shock had a negative effect on income distribution. Suksai (2008) used 2008 data and discovered that an increase in the rate of personal income tax, corporate income tax, capital gain tax and value-added tax slowed the economy (i.e. decreased private investment and employment). However, Suksai's study assumed only one manufacturing sector, which did not correspond to reality.

Robalino and Warr (2006) investigated the impact of changes in the composition of taxes and public expenditures on the incidence of poverty in Thailand, based on recent micro-level research on the distribution effects of government taxes and expenditures in Thailand. Although the study was not developed within an explicit CGE model, it can be considered as an attempt to approximate the CGE distributional effects of all major taxes and most major expenditures. It was found that if the government increased the ratio of personal income tax to total tax to 10%, it resulted in a decrease in the poverty incidence from 16.3% of the total population to 15.4%. Moreover, it was found that the expenditure that can greatly benefit the poor is spending on health and agriculture.

Fakthong (2006) used VAR with Cholesky decomposition from 1993:1 to 2006:4 and found that total government expenditure crowded out private investment after the second quarter, and that the effect remained until the 10th quarter. Atukeren (2004), using data from 1970 to 2000 with cointegration analysis, discovered that an increase in public spending had a contractionary effect on private investment; that is, it had a crowding out effect. Tubtintong et al. (2009), using a VAR with BP method employing data from 1995:1 to 2004:4, discovered that an increase in total government spending decreased output after the second quarter, but the effect was insignificant; the effect from total tax was positive, but also insignificant. They also divided government spending into social and non-social spending and found a negative response after the second quarter from both shocks, though it was insignificant.

Winothai (2004), using VECM from 1980 to 2003, found that gross public investment had a negative effect on GDP and private investment after the second and fifth quarters, respectively, and the responses remained for at least 20 quarters (when the data ended),

though it was insignificant. Baharumshah and Lau (2007) used VECM to study the twin deficit from 1976:1 to 2001:4 and found that an increase in budget deficit raised interest rates and resulted in an appreciation in the Thai baht, which brought about a current account deficit. Chang et al. (2002), using data from 1951 to 1995, found that over 10 years the cumulative multipliers for taxes and government spending in Thailand were both just 0.04, and not significant, so they concluded that fiscal policy could not promote the economy. Nidhiprabha (2010) used VAR to investigate the macroeconomic policy from July 1997 to September 2001 in Thailand, and found that monetary policy seemed to be more effective than fiscal policy, while depreciation in the baht–dollar exchange rate had a negative effect on output. However, changes in monetary policy affected inflation more than changes in fiscal policy, but changes in the baht–dollar exchange rate had a greater impact on inflation than other policies.

Nevertheless, a positive effect from an expansionary fiscal policy in a VAR model can also be found. Vorasangasil (2008), using VAR with Cholesky decomposition from 1997:3 to 2007:4 (i.e. after the financial crisis), found that an increase in current spending raised output to peak in the third quarter, with the peak multiplier at 1.02. This response remained for at least 10 quarters, when the data ended. In terms of the effect from capital spending, the peak multiplier was at 1.36 in the second quarter, and the response remained for eight quarters. Chansom, Sudsawasd, Chaisrisawatsuk and Sukcharoensin (2007) used VAR with Cholesky decomposition to study the effect of mega projects in Thailand (planned between 2005 and 2013) on output, inflation and the trade balance. Capital expenditure in their study was divided into productive expenditure (having a direct effect on the steady-state rate of growth) and unproductive expenditure (having no direct effect on the steady-state rate of growth; e.g. social spending). It was found that an increase in both raised output, but the shocks also increased inflation. Inflation was raised temporarily (for 3 years) from the productive expenditure, but it was more persistent from unproductive expenditure (it remained for at least 5 years, when the data ended). Leangman (2006), using data from 1972 to 2006, found that an increase in total government spending had a positive effect on prices after the second year of the shock. Hsing (2003), using data from 1993:1 to 2001:1 and using VAR with Cholesky decomposition, found that the results supported an IS-LM model in that an increase in government spending raised output, while an increase in taxes diminished output.

In relation to the production function, Suwanrada (1999) studied the effect of public investment on GDP between 1990 and 1996 and found that an increase in public investment increased GDP. Fan and Rao (2003) studied the effect of government spending on private investment in developing countries, including Thailand, and found that government spending

on agriculture, education and defence had a positive effect on private investment. Ramangkura and Nidhiprabha (1991), using data from 1976 to 1986, concluded that private investment would be increased if the government increased the ratio of public investment to total government spending.

Looking now at other methods used, Kuehlwein and Samalapa (2004) used regression analysis with data from 1980:1 to 1994:4 and found that a decrease in government consumption decreased interest rates, while a decrease in public investment raised interest rates. Noonim (2004), employing regression analysis with data from 1979 to 2003, found that an increase of 1% in the ratios of government economic expenditure to output, expenditure on health and education to output, and government general management expenditure to output, raised GDP per head by 1.3%, 1.88% and 3.49%, respectively. Moreover, an increase in the ratio of personal income tax to GDP had a negative effect on GDP. Phaengthai (2001), using regression analysis with data from 1981 to 1998, found that an increase in the ratio of current and capital spending to output of 1% raised GDP per head to 0.49% and 0.25%, respectively. Hongthong (2003) employed a regression analysis with data from 1982 to 2001 and discovered that an increase of 1% in the ratios of current spending, capital spending and total tax to output increased GDP per head by 0.03%, 0.01% and 0.033%, respectively.

Leightner (2005), studying the effect of government spending on output in 23 Asian countries, including Thailand, from 1983 to 2000, by Reiterative Truncated Projected Least Squares (RTPLS), produced 50% of the error of OLS when omitted variables interacted with the included independent variable. It was found that the effect of government spending on output was positive. Moreno-Dodson (2006) assessed the impact of fiscal policy in seven fast-growing countries, including Thailand. Data from 1970 to 2006 were used and OLS, seemingly unrelated regression equations (SURE) and generalized method of moments (GMM) were the main methods. Government expenditure was divided into education, health, transport and communication, and all had positive effects on growth rate. Wongpanich (1995), using data from 1962 to 1992 with the hypothesis of macro-rational expectation (MRE), found that an increase in both anticipated and unanticipated fiscal policy had positive effects on output. There was also a study investigating the effect of taxes on poverty. Son (2006) used elasticity of general class of poverty and found that tax subsidies in education and health led to reductions in poverty.

In summary, in all methods it was found by most studies that an expansionary fiscal policy had positive effects on output, although some studies discovered a non-significant effect on

output from an increase in government spending. However, considering the effect of different kinds of spending, there were controversies in some studies. For example, Yongpitayapong (2004) found that an increase in both current and capital spending could raise output equally, while Vorasangasil (2008) found that output increased more from an increase in capital spending. Although most studies focused on changes from the spending side, the effect from changes in taxation could also be found. Further, most studies found a negative effect from taxation shock on the economy, except Chang et al. (2002) and Tubtintong et al. (2009), who found an insignificant effect from taxation shock on output, and Hongthong (2003), who found a positive response on output from taxation.

2.5 Conclusion

In conclusion, at the theoretical level there are controversies about the effects of fiscal policy. The effect of an expansionary fiscal policy on output can be positive, zero or negative: with an increase in government spending, output increases in Keynesian theory but remains unchanged in classical theory, while a decrease in government expenditure raises output in the German view of Expansionary Fiscal Contraction (EFC). An expansionary fiscal policy also affects the crowding out variables (e.g. either interest rate or price increases from an expansionary fiscal policy in classical and Keynesian theories).

At the empirical level, whatever method was employed it was found by most studies that an increase in total government spending yielded a positive effect on output, consistent with Keynesian theory. The positive response of output to an increase in total government spending was found in most countries except Denmark and Ireland, where some studies found a negative effect from the positive total government shock on output, consistent with the EFC view. However, while output positively responded to an increase in total government spending, each kind of spending resulted in a different impact on output. For example, an increase in public consumption and public investment was mostly found to have a positive effect on output, while an increase in public wages and public employment was mostly found to have a negative effect on output.

The effect of total tax shock was more varied than the effect of total government expenditure; for example, some studies found a positive response of output from a positive total tax shock, while some studies found the opposite result. However, in the U.S., studies using both VAR and other methods found that output responded negatively to a positive taxation shock, but each kind of taxation yielded a different result on output.

In Thailand, whatever method was employed, most studies discovered a positive response of output from a positive shock of total government spending. However, there was controversy about the effect of government spending by type; e.g. the different results for the effect of an increase in current spending and capital spending found by Yongpitayapong (2004) and by Vorasangasil (2008). As a result, it is worth investigating the effect from the shock of government spending by type on output. Most studies focused on the effect of spending policy, so the effect from taxation shock on output is also worth examining.

From the review of literature in Thailand it can be seen that many studies used the SEM method for analysing the effect of fiscal policy. However, Lucas has criticised SEM's usefulness in policy evaluation since the structure described by the SEM may change as policy changes, and so it may fail to reflect reality. According to Sims (2002), the intervention a policy VAR is designed to analyse is precisely the sort of thing Lucas warned of (i.e. VAR, unlike SEM, does not contain a fixed coefficient).

A number of studies in Thailand used VAR to investigate the effect of fiscal policy. However, some examined the effect of only one kind of government spending on the economy, such as the effect of public investment on private investment, or the effect of total government spending on private investment. Some studied the effect of government spending by type on output and its components without considering the effect of taxation. Some investigated the effect of total government spending and total tax on output, but did not consider the effect of government spending by type and taxation by type. Some studies focused on the effect of government spending by type and total tax on output and its components.

In my study, not only will the effect of government spending by type and total taxation on GDP and its components be investigated (as in Tubtimtong et al., 2009), but total taxation will also be divided into three types in order to find the effect of taxation by type. The effect of fiscal policy on prices and interest rates will also be examined. Further, some of the previous literature employed VAR with level data without testing for stationarity, while some studies used VAR with first difference data without testing for cointegration relations. A VAR model with first difference might not be the correct specification when non-stationary data are cointegrated, since an error correction would be missing from VAR (Enders, 1995). My study will employ VECM when data are non-stationary and there is at least one cointegration relation between non-stationary variables.

Finally, most studies in Thailand have the problem of a limited number of observations because they employ annual data or quarterly data from just over 10 years (no previous

studies have employed quarterly data before the first quarter of 1993). In my study, the data used for examining the effect of fiscal policy will start from the first quarter of 1988.

Chapter 3

Fiscal Policy in Thailand

3.1 Introduction

This chapter will provide details about Thailand's economy, beginning with output and its components, interest rates and inflation, then moving on to fiscal policy variables. The details of almost all data presented in this chapter cover the period of analysis in chapter 4 (1988:1 to 2009:4), but the details of some data are not available before 1995 (e.g. in Figure 3.4 and Figure 3.5). In the first section, Thailand's economy will be considered, and the details of output and its components, the price level and interest rate will be discussed. Then, fiscal policy in Thailand will be examined. The effect of the Asian Financial Crisis on Thailand's economy and the implementation of fiscal policy will also be considered by taking the period before the crisis hit Thailand (pre-1997) and the period since the crisis (post-1997), because both how fiscal policy was implemented and Thailand's economy are different in these two periods.

3.2 Thailand's economy

In this section details about output and its components will be looked at first, followed by details of interest rates and inflation.

3.2.1 The GDP of Thailand

In Thailand, agriculture used to make up a high proportion of GDP. However, its importance is decreasing, as shown Table 3.1.

Table 3.1: Relative size of sectors, 1957–1992

Year	% of agricultural product to total product	% of non-agricultural product to total product	% of manufacturing to non-agricultural product	% of wholesale and retail trade to non-agricultural product	% of transport, storage, and communication to non-agricultural product	% of other non-agricultural product
1957–73	28.17	71.83	24.00	24.30	8.00	43.70
1974–84	21.80	78.20	27.40	23.50	7.40	41.70
1985–87	14.90	85.10	31.50	21.20	8.97	38.33
1988–92	12.10	87.90	33.00	20.50	8.40	38.10

Source: Office of the National Economic and Social Development Board (NESDB), GDP 51-96.

From Table 3.1 it can be seen that there was a structural change in Thailand's economy before the 1990s. Between the periods 1957–73 and 1985–87 the share of agriculture in GDP

decreased from 28.17% to 12.10%, less than half its former share. Conversely, non-agricultural products (mostly comprising manufacturing, transport and others, especially manufacturing) increased in importance, as seen from the ratio of manufacturing to non-agricultural product between 1957 and 1973 (about 24%), but this ratio increased to more than 30% during 1985 to 1987 (i.e. an increase of about 31%).

One of the reasons why the agriculture sector has decreased its role is heavy taxation on rice. After World War 2 a heavy tax on rice had a negative effect on production. This tax was imposed when Great Britain forced Thailand to pay its war indemnity in rice. It is also related to productivity: “Thailand has typically expanded cultivated areas as a source of agricultural growth stemming from the resource endowment; abundant land itself permitted the Thai farmer to expand land frontiers instead of improving productivity” (Siriprachai, 2007, p. 134). Nowadays, manufacturing has taken the main role in GDP in place of agriculture.

Table 3.2: Relative size of sectors, 1993–2009

Year	% of agricultural product to total product	% of non-agricultural product to total product	% of manufacturing to non-agricultural product	% of wholesale & retail trade to non-agricultural product	% of transport, storage, and communication to non-agricultural product	% of other non-agricultural products
1993	10.30	89.70	35.20	19.40	8.60	36.80
1994	7.87	90.10	35.30	19.40	8.70	36.60
1995	9.40	90.60	35.90	15.38	8.97	39.75
1996	9.27	90.70	36.10	18.60	9.45	35.85
1997	9.30	90.70	37.19	18.30	10.00	34.51
1998	10.2	89.80	37.40	17.90	10.30	34.40
1999	10.00	90.00	40.00	17.70	10.40	31.90
2000	10.30	89.70	40.60	17.60	10.70	31.10
2001	10.40	89.60	40.30	17.00	11.20	31.50
2002	9.90	90.10	40.80	16.40	11.30	31.50
2003	10.40	89.60	42.40	15.90	10.97	30.73
2004	9.60	90.30	42.70	15.60	10.90	30.80
2005	9.01	90.90	42.70	15.40	10.90	31.00
2006	9.04	90.90	43.00	15.20	11.00	30.80
2007	8.60	91.30	43.40	15.10	11.10	30.40
2008	8.70	91.20	44.00	15.00	10.80	30.20
2009	8.90	91.00	42.87	15.00	10.80	31.33

Source: NESDB (2010), Gross Domestic Product.

The period since the 1990s (see Table 3.2) experienced no big change, as was seen in the period from the 1950s to the 1980s. Manufacturing was the largest part of non-agricultural production and slightly increased between 1993 and 2009. The ratio of manufacturing to non-agricultural product increased from 35.2 in 1993 to 42.8 in 2009, or about 21%. Moreover,

agriculture was decreasing in its role, as seen from the ratio of agriculture to total product, which decreased from 10.3 in 1993 to 8.9 in 2009, or about 13.5%.

3.2.1.1 *The period of low-level growth*

Between 1855 and 1950, according to Siriprachai (2007), Thailand's economy had a slow rate of growth of about 0.2% per year. One of the reasons for this was the Sakdina system (Thai feudalism), which did not create an entrepreneurial class. Most entrepreneurs working in Thailand during that period came from Europe and China. Chinese traders and workers earned money in Thailand and sent it back to China. According to Ingram (1971), the amount of money that was sent back to China was substantial. As a result, there was hardly any capital accumulation in Thailand.

3.2.1.2 *GDP before the 1997 Asian Financial Crisis*

After 1950 the growth of the economy was good, especially from 1990 to 1996. It can be seen from Table 3.3 that the average growth rate between 1950 and 1996 was about 6.8% per year, before turning negative during 1997 and 1999 due to the financial crisis. Rapid capital accumulation was one of the main factors in this growth.

Table 3.3: GDP growth rate, inflation rate, ratio of saving and investment to output

Variables	1950–1959	1960–1969	1970–1979	1980–1989	1990–1996	1997–1999
Growth rate real GDP	5.4	8.0	7.1	7.3	8.5	-2.0
Saving/GDP ratio	11.5	20.6	21.8	25.1	34.1	31.0
Investment/GDP ratio	13.6	20.8	23.8	28.6	40.7	24.3
Inflation rate	5.1	2.2	8.0	5.8	5.1	4.7

Source: Siriprachai, 2007, p. 132

From Table 3.3 it can be seen that the ratio of investment to output increased to about 40% between 1990 and 1996, from about 13% between 1950 and 1959. Between 1990 and 1996 the ratio of investment to output was high (40%) because a large amount of funds from overseas flowed into Thailand after the government relieved restraints on capital mobility. This ratio then dropped to 24.3% during the financial crisis. The high capital accumulation in Thailand was mostly financed domestically until the mid-1980s.

It can be seen that the ratio of saving per GDP was quite high (see Table 3.3), especially from 1990 to 1996, because of high income from the economic boom. From 1997 to 1999 the ratio of saving to GDP was still high because households had no confidence to spend, due to the financial crisis. In Thailand, although the country suffers from many coup d'états, these do

not have a substantial big effect on the stability of the economy because the monarchy in Thailand can keep national conflicts at a low level.

Table 3.4: Sources of growth (%)

Sources	1960–1970	1985–1988
Domestic demand	89.1	78.1
Import substitution	–0.6	–23.4
Export demand	11.4	45.3

Source: Siriprachai, 2007, p. 133

From Jansen’s (1991) study it was found that the sources of Thailand’s growth were domestic demand, import substitution and export demand. Table 3.4 shows that domestic demand was the main factor driving the economy. However, exports increased from just 11.4% between 1960 and 1970 to just over 45% between 1985 and 1988.

Table 3.5: Percentage change of output

Year	% change of GDP	% change of agricultural product	% change of non-agricultural product
1987	9.5	0.0	11.6
1988	13.2	10.5	13.8
1989	12.1	9.6	12.6
1990	11.1	–4.6	14.6
1991	8.5	7.3	8.7
1992	8.0	4.7	8.5
1993	8.3	–2.4	9.8
1994	8.9	5.3	9.4
1995	8.8	2.5	9.7
1996	5.5	3.8	5.7
1997	–0.4	1.4	–0.7
1998	–10.2	–1.4	–11.2
1999	4.4	2.3	4.7
2000	4.8	7.2	4.5
2001	2.2	3.2	2.0
2002	5.3	0.7	5.9
2003	7.1	12.7	6.2
2004	6.3	–2.4	7.4
2005	4.6	–1.8	5.3
2006	5.1	5.4	5.1
2007	4.9	0.9	5.3
2008	2.5	3.5	2.4
2009	–2.2	–0.5	–2.4

Source: BOT, 2010, Stat Macroeconomic Indicators.

Before the financial crisis, from 1987 to 1997, the growth rate of Thailand’s economy was high. Table 3.5 shows that the average rate between 1987 and 1996 was 9.4% per year. There were many factors involved. The first was the growth of the world economy, resulting in a

growth in exports (see Table 3.6). With both local and international investors confident about Thailand's economy, private investment grew rapidly (see Table 3.6). The government also had measures in place for encouraging export and investment, as seen from the ratio of capital spending to government spending, which was reasonably high during this period (see Figure 3.3).

3.2.1.3 GDP during and after the 1997 crisis

However, the high growth rate of the economy after 1987 resulted in the instability of the economy later. The growth rate in 1996 reduced to 5.5%, from 8.8% in 1995 (see Table 3.5), because of problems in the export sector (see Table 3.6): the demand for Thai products in many countries (especially in Asia) dropped during this year. During that period Thailand's economy relied heavily on short-run international borrowing. In addition, the economy suffered from a trade deficit from 1987 to 1997 (see Figure 3.2), resulting in problems with the current account, which affected confidence in Thailand's economy. This brought about a currency attack and caused the financial crisis in 1997. Thailand changed its exchange rate system from fixed rate to floating rate in July 1997.

The financial crisis strongly affected the economy, as can be seen from the growth rate of Thailand, which fell from 5.5% in 1996 to -10.2% in 1998 (see Table 3.5). The reasons were a decrease in expenditure from both the private and government sectors (see Tables 3.6 and 3.9) and high unemployment rates, which jumped to over 4% in 1998 from just 1.0% in 1997 (see Table 3.7). However, in 1999 the economy began to recover and grew by 4.4%, led by higher exports (see Table 3.6) and the measures taken by the government to stimulate the economy (e.g. the Miyazawa budget). After this, the economy continued to recover from the crisis and many factors supported this expansion, including the world economy, higher exports, the confidence of consumers and investors, and low interest rates (see Table 3.7).

After the crisis, the economy expanded for 10 years, and one of the important factors was an increase in exports resulting from a decrease in the value of the Thai baht. However, in 2009 GDP decreased again, by 2.2% (Table 3.5), as the world economy caused problems for exports, which were down by 13.9% from the previous year (Table 3.6).

3.2.2 Components of output

Looking at the components of GDP, from Figure 3.1 it can be seen that private consumption was the largest component, at more than 50% of GDP. After 1996 the ratio of private investment to GDP significantly decreased due to the financial crisis, but after 1999 this ratio started to recover again. The ratio of government spending to GDP was increased during the crisis period in order to stimulate the economy. Lastly, net export (X-M) became positive after the crisis due to an increase in exports.

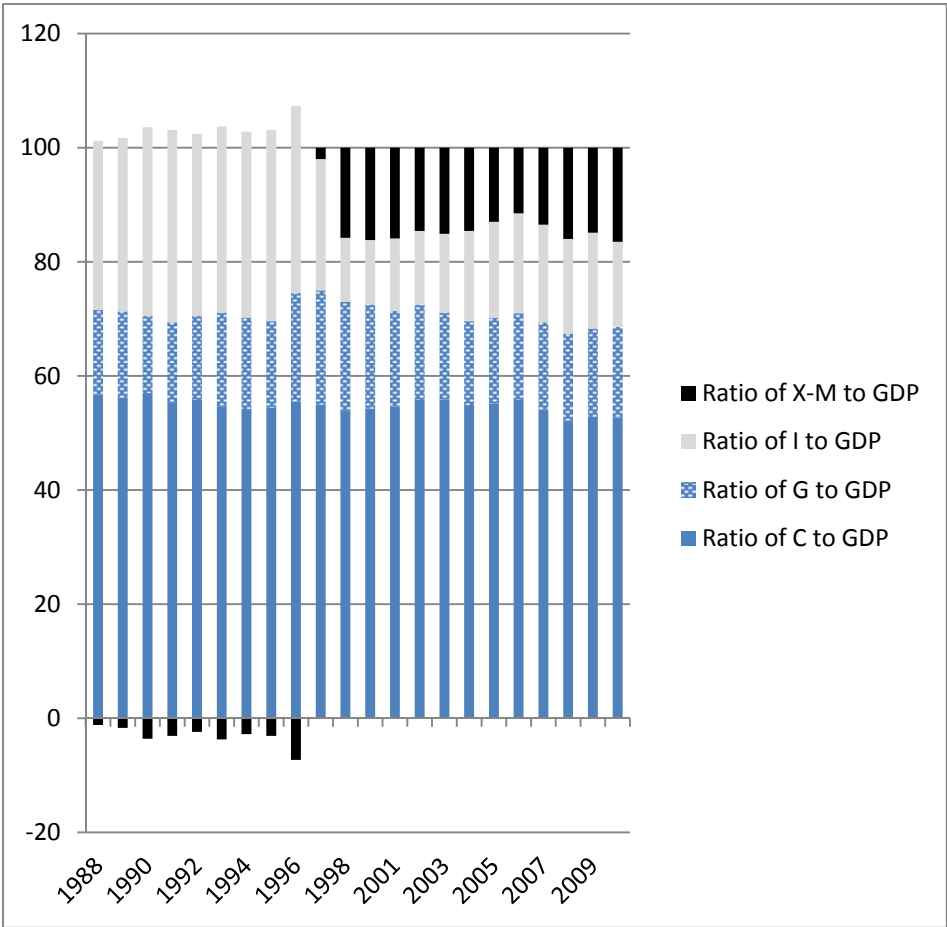


Figure 3.1: Ratios of GDP components (%)

Source: NESDB, 2010, Gross Domestic Product.

Table 3.6: Percentage change of output components, 1988 prices

Year	% change of C	% change of I	% change of EX	% change of IM	% change of G	% change of GDP
1988	–	–	–	–	6.2	13.2
1989	10.0	20.1	25.1	27.2	12.6	12.1
1990	11.4	22.4	15.0	29.7	17.3	11.1
1991	5.1	9.2	23.5	15.6	17.4	8.5
1992	8.0	2.5	13.7	6.0	23.4	8.0
1993	7.7	9.5	13.4	12.3	17.2	8.3
1994	7.1	8.2	22.5	18.1	17.6	8.9
1995	7.2	9.8	24.8	31.9	10.5	8.8
1996	5.4	2.6	–1.9	0.6	16.6	5.5
1997	–1.3	–43.7	3.8	–13.4	18.4	–0.4
1998	–13	–51.5	–13.8	–34.0	–6.0	–10.2
1999	4.1	–3.4	7.4	16.9	–1.6	4.4
2000	4.9	14.3	19.5	31.5	3.5	4.8
2001	3.9	4.7	–7.1	2.9	3.0	2.2
2002	5.1	11.8	4.7	4.5	3.2	5.3
2003	6.1	15.0	18.1	17.3	–3.5	7.1
2004	5.8	14.0	21.5	25.7	17.8	6.3
2005	4.3	9.4	15.1	25.8	7.0	4.6
2006	3.0	3.9	16.9	7.9	13.9	5.1
2007	1.7	0.0	18.2	9.0	12.8	4.9
2008	2.6	3.1	15.8	26.8	3.7	2.5
2009	–1.1	–14.6	–13.9	–25.2	17.4	–2.2

Source: BOT, 2010, Stat Macroeconomic Indicators.

From Table 3.6 it can be seen that before the crisis (1989 to 1996), GDP growth was high with employment growing in most sectors (e.g. construction and tourism). Private consumption continually expanded by an average of 7.8% per year, especially in 1990, when private consumption grew more than 11% due to the government raising salaries for government officials and raising the level of minimum wages. However, during the crisis private consumption fell by 1.3% in 1997 and then by 13% in 1998 (Table 3.6). This was because unemployment increased to 4.3% in 1998 from about 1% in 1996 (see Table 3.7). Moreover, households suffered from uncertainty about employment, which resulted in a reduction in household spending. Nevertheless, private consumption increased again in 1999 by 4.1%.

The main factors in the recovery were decreases in valued-added tax, low interest rates (see Table 3.7) and government measures to stimulate the spending of people in the countryside (e.g. the Miyazawa budget for boosting employment). After 1999 private consumption expanded more than 4% per year every year until 2005. In 2006 and 2007 the growth rate of private consumption decreased because of an increase in oil prices and people having no confidence in the political situation. In 2008 the growth rate of private consumption rose again after the government increased the level of minimum wages that year. In 2009 the

growth rate of consumption turned negative again, at -1.1% (see Table 3.6), due to a decrease in GDP resulting from world economic problems.

The trend in private investment corresponds to output and private consumption. Private investment grew strongly from 1989 to 1995 by an average of just over 10% per year. Growth in private investment mostly came from small and medium business and the real estate sector. Factors encouraging private investment were low levels of wages, high levels of loanable funds from overseas, the government's measures to stimulate and diversify private investment to other areas, and the measures for promoting investment in small and medium enterprises. According to Siriprachai (2007), in 1989 and 1990 the growth rate of private investment was very high (over 20%) because of foreign direct investment, especially from Japan. However, the Board of Thailand increased the interest rate ceiling for loans in the second half of 1990, and private investment fell in 1991.

A high growth rate of private investment from 1989 to 1995 caused an excess in private investment (e.g. in real estate). This resulted in the slowdown in the growth rate of private investment in 1996 (just 2.6% per year). Later, when the financial crisis occurred, the growth rate in private investment turned to negative (-43.7% in 1997). Because of previous over-investment, banks' caution over lending and high interest rates, the growth rate in private investment continued to be negative in 1998 and 1999. However, as can be seen from Table 3.6, private investment started to recover again in 2000 due to investment in real estate. The growth rate in private investment from 2000 to 2008 was higher than 3% every year, except in 2007, when the growth rate was low due to the political situation. In 2009, due to a decrease in GDP, the growth rate fell to -14.6% .

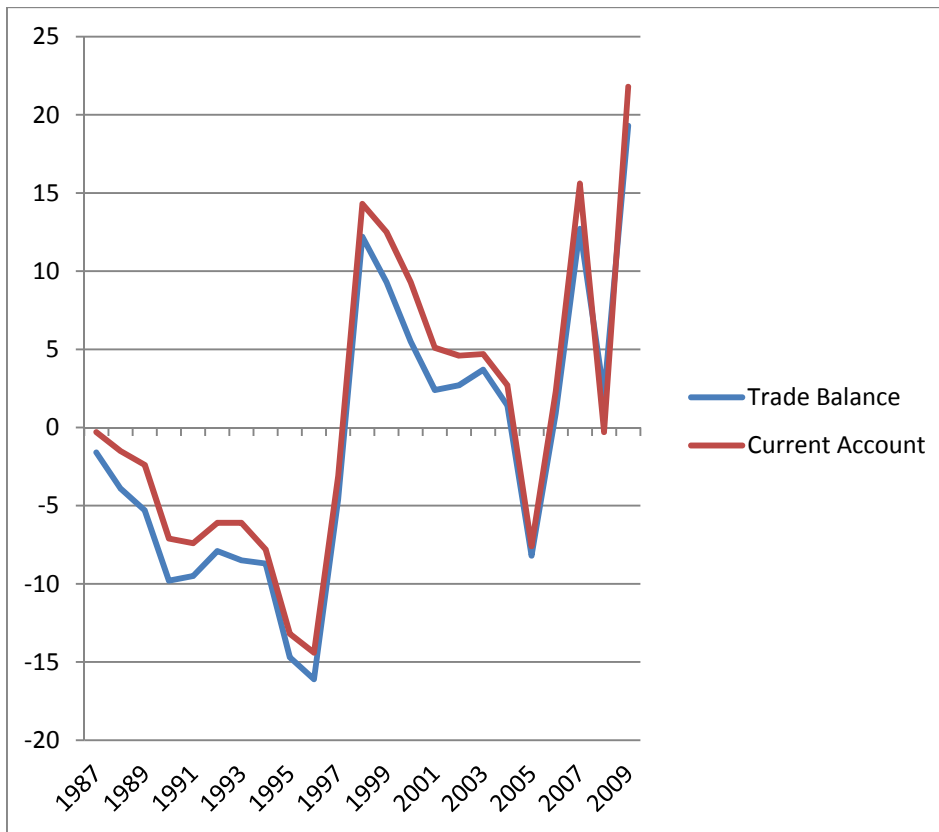


Figure 3.2: Trade balance and current account (billions of baht at current prices)

Source: BOT, 2010, Stat Economic Indicators.

Turning now to the trade balance, in the 1950s the most important export good was rice, along with others goods from the agriculture sector, such as rubber, tin and teak. However, according to Siriprachai (2007), since the 1980s the manufacturing sector has increased its role in export dramatically. From 1985 to 1990 important manufacturing export goods were textiles, garments, canned foods, canned fish, gems, jewellery and circuits. From the mid-1980s imports were increasing faster than exports.

From 1987 to 1997 Thailand suffered from a trade deficit (see Figure 3.2) because the growth of the economy was high. As a result, the level of imports increased strongly (see Table 3.6) because of the demand for capital in order to support higher investment. The government also reduced import taxes. Although the rate of expansion in exports was also positive, the level of exports was still less than that from import. This is why the trade balance was in deficit during this period, which resulted in a deficit in the current account.

However, after the crisis, imports fell by 35% (1998) due to a reduction in the baht and lower domestic demand. In contrast, exports mostly increased after 1998 due to changes in the

exchange rate. The trade balance, in deficit up to 1997, turned to surplus from 1998, resulting in a current account surplus between 1998 and 2007 (except for 2005, due to oil and material imports). In 2008, although the trade balance was still in surplus, there was a deficit in the current account because of a deficit in the services balance, due to a decrease in tourists from overseas. The trade surplus continued in 2009, when imports decreased more than exports (–25.2% and –13.9%, respectively).

3.2.3 Interest rates

From Table 3.7 it can be seen that the level of real interest rates ($Rr = R - \text{inf}$) did not change as much as nominal interest rates (R), which ranged between 5.5% and 16.3% per year from 1987 to 2009.

From 1987 to 1990 the situation of private investment corresponded to the level of nominal interest rates. From Table 3.6 it can be seen that the growth rate of private investment in 1989 and 1990 was very high. Nominal interest rates in Thailand also increased strongly from 1988 to 1990, from about 12.5% in 1988 to 16.3% in 1990 (see Table 3.7). However, after the government reduced constraints on capital mobility, more foreign capital flowed in. Then liquidity was increased from 1991 to 1992, so interest rates started to reduce. In 1995 the Bank of Thailand aimed to reduce inflation rates, so interest rates were raised to reduce expenditure. In addition, at the end of 1996, liquidity decreased due to the reduction in capital from overseas and uncertainty about politics, so interest rates increased again.

In 1997, during the financial crisis, problems in the financial sector, currency attacks and the devaluation of the Thai baht were all factors creating uncertainty about the economy, which resulted in the mobility of international funds flowing from Thailand. As a result, interest rates in 1997 were high, at more than 15% (see Table 3.7) to prevent funds flowing out of the country. However, in 1998, because households felt that the situation was bad and they were uncertain about the future, they saved more. As a result, the liquidity situation improved. Then, nominal interest rates decreased.

After the crisis, the level of nominal interest rates was significantly lower than before the crisis because of high levels in liquidity (see Table 3.7). In addition, due to excesses in production capacity, demand for credit was still not high. Nevertheless, from 2004 to 2006 nominal interest rates started to increase again after the Bank of Thailand raised policy interest rates to slow inflation rates. However, from 2008, the interest rate started to fall again due to a depressed world economy.

3.2.4 Inflation

From Table 3.7 it can be seen that before the financial crisis the inflation rate was quite high, but it reduced markedly after the financial crisis.

Table 3.7: Inflation, interest rates and unemployment rate

Year	Inflation rate (% p.a.)	Nominal interest rate (% p.a.)	Real interest rate (% p.a.)	Unemployment rate (% labour force)
1987	2.4	11.5	9.1	4.7
1988	3.9	12	8.1	4.3
1989	5.3	12.5	7.2	3.5
1990	5.9	16.3	10.3	2.2
1991	5.7	14.0	8.3	3.1
1992	4.1	11.5	7.4	2.8
1993	3.4	10.5	7.1	2.6
1994	5.0	11.7	6.7	1.7
1995	5.8	13.7	7.9	1.3
1996	5.9	13.2	7.3	1.1
1997	5.6	15.2	9.6	1.0
1998	8.1	11.5	3.4	4.3
1999	0.3	8.3	7.9	4.1
2000	1.6	7.5	5.9	3.5
2001	1.3	7.0	5.7	3.3
2002	0.4	6.5	6.1	2.4
2003	0.2	5.5	5.3	2.2
2004	0.4	5.5	5.1	2.1
2005	1.6	6.5	4.9	1.8
2006	2.3	7.5	5.2	0.7
2007	1.1	6.8	5.7	0.6
2008	2.4	6.7	4.3	0.5
2009	0.3	5.8	5.5	0.5

Source: BOT, 2010, Stat Macroeconomic Indicators.

The inflation rate increased from about 2% in 1987 to 6% in 1990 (see Table 3.7) due to manufacturers raising prices because of higher wage and material costs. High expenditure from the growth of the economy and an expansion in both export and investment were also reasons for the higher inflation rate. However, because of a decrease in oil prices and material costs, the inflation rate decreased from 5.7% in 1991 to 3.4% in 1993. In 1994 the inflation rate increased to 5%, compared to only 3.4% in 1993, due to high demand from both domestic and overseas markets, as can be seen from the high growth rate of exports in this year.

From 1994 to 1996 the inflation rate remained constant at 5 to 6%. After the crisis, in 1998 the inflation rate increased to 8.1% (see Table 3.7) because of increases in import costs due to the devaluation of the Thai baht, high oil prices, and increases in value-added tax from 7% to 10%. However, in 1999, because of a decrease in oil prices, the inflation rate was only 0.3%. After the crisis the inflation rate was still low because the country continued to suffer from

excess capacity. In 2005 the inflation rate increased again from 0.4% in 2004 to 1.6%. The main reasons for this were increases in the prices of oil and agricultural products. The inflation rate remained at about 1 to 2% per year until 2009.

3.3 Fiscal policy in Thailand

In this section details about government spending, taxes, public debt and implementation of fiscal policy in Thailand are considered.

3.3.1 Government expenditure

According to the Ministry of Finance (n.d.), government expenditure can be classified as follows:

1. Classified by economic function
 - Current budget
 - Capital budget
2. Classified by expenditure
 - Salaries and wages
 - Remuneration, services other than personal and supplies
 - Equipment, properties and construction
 - Subsidies
 - Other
3. Classified by ministry (26 categories)
4. Classified by economic function and ministry (26 categories).

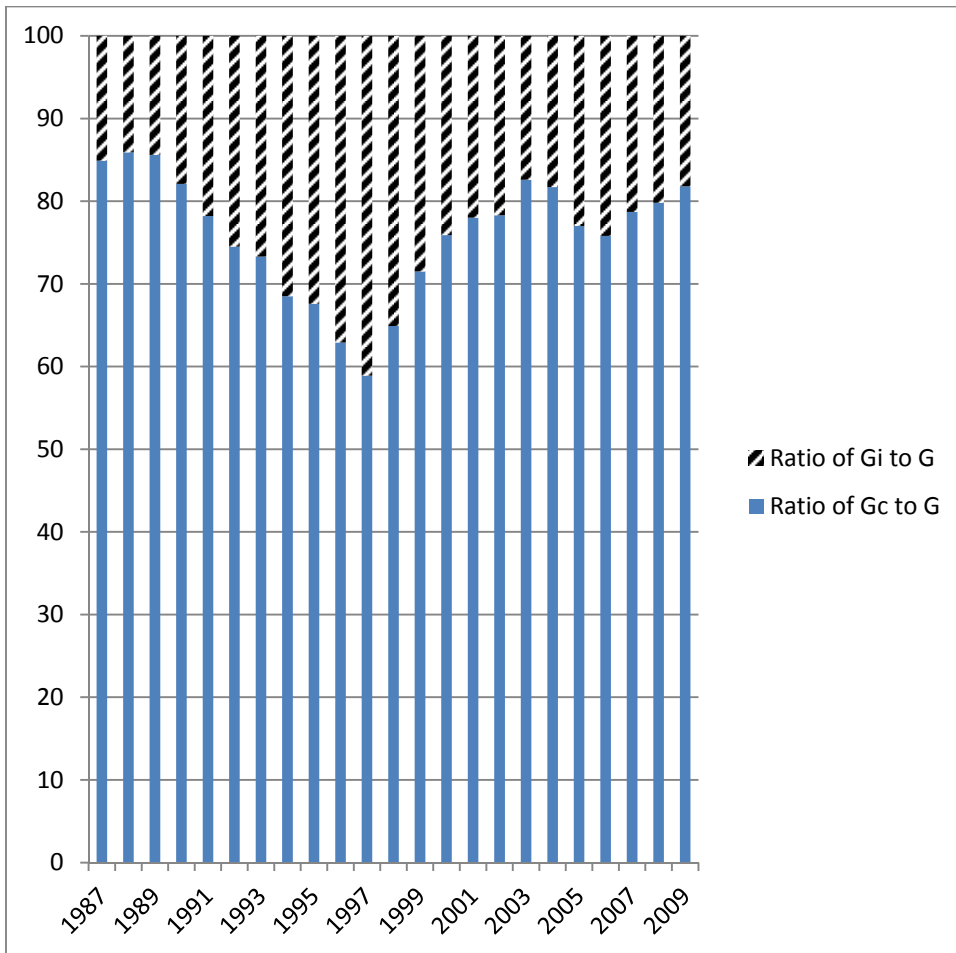


Figure 3.3: Ratios of government spending to total government spending, by type (%)

Source: BOT, (Various Years), Economic Conditions.

It can be seen from Figure 3.3 that most government spending is current budget (Gc). However, before the crisis, since the economy was in a good situation, the government did not need to stimulate the economy. It therefore focused on increasing the ratio of capital budget (Gi) to total expenditure to improve the economic structure, in order to promote investment, production and exports. This can be seen from the change in the ratio of capital spending to total government spending from only 15% in 1987 to almost 40% in 1996. However, after the crisis, the government focused on stimulating the economy, and the ratio of capital spending to total spending was reduced so that the government could spend more money on the current budget in order to boost the economy.

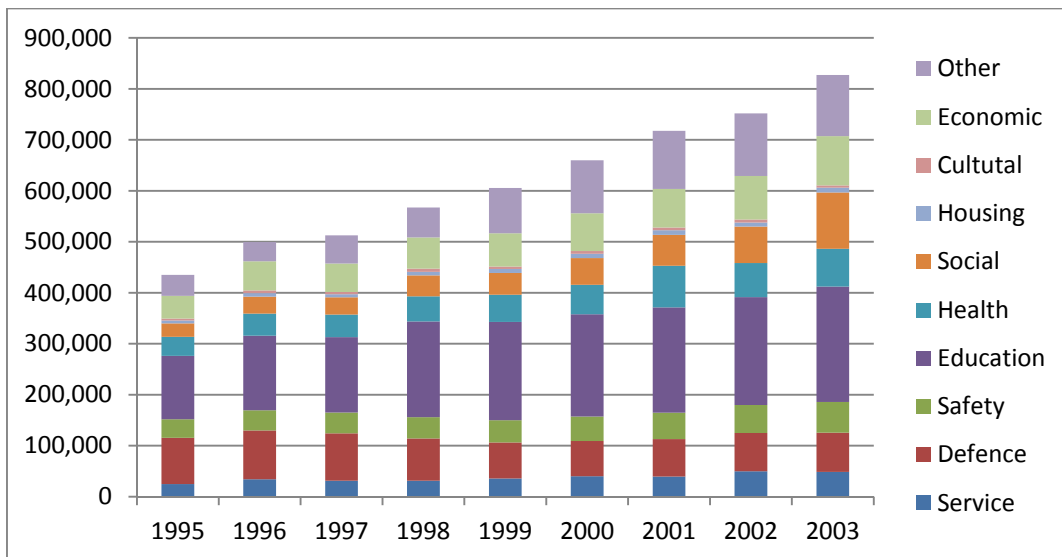


Figure 3.4: Components of current spending (millions of baht at current prices)

Source: BOT, National Government Actual Expenditure

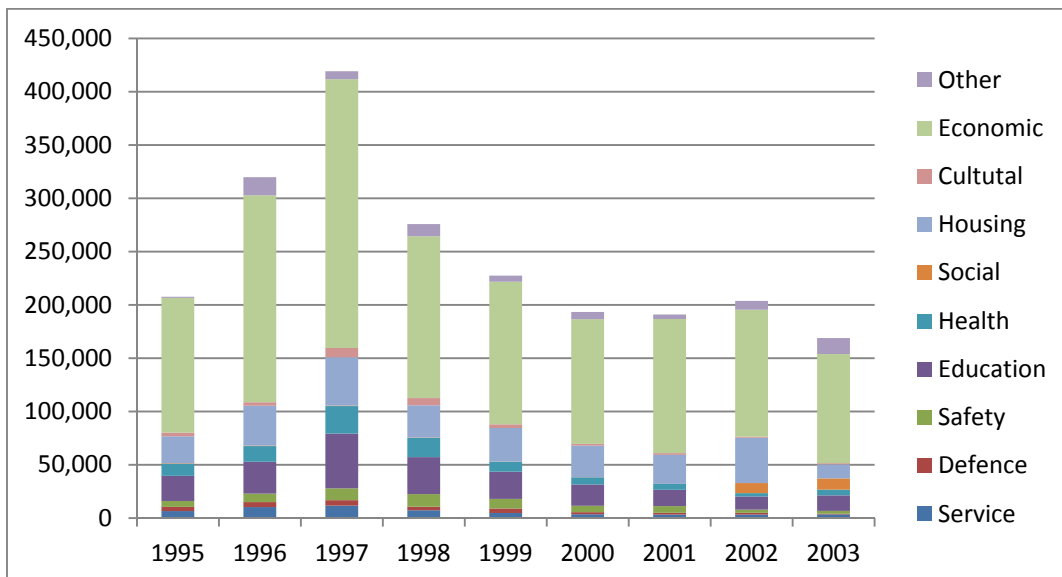


Figure 3.5: Components of capital spending (millions of baht at current prices)

From Figure 3.4 it can be seen that in the current budget the main spending is for education, health, defence and economic services (such as transportation and communication). If the current budget is classified by expenditure, the largest component is wages and salaries (at 42% of current spending in 2008). In terms of capital budget, from Figure 3.5 the main expenditure goes to economic services (such as transportation and communication), education, and housing and community amenities.

3.3.2 Government revenue

Government revenue can be divided into two sources: tax revenue and non-tax revenue. In Thailand, nearly all government revenue is from tax (see Figure 3.6).

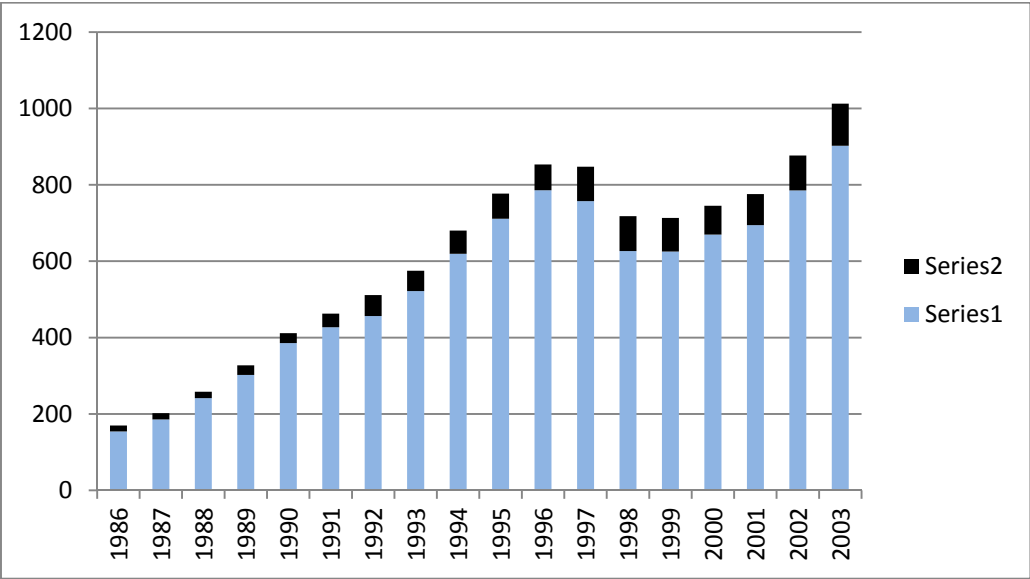


Figure 3.6: Tax and non-tax revenue (billions of baht at current prices)

Source: BOT, National Government Actual Revenue

Taxes can be separated out using different approaches. One of the main approaches is to separate total tax into direct and indirect taxes. As Table 3.8 shows, indirect tax revenue is greater than direct tax revenue. Corporate income tax and personal income tax are the main components of direct tax in Thailand.

According to Pinto, Munvichachai and Chucherd (2007), in Thailand personal income tax is not the main contributor of revenue for the central government (compared to indirect tax and corporate income tax) because the average tax rate of personal income tax is low, at only about 5%. Although the rate of personal income tax is divided into five levels (0%, 10%, 20%, 30% and 37%), the ratio of people who pay high tax rates is low. Moreover, the tax base of personal income tax is very narrow. Out of the total number of labourers (more than 30 million people), only 5 to 7 million pay personal income tax.

Table 3.8: Ratios of different kinds of taxes in Thailand (%)

Year	Direct taxes to total taxes (%)	Personal income tax to direct taxes (%)	Corporate income tax to direct taxes (%)	Other direct taxes to direct taxes (%)	Indirect taxes to total taxes (%)	VAT and trade taxes to indirect taxes (%)	Excise taxes to indirect taxes (%)	Import taxes to indirect taxes (%)	Other indirect taxes to indirect taxes (%)
1988	21.7	46.3	52.6	1.0	78.3	34.3	32.6	31.2	1.8
1989	22.8	42.3	56.6	1.1	77.2	35.7	31.5	30.8	2.0
1990	28.0	39.3	53.8	1.8	72.0	34.3	28.5	35.0	2.2
1991	29.9	38.5	59.2	2.3	70.1	39.4	31.2	31.0	1.8
1992	31.8	36.9	60.9	2.0	68.2	34.0	33.3	27.8	4.8
1993	30.9	34.7	63.1	2.0	69.1	31.3	34.1	28.4	6
1994	32.4	33.5	66.1	1.7	67.6	32.3	32.9	27.4	7.2
1995	34.0	34.8	63.5	1.3	66.0	34.1	32.2	26.4	7.1
1996	35.4	38.3	60.4	1.2	64.6	35.5	32.1	24.6	7.7
1997	35.2	40.6	57.4	1.8	64.8	37.7	34.6	19.7	7.8
1998	31.4	53.9	43.6	2.3	68.6	46.9	31.3	13.5	8.2
1999	32.9	46.9	48.2	4.8	67.1	44.0	35.7	14.6	5.5
2000	34.6	36.9	58.6	4.3	65.4	41.1	35.8	18.2	4.7
2001	34.8	37.7	55.8	6.4	65.2	42.9	35.3	18.2	3.6
2002	35.0	36.3	57.2	6.4	65.0	41.3	37.6	17.4	3.7
2003	35.2	33.7	60.0	6.3	64.8	40.9	38.6	17.2	3.1
2004	37.1	31.5	61.1	7.4	62.9	43.5	38.0	14.2	4.2
2005	39.0	28.5	63.6	8.0	61.0	47.6	34.5	13.2	4.5
2006	42.1	28.3	63.0	8.0	57.9	50.5	33.2	11.3	4.9
2007	42.9	29.9	59.8	8.9	57.1	50.8	33.6	10.3	5.1
2008	40.2	27.7	62.2	10.1	59.8	49.8	32.6	9.8	7.8
2009	40.4	29.0	59.5	11.5	59.6	49.0	33.1	9.2	8.7

Source: FPO, 2010, Government Revenue of Thailand.

In the case of indirect taxes, from Table 3.8 we can see that the main revenue comes from value-added tax and trade taxes, excise taxes and import taxes. It is interesting to note that although indirect taxes remain larger as a proportion of total tax, direct taxes have increased their role over time. The ratio of direct taxes to total taxes increased from 28% in 1990 to just over 40% in 2009. This is a good signal because direct taxes (income taxes) can normally be a good automatic stabiliser.

3.3.3 Implementation of fiscal policy in Thailand

In general, expansionary fiscal policy can be used to stimulate the economy during recession. Contractionary fiscal policy (a decrease in government expenditure or an increase in tax rate) can be used to calm the economy from growing too fast during a boom. Thailand runs a fiscal policy following this procedure. This can be seen from the budget surplus before the crisis turning to a budget deficit after the crisis (Figure 3.7). The economy of Thailand was able to recover from the financial crisis in just a few years. However, according to Siriprachai (2007)

it is still uncertain whether an economy recovers from an expansion in fiscal policy or from improvement in the external environment.

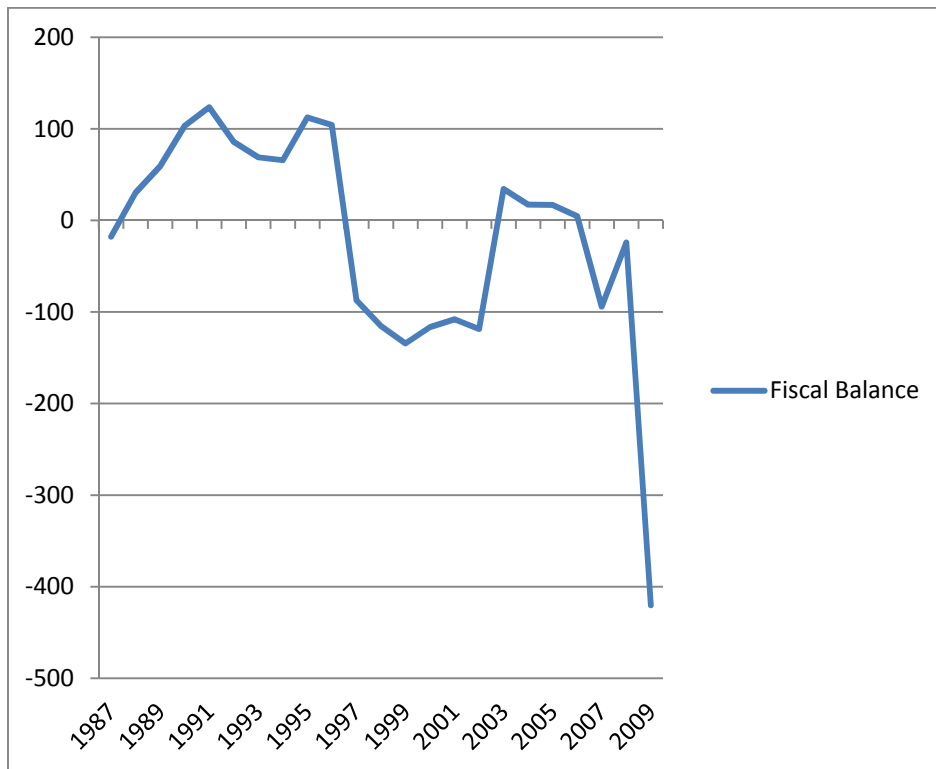


Figure 3.7: Fiscal balance (billions of baht at current prices)

Source: BOT, 2010, Stat Macroeconomic Indicators.

3.3.3.1 Budget surplus 1988–1996

During this period (1988–1996) the government continuously had a budget surplus for about 10 years (see Figure 3.7) because revenue expanded more than spending (see Table 3.9). Over these 10 years, revenue increased more than 18% per year while spending increased just 15% per year. From 1987 to 1991 the economy of Thailand was in a good situation, with a high growth rate of GDP. The government had a budget surplus during this period because it earned more revenue from taxes, especially from corporate income tax (see Table 3.10) due to the high growth of the economy and an improved method of collecting taxes. For example, the growth rate in tax revenue in 1988 was about 30%, while the expansion rate of government expenditure was less than 8% (see Table 3.9).

Table 3.9: Percentage change of total taxes and government expenditure

Year	% change of G	% change of Gc	% change of Gi	% change of total taxes
1987	–	–	–	–
1988	6.2	7.4	–0.9	30.3
1989	12.6	12.3	14.2	24.8
1990	17.3	12.5	45.9	28.5
1991	17.4	11.7	43.3	17.3
1992	23.4	17.8	43.6	2.9
1993	17.2	14.1	26.6	14.4
1994	17.6	10.3	37.2	17.5
1995	10.5	9.7	12.1	17.2
1996	16.6	11.1	27.3	11.8
1997	18.4	10.9	31.2	–0.7
1998	–6.0	3.6	–19.8	–13.8
1999	–1.6	9.8	–22.1	–4.5
2000	3.5	8.1	–12.5	6.2
2001	3.0	5.9	–6.3	3.4
2002	3.2	11.3	9.8	10.7
2003	–3.5	1.8	–22.5	15.9
2004	17.8	16.7	23.3	16.8
2005	7.0	3.8	19.0	14.3
2006	13.9	12.5	17.6	7.6
2007	12.8	17.2	–0.2	4.9
2008	3.7	5.2	–2.4	10.5
2009	17.4	20.3	5.9	–8.3

Source: BOT (various years), Economic Conditions

During 1994 and 1995, as shown in Figure 3.7, the government budget was still in surplus since the growth rate of revenue was higher than that of spending (see Table 3.9). The growth of revenue mainly came from the expansion of business, and this can be seen from the increase in the ratio of corporate income tax to total tax (see Table 3.8). Direct taxes became more important, although the ratio of indirect taxes was still higher. On the spending side, the government still gave importance to its capital budget. The ratio of capital spending to total government spending increased from 15% in 1986 to 37% in 1996 (see Figure 3.3). This means that the government focused more on the future of the country, and investment spending went to education, transportation, the agriculture sector and the like. From Table 3.9 it is clear that the growth rate of capital spending between 1990 and 1992 was very high (over 40% per year) because the government invested strongly in the infrastructure of the country during that time. In 1994 capital spending continued to expand at a high rate for infrastructure and developing human resources. The growth rate of current spending in 1992 was quite high (just under 18%) because there were increases in salaries for government officers.

However, in 1996, although the government budget was still in surplus, government spending was extended more than the growth of revenue, especially spending in the capital budget for infrastructure (see Table 3.9). On the revenue side, the ratio of revenue from direct taxes still

increased from the previous year because of an increase in personal income tax (see Table 3.8). However, the ratio of indirect taxes was still higher.

3.3.3.2 Budget deficit since 1997

In 1997, as Figure 3.7 shows, for the first time in many years the government had a budget deficit. This was because revenue decreased as a result of the financial crisis (see Table 3.9), so the treasury reserve dwindled. In this year the government revenue was approximately 844 billion baht, reduced by 0.7% from the previous year because the economy slowed down. The main taxes that decreased were corporate income tax and import tax, which decreased 5.8 and 24.8%, respectively (see Table 3.10). As a result, the government tried to raise revenue by increasing the rate of value-added tax from 7 to 10%. On the spending side, because the government had to borrow money from the IMF and follow the IMF's conditions, the government tried to decrease the budget. However, real spending still expanded from the previous year. In 1997, as Table 3.9 shows, the current budget increased by 10%, while capital spending rose by just over 31% due to direct investment of the government in transportation, communication, education, agriculture and the like.

Table 3.10: Percentage change of important taxes

Year	% change of personal income tax	% change of corporate income tax	% change of VAT or trade tax	% change of excise tax	% change of import tax
1987	–	–	–	–	–
1988	27.8	55.0	49.1	6.8	46.6
1989	27.0	41.8	29.8	19.2	21.3
1990	47.0	48.0	34.0	–0.80	30.9
1991	19.0	21.5	16.9	20.2	23.0
1992	7.6	14.0	–1.7	9.3	–7.5
1993	7.5	16.0	9.5	18.8	18.6
1994	15.4	22.0	15.3	8.0	9.4
1995	21.5	15.1	17.0	10.7	9.1
1996	21.2	8.8	11.1	7.0	0.008
1997	4.9	–5.8	5.7	7.2	–24.8
1998	6.3	–63.5	15.7	–15.8	–53.0
1999	–15.9	8.5	–15.1	2.58	–0.0017
2000	–15.5	31.7	–4.9	1.6	21.4
2001	9.2	2.7	10.5	4.9	6.5
2002	6.6	12.1	5.7	14.9	5.1
2003	7.6	13.2	8.2	13.1	11.7
2004	18.4	20.2	17.3	10.5	6.1
2005	8.2	20.5	18.0	1.3	3.1
2006	13.3	12.0	7.6	–1.9	–14.1
2007	11.7	2.5	3.9	4.5	–6.2
2008	5.6	25.9	15.5	–0.8	13.8
2009	3.3	14.9	–14.2	4.6	–20.7

Source: FPO, 2010, Government Revenue of Thailand

In 1998 the government still had a budget deficit, and it was larger than the previous year. Although the government tried to cut spending, revenue fell markedly due to the recession. Government spending, especially capital budget, was down about 20% (see Table 3.9) from the previous year after the government cut the budget. The growth rate of government spending was negative because the government had to follow the IMF conditions in order to make the economy stable. However, investment spending was set by focusing on the rural side of the country, such as spending on agriculture, small and medium business, education, infrastructure and transportation.

In 1999, the third year of budget deficits, the government again had to stimulate the economy. The budget deficit was covered by selling bonds within the country. However, the private sector did not seem to be crowded out by this borrowing due to an excess liquidity in the banking system. As a result there was little effect on real interest rates, which generally decreased (see Table 3.7). Tax revenue (see Table 3.9) decreased from the previous year because some taxes were reduced to stimulate the economy. The government exempted personal income tax for people with incomes less than 50,000 baht per year. The government also decreased the rate of value-added tax from 10 to 7%. On the spending side, the ratio of capital budget still decreased from the last year. Although capital spending decreased, current spending expanded rapidly (almost 10% in that year).

In 2000 and 2001 budget deficit was still employed to stimulate the economy. However, the tax revenue increased by 6.2% and 3.4% in 2000 and 2001, respectively (see Table 3.9). At the same time spending also increased. The main policy during this period was the exemption of corporate income tax for businesses that registered in both the stock market and the MAI (market for alternative investment). Reduction of corporate income tax was also employed for small and medium businesses having authorised capital of not more than 5 million baht and receiving a profit of less than 3 million baht per year. The government also allocated a budget for boosting the economy by exempting debt payment by agriculturalists for 3 years, setting up a fund to help every village in the countryside. It can be seen that the government planned to stimulate the economy by encouraging people in the countryside to spend more. The government also tried to help the real estate sector by offering credit.

In 2002 and 2003 the budget deficit policy continued and the government borrowed locally. In contrast, there was a sign of economic recovery from an increase in revenue, especially in corporate income tax, excise tax and value-added tax (see Table 3.10). The important policies in this year were extending the personal income tax exemption from 50,000 baht to 80,000

baht per year, and reducing the tax rate for selling real estate from 3.3 to 0.11%. The government also intended to increase both capital and current spending, although in 2003 the growth rate of government spending was negative because there was a change of structure in the Ministry of Finance.

From 2004 to 2006 there were budget surpluses again due to growth of the economy. Revenue increased, especially corporate income tax, value-added tax and personal income tax (see Table 3.10). The main policies employed in this period were the further extension of the exemption for personal income tax from 80,000 baht to 100,000 baht per year, reducing the rate of corporate income tax for the first 1,000,000 baht of profit per year from 20 to 15%, and increasing the salaries of government officers. In 2004 the growth rate of government spending was quite high (almost 18%) because the government spent a lot on social insurance and health funds.

From 2007 until the present a budget deficit has been employed again to boost the economy, which is suffering from the world economic crisis. The main measures have been a further increase in the exemption for personal income to 150,000 baht per year, providing free education to children aged less than 15 years, and payments for the elderly. Government spending expanded quickly, except for 2008, when spending was altered in response to high oil prices.

Besides spending from budgetary funds, the government also gave more attention to non-budgetary funds. According to Vorasangasil (2008), spending on non-budgetary funds from 2001 to 2007 was about 122,440 million baht, compared to about 14,781.9 million baht from 1990 to 2000. However, because of the limitations of the availability of data, only spending from budgetary data will be investigated in this study.

3.3.4 Public debt

Thailand suffered economic instability during the financial crisis. Most financial institutions suffered from the lack of credit and liquidity problems. As a result, using monetary policy in order to solve the crisis in the economy was ineffective. Accordingly, fiscal policy was the only effective macroeconomic tool during this time.

However, because of the use of expansionary fiscal policy to help the Thai economy recover from the recession, and during the government of Taksin Shinawat, the public debt rapidly increased after the financial crisis in 1997. According to the Bank of Thailand, the level of

public debt at the end of 1996 was only about 14.9% of GDP. However, the level of public debt was just over 40% of GDP in 2009 (see Figure 3.8).

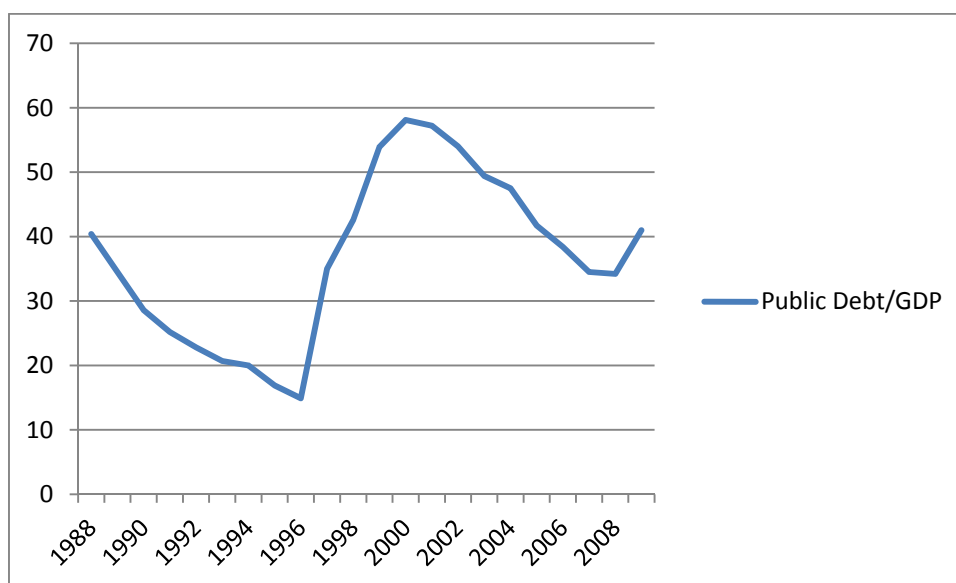


Figure 3.8: Public debt as percentage of GDP in Thailand, 1988–2009

Source: BOT, 2010, Stat Macroeconomic Indicators

As Figure 3.8 shows, the public debt was reduced from about 58% of GDP in 2001 to only 38% of GDP in 2006. However, since 2007 the government has used a budget deficit, and public debt has started to increase again (see Figure 3.8), such that the ratio of public debt to GDP is again over 40%, after declining to below 40% during 2006 to 2008, although the level of public debt was still lower than the fiscal sustainability framework criterion (60% of GDP; see Appendix A). However, according to Economic Conditions 2011 (BOT), there is a risk of debt crisis: the average growth rate of government spending since 2007 has been two times higher than revenue, there has been an increase in government spending from the populist policy, and there is risk of a downturn in the world economy.

An expansionary fiscal policy comes at the cost of higher public debt. A high level of debt may be an obstacle to using fiscal policy in the future because the government must set the budget to pay for the debt in place of using that budget for developing the country. Thailand is a developing country that needs to use a lot of its budget to develop the country and it does not have unlimited resources to employ. Thus, improving the effectiveness of fiscal policy should not be neglected.

3.4 Conclusion

It is likely that from 1987 to 1996 fiscal policy was not the main instrument employed in stimulating the economy because the economy was in good condition, which can be seen from the budget surpluses during that time. However, fiscal policy seemed to increase its role after 1996 because Thailand's economy suffered from the financial crisis, and this can be seen from the budget deficits during that time, when monetary policy was not an effective tool. However, the cost of an expansionary fiscal policy was a higher level of public debt.

The government of Thailand placed more importance on current spending than capital spending because the ratio of current spending to GDP was higher than the ratio of capital spending to GDP every year for the period covered. Moreover, the main spending from both current and capital budgets was for education, health and economic services (e.g. transportation and communication). Indirect tax was the main revenue for the government, followed by corporate income tax and personal income tax, respectively.

Chapter 4

Model Specifications and Empirical Results

4.1 Introduction

This chapter presents the Vector Auto-Regression (VAR) model specifications and empirical results. In this study, eight models are investigated: the baseline model, Model Gc, Model Gi, Model Ti, Model Tp, Model Tc, Model Cp and Model I. The effects of total government spending and total tax on output are analysed in the baseline model. Model Gc and Model Gi are used to examine the effects of current spending and capital spending on output. The effects of indirect tax, corporate income tax and personal income tax on output are studied in Model Ti, Model Tc and Model Tp, respectively. Finally, the effects of total government spending and total tax on private consumption and private investment are investigated in Model Cp and Model I, respectively.

This chapter begins by testing the stationarity of the data and the lag-length for the VAR model, followed by the residual test (section 4.4). The process of vector error correction (VECM) is then focused on. Finally, the impact of fiscal policy will be evaluated by the impulse response functions of the VAR model.

VAR SPECIFICATION

The VAR specification for this study can be written as:

$$X_t = A_0 + A_1 X_{t-1} + \dots + A_i X_{t-i} + \mu_t \quad (4.1)$$

where X_t = a (5×1) vector containing five variables: output (Y), price level (P), interest rate (R), government spending (G) and taxes (T).

A_0 = a (5×1) vector of intercept terms

A_i = a (5×5) matrix of parameters for the i th lag variables

μ_t = a (5×1) vector of error terms

All variables are in 1988 prices. The data are seasonally adjusted before being analysed. Equation (4.1) is a VAR model in the standard or reduced form. According to King et al. (1991), the purpose of the reduced form is forecasting. What is of interest for policy evaluations are the residuals from the structural form of a VAR. Thus, a structural vector auto-regression (SVAR) is needed. "VAR models explain the endogenous variables solely by their own history, apart from deterministic regressors. In contrast, SVAR allows the explicit modelling of contemporaneous interdependence between the left-hand side variables" (Pfaff, 2008, p. 1). The SVAR can be written as follows:

$$BX_t = T_0 + T_1 X_{t-1} + \dots + T_i X_{t-i} + \varepsilon_t \quad (4.2)$$

$$A_0 = B^{-1}T_0$$

$$\text{where } A_1 = B^{-1}T_1$$

$$\mu_t = B^{-1}\varepsilon_t$$

4.2 Stationarity

The problem with using non-stationary variables is the potential to encounter a spurious regression or fake relationship between the variables (Granger & Newbold, 1974). When the variables are not stationary, they may move together due to the economic cycle in the absence of a real relationship between them. However, it is common for most macroeconomic variables to be non-stationary (Nelson & Plosser, 1982). A random walk model is the classic example of a non-stationary time series, and a test for stationarity, such as the Dickey–Fuller

test, is based on the random walk model. According to Enders (1995, p. 166), the random walk model is a special case of an AR(1) process:

$$X_t = a_0 + a_1 X_{t-1} + \mu_t \quad (4.3)$$

From AR(1) in (4.3), the pure random walk model is the case where $a_0=0$ and $a_1 = 1$.

$$X_t = X_{t-1} + \mu_t \quad (4.4)$$

According to Gujarati (2003, p. 802), different types of non-stationary processes can be distinguished into random walk, random walk with drift, deterministic trend and random walk with drift, and deterministic trend.

If the process starts at time 0 with value X_0 , one can write the equation as follows:

$$X_t = X_0 + \sum \mu_t \quad (4.5)$$

where $E(X_t) = X_0$, $VAR(\mu_t) = \sigma^2$, $VAR(X_t) = t\sigma^2$.

In the random walk model, although the mean of X_t is constant, the variance of X_t is not, because when t increases, its variance also increases. Thus, X_t follows a non-stationary process.

In the case of a random walk with drift, a constant term will be added to the random walk model:

$$X_t = \beta_1 + X_{t-1} + \mu_t \quad (4.6)$$

where $E(X_t) = X_0 + t\beta_1$, $VAR(X_t) = t\sigma^2$.

In this case, both the mean and variance of X_t are time-varying.

In the case of a deterministic trend, trend (t) will be included in this model:

$$X_t = \beta_1 + \beta_2 t + \mu_t \quad (4.7)$$

where $E(X_t) = \beta_1 + \beta_2 t$, $VAR(X_t) = \sigma^2$.

It can be seen that the mean of X_t is not constant, while its variance is constant.

Finally, in the case of a random walk with drift and a deterministic trend, the equation can be written as follows:

$$X_t = \beta_1 + \beta_2 t + X_{t-1} + \mu_t. \quad (4.8)$$

In this case, both the mean and variance of X_t are not constant.

In order to transform non-stationary time series data to stationary data, differencing can be applied to the random walk and the random walk with drift models. However, in the case of a deterministic trend, removing the deterministic trend (detrending by running a linear regression of X_t on the trend variables and subtracting that trend out) is the focus. While detrending can remove a deterministic trend, the variance of X_t is still not constant, so differencing must be used in the case of a random walk with drift and a deterministic trend. Non-stationarity can be caused by the unit root problem; therefore, unit root tests are tests of non-stationarity.

The AR(1) model for unit root test is:

$$X_t = \rho X_{t-1} + \mu_t. \quad (4.9)$$

In (4.9), if ρ equals 1, this equation will be a random-walk model; i.e. X_t is non-stationary or the model suffers from a unit root problem. Gujarati (2003, p. 802) states that “the name unit root is due to the fact that ρ ”. In (4.9), Dickey and Fuller (1979) explain that X_t is generated by its own past, and a disturbance or residual term (μ_t) representing the impact of other variables is not included in the model. X_t will be stationary if the term ρ has a value between -1 and 1 . Moreover, “ μ_t is a sequence of independent normal random variables with a mean zero and variance σ^2 ” (Dickey & Fuller, 1979, p. 427).

According to Gujarati (2003, p. 814), the Dickey–Fuller test has become extremely popular for the unit root test. In conducting the Dickey–Fuller test, the error term μ_t is assumed to be uncorrelated. However, in time series data, error terms are likely to be correlated. If μ_t is correlated, the Augmented Dickey–Fuller (ADF) test developed by Dickey and Fuller (1979) should be employed.

In this study, the ADF test was employed to test for the stationarity of the series. According to Dickey and Fuller, three different regression equations are used to test for the presence of a unit root with the ADF test:

$$\Delta X_t = \gamma X_{t-1} + \sum_{i=1}^p \phi \Delta X_{t-1} + \mu_t \quad (4.10)$$

$$\Delta X_t = a + \gamma X_{t-1} + \sum_{i=1}^p \phi \Delta X_{t-1} + \mu_t \quad (4.11)$$

$$\Delta X_t = a + \gamma X_{t-1} + \beta t + \sum_{i=1}^p \phi \Delta X_{t-1} + \mu_t \quad (4.12)$$

where a is an intercept or drift term, t is a trend, $\gamma = \rho - 1$, and the null and alternative hypotheses can be written as follows:

$$H_0 : \gamma = 0$$

$$H_1 : \gamma < 0 .$$

They were then evaluated using the conventional t -ratio for γ :

$$t_\gamma = \hat{\gamma} / (se(\hat{\gamma}))$$

where $\hat{\gamma}$ is the OLS estimate of γ , and $se(\hat{\gamma})$ is the standard error.

The next step is to compare t_γ with the critical value to see if the null hypothesis of a unit root can be rejected. According to Dickey and Fuller (1979), under the null hypothesis of a unit root, this statistic does not follow the conventional Student's t -distribution, and they derive asymptotic results and simulate critical values for various forms of the regression and sample sizes. The statistics labelled τ , τ_μ , and τ_τ are suitable statistics for equations (4.10), (4.11) and (4.12), respectively.

Dolado, Jenkinson and Sosvilla-Rivero (1990) suggest starting with the least restricted equation (equation 4.12) and use the τ_τ statistic to check the null hypothesis, $\gamma = 0$. If we can reject the null hypothesis of a unit root, the variable contains no unit root. If the null hypothesis of $\gamma = 0$ is not rejected, a test for the significance of the trend term must be employed. The statistic for testing the deterministic terms does not follow the conventional Student's t -distribution either. For checking the significance of the trend term in (4.12), $\tau_{\beta t}$ will be used to test whether the null hypothesis of $\beta = 0$ given $\gamma = 0$ is rejected. If the null hypothesis of $\beta = 0$ given $\gamma = 0$ cannot be rejected, we have to go to a more restricted model; that is, (4.11). Then, if we cannot reject the null hypothesis of a unit root by using τ_μ , the

significance of the drift term must be checked. For checking the significance of the drift term, τ_{α} will be employed to test whether the null hypothesis of $\alpha = 0$ given $\gamma = 0$ is rejected. If the null hypothesis of $\alpha = 0$ given $\gamma = 0$ is rejected, we have to go for testing whether the null hypothesis of $\gamma = 0$ in (4.10) is rejected by the τ statistic.

4.3 Lag-length

According to Gujarati (2003, p. 853), choosing lag-length is one of the biggest practical challenges in a VAR model. The model will be mis-specified, if the lag-length is too small. In contrast, degrees of freedom are reduced if the lag-length is too large (Enders, 1995, p. 313). Before choosing a suitable lag-length, possible lag-lengths from statistical tests need to be examined.

There are different ways to undertake a lag-length test. One of the popular methods is the likelihood ratio (LR) test. In this test, we estimate the two VARs with different lag-lengths, (i.e. one with a longer lag-length and the other with a shorter lag-length). Then we compare the determinants of the variance–covariance matrices (Σ) of the VARs, estimated using different lag-lengths, as in equation (4.13):

$$(T - c)(\log|\Sigma_r| - \log|\Sigma_u|) \quad (4.13)$$

where T = number of observations

c = number of parameters in the unrestricted system

Σ_r = variance–covariance matrix of the restricted system

Σ_u = variance–covariance matrix of the unrestricted system.

The longer length specification is called the unrestricted model, while the other is the restricted model (e.g. comparing a VAR with eight lags with a VAR with four lags). In this case, we want to know whether four lags are suitable. We have to estimate a VAR with eight lags to get a variance–covariance matrix of the residuals, or Σ_8 . Then, a VAR with four lags will be estimated to get a variance–covariance matrix of the residuals, or Σ_4 .

$$(T - c)(\log|\Sigma_4| - \log|\Sigma_8|) \quad (4.14)$$

where Σ_4 = variance–covariance matrix of the restricted system (i.e. four lags)

Σ_8 = variance–covariance matrix of the unrestricted system (i.e. eight lags).

The LR test in (4.14) has an asymptotic χ^2 distribution. If the calculated statistic is larger than χ^2 , the null hypothesis of lag-length four will be rejected. If we can reject the null hypothesis, it is believed that the lag in VAR model is the optimal lag.

According to Enders (1995, p. 315), the likelihood ratio test may be not good for small samples. Furthermore, this test is applicable only in the case where one model is the restricted version of the other. Besides the LR test, there are other criteria, including the final prediction error (FPE), the Akaike information criterion (AIC), the Schwarz information criterion (SIC) and the Hannan-Quinn information on criterion (HQ). According to Lutkepohl (1991), the model with the smallest information criterion will be chosen. Lutkepohl also stated that AIC and FPE may be more suitable for models with small samples than SIC and HQ.

According to Baltagi and Wang (2006) and Caldara and Kamps (2008), the standard lag-length for quarterly data is four. Some studies set the maximum lag-length at four (e.g. Baltagi & Wang, 2006; Fisher et al., 1995; Giordano et al., 2007). This study also set the maximum lag-length at four.

After a possible lag-length for each model was tested by AIC, SIC, HQ, LR and FPE, a suitable lag-length was chosen. However, before selecting a lag-length, residuals must be tested, since a lag-length can be used only if the residuals are a white-noise process.

4.4 Residual tests

In order to interpret the results from the VAR model, the assumption of VAR is important. This assumption is that the difference between the actual value and the mean is a white-noise process (Juselius, 2006, p. 46):

$$X_t - \bar{X}_t = \mu_t, \mu_t \sim NI_p(0, \Omega) \quad (4.15)$$

where:

NI = normally independently distributed (white noise)

X_t = a (5×1) vector containing observations on each of the variables

\bar{X}_t = mean of X_t

Ω = time-invariant or constant variance.

Juselius (2006) stated that:

This assumption is consistent with economic agents who are rational in the sense that they do not make systematic errors when they make plans for time t based on the available information at time $t-1$. For example, a VAR model with autocorrelated and or heteroscedastic residuals would describe agents that do not use all information in the data as efficiently as possible. (p. 46)

Juselius (2006, p. 46) advises that testing for residual autocorrelation, normality and heteroscedasticity should not be neglected. To test for autocorrelation, according to Juselius (2006, p. 74) the Lagrange multiplier test (LM test) is used.

According to Lutkepohl, Kratzig and Boreiko (2006), the LM test for h^{th} order residual autocorrelation assumes a model:

$$\mu_t = B_1^* \mu_{t-1} + \dots + B_h^* \mu_{t-h} + error_t$$

and the null hypothesis of no autocorrelation at lag 1 to lag h will be tested:

$$H_0 : B_1^* = \dots = B_h^* = 0$$

$$H_1 : B_1^* \neq 0 \text{ or } \dots \text{ or } B_h^* \neq 0$$

The LM test can be written as follows:

$$LM_h = -(T - n(k + 1) - 1/2) \ln(|\Omega(R)|/|\Omega|)$$

where T is the length of the effective sample, n is the number of variables and k is the lag-length.

From the LM test above, R in $|\Omega(R)|$ showed the restrictions of the null hypothesis:

$$(H_0 : B_1^* = \dots = B_h^* = 0) \text{ and } \Omega(R) = 1/T \sum_{t=h}^T \mu_t \mu'_{t-h}$$

The LM test is distributed as χ^2 with n^2 degrees of freedom.

Most normality tests are based on skewness and kurtosis (Juselius, 2006, p. 75). Skewness and kurtosis were considered under the χ^2 distribution with n degrees of freedom, where n is the number of variables in the model. Joint hypotheses of skewness and kurtosis, or the Jarque-Bera (JB) test (Gujarati, 2003, p. 148), were tested with a distribution of χ^2 and $2n$

degrees of freedom. According to Juselius (2006, p. 75), skewness and kurtosis can be written as follows:

$$\text{skewness} = T^{-1} \sum_{t=1}^T (\mu_i / \sigma_i)^3$$

$$\text{kurtosis} = T^{-1} \sum_{t=1}^T (\mu_i / \sigma_i)^4.$$

From skewness and kurtosis above, T is the number of observations at the present time and σ is the variance that can be found from $\sigma = s\sqrt{T-1/T}$, where s is standard deviation

$$[s = \sqrt{(\sum_{i=1}^T (\mu_i)^2)/(T-1)}].$$

The values of skewness and kurtosis for the normal distribution are 0 and 3, respectively. According to Juselius (2006, p. 75), the null hypothesis is that the residuals are from a normal distribution.

In the case of the heteroscedasticity test, according to Gujarati (2003, p. 413), White's heteroscedasticity test, which will be employed in this study, does not rely on the assumption of normality and is easily used. In this test, the null hypothesis is that there is no heteroscedasticity in the model. For example, if the system consists of three variables, H_t , J_t , and M_t , then:

$$H_t = B_1 + B_2M_t + B_3J_t + \mu_t.$$

The auxiliary regression can then be written as follows:

$$\mu_t^2 = \alpha_1 + \alpha_2M_t + \alpha_3J_t + \alpha_4M_t^2 + \alpha_5J_t^2 + \alpha_6M_tJ_t.$$

According to Gujarati (2003, p. 413), if $\alpha_2 = \alpha_3 = \alpha_4 = \alpha_5 = \alpha_6$ in the equation above are zero, the error variance is the homoscedastic constant and the null hypothesis of no heteroscedasticity cannot be rejected.

4.5 Results of stationarity test

The ADF tests for all variables are shown in Table 4.1. The 12 variables analysed are total government spending (G), current spending (Gc), capital spending (Gi), total tax revenue (T), personal income tax revenue (Tp), indirect tax revenue (Ti), corporate income tax revenue

(Tc), output (Y), interest rate (R), price level (P), private consumption (Cp) and private investment (I).

Table 4.1: Summary of unit root tests

Variable	Constant and trend			Constant, no trend			No constant, no trend	
	Stats	p-value	(trend)	Stats	p-value	(drift)	Stats	p-value
G	-2.70	0.22	2.3	-1.40	0.57	1.46	1.69	0.97
DG	-13.40	0.00						
Gc	-2.13	0.51	2.16	0.12	0.96	0.04	2.30	0.99
DGc	-15.00	0.00						
Gi	-2.31	0.51	0.03	-2.46	2.51		0.86	0.89
DGi	-14.4	0.00						
T	-2.31	0.42	1.67	-1.85	0.35	1.92	2.39	0.99
DT	-9.70	0.00						
Ti	-2.77	0.21	2.1	-1.83	0.36	1.88	2.01	0.98
DTi	-120.00	0.00						
Tc	-2.50	0.32	1.61	-2.26	0.18	2.37	2.07	0.99
DTc	-11.60	0.00						
Tp	-2.24	0.46	1.17	-2.63	0.08	2.75	2.65	0.99
DTp	-9.60	0.00						
Y	-2.45	0.35	1.67	-2.80	0.07	2.90	5.09	1.00
DY	-8.08	0.00						
P	-1.65	0.76	1.29	-2.05	0.26	2.31	4.06	1.00
DP	-6.07	0.00						
R	-2.94	0.15	-2.47	-2.04	0.26	1.76	-1.30	0.17
DR	-6.67	0.00						
Cp	-2.97	0.14	2.51	-2.27	0.18	2.34	3.07	0.98
DCp	-6.7	0.00						
I	-2.79	0.20	2.8	-2.81	0.06	-0.24	0.19	0.73
DI	-4.48	0.00						

From Table 4.1, according to Dolado et al. (1990) one can first test for a unit root using the τ_τ statistic, and if the null hypothesis is rejected then the variable contains no unit root. For example, with variable Gc at level, using the τ_τ statistic, the null hypothesis of unit root cannot be rejected. Then, focusing on the trend term, the calculated statistic of the trend term is 2.16; i.e. less than 2.79 and 3.53 (the critical values of the statistic at 95% and 99% level of confidence, respectively), so the null hypothesis of having no trend term is not rejected. Thus, using the τ_μ statistic, the null hypothesis of unit root still cannot be rejected. Moreover, the null hypothesis of having no drift term is not rejected. As a result, the τ statistic can be used, and we cannot reject the null hypothesis of the unit root. Therefore, variable Gc in level contains a unit root. Then, at first difference (DGc), the null hypothesis is rejected, so variable Gc is stationary at the first difference.

From Table 4.1 it can be seen that all variables are stationary at first difference; in other words, all of them have a unit root and are non-stationary at level because the null hypothesis

of having a unit root cannot be rejected at the 95% level of confidence. This can be seen from the p-values that are over 0.05 in Table 4.1.

Using non-stationary data can give spurious results. When data are non-stationary there are two ways to prevent spurious regressions. The first method is to first difference all variables before using them for modelling structural vector auto-regression (SVAR). However, using only first differences can make the long-run relationship disappear (Enders, 1995, p. 355). As a result, if it is found that the variables are cointegrated, or if there is at least one cointegration relation between the non-stationary variables, the second method (i.e. the cointegration method) should be employed.

4.6 Vector error correction (VECM) in the baseline model

In the baseline model, vector X_t in (4.16) can be written as $X_t \equiv (T, P, Y, G, R)$ (an explanation of the variables' order will be given in section 4.6.4). This is called the baseline model, because later we will substitute different kinds of government spending and tax revenue, respectively, for G or T in the model to determine their effects on output. For example, in Model Ti (section 4.8), the effect of indirect tax revenue will be investigated; T in the baseline model will be replaced by Ti (other variables are still the same as in the baseline model) and vector X_t in Model Ti can be written as: $X_t \equiv (T_i, P, Y, G, R)$. In the same way, G will change to Gc or current spending in Model Gc (section 4.6), while the other variables remain the same as in the baseline model. In Model Gi (section 4.7), G in the baseline model will be replaced by capital spending (Gi). In Models Ti, Tp and Tc (sections 4.8, 4.9 and 4.10, respectively), T in the baseline model will be changed to Ti (indirect tax revenue), Tp (personal income tax revenue) and Tc (corporate income tax revenue), respectively. In order to investigate the effect of fiscal policy on private consumption and private investment, GDP will be replaced by private consumption in Model Cp (section 4.11) and GDP will be replaced by I in Model I (section 4.12).

According to Enders (1995), the VAR model with first difference may not be the correct specification when non-stationary data are cointegrated because an error correction would be missed from the VAR. As a result, a VECM may be more appropriate because it considers the variables that are cointegrated and also includes the error correction:

$$\Delta X_t = C + D_1 \Delta X_{t-1} + \mu_t \quad (\text{VAR with first difference})$$

$$\Delta X_t = \Gamma_1 \Delta X_{t-1} + \alpha \beta' X_{t-1} + C + \mu_t \quad (\text{VECM}).$$

These two equations compare a VAR with first difference and a VECM, both with one lag. It can be seen that VECM consists of first differenced variables, the same as in a VAR with first difference. However, there is a cointegration relation (long-run relation) part or $\alpha\beta' X_{t-1}$ in VECM. The concept of cointegration is that a linear combination of non-stationary variables is stationary because their stochastic trends cancel each other out.

Harris (1995) notes that

Alongside the economic interpretation of cointegration, which states that if two (or more) series are linked to form an equilibrium relationship spanning the long-run, then even though the series themselves may contain stochastic trends (i.e. be non-stationary) they will nevertheless move closely overtime and the difference between them will be stable (i.e. stationary). (p. 6)

As a result, variables cannot move independently of each other. Thus, although variables in the cointegration part ($\alpha\beta' X_{t-1}$) are in levels and non-stationary, the $\alpha\beta' X_{t-1}$ part in VECM is stationary if the non-stationary variables are cointegrated. The omission of the long-run relationship by running a VAR with first difference entails a mis-specification error. Hence, estimating by VAR in first difference is inappropriate if there is at least one cointegration relation in the model (Enders, 1995, p. 368):

$$\Delta X_t = \Gamma_1 \Delta X_{t-1} + \alpha\beta' X_{t-1} + \mu_t. \quad (4.16)$$

Equation (4.16) is a VECM specification with one lag, where Γ_1 is a (5×5) matrix of parameters on each individual lag and μ_t is a (5×1) vector of error terms. The $\alpha\beta' X_{t-1}$ term represents the long-run relationship between the variables in levels.

Actually, we can write the VECM in the form of the VAR model in levels and vice versa:

$$X_t = A_1 X_{t-1} + \dots + A_p X_{t-p} + \mu_t \quad (4.17)$$

$$\Delta X_t = \alpha\beta' X_{t-1} + \Gamma_1 \Delta X_{t-1} + \dots + \Gamma_{p-1} \Delta X_{t-p+1} + \mu_t. \quad (4.18)$$

From (4.18), $\Pi = \alpha\beta'$ (matrix containing information about the long-run relationship), the relationship between (4.17) and (4.18) can be shown as follows:

$$\Pi = -(I - A_1 - \dots - A_p)$$

$$\Gamma_j = -(A_{j+1} + \dots + A_p) \text{ for } j = 1, \dots, p-1.$$

Johansen’s approach to testing for cointegration was used to estimate the long-run parameter and test the hypothesis (Burke & Hunter, 2005). Before beginning the process, a lag-length test was employed to find the possible lag-length.

Table 4.2: Results of lag-length test in the baseline model in VECM

Model	LR	FPE	AIC	SC	HQ
Baseline model	2	2	2	1	1

In the five-variable baseline model, starting from four lags, all criteria except SC and HQ chose two lags, while SC and HQ chose only one lag. There is the issue of setting appropriate lag-length to ensure that the residuals follow the assumption $\mu_t \sim NI(0, \Omega)$; thus, testing for residual autocorrelation, normality and heteroscedasticity is examined.

Table 4.3a: Residual tests of the baseline model in VECM (normality and heteroscedasticity)

Model	Skewness (χ^2)	p-value	Kurtosis (χ^2)	p-value	SK & KU	p-value	Heteroscedasticity (p-value)
Baseline model (2 lags)	8.45	0.13	51.90	0.00	60.40	0.00	326.24 (0.14)
Baseline model (1 lag)	10.10	0.07	113.60	0.00	123.7	0.00	177.82 (0.06)

Table 4.3b: Results of the residual test (test of autocorrelation in VAR with 1 lag)

Lags	LM-statistic	p-value
1	51.80	0.00

Table 4.3c: Results of the residual test (test of autocorrelation in VAR with 2 lags)

Lag	LM-statistic	p-value
1	29.20	0.25
2	39.70	0.03

In the one-lag model, the normality test in Table 4.3a was based on skewness and kurtosis, which have a χ^2 distribution with n degrees of freedom. The joint hypothesis of skewness and kurtosis, or JB test, has a χ^2 distribution with 2n degrees of freedom. The null hypothesis is that residuals have a normal distribution. In the one-lag model, the null hypothesis of normality was rejected for kurtosis and the JB tests, but not for skewness, because the p-values of these tests were less than 0.05, or even less than 0.01. Moreover, there was no evidence of heteroscedasticity in this model because the null hypothesis of no heteroscedasticity cannot be rejected. The test of autocorrelation in Table 4.3b used an LM-test with the null hypothesis of no autocorrelation at lag one and was asymptotically

distributed as χ^2 with degrees of freedom n^2 , where n is the number of variables in the model. In the one-lag model, χ^2 was 51.08 with a p-value of 0.0016. Thus, the null hypothesis of no autocorrelation is rejected, even at the 99% level of confidence and with evidence of autocorrelation.

In the two-lag model, for the normality test (Table 4.3a) there was evidence of non-normality due to kurtosis, which Juselius (2006) claims is less serious than skewness, but the model had no evidence of non-normality due to skewness. Furthermore, heteroscedasticity did not exist in this model. In the case of autocorrelation, the null hypothesis of no autocorrelation at lags one and two was tested. At lag one, from Table 4.3c there was no evidence of autocorrelation at the 95% level of confidence because the p-value was larger than 0.05. At lag two, from Table 4.3c there was no evidence of autocorrelation at the 99% level of confidence. As a result, in the two-lag model there was no evidence of autocorrelation at either lag one or lag two.

After testing these two models, it was clear that the two-lag model performed better because there was no evidence of autocorrelation in either lag one or lag two, while there is clear evidence of autocorrelation in the one-lag model. As a result, the two-lag model was chosen despite some evidence of non-normality in terms of kurtosis.

In Johansen's cointegration test between the trace test and the maximal eigenvalues test, Harris (1995, p. 89) stated that the trace test showed more robustness to both skewness and kurtosis than maximal eigenvalues. If the model suffers from non-normality due to kurtosis, it may be preferable to place greater weight on the trace test.

4.6.1 Testing for cointegration

Johansen's cointegration test is a method for testing cointegration. It is different from the Engle-Granger test in that it allows more than one cointegration relation, while the Engle-Granger test is for a single cointegration relationship. The Johansen test includes the trace test and maximal eigenvalues. After determining the appropriate lag-length – two, in this case – according to Asteriou and Hall (2007) the next step for undertaking the Johansen approach is to choose appropriate deterministic components in the multivariate system. In theory, there are five distinct models that can be considered.

According to Juselius (2006, p. 95), the basic idea can be illustrated by a VAR(1) model containing a constant (C_0) and a trend (C_1t); all short-run dynamic effects (Γ) can be set to zero.

$$\Delta X_t = \alpha\beta' X_{t-1} + C_0 + C_1t + \mu_t$$

$$\text{where } C_0 = \alpha D_0 + \gamma_0$$

$$C_1 = \alpha D_1 + \gamma_1$$

So,

$$\Delta X_t = \alpha\beta' X_{t-1} + \alpha D_0 + \alpha D_1t + \gamma_0 + \gamma_1t + \mu_t$$

where γ_0 = linear growth in at least some of variables

D_0 = intercept in the cointegration relation

D_1t = linear trend in the cointegration relation

γ_1t = quadratic trend in the variables.

The five models can then be described as follows:

Model 1: $C_1, C_0 = 0$, so $\Delta X_t = \alpha\beta' X_{t-1}$. There are no deterministic components in the data, nor can it be implied that $E(\Delta X_t) = 0$. Also, there is no intercept in every cointegration relation, nor can it be implied that $E(\beta' X_t) = 0$.

Model 2: $C_1 = 0, \gamma_0 = 0$ but $D_0 \neq 0$, so $\Delta X_t = \alpha(\beta' X_{t-1} + D_0)$. In this case, the constant term will be in the cointegration relation. Moreover, there is no trend in the data, nor is it consistent with $E(\Delta X_t = 0)$.

Model 3: $C_1 = 0$, so $\Delta X_t = \alpha(\beta' X_{t-1} + D_0) + \gamma_0$. There are linear trends in the variables (level data) that are consistent with $E(\Delta X_t = \gamma_0 \neq 0)$. However, the cointegration relation consists of only an intercept.

Model 4: $\gamma_1 = 0$, so $\Delta X_t = \alpha(\beta' X_{t-1} + D_0 + D_1t) + \gamma_0$. In this case, the linear trend is restricted in the cointegration relation and in the level data. However, because γ_1 is

zero, there are no quadratic trends in the variables, only a linear trend that is consistent with $E(\Delta X_t = \gamma_0 \neq 0)$.

Model 5: No restriction on C_1, C_0 . According to Juselius (2006, p. 100), “the model is consistent with linear trend in the differenced variables (ΔX_t) and the quadratic trend in X_t .”

With the Johansen method, the test statistics for the number of cointegration vectors are the trace test and the eigenvalues test (λ_{\max}). In the case of the trace test, I tested the null hypothesis of r cointegration relations against the alternative of p cointegration relations, where p is the number of variables in the system, for $r = 0, 1, \dots, p-1$. For the eigenvalues test, I tested the null hypothesis of r cointegration relations against $r+1$ cointegration relations. However, according to Harris (1995, p. 96), model 1 is improbable in practice because an intercept is generally need to account for the units of measurement of the variables. Moreover, “model 5 is economically difficult to justify (especially since if the variables are entered in logs, this would imply an implausible ever-increasing or decreasing rate of change)” (Harris, 1995, p. 96). Thus, in this case, there were three models to be considered: Models 2, 3 and 4.

Harris (1995) stated that

Johansen (1992) suggests that the need to test the joint hypothesis of both the rank order and the deterministic components, based on the so-called Pantula principle. That is, all three models are estimated and the results are presented from the most restrictive model (model 2) through to the least restrictive alternative (model 4). The test procedure is then to move through from the most restrictive model and at each stage to compare the trace and eigenvalues (λ_{\max}) test statistic to its critical value and only stop the first time the null hypothesis is not rejected. (p. 97)

However, Harris (1995, p. 89) argued that “the trace test shows more robustness to both Skewness and Kurtosis than the eigenvalues test. If the model suffers from Kurtosis, it may be preferable to place greater weight on the trace test.”

Table 4.4: Determining the cointegration rank

Test statistic	Rank (r)	Model 2	Model 3	Model 4
Trace statistic (critical values)	0	139.77 (76.97)	114.69 (67.18)	130.03 (88.80)
	1	87.30 (54.08)	62.30 (47.85)	77.62 (63.86)
	2	41.90 (35.20)	34.20 (29.97)	47.60 (42.90)
	3	20.72 (20.26)	18.10 (15.50)	24.54 (25.70)
	4	6.87 (9.16)	–	–

Note: Numbers in parentheses are the 95% critical value of the trace test.

From Table 4.4, and based on the 95% level of confidence, the null hypothesis of the three cointegration relations in Model 4 was borderline accepted ($24.54 < 25.7$), while the four cointegration relations in Model 2 were the first to be clearly accepted ($6.87 < 9.16$). The trace test, therefore, points to the four cointegration relations of Model 2 as the favourite model specification.

As a result, the equation can be written as follows:

$$\Delta X_t = \Gamma_i \Delta X_{t-i} + \alpha(\beta' X_{t-i} + D_0) + \mu_t \quad (4.21)$$

where

X_t = a (5×1) vector containing observations on each of the variables $[T_t, P_t, Y_t, G_t, R_t]$

α = a $(5 \times r)$ vector of the speed of adjustment to equilibrium coefficients

β = a $(5 \times r)$ vector of long-run matrix of coefficients

μ_t = a (5×1) vector of error terms

D_0 = intercept term of the CI relation.

The next step was to test for weak exogeneity.

4.6.2 Testing for weak exogeneity

According to Juselius (2006, p. 194), searching for weakly exogenous variables is always useful for identification of the common driving trend, and this will be illustrated in the identification section. Juselius (2006) stated that:

The test of zero rows in $[\alpha]$ is the equivalent of testing whether a variable can be considered weakly exogenous for the long-run parameter in $[\beta]$. When accepted it also defines a common driving trend as the cumulated sum of the empirical shocks to the variables in question. (p. 193)

It can be said that a weakly exogenous variable has influenced the long-run stochastic path of the other variables of the system but has not been simultaneously affected by them.

For example, suppose model Z_t consists of three variables: H_t, S_t and J_t or

($Z_t = [H_t, S_t, J_t]'$) and has one cointegration relation with $\alpha = [\alpha_{11}, \alpha_{21}, \alpha_{31}]'$. Then, Harris (1995) argues that:

α_{11} can represent the speed at which ΔH_t , the dependent variable in the first equation of the VECM adjusts towards the single long-run cointegration relationship ($\beta_{11}H_{t-1} + \beta_{21}S_{t-1} + \beta_{31}J_{t-1}$), while α_{21} represents the speed at which ΔS_t adjusts, and α_{31} shows how fast ΔJ_t responds to the disequilibrium changes. ... More generally, each of the r (assuming there are r cointegration vectors) non-zero rows of $[\alpha]$ contain information on which the cointegration vector enters which the short-run equation, and on the speed of the short-run response to disequilibrium. (p. 98)

He also suggests that all zeros in row i of $\alpha_{ij}, j = 1, \dots, r$ implies there is no loss of information from not modelling the determinants of ΔZ_{it} when estimating the parameters of the model, or it can be said that this variable is weakly exogenous to the system and can be entered onto the right-hand side of the VECM. Now, suppose this model has two cointegration relations:

$$\begin{bmatrix} \Delta S_t \\ \Delta J_t \\ \Delta H_t \end{bmatrix} = C + \Gamma_1 \begin{bmatrix} \Delta S_{t-1} \\ \Delta J_{t-1} \\ \Delta H_{t-1} \end{bmatrix} + \begin{bmatrix} \alpha_{11} & \alpha_{12} \\ \alpha_{21} & \alpha_{22} \\ \alpha_{31} & \alpha_{32} \end{bmatrix} \begin{bmatrix} \beta_{11} & \beta_{21} & \beta_{31} \\ \beta_{12} & \beta_{22} & \beta_{32} \end{bmatrix} \begin{bmatrix} S_{t-1} \\ J_{t-1} \\ H_{t-1} \end{bmatrix} + \mu_t. \quad (4.22)$$

If $\alpha_{31} = \alpha_{32} = 0$, the equation of ΔH_t contains no information about the long-run $[\beta]$ and is therefore valid to condition on the weakly exogenous variable H_t . We proceed with the following partial version of VECM (Harris, 1995, p. 98):

$$\Delta M_t = C + \Gamma_0 \Delta H_t + \Gamma_1 \Delta Z_{t-1} + \begin{bmatrix} \alpha_{11} & \alpha_{12} \\ \alpha_{21} & \alpha_{22} \\ 0 & 0 \end{bmatrix} \begin{bmatrix} \beta_{11} & \beta_{12} & \beta_{13} \\ \beta_{21} & \beta_{22} & \beta_{23} \end{bmatrix} Z_{t-1} + \mu_t \quad (4.23)$$

where $M_t = [S_t, J_t]'$, and $[\alpha]$ equals $[\alpha]$ with $\alpha_{31} = \alpha_{32} = 0$. Harris (1995, p. 98) explains that “the weakly exogenous variable, H_t remains in the long-run model (i.e. the cointegration vectors) although its short-run behaviour is not modelled because of its exclusion from the vector on the left-hand side of the equation.”

Because a variable that has a zero row in $[\alpha]$ does not adjust to the long-run relations, it can be considered a common driving trend in the system (Juselius, 2006, p. 196). According to Juselius (2006, p. 194), if there are r cointegration vectors in $[\beta]$, it can be said that the number of zero-row restrictions in $[\alpha]$ can be up to or equal to $p-r$ (p is the number of variables). Because there are four cointegration relations in the baseline model (from Table 4.4), there is one weakly exogenous variable ($5 - 4 = 1$).

In the five-variable baseline model, if we choose to order the variables as follows: $\Delta T_t \rightarrow \Delta P_t \rightarrow \Delta Y_t \rightarrow \Delta G_t \rightarrow \Delta R_t$, the equation can be written in the form below. (The explanation and interpretation of the ordering of variables will be given in section 4.6.4, but in this process the ordering of variables does not affect the result of testing for weakly exogenous variables.)

$$\begin{bmatrix} \Delta T_t \\ \Delta P_t \\ \Delta Y_t \\ \Delta G_t \\ \Delta R_t \end{bmatrix} = C + \Gamma_1 \begin{bmatrix} \Delta T_{t-1} \\ \Delta P_{t-1} \\ \Delta Y_{t-1} \\ \Delta G_{t-1} \\ \Delta R_{t-1} \end{bmatrix} + \begin{bmatrix} \alpha_{11} & \alpha_{12} & \alpha_{13} & \alpha_{14} \\ \alpha_{21} & \alpha_{22} & \alpha_{23} & \alpha_{24} \\ \alpha_{31} & \alpha_{32} & \alpha_{33} & \alpha_{34} \\ \alpha_{41} & \alpha_{42} & \alpha_{43} & \alpha_{44} \\ \alpha_{51} & \alpha_{52} & \alpha_{53} & \alpha_{54} \end{bmatrix} \begin{bmatrix} \beta_{11} & \beta_{12} & \beta_{13} & \beta_{14} & \beta_{15} \\ \beta_{21} & \beta_{22} & \beta_{23} & \beta_{24} & \beta_{25} \\ \beta_{31} & \beta_{32} & \beta_{33} & \beta_{34} & \beta_{35} \\ \beta_{41} & \beta_{42} & \beta_{43} & \beta_{44} & \beta_{45} \end{bmatrix} \begin{bmatrix} T_{t-1} \\ P_{t-1} \\ Y_{t-1} \\ G_{t-1} \\ R_{t-1} \end{bmatrix} + \mu_t \quad (4.24)$$

Table 4.5: The result of testing for restrictions on α (test of weak exogeneity)

Variables	T_t	P_t	Y_t	G_t	R_t
Restrictions	$H_0 : \alpha_{11} = \alpha_{12}$ $= \alpha_{13} = \alpha_{14}$ $= 0$	$H_0 : \alpha_{21} = \alpha_{22}$ $= \alpha_{23} = \alpha_{24}$ $= 0$	$H_0 : \alpha_{31} = \alpha_{32}$ $= \alpha_{33} = \alpha_{34}$ $= 0$	$H_0 : \alpha_{41} = \alpha_{42}$ $= \alpha_{43} = \alpha_{44}$ $= 0$	$H_0 : \alpha_{51} = \alpha_{52}$ $= \alpha_{53} = \alpha_{54}$ $= 0$
χ^2 (v)	12.30	21.90	40.50	23.20	7.11
(p-value)	(0.01)	(0.00)	(0.00)	(0.00)	(0.12)

A weakly exogenous test is based on the likelihood ratio test with asymptotically χ^2 distribution. From Table 4.5, v is the degrees of freedom (4) and can be calculated by $v = r \times m$ (Juselius, 2006, p. 195), where $m(1)$ is the number of weakly exogenous variables. The table shows that we cannot reject the null hypothesis that R_t is a weakly exogenous variable here at the 95% level of confidence because the p-value of the test is more than 0.05. Therefore, the weakly exogenous variable in the model is the interest rate.

4.6.3 Identification of the long-run structure

After testing for weak exogeneity, the next step is identification. According to Juselius (2006, p. 207), there is a need to discuss two different identification problems: identification of the long-run structure (i.e. cointegration relations) and identification of the short-run structure (i.e. equations of the system; this will be discussed in section 4.6.4).

According to Juselius (2006, p. 207), “to illustrate the difference between the two identification problems, it is useful to consider the cointegrated VAR model both in the so-called reduced form and the structure form.” First, we consider the reduced-form representation:

$$\Delta X_t = \Gamma_1 \Delta X_{t-1} + \alpha \beta' X_{t-1} + \mu_t, \quad \mu_t \sim IN(0, \Omega). \quad (4.25)$$

According to Lutkepohl et al. (2006), in VAR it is always assumed that an error term must be a zero-mean independent white-noise process with time-invariant variance, or $\mu_t \sim IN(0, \Omega)$.

We then pre-multiply (4.25) with a non-singular $p \times p$ matrix B to obtain the so-called structural-form representation:

$$B \Delta X_t = b \beta' X_{t-1} + B_1 \Delta X_{t-1} + \varepsilon_t, \quad \varepsilon_t \sim IN(0, \Sigma). \quad (4.26)$$

From (4.25), these were reduced-form parameters: $\lambda_{RF} = \{\Gamma_1, \alpha, \beta, \Omega\}$. In the same way, from (4.26) these were structural-form parameters: $\lambda_{SF} = \{B, B_1, b, \beta, \Sigma\}$.

To distinguish between the parameters of the short-run and long-run parameter structures, parameters can be divided into $\lambda_{RF} = \{\lambda_{RF}^S, \lambda_{RF}^L\}$, where $\lambda_{RF}^S = \{\Gamma_1, \alpha, \Omega\}$ and $\lambda_{RF}^L = \{\beta\}$ and $\lambda_{SF} = \{\lambda_{SF}^S, \lambda_{SF}^L\}$, where $\lambda_{SF}^S = \{B, B_1, b, \Sigma\}$ and $\lambda_{SF}^L = \{\beta\}$. Moreover, the relationship between variables in the reduced form and the structural form can be shown as $\Gamma_1 = B^{-1} B_1, \alpha = B^{-1} b, \mu_t = B^{-1} \varepsilon_t, \Omega = B^{-1} \Sigma B^{-1}$.

According to Juselius (2006, p. 208), the long-run parameters do not change under linear transformations of the VAR model, or it can be said that $[\beta]$ is the same in both the reduced and structural forms. As a result, the identification process can begin with the identification of $[\beta]$ in the reduced form and continue to the identification of the short-run structure by keeping the identified $[\beta]$ fixed.

In order to impose restrictions on $[\beta]$, according to Juselius (2006, p. 210), “it is often useful to start with a just-identified system and then impose further restrictions if the significance of the estimated parameters indicates that a further restriction in the statistical model is possible.”

According to Juselius (2006, p. 216), for the long-run matrix in VECM, $\Pi = \alpha\beta'$. This can be transformed by a non-singular $r \times r$ matrix Q : $\Pi = \alpha Q Q^{-1} \beta' = \tilde{\alpha} \tilde{\beta}'$, where $\tilde{\alpha} = \alpha Q$ and $\tilde{\beta} = \beta Q^{-1}$. Matrix Q was then selected so that it imposed $r - 1$ just-identifying restrictions on each cointegration relation. It was considered that matrix $Q = [\beta_1']$, where $\beta_1' = r \times r$ non-singular matrix. For example, if there were four cointegration relations in the model, $(4 - 1)$ restrictions will be imposed on each cointegration relation. Just-identifying restrictions can be specified by the endogenous variables as a function of the exogenous variables (Juselius, 2006, p. 216).

$$\beta = \begin{bmatrix} \beta_{11} & \beta_{12} & \beta_{13} & \beta_{14} \\ \beta_{21} & \beta_{22} & \beta_{23} & \beta_{24} \\ \beta_{31} & \beta_{32} & \beta_{33} & \beta_{34} \\ \beta_{41} & \beta_{42} & \beta_{43} & \beta_{44} \\ - & - & - & - \\ \beta_{51} & \beta_{52} & \beta_{53} & \beta_{54} \end{bmatrix} = \begin{bmatrix} \beta_1 \\ - \\ \beta_2 \end{bmatrix} \beta_1^{-1} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ - & - & - & - \\ \tilde{\beta}_{51} & \tilde{\beta}_{52} & \tilde{\beta}_{53} & \tilde{\beta}_{54} \end{bmatrix} \quad (4.27)$$

According to Juselius (2006, p. 216), in (4.26), “ $[\beta']$ can be written as matrix $\beta' = [\beta_1', \beta_2']$. In this case $\alpha\beta' = \alpha(\beta_1' \beta_1^{-1}, \tilde{\beta}') = \alpha[I_r, \tilde{\beta}']$ and I_r is an $(r \times r)$ identity matrix and $\tilde{\beta}' = \beta_1^{-1} \beta_2'$ is $r \times (p - r)$ matrix of full rank.” In (4.27), because $r - 1$ restrictions are required for a just-identified system, $4 - 1 = 3$ or three zero restrictions and one normalisation will be imposed on each cointegration relation.

Juselius (2006) noted that:

These just-identifying restrictions have transformed $[\beta]$ to the long-run ‘reduce form’. Thus, the above example for $X_t = [X'_{1t}, X'_{2t}]'$, where $X'_{1t} = [x_{1t}, x_{2t}, x_{3t}, x_{4t}]$ and $X'_{2t} = [x_{5t}]$, would describe an economic application where the four variables in X'_{1t} are endogenous and one in X'_{2t} is exogenous (p. 216).

Moreover, $[\alpha]$ can be written as matrix $\alpha = \begin{bmatrix} \alpha_1 \\ \alpha_2 \end{bmatrix}$ and $\alpha_2 = 0$. Thus, $\beta' X_t$ does not appear in the equation for $\Delta X'_{2t}$.

Juselius (2006, p. 216) argues that “efficient inference on the long-run relations can be conducted in the model of $\Delta X'_{1t}$, given $\Delta X'_{2t}$ is weakly exogenous for $[\beta]$.” (In this case, X'_{1t} are T_t, P_t, Y_t, G_t and X'_{2t} are R_t). “A weakly exogenous variable has influenced the long-run stochastic path of the other variables of the system, while at the same time has not been influenced by them” (Juselius, 2006, p. 193). This can be explained more in the partial VECM form below.

According to Harris (1995), $x_t = [y_{1t}, y_{2t}, z_t]$ if there were three variables in vector x_t that were y_{1t}, y_{2t} , and z_t . Variable z_t was the weakly exogenous variable, and this system consisted of two cointegration relations and one lag. The VECM with the just-identifying restriction can then be shown as follows:

$$\begin{bmatrix} \Delta y_{1t} \\ \Delta y_{2t} \\ \Delta z_t \end{bmatrix} = \Gamma_1 \begin{bmatrix} \Delta y_{1t-1} \\ \Delta y_{2t-1} \\ \Delta z_{t-1} \end{bmatrix} + \begin{bmatrix} \alpha_{11} & \alpha_{12} \\ \alpha_{21} & \alpha_{22} \\ \alpha_{31} & \alpha_{32} \end{bmatrix} \begin{bmatrix} 1 & 0 & \tilde{\beta}_{31} \\ 0 & 1 & \tilde{\beta}_{32} \end{bmatrix} \begin{bmatrix} y_{1t-1} \\ y_{2t-1} \\ z_{t-1} \end{bmatrix} + \mu_t.$$

However, because z_t was the weakly exogenous variable that has influenced the long-run stochastic path of y_{1t}, y_{2t} but its short-run behaviour is not modelled, it can be written as $[y_t]$ or vector $y_t = [y_{1t}, y_{2t}]$. As a result, a partial version of the VECM can be written as follows:

$$\Delta y_t = \Gamma_0 \Delta z_t + \Gamma_1 \Delta x_{t-1} + \alpha_1 \beta' x_{t-1} + \mu_t.$$

From the equation above, x_t is composed of y_{1t}, y_{2t} and z_t ; i.e. $x_t = [y_{1t}, y_{2t}, z_t]$, Γ_0 is the parameter of the weakly exogenous variable (z_t) and in $[\alpha_1]$ term, zero restrictions will be

$$\text{imposed on } \alpha_{31} \text{ and } \alpha_{32}, \text{ or it can be shown as: } \begin{bmatrix} \alpha_{11} & \alpha_{12} \\ \alpha_{21} & \alpha_{22} \\ 0 & 0 \end{bmatrix}.$$

From the testing for exogeneity in section 4.5.2, R_t corresponded to z_t and T_t, P_t, Y_t, G_t corresponded to $[y_t]$. Thus, long-run relations could be conducted as the equations of total government expenditure, output, total tax and price level. Moreover, in this model there were four cointegration relations. Thus, there were $4 - 1 = 3$ restrictions imposed in each relation. The cointegration part with a just-identifying restriction (ordering of endogenous variables can be: T, P, Y, G; the explanation of ordering is in section 4.6.4, but in this process, the way the variables were ordered had no effect) can be written as:

$$[\alpha] \begin{bmatrix} 1 & 0 & 0 & 0 & \tilde{\beta}_{51} \\ 0 & 1 & 0 & 0 & \tilde{\beta}_{52} \\ 0 & 0 & 1 & 0 & \tilde{\beta}_{53} \\ 0 & 0 & 0 & 1 & \tilde{\beta}_{54} \end{bmatrix} \begin{bmatrix} T_{t-1} \\ P_{t-1} \\ Y_{t-1} \\ G_{t-1} \\ R_{t-1} \end{bmatrix}.$$

The just-identifying restriction can then be shown in the table as follows:

Table 4.6: Just-identifying restriction of the five-variable baseline model

Variable	$[\beta_1]$	$[\beta_2]$	$[\beta_3]$	$[\beta_4]$
T	1	0	0	0
P	0	1	0	0
Y	0	0	1	0
G	0	0	0	1
R	0.13	0.06	0.09	0.11
	(5.92)	(7.97)	(7.00)	(6.52)
Intercept	-11.90	-5.43	-13.80	-12.10
	(-72.90)	(-89.40)	(-132.20)	(-96.90)

Table 4.6, estimated by OLS (Juselius, 2006, p. 122), showed the just-identifying restrictions as in (4.27) and it can be seen that all coefficients were significant at the 95% level of confidence because the $|t\text{-value}|$ of all coefficients was more than 1.96. However, for the proper specification of cointegration relations, especially those relating to fiscal policy, the

relationship between fiscal policy variables and other macroeconomic variables (especially GDP) and the relationship between the two fiscal policy variables (tax revenue and government spending) were focused on. This is in line with Krusec (2003). The restrictions were changed as follows: in the $[\beta_4]$ relation, zero will be restricted to coefficients of Y, P and R so that they represent the relationship between government spending and total tax revenue that was relevant to budget sustainability (Puah, Lau, & Teo, 2011). In the $[\beta_1]$ relation, zero will be restricted to coefficients of G, P and R so that the $[\beta_1]$ relation can be the long-run relationship of automatic stabilisation between total tax revenue and output.

Table 4.7: Just-identifying restriction of the five-variable baseline model reflecting budget sustainability and automatic stabilisation between total tax revenue and output

Variable	$[\beta_1]$	$[\beta_2]$	$[\beta_3]$	$[\beta_4]$
T	1	0	0	-0.84
				(-10.40)
P	0	1	0	0
Y	-1.32	0	1	0
	(-27.60)			
G	0	0	0	1
R	0	0.06	0.09	0
		(9.20)	(9.81)	
Intercept	6.37	-5.43	-13.80	-2.09
	(9.70)	(-92.80)	(-142.80)	(-2.17)

From Table 4.7, estimated by OLS, the first cointegration relation shows the positive long-run relationship of automatic stabilisation between total tax revenue and output.

Krusec (2003) argued that:

Automatic stabilization merely states that there must exist a stationary relationship between government activity variable and output variable which is intuitive since when the output moves over the cycle, the taxes should commove since many tax revenues are specified in the way so as to depend on the level of economic activity. (p. 10)

The second cointegration was the negative relationship between interest rate and price level. The third cointegration was the negative relationship between interest rate and output. The fourth cointegration was the positive relationship between government spending and tax revenue. This cointegration relation represented the traditional relationship between revenue

and spending (Carneiro, Faria & Barry, 2004, p. 8). The positive relationship in the fourth cointegration relation implies that raising revenue will lead to higher spending, so this can worsen the budget balance. From Table 4.7 it can be seen that all coefficients were significant at the 95% level of confidence because the $|t - \text{value}|$ of all coefficients was larger than 1.96. However, the hallmark of VAR is the impulse response function (Keating, 1992).

In addition, Orden and Fisher (1993) noted that:

Since the individual regression coefficients of the VECM models are hard to interpret, we evaluated the dynamic interactions among the series by inverting the estimated models to derive their corresponding moving average representations. (p. 286)

4.6.4 Short-run identification

According to King et al. (1991), the purpose of the reduced form is forecasting. What is of interest are the residuals from the structural form. As Lutkepohl (2006) noted:

Tracing the marginal effects of a change in one component of a reduced-form residual through the system may not reflect the actual responses of the variables because in practice an isolated change in a single component of reduced-form residuals is not likely to occur if the component is correlated with the other components. (p. 3)

As a result, uncorrelated or orthogonal shocks are needed to make us see the real effect of the shock from the variables of interest without disturbance from other shocks. If the shocks are correlated with each other, it confuses the picture of which shock generated the effect. In short-run identification, residuals must be uncorrelated (Juselius, 2006, p. 229).

Fisher et al. (1995) said that:

Use of VAR and VECM models for structural analysis, as opposed to purely for forecasting, requires identification of the underlying behavioural shocks. Sims (1980) initially proposed that the structural relationships between contemporaneous and lagged variables be left unrestricted and exact identification be achieved by imposing a recursive ordering of the variables to account for the contemporaneous correlations among the reduced-form errors. (p. 128)

According to Juselius (2006, p. 240), recursive ordering can result in uncorrelated residuals. Nevertheless, according to Fisher et al. (1995, p. 128), “with the recent attention to non-stationarity and cointegration, issues of identification have focused on restrictions on the

long-run effects of the structural shocks rather than on restrictions on the contemporaneous interactions among the variables.”

The long-run restriction, allowing the data to determine short-run dynamics based conditionally on a particular long-run model, was developed by Blanchard and Quah (1989). If each shock has a permanent effect on at least one of the variables, VAR can be estimated (Keating, 1992). According to Fisher et al. (1995), the KPSW method (King et al., 1991) is also classified as a long-run restriction. Both methods separate shocks into transitory and permanent shocks, but only the KPSW can be used for a model that has more than one common trend. According to King et al. (1991), the shocks to the permanent components are assumed to be uncorrelated with the shocks to the remaining transitory components.

According to Juselius (2006, p. 277), this short-run identification makes the following assumptions.

1. VAR residuals are related to structural shocks that are linearly independent.
2. Structural shocks can be separated into $(p - r)$ permanent and r transitory shocks. The term p is the number of variables and r is the number of cointegration relations in the system.
3. A transitory shock has no long-run impact on any variable in the system.
4. A permanent shock must have a long-run effect on at least one of the variables in the system.

The reduced form in (4.25) can be converted to a structural model, as in (4.26), by pre-multiplying with a non-singular $p \times p$ matrix B . The B matrix defines how the structural shocks ε_t are associated with the reduced-form residuals (Juselius, 2006, p. 277).

$$\varepsilon_t = B\mu_t \tag{4.28}$$

From (4.28), where $\varepsilon_t \sim IN(0, I)$, the structural shocks were assumed to be uncorrelated, standardised, normal variables with a mean of zero. According to Juselius (2006, p. 278), “the idea is to choose B so that the ‘usual’ assumptions underlying a structural interpretation are satisfied.”

1. A difference between r transitory and $p - r$ permanent shocks is made; i.e. $\varepsilon_t = [\varepsilon_{s,t}, \varepsilon_{l,t}]$. In this case, $\varepsilon_{s,t}$ was the transitory shock and $\varepsilon_{l,t}$ was the permanent shock. According to Juselius (2006, p. 275), the permanent shock can

be defined as the residual of weakly exogenous variables. As a result, from the test of weak exogeneity, it can be seen that the permanent shock was the residual from the interest rate equation because it was a weakly exogenous variable. Thus, the residuals from the equations of the other variables in the model can be treated as transitory shocks and were from government expenditure, total tax, GDP and price level.

2. All structural shocks were linearly independent ($E(\varepsilon_t \varepsilon_t') = I_p$). This meant both orthogonality between the two groups (transitory and permanent shocks) and orthogonality within each group.

From the three conditions above, orthogonality of the transitory shocks and permanent shocks can be written as follows (Juselius, 2006, p. 278):

$$\varepsilon_{s,t} = \alpha' \Omega^{-1} \mu_t$$

$$\varepsilon_{l,t} = \alpha_{\perp}' \mu_t$$

where Ω is the covariance matrix of μ_t and α_{\perp} represents orthogonal complements ($\alpha \alpha_{\perp}' = 0$).

Orthogonality within two groups was obtained as follows:

$$B = \begin{bmatrix} (\alpha' \Omega^{-1} \alpha)^{-1/2} \alpha' \Omega^{-1} \\ (\alpha_{\perp}' \Omega \alpha_{\perp})^{-1/2} \alpha_{\perp}' \end{bmatrix}.$$

Following Juselius (2006), a consequence of defining the structural errors by equation (4.28) is that we have added $p \times p$ additional parameters to the unrestricted VAR model so we need to impose exactly the same number of restrictions on the parameters of the model to achieve just identification.

As a result, because in this model $p = 5$, we have to impose $5 \times 5 = 25$ additional restrictions. According to Juselius (2006, p. 279), these 25 restrictions can be divided into three groups. The first group is restrictions for the assumptions of uncorrelated structural shocks. This can be done by imposing $\{p \times (p + 1)\}/2 = 15$ restrictions on matrix B (that is, the first matrix on the left side in (4.26) and (4.29)); and 10 zero restrictions on the off-diagonal element of five

unit coefficients on the diagonal elements, due to the condition that all structural shocks are linearly independent ($E(\varepsilon_t \varepsilon_t') = I_p$).

According to Juselius (2006, p. 280), the second group of restrictions is for separating permanent and transitory shocks. This can be done by imposing $(p - r) \times r = (5 - 4) \times 4 = 4$ additional restrictions to b in (4.26). These were the four zero restrictions in the last row of matrix b in (4.29); that is, the first matrix on the right side of the equations.

$$B\Delta X_t = b\beta' X_{t-1} + B_1\Delta X_{t-1} + \varepsilon_t \quad (4.26)$$

From (4.26), this can be written as follows:

$$\begin{bmatrix} (\alpha' \Omega^{-1} \alpha)^{-1/2} \alpha' \Omega^{-1} \\ (\alpha'_\perp \Omega \alpha_\perp)^{-1/2} \alpha_\perp^{-1} \end{bmatrix} \begin{bmatrix} \Delta T_t \\ \Delta P_t \\ \Delta Y_t \\ \Delta G_t \\ \Delta R_t \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 \end{bmatrix} [\beta' X_{t-1}] + B_1 \Delta X_{t-1} + \begin{bmatrix} \varepsilon_{s1,t} \\ \varepsilon_{s2,t} \\ \varepsilon_{s3,t} \\ \varepsilon_{s4,t} \\ \varepsilon_{11,t} \end{bmatrix}. \quad (4.29)$$

A third group of restrictions – an exclusive restriction – was needed because there were different ways to order transitory shocks. A unique specification can be gained by imposing $[25 - (4 + 15)] = 6$ zero restrictions on transitory impulse responses (Juselius, 2006, p. 281). There was no need to impose an exclusive restriction on a permanent shock because there was only one permanent shock, R_t , here according to Juselius (2006, p. 280). The weakly exogenous variable is ordered after the transitory variables so that the adjusting variables can come first.

In an exclusion restriction, equation (4.29) can be written in the moving average form. The moving average representation is a useful tool to examine the interaction between variables. It is the equations that the variables are expressed in, in terms of current and past values of shocks from the residuals. According to Juselius (2006, p. 278), the moving average form of equation (4.29) can be written as follows:

$$X_t = CB^{-1} \sum \varepsilon_t + C^*(L)B^{-1} \varepsilon_t + \tilde{X}_0. \quad (4.30)$$

From (4.30), it can be said that $C = \tilde{\beta}_\perp \alpha'_\perp$, $\tilde{\beta}_\perp = \beta_\perp (\alpha'_\perp \Gamma \beta_\perp)^{-1}$, where β_\perp represents orthogonal complements ($\beta \beta_\perp = 0$) and $C^*(L) = \alpha (\beta' \Gamma \alpha)^{-1} \beta^{-1}$, where C contains the

permanent components, while C^* is a transitory component that contains instantaneous coefficients. Moreover, \tilde{X}_0 represents the initial values.

Equation (4.30) can then be written in the matrix form as follows:

$$\begin{bmatrix} T_t \\ P_t \\ Y_t \\ G_t \\ R_t \end{bmatrix} = \begin{bmatrix} 0 & 0 & 0 & 0 & * \\ 0 & 0 & 0 & 0 & * \\ 0 & 0 & 0 & 0 & * \\ 0 & 0 & 0 & 0 & * \\ 0 & 0 & 0 & 0 & * \end{bmatrix} \begin{bmatrix} \sum_{i=1}^t \varepsilon_{s1,i} \\ \sum_{i=1}^t \varepsilon_{s2,i} \\ \sum_{i=1}^t \varepsilon_{s3,i} \\ \sum_{i=1}^t \varepsilon_{s4,i} \\ \sum_{i=1}^t \varepsilon_{l1,i} \end{bmatrix} + \begin{bmatrix} * & * & * & * & * \\ * & * & * & 0 & * \\ * & * & 0 & 0 & * \\ * & 0 & 0 & 0 & * \\ * & * & * & * & * \end{bmatrix} \begin{bmatrix} \varepsilon_{s1,t} \\ \varepsilon_{s2,t} \\ \varepsilon_{s3,t} \\ \varepsilon_{s4,t} \\ \varepsilon_{l1,t} \end{bmatrix} + C_1 B^{-1} \begin{bmatrix} \varepsilon_{s1,t-1} \\ \varepsilon_{s2,t-1} \\ \varepsilon_{s3,t-1} \\ \varepsilon_{s4,t-1} \\ \varepsilon_{l1,t-1} \end{bmatrix} + \dots \quad (4.31)$$

From (4.31), matrix $\begin{bmatrix} 0 & 0 & 0 & 0 & * \\ 0 & 0 & 0 & 0 & * \\ 0 & 0 & 0 & 0 & * \\ 0 & 0 & 0 & 0 & * \\ 0 & 0 & 0 & 0 & * \end{bmatrix}$ is $C_0 B^{-1}$ matrix. This matrix was long run. Transitory

shocks cannot have a long-run effect on any variable in the system, and this can be seen from the zeros in the first four columns of the matrix. The unrestricted elements in the last column mean the interest rate (R) can have a long-run effect on all variables. The interest rate (R) can be a permanent shock because, from the testing for weak exogeneity in section 4.5.2, interest rate (R) is a weakly exogenous variable and, according to Juselius (2006, p. 275), a permanent shock can be defined as the residual of weakly exogenous variables.

From (4.31), matrix $\begin{bmatrix} * & * & * & * & * \\ * & * & * & 0 & * \\ * & * & 0 & 0 & * \\ * & 0 & 0 & 0 & * \\ * & * & * & * & * \end{bmatrix}$ is $C_0 B^{-1}$ matrix. This matrix was a short-run matrix.

This defined ε_{s1} as a government spending shock, ε_{s2} as an output shock, ε_{s3} as a price-level shock and ε_{s4} as a tax revenue shock. In this matrix, the assumption of six exclusion restrictions on the transitory shocks can be explained as follows.

1. Government spending (G) reacts immediately only to a shock from itself, and other transitory shocks can impact contemporaneously on it. This corresponds to the idea of Blanchard and Perotti (2002) that it generally takes longer than one quarter for the government to implement new policy. This can be seen from three zero restrictions in row 4 of the $C_0 B^{-1}$ matrix in (4.31). Moreover, government spending (G) can have a

contemporaneous effect on all variables, and this can be seen from the unrestricted elements in column 1 of the C_0B^{-1} matrix in (4.31).

2. Output (Y) reacted immediately to shocks from itself and also government spending (G). This corresponded to the idea of Perotti (2004) that government spending (G) is a component of GDP (Y), so it was possible for government spending to have a contemporaneous effect on output (Y). This can be seen from unrestricted elements in column 1 and column 2 of row 3 in matrix C_0B^{-1} in (4.31).

Tax (T) reacted immediately to shocks from government spending (G), price level (P), output (Y) and itself. This corresponded to Caldara and Kamps's (2008) idea that movements in tax (T), unlike government spending (G), can relate to the business cycle. Thus, shocks of output (Y) and price level (P) can have a contemporaneous effect on tax (T), although it was not a discretionary response of tax to these variables: it was an automatic response of tax to these variables, especially the elasticity of tax to output (changing tax revenue arising automatically as the economy moved through the different stages of the business cycle). This can be seen from unrestricted elements in row 1 of matrix C_0B^{-1} in (4.31).

4.6.5 Impulse response functions

After looking at short-run and long-run identifications, it is time to analyse the effects of shocks to fiscal policy variables on other variables, especially GDP via the impulse response function (IRF). IRFs show the reactions of the variables to a unitary shock of one standard deviation. According to Jin-Lung (2006), IRFs are employed to evaluate the effectiveness of a policy. To arrive at the IRFs, the VECM below is first converted to VAR in levels (Szeto, 1992).

$$\Delta X_t = \Gamma_1 \Delta X_{t-1} + \dots + \Gamma_{p-1} \Delta X_{t-p+1} + \alpha \beta' X_{t-1} + B^{-1} \varepsilon_t. \quad (4.32)$$

In (4.32), $\mu_t = B^{-1} \varepsilon_t$, the VAR in levels becomes:

$$X_t = A_1 X_{t-1} + \dots + A_p X_{t-p} + \mu_t \quad (4.33)$$

$$A_1 = \Gamma_1 + \alpha \beta' + I$$

where $A_i = \Gamma_i - \Gamma_{i-1}$ for $i=2, \dots, p-1$.

$$A_p = -\Gamma_{p-1}$$

Then, the VAR in (4.33) is written in the moving average form as follows:

$$X_t = \bar{X} + \sum_{i=0}^{\infty} \phi_i \mu_{t-1} \quad (4.34)$$

where X_t includes the variables: G, Y, P, T and R

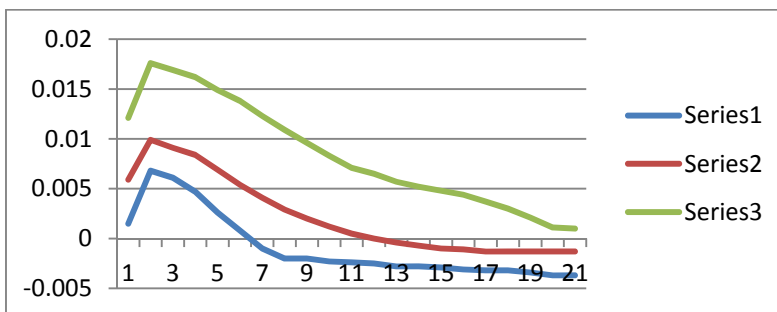
$\phi_0 = I$ is a 5×5 identity matrix,

$$\phi_i = \sum_{j=1}^i \phi_{i-j} A_j \text{ for } i = 0, 1, 2, \dots, 40.$$

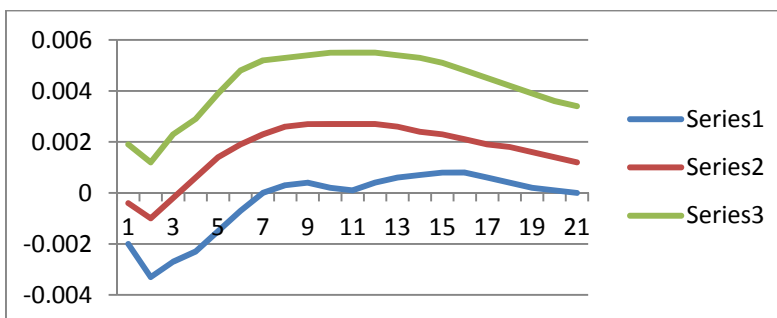
The IRF of the reduced form VAR (ϕ) can be transformed to an IRF of structure form (Θ), as follows (Bruggemann, 2006):

$$\Theta_i = \phi_i B^{-1} \text{ for } i = 0, 1, 2, \dots, 40.$$

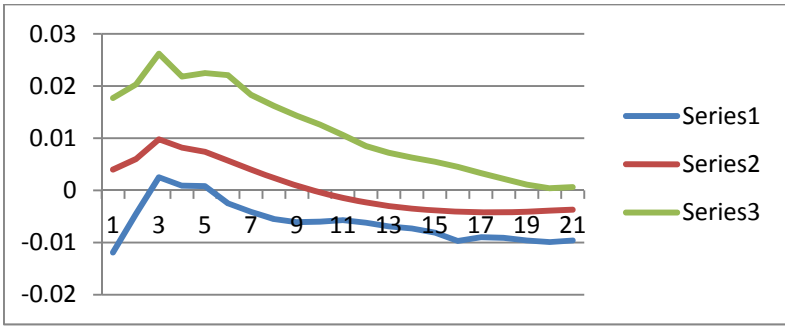
IRFs are typically illustrated by graphs that provide a visual representation of responses. The horizontal axis in all graphs shows time period (a quarter, in this case). Points on the graph above zero display positive responses, while points below zero represent negative responses. In this study, all variables (except interest rate, which is a percentage) were transformed to logarithms because this can transform the data to percentage changes and make interpretation of the results, such as elasticity, more economically meaningful.



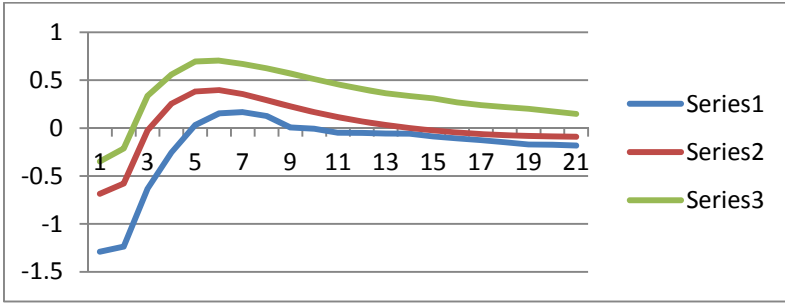
a. The effect of government spending on output



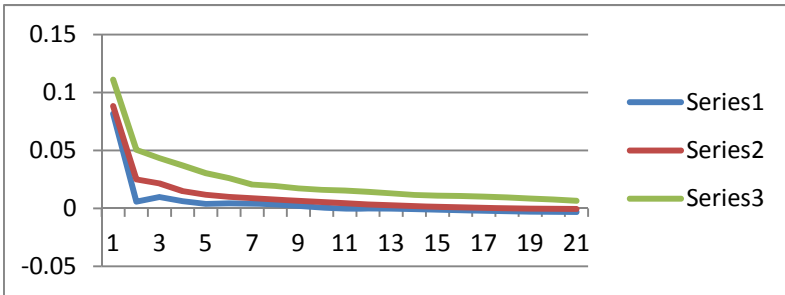
b. The effect of government spending on price level



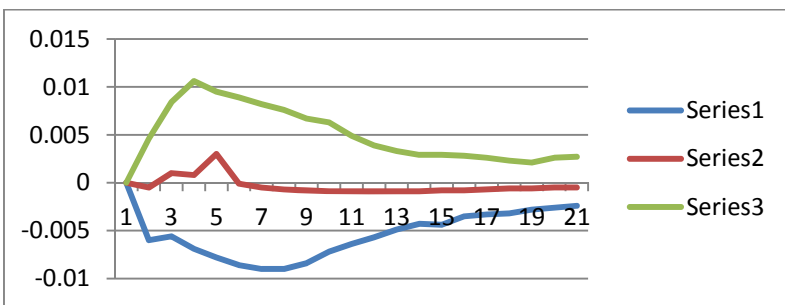
c. The effect of government spending on total tax



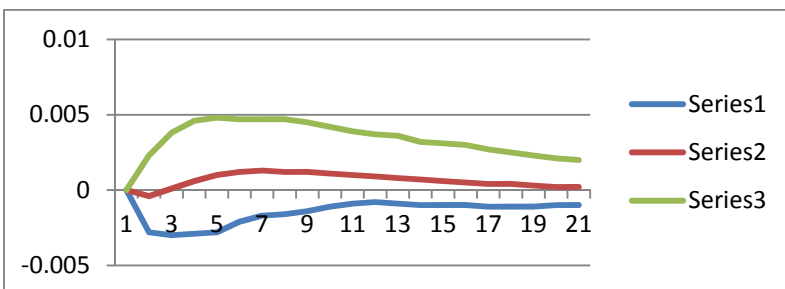
d. The effect of government spending on interest rate



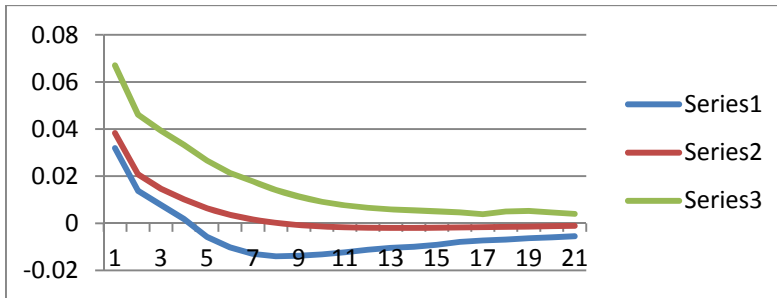
e. The effect of government spending on government spending



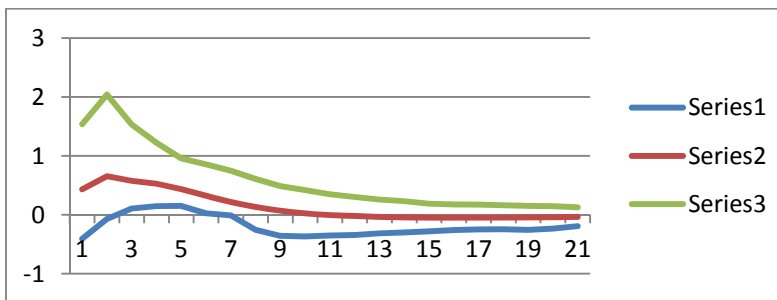
f. The effect of total tax on output



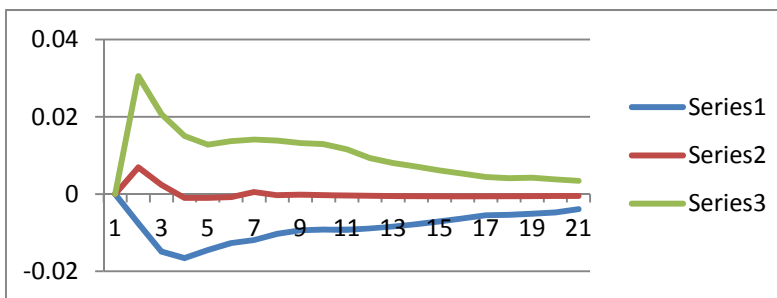
g. The effect of total tax on price level



h. The effect of total tax on total tax



i. The effect of total tax on interest rate



j. The effect of total tax on government spending

Figure 4.1: Impulse response functions of the baseline model

Shocks to government expenditure

Figure 4.1 shows the 95% level of confidence from the confidence bands: the line Series 1 represents the lower confidence band, while the line Series 3 represents the upper confidence band and the line Series 2 shows IRFs. According to Hur (2007, p. 10), “the size of innovation to be applied in calculating an impulse response function is set to be 1 standard deviation of the error term.” With the estimate sample standard innovation of total government spending error term being 0.39, the log level variable shocks should be read as a percentage term, so that the shock of total government spending, in this case, is 39% (Dungey & Fry, 2007).

In this model, a positive shock of 39% to total government spending (Figure 4.1a) contemporaneously had a positive effect on output with a magnitude of 0.6. Dividing the magnitude of GDP, which was 0.6, by the estimated sample standard deviation of the spending shock term, which was 0.39, one could obtain the elasticity of GDP with respect to fiscal stimuli. Accordingly, a 1% increase in total government spending resulted in an increase in GDP by 0.015% in the first quarter. This elasticity can be converted to a fiscal multiplier (see Appendix C). With an impact multiplier of 0.1, an increase in 1 baht in total government spending increased the output by 0.1 baht in the first quarter of the shock. Output then increased and peaked in the second quarter, with the peak multiplier being about 0.17. Then, the positive multiplier from the spending started to decline and was associated with increases in both interest rates and prices.

Moreover, a positive multiplier remained significant until the sixth quarter. This was in line with Keynesian theory that an increase in government spending has a positive effect on output in the short term. In the same way, it also has a significant positive effect on the crowding out variables of prices and interest rates. Finally, an increase in total government spending also contemporaneously affected total tax in a positive way, and the effect was also temporary and significant between the second and fifth quarters.

Shocks to taxes

It cannot be concluded that the effect from an increase in total tax on output supported the idea of a Keynesian effect of non-Keynesian fiscal policy (see section 2.2.3), although output was positive between the second and fifth quarters after a positive total tax shock. From the response of GDP to an increase in total tax (Figure 4.1f), it can be seen that an increase in this tax also had a positive effect on government spending in the first four quarters. It is possible that the increase in government spending was high enough to offset the effect of an increase in total tax. This can be seen from the positive multiplier, which decreased after the fourth quarter of the shock and changed to being slightly negative after the fifth quarter, when the positive effect of government spending disappeared.

Thus, an increase in total tax had a negative effect on output, but the effect was delayed because it was offset by the effect of total government spending. However, from the confidence bands, it can be seen that the effect of a positive total tax shock on output was insignificant. In the case of the effect of total tax on price level, a positive shock on tax had a positive effect on price level but the effect was insignificant. In the case of the effect of total

tax on interest rates, a positive shock of tax had a significant positive effect on interest rates between the second and the sixth quarter after the shock that was consistent with the positive multiplier in the first five quarters.

4.7 Vector Error Correction (VECM) of Model Gc

The first step in this model is to test for the lag-length.

Table 4.8: Results of the lag-length test of Model Gc in VECM

Model	LR	FPE	AIC	SC	HQ
Gc model	3	3	3	1	1

From Table 4.8, it can be seen that there are two possible lag-lengths: 3 and 1.

Table 4.9a: Residual tests of the Model Gc in VECM (normality and heteroscedasticity)

Model	Skewness (χ^2)	p-value	Kurtosis (χ^2)	p-value	SK and KU	p-value	Heteroscedasticity (p-value)
Gc model with 3 lags	7.06	0.21	82.10	0.00	89.20	0.00	514.06 (0.02)
Gc model with 1 lag	20.80	0.00	65.60	0.00	86.40	0.00	169.00 (0.13)

Table 4.9b: Residual tests of Model Gc (autocorrelation at 1 lag)

Lag	LM-stat	p-value
1	48.50	0.00

Table 4.9c: Residual tests of Model Gc (autocorrelation at 1 to 3 lags)

Lag	LM-stat	p-value
1	27.60	0.32
2	19.90	0.75
3	31.06	0.18

From Tables 4.9a to 4.9c, the three-lag model was chosen because the statistic of autocorrelation and skewness performed better than the other. There was no evidence of autocorrelation from lag 1 to lag 3 in the three-lag model, while there was clear evidence of autocorrelation in the one-lag model. Moreover, there was no evidence of non-normality due to skewness in the three-lag model as there was in the one-lag model.

4.7.1 Testing for cointegration

For the cointegration test, the results from the trace test are shown below.

Table 4.10: Determining the cointegration rank and the model

Test statistic	r	Model 2	Model 3	Model 4
Trace test (critical values)	0	127.20	96.70	121.40
	1	(76.97) 76.70	(67.18) 58.60	(88.80) 81.50
	2	(54.08) 38.70	(47.85) 31.80	(63.86) 52.70
	3	(35.20) 15.00	(29.97) –	(42.90) –

(20.26)

Note: Numbers in parentheses are 95% of the critical value of the trace test.

From Table 4.10, based on the 95% level of confidence, the null hypothesis of the three cointegration relations in Model 4 was the first to be clearly accepted ($15 < 20.26$). As a result, the trace test points to the three cointegration relations of Model 2 as the favourite model specification.

4.7.2 Testing for weak exogeneity

Because there were three cointegration relations in this model, there were two weakly exogenous variables ($5 - 3 = 2$). We chose to order the variables as follows: $\Delta T_t \rightarrow \Delta Y_t \rightarrow \Delta Gc_t \rightarrow \Delta R_t \rightarrow \Delta P_t$, so equation (4.35) can be written in the form below (an explanation of the ordering is given in section 4.7.4, but the order has no effect on testing for exogeneity).

$$\begin{bmatrix} \Delta T_t \\ \Delta Y_t \\ \Delta Gc_t \\ \Delta R_t \\ \Delta P_t \end{bmatrix} = C + \Gamma_1 \begin{bmatrix} \Delta T_{t-1} \\ \Delta Y_{t-1} \\ \Delta Gc_{t-1} \\ \Delta R_{t-1} \\ \Delta P_{t-1} \end{bmatrix} + \Gamma_2 \begin{bmatrix} \Delta T_{t-2} \\ \Delta Y_{t-2} \\ \Delta Gc_{t-2} \\ \Delta R_{t-2} \\ \Delta P_{t-2} \end{bmatrix} + \begin{bmatrix} \alpha_{11} & \alpha_{12} & \alpha_{13} \\ \alpha_{21} & \alpha_{22} & \alpha_{23} \\ \alpha_{31} & \alpha_{32} & \alpha_{33} \\ \alpha_{41} & \alpha_{42} & \alpha_{43} \\ \alpha_{51} & \alpha_{52} & \alpha_{53} \end{bmatrix} \begin{bmatrix} \beta_{11} & \beta_{21} & \beta_{31} & \beta_{41} & \beta_{51} \\ \beta_{12} & \beta_{22} & \beta_{32} & \beta_{42} & \beta_{52} \\ \beta_{13} & \beta_{23} & \beta_{33} & \beta_{43} & \beta_{53} \end{bmatrix} \begin{bmatrix} T_{t-1} \\ Y_{t-1} \\ Gc_{t-1} \\ R_{t-1} \\ P_{t-1} \end{bmatrix} + \mu_t$$

Table 4.11: The result of testing restrictions on α (test of weak exogeneity)

Variables	T_t	Y_t	Gc_t	R_t	P_t
Restrictions	$H_0 : \alpha_{11} = \alpha_{12}$ $= \alpha_{13} = 0$	$H_0 : \alpha_{21} = \alpha_{22}$ $= \alpha_{23} = 0$	$H_0 : \alpha_{31} = \alpha_{32}$ $= \alpha_{33} = 0$	$H_0 : \alpha_{41} = \alpha_{42}$ $= \alpha_{43} = 0$	$H_0 : \alpha_{51} = \alpha_{52}$ $= \alpha_{53} = 0$
$\chi^2(v)$	17.80 (0.00)	33.80 (0.00)	27.69 (0.00)	1.87 (0.59)	10.50 (0.02)

From Table 4.11, we cannot reject the null hypothesis that interest rate is a weakly exogenous variable at the 95% level of confidence because the p-value from testing for weak exogeneity is more than 0.05. As a result, the interest rate is one of the weakly exogenous variables. The other weakly exogenous variable in the model is price level, because the null hypothesis of weakly exogenous variable of price level cannot be rejected at the 99% level of confidence since the p-value is larger than 0.01.

4.7.3 Identification of the long-run structure

After testing for exogeneity, it can be seen that R_t, P_t were weakly exogenous variables and that T_t, Y_t, Gc_t were endogenous variables. Thus, long-run relationships were current spending, tax and output functions. Moreover, in this model, there were three cointegration relations; thus, there were $3 - 1 = 2$ restrictions imposed in each relationship. The just-identifying restriction can then be written as follows:

Table 4.12: Just-identifying restriction of the five-variable Model Gc

Variable	$[\beta_1]$	$[\beta_2]$	$[\beta_3]$
T	1	0	0
Y	0	1	0
Gc	0	0	1
R	0.06	0.06	0.01
P	(2.92) -1.10	(4.32) -0.60	(0.55) -1.81
Intercept	(-2.50) -5.70	(-2.26) -10.30	(-10.10) -2.01
	(-2.40)	(-7.20)	(-2.10)

From Table 4.12, estimated by OLS (Juselius, 2006, p. 122), it can be seen that not all coefficients were significant at the 95% level of confidence because the $|t\text{-value}|$ of some coefficients was not more than 1.96. As a result, over-identifying restrictions were considered.

Moreover, the proper specification of cointegration relations, especially in terms of fiscal policy, is focused on when imposing restrictions. The restrictions can then be shown as follows:

Table 4.13: Beta restriction in Model Gc

Variable	$[\beta_1]$	$[\beta_2]$	$[\beta_3]$
T	1	0	-0.13
Y	-1.24 (-5.80)	1	(-1.08) 0
Gc	0	0	1
R	0	0.10 (8.86)	0
P	-0.21 (-1.77)	0	-1.60 (-7.95)
Intercept	6.45 (4.02)	-13.60 (-145.80)	-1.57 (-2.10)

From Table 4.13, estimated by OLS (Juselius, 2006, p. 122), these restrictions can be accepted at the 95% level of confidence because the chi-square is 0.32 with a p-value of 0.56. The p-value is larger than 0.05, so these restrictions are not rejected. It can be seen that the first was the long-run relationship between total tax and output as in the baseline model, but price level was included. The second relation was the negative long-run relationship between interest rate and output. The last was the long-run relationship of current spending and tax revenue, as in the baseline model, but in this model price level was included in the relationship.

4.7.4 Short-run identification

To illustrate this idea, according to Juselius (2006, p. 280) the ordering of the variables will begin with transitory variables. It can then be written as follows:

$$\begin{bmatrix} (\alpha' \Omega^{-1} \alpha)^{-1/2} \alpha' \Omega^{-1} \\ (\alpha_{\perp}' \Omega \alpha_{\perp})^{-1/2} \alpha_{\perp}' \end{bmatrix} \begin{bmatrix} \Delta T_t \\ \Delta Y_t \\ \Delta Gc_t \\ \Delta R_t \\ \Delta P_t \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix} [\beta' X_{t-1}] + B_1 \Delta X_{t-1} + B_2 \Delta X_{t-2} + \begin{bmatrix} \varepsilon_{s1,t} \\ \varepsilon_{s2,t} \\ \varepsilon_{s3,t} \\ \varepsilon_{l1,t} \\ \varepsilon_{l2,t} \end{bmatrix}. \quad (4.36)$$

From (4.36), the restrictions that separate permanent and transitory shocks were $(p - r) \times r = (5 - 3) \times 3 = 6$; i.e. six zero restrictions in b (the first matrix in the right side of equation (4.36)). This was different from equation (4.29) of the baseline model in that there were four cointegration relations (r) and one weakly exogenous variable (interest rate) in equation (4.29), so there were only four zero restrictions $[(5 - 4) \times 4 = 4]$ in the α matrix. In equation (4.36) there were three cointegration relations (r) and two weakly exogenous variables (price level and interest rate), so there were six zero restrictions on the α matrix. In the case of an exclusion restriction, equation (4.36) can be written in moving average form as in equation (4.30) and the matrix form of moving average can be written as follows:

$$\begin{bmatrix} T_t \\ Y_t \\ Gc_t \\ R_t \\ P_t \end{bmatrix} = \begin{bmatrix} 0 & 0 & 0 & * & * \\ 0 & 0 & 0 & * & * \\ 0 & 0 & 0 & * & * \\ 0 & 0 & 0 & * & 0 \\ 0 & 0 & 0 & * & * \end{bmatrix} \begin{bmatrix} \sum_{i=1}^t \varepsilon_{s1,i} \\ \sum_{i=1}^t \varepsilon_{s2,i} \\ \sum_{i=1}^t \varepsilon_{s3,i} \\ \sum_{i=1}^t \varepsilon_{l1,i} \\ \sum_{i=1}^t \varepsilon_{l2,i} \end{bmatrix} + \begin{bmatrix} * & * & * & * & * \\ * & * & 0 & * & * \\ * & 0 & 0 & * & * \\ * & * & * & * & * \\ * & * & * & * & * \end{bmatrix} \begin{bmatrix} \varepsilon_{s1,t} \\ \varepsilon_{s2,t} \\ \varepsilon_{s3,t} \\ \varepsilon_{l1,t} \\ \varepsilon_{l2,t} \end{bmatrix} + C_1 B^{-1} \begin{bmatrix} \varepsilon_{s1,t-1} \\ \varepsilon_{s2,t-1} \\ \varepsilon_{s3,t-1} \\ \varepsilon_{l1,t-1} \\ \varepsilon_{l2,t-1} \end{bmatrix} + \dots \quad (4.37)$$

From (4.37), matrix $\begin{bmatrix} 0 & 0 & 0 & * & * \\ 0 & 0 & 0 & * & * \\ 0 & 0 & 0 & * & * \\ 0 & 0 & 0 & * & 0 \\ 0 & 0 & 0 & * & * \end{bmatrix}$ is the CB^{-1} matrix. Restriction in this long-run matrix

was for identifying the permanent shocks: shocks from P_t , and R_t that were weakly exogenous variables. According to Juselius (2006, p. 275), permanent shocks can be defined as the residuals of weakly exogenous variables. In this case, the permanent shocks can be ordered by $R_t \rightarrow P_t$. From this order, the zero restrictions and unrestricted parameters can be explained as follows.

1. The first three columns mean that three transitory shocks in the model – current spending (Gc), tax revenue (T) and output (Y) – have no long-run effect on any variable in the system.
2. The unrestricted fourth column means that the first permanent shock, the interest rate (R), can have a long-run effect on all variables in the system.
3. In the last column, zero restrictions in the fourth row mean that price level (P) has no long-run effect on the first permanent shock (interest rate). Moreover, the unrestricted parameters in this column mean that price level (P) has a long-run effect on all variables except interest rate (R).

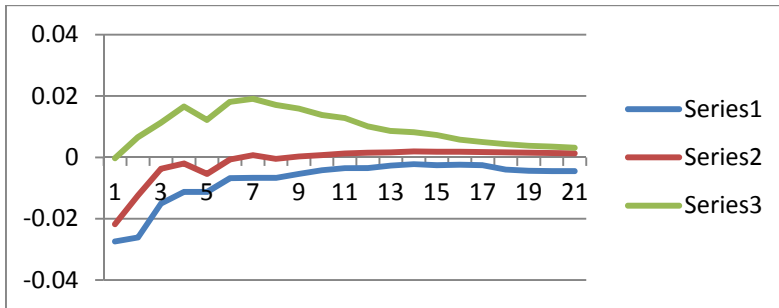
From (4.37), matrix $\begin{bmatrix} * & * & * & * & * \\ * & * & 0 & * & * \\ * & 0 & 0 & * & * \\ * & * & * & * & * \\ * & * & * & * & * \end{bmatrix}$ is a C_0B^{-1} matrix. The restriction in this short-run

matrix identified three transitory shocks. This defined ε_{s1} as a current spending shock, ε_{s2} as an output shock and ε_{s3} as a tax shock. The assumption of the three exclusion restrictions on the transitory shocks can be shown as follows.

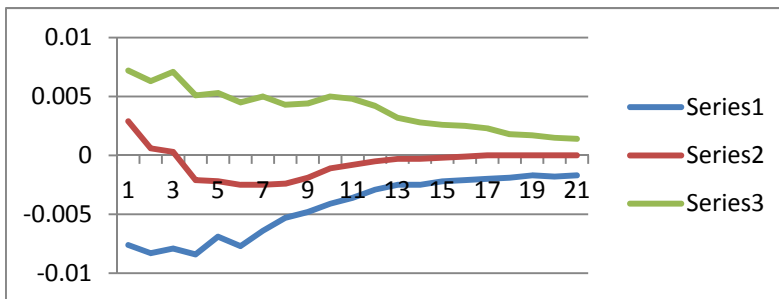
1. Current spending (Gc), which was the first transitory shock, reacted immediately only to a shock from itself and no other transitory shocks could contemporaneously impact on it. This corresponds to the idea of Blanchard and Perotti (2002) that it generally takes longer than one quarter for a government to implement a new policy. This can be seen from two zero restrictions in row 3. Moreover, current spending (Gc) can have a contemporaneous effect on all variables, and this can be seen from the unrestricted elements in column 1.
2. Output (Y) reacted immediately to shocks from itself and current spending. This corresponds to the idea of Perotti (2004) that current spending is a component of GDP (Y), so it is possible for current spending (Gc) to have a contemporaneous effect on output (Y). This can be seen from the unrestricted elements in column 1 of row 2 and column 2 of row 2.
3. Tax (T) reacted immediately to shocks from current spending (Gc), output (Y) and itself. This corresponds to the idea of Caldara and Kamp (2008), who argue that movements in tax, unlike government spending, relate to the business cycle. Thus, shocks of output (Y) can have a contemporaneous effect on tax (T). However, this was not a discretionary response of tax to this variable; rather, it was an automatic response of tax or elasticity of tax to output. This can be seen from unrestricted elements in row 1.

After imposing restrictions, the next task was to examine the IRF. This involved estimating the effect of the fiscal policy variable on GDP.

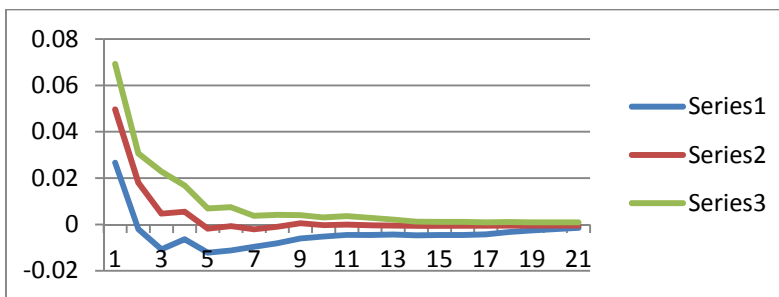
4.7.5 Impulse response functions



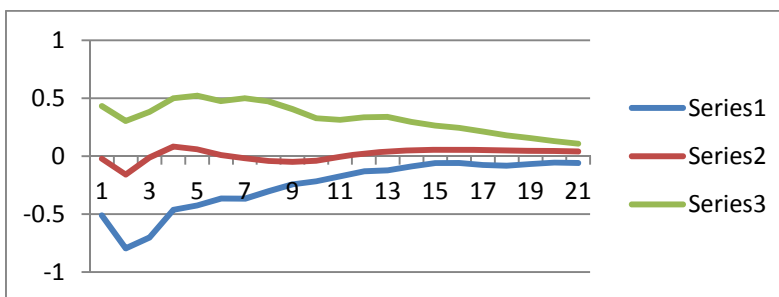
a. The effect of current spending on total tax



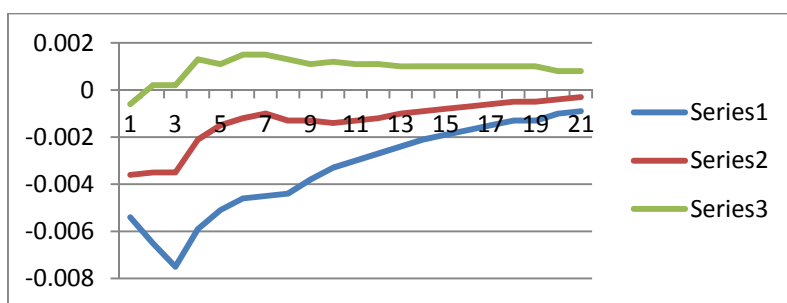
b. The effect of current spending on output



c. The effect of current spending on current spending



d. The effect of current spending on interest rate



e. The effect of current spending on price level

Figure 4.2: Impulse response functions of Model Gc

Shocks to current spending

In displaying the response of GDP to current spending in Figure 4.2b, the vertical axis provides the scale of responses of GDP in percentages. With the estimated sample standard innovation of current spending error term being 0.38, a positive shock of 38% to current spending contemporaneously had a positive effect on output with a magnitude of 0.3%. In terms of the fiscal multiplier, the impact multiplier (the same as the peak multiplier) was only 0.09; i.e. a 1 baht increase in current spending raised output by 0.09 baht in the first quarter of the shock, but the effect was insignificant. Then, the multiplier started to decline and remained positive for only three quarters before turning negative. An increase in current spending did not have a significant effect on interest rate and prices.

4.8 Vector Error Correction (VECM) of Model Gi

The first step in this model was to test for the lag-length.

Table 4.14: Results of lag-length test Model Gi in VECM

Model	LR	FPE	AIC	SC	HQ
Gi model	2	2	2	1	1

From Table 4.14, there are two possible lag-lengths: 1 and 2.

Table 4.15a: Residual tests of the Model Gi in VECM (normality and heteroscedasticity)

Model	Skewness (χ^2)	p-value	Kurtosis (χ^2)	p-value	SK and KU	p-value	Heteroscedasticity (p-value)
Gi model with 2 lags	12.50	0.027	14.50	0.012	27.10	0.002	325.40
Gi model with 1 lag	24.90	0.00	69.20	0.00	90.20	0.00	(0.15) 185.90
							(0.02)

Table 4.15b: Residual tests of the Model Gi in VECM (autocorrelation in the 1-lag model)

Lag	LM-stat	p-value
1	54.50	0.00

Table 4.15c: Residual tests of the Model Gi in VECM (autocorrelation in the 2-lag model)

Lag	LM-stat	p-value
1	29.09	0.25
2	35.68	0.07

From Tables 4.15a to 4.15c, the two-lag model was chosen because the statistics for autocorrelation, skewness, kurtosis and heteroscedasticity were better than the others. There was no evidence of autocorrelation and heteroscedasticity in the two-lag model at the 95% level of confidence. Moreover, the normality test in the two-lag model was better than the other; i.e. there was no evidence of non-normality due to skewness and kurtosis at the 99% level of confidence.

The next step was to choose an appropriate model.

4.8.1 Testing for cointegration

For the cointegration test section, the results from trace tests are shown below.

Table 4.16: Determining the cointegration rank and the model

Test statistic	r	Model 2	Model 3	Model 4
Trace test (critical values)	0	123.10	100.20	125.00
	1	(76.97) 71.20	(67.18) 51.40	(88.80) 76.30
	2	(54.08) 37.20	(47.85) 29.60	(63.86) 47.00
	3	(35.20) 17.80	(29.97) –	(42.90) –
(20.26)				

Note: Numbers in parentheses are 95% of the critical value of the trace test.

From Table 4.16, at the 95% level of confidence the null hypothesis of the three cointegration relations of Model 2 was the first to be accepted ($17.8 < 20.26$), while the two cointegration

relations of Model 3 were just borderline accepted ($29.6 < 29.7$). Therefore, the trace test points to the three cointegration relations of Model 2 as the favourite model specification.

4.8.2 Testing for weak exogeneity

Because there were three cointegration relations in this model, there were two weakly exogenous variables ($5 - 3 = 2$). We chose to order the variables as follows: $\Delta T_t \rightarrow \Delta Y_t \rightarrow \Delta G_t \rightarrow \Delta R_t \rightarrow \Delta P_t$, in reference to equation (4.35). The results of the test are shown below.

Table 4.17: The result of testing restrictions on α (test of weak exogeneity)

Variables	T_t	Y_t	G_t	R_t	P_t
Restrictions	$H_0 : \alpha_{11} = \alpha_{12}$ $= \alpha_{13} = 0$	$H_0 : \alpha_{21} = \alpha_{22}$ $= \alpha_{23} = 0$	$H_0 : \alpha_{31} = \alpha_{32}$ $= \alpha_{33} = 0$	$H_0 : \alpha_{41} = \alpha_{42}$ $= \alpha_{43} = 0$	$H_0 : \alpha_{51} = \alpha_{52}$ $= \alpha_{53} = 0$
$\chi^2(v)$	11.30 (0.009)	33.00 (0.00)	12.30 (0.00)	0.21 (0.97)	9.20 (0.03)

From Table 4.17, we cannot reject the null hypothesis that interest rate was a weakly exogenous variable at the 95% level of confidence because the p-value from testing for weak exogeneity was more than 0.05. As a result, the interest rate was one of the weakly exogenous variables in the model. The other weakly exogenous variable was price level, because the null hypothesis of the weakly exogenous variable of price level cannot be rejected at the 99% level of confidence (the p-value was larger than 0.01).

4.8.3 Identification of the long-run structure

From the testing for exogeneity, it can be seen that R_t, P_t were weakly exogenous variables and T_t, Y_t, G_t were endogenous variables. Thus, long-run relations were capital spending, tax revenue and output functions. Moreover, in this model, there were three cointegration relations. Thus, there were $3 - 1 = 2$ restrictions imposed in each relationship. The just-identifying restriction can then be written as follows:

Table 4.18: Just-identifying restriction of the five-variable Model Gi

Variable	$[\beta_1]$	$[\beta_2]$	$[\beta_3]$
T	1	0	0
Y	0	1	0
Gi	0	0	1
R	0.15	0.14	1.18
	(4.15)	(4.99)	(5.57)
P	0.11	0.41	15.68
	(0.17)	(0.78)	(3.92)
Intercept	-12.50	-15.97	-95.48
	(-3.33)	(-5.77)	(-4.47)

From Table 4.18, estimated by OLS (Juselius, 2006, p. 122), it can be seen that not all coefficients were significant at the 95% level of confidence because the $|t\text{-value}|$ of some coefficients was not more than 1.96. As a result, over-identifying restrictions were considered. Moreover, the proper specification of cointegration relations, especially relating to fiscal policy, was the focus when imposing restrictions. The restrictions can then be shown as follows:

Table 4.19: Beta restriction in the Model Gi

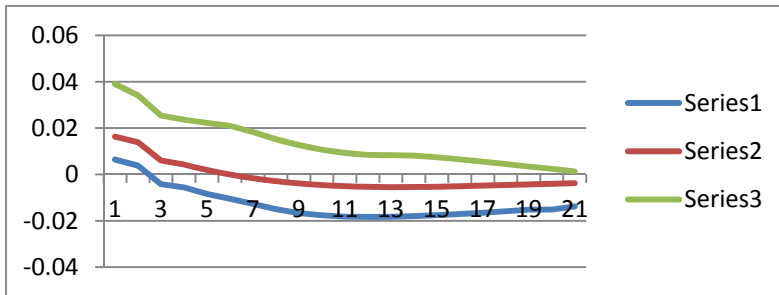
Variable	$[\beta_1]$	$[\beta_2]$	$[\beta_3]$
T	1	0	-1
Y	0	1	0
Gi	0	0	1
R	0	0.11	0.55
		(6.93)	(7.76)
P	0.15	0	8.92
	(5.90)		(17.13)
Intercept	11.90	-13.78	-47.06
	(-64.50)	(-119.15)	(-16.68)

From Table 4.19, estimated by OLS (Juselius, 2006, p. 122), these restrictions can be accepted at the 95% level of confidence because the chi-square was 0.642 with a 0.72 p-value. The p-value was larger than 0.05, so these restrictions were not rejected. The first relationship was the long-run relation between total tax and price level. The second relationship was the negative long-run relation between interest rate and output. The last relationship was the long-run relation of capital spending and tax revenue, as in the baseline model, but in this model price level and interest rate were included in the relationship.

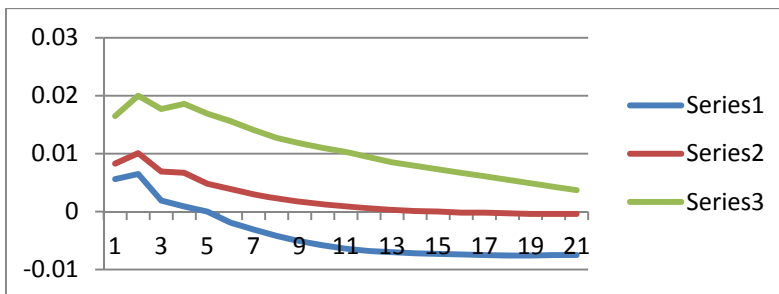
4.8.4 Short-run identification

To illustrate this idea, according to Juselius (2006, p. 280), the ordering of the variables begins with the transitory variable: T_t, Y_t, G_t, R_t, P_t . In reference to equation (4.37), the details of the ordering are shown in section 4.7.4.

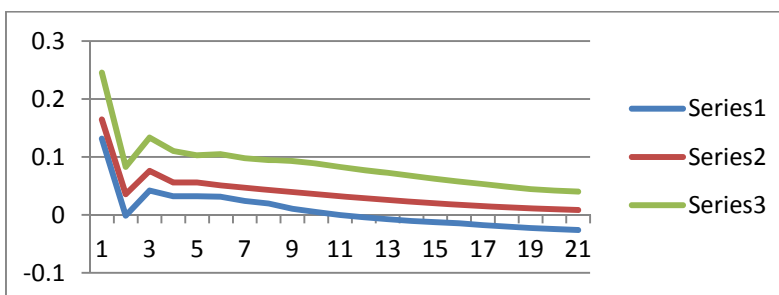
4.8.5 Impulse response functions



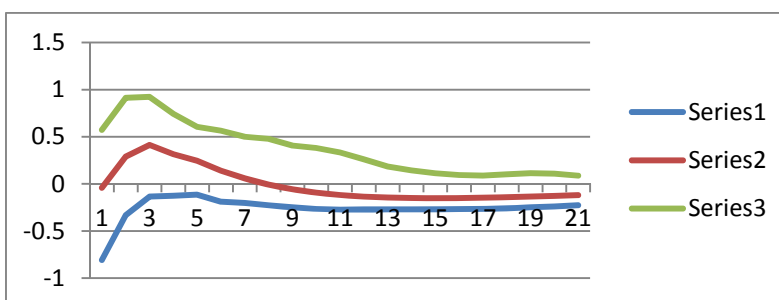
a. The effect of capital spending on total tax



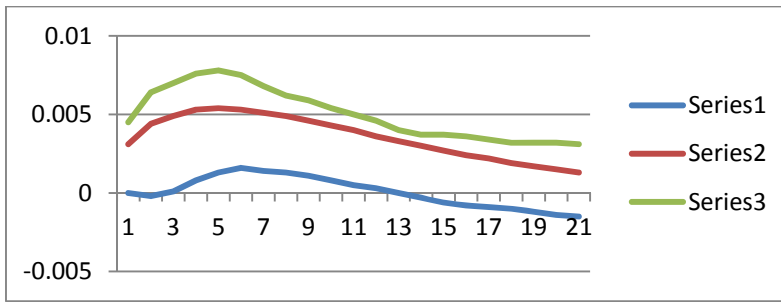
b. The effect of capital spending on output



c. The effect of capital spending on capital spending



d. The effect of capital spending on interest rate



e. The effect of capital spending on price level

Figure 4.3: Impulse response functions of Model Gi

Shocks to capital spending

With the estimated sample standard innovation of the capital spending error term at 0.57, as shown from the response of GDP to capital spending in Figure 4.3b, a positive shock of 57% to capital spending contemporaneously and positively affected output with a magnitude of 0.9; i.e. an increase in capital spending raised output by 0.9%. In terms of a fiscal multiplier, with the impact multiplier at 0.50, a 1 baht increase in capital spending raised the output by 0.50 baht in the first quarter. Furthermore, the peak multiplier was about 0.6 at the second quarter. It was observed that an increase in capital spending had a larger impact on output than an increase in current spending, and the effect was also significant until the sixth quarter after the shock. A positive shock of capital spending also had a temporary significantly positive effect on prices, while it insignificantly affected the interest rate. As a result, an increase in capital spending raised GDP, with the cost of increasing prices.

4.9 Vector Error Correction (VECM) of Model Ti

Before beginning the process, a lag-length test was employed.

Table 4.20: Results of lag-length test in the Model Ti in VECM

Model	LR	FPE	AIC	SC	HQ
Ti model	4	2	4	1	1

There were three possible lag-lengths. Before choosing a lag-length, residual tests were employed for a white-noise process in the residuals.

Table 4.21a: Residual tests of the Model Ti in VECM (normality and heteroscedasticity)

Model	Skewness (χ^2)	p-value	Kurtosis (χ^2)	p-value	SK and KU	p-value	Heteroscedasticity (p-value)
Ti model with 4 lag	7.15	0.20	7.54	0.18	14.70	0.14	628.60 (0.20)
Ti model with 2 lag	21.08	0.00	132.80	0.00	153.90	0.00	335.50 (0.07)
Ti model with 1 lag	18.50	0.00	209.00	0.00	227.00	0.00	193.00 (0.01)

Table 4.21b: Residual tests of the Model Ti in VECM (autocorrelation in the 1-lag model)

Lag	LM-stat	p-value
1	55.70	0.01

Table 4.21c: Residual tests of the Model Ti in VECM (autocorrelation in the 2-lag model)

Lag	LM-stat	p-value
1	24.10	0.50
2	32.50	0.14

Table 4.21d: Residual tests of the Model Ti in VECM (autocorrelation in the 4-lag model)

Lag	LM-stat	p-value
1	44.10	0.01
2	27.60	0.32
3	30.40	0.20
4	21.30	0.67

From Tables 4.21a to 4.21d, the four-lag model was chosen because the statistics from the normality test were better than the others. There was no evidence of non-normality due to skewness and kurtosis in the four-lag model. Moreover, there was also no evidence of heteroscedasticity. In the case of autocorrelation in the four-lag model, there was no evidence of autocorrelation at lags 2, 3 or 4 at the 95% level of confidence, while there was no evidence of autocorrelation at lag 1 at the 99% level of confidence.

The next step was to choose a suitable model.

4.9.1 Testing for cointegration

In this section, the results from the trace test are shown as follows:

Table 4.22: Determining the cointegration rank and model

Test statistic	Rank (r)	Model 2	Model 3	Model 4
Trace statistic (critical values)	0	123.60	106.20	117.60
	1	(76.97) 73.40	(67.18) 67.60	(88.80) 78.30
		2	(54.08) 41.60	(47.85) 37.10
	3		(35.20) 20.70	(29.97) 18.80
		4	(20.26) 6.43	(15.50) –
(9.16)				

Note: numbers in parentheses are 95% of the critical value of the trace test.

From Table 4.22, at the 95% level of confidence the null hypothesis of the four cointegration relations of Model 2 was the first to be accepted ($6.43 < 9.16$). Thus, the trace test points to the four cointegration relations of Model 2 as the favourite model specification.

4.9.2 Testing for weak exogeneity

Because there were four cointegration relations in this model, there was one weakly exogenous variable ($5 - 4 = 1$). We chose to order the variables as follows: $\Delta T_i \rightarrow \Delta P_i \rightarrow \Delta Y_i \rightarrow \Delta G_i \rightarrow \Delta R_i$ (refer to equation (4.24)). The results of the test are shown in Table 4.23.

Table 4.23: The result of testing restrictions on α (test of weak exogeneity)

Variables	T_i	P_i	Y_i	G_i	R_i
Restrictions	$H_0 : \alpha_{11} = \alpha_{12}$ $= \alpha_{13} = \alpha_{14}$ $= 0$	$H_0 : \alpha_{21} = \alpha_{22}$ $= \alpha_{23} = \alpha_{24}$ $= 0$	$H_0 : \alpha_{31} = \alpha_{32}$ $= \alpha_{33} = \alpha_{34}$ $= 0$	$H_0 : \alpha_{41} = \alpha_{42}$ $= \alpha_{43} = \alpha_{44}$ $= 0$	$H_0 : \alpha_{51} = \alpha_{52}$ $= \alpha_{53} = \alpha_{54}$ $= 0$
χ^2 (v)	15.90	26.00	29.60	17.60	13.10
(p-value)	(0.00)	(0.00)	(0.00)	(0.00)	(0.02)

From Table 4.23, R_t was a weakly exogenous variable at the 99% level of confidence because the p-value from testing for weak exogeneity was more than 0.01. Therefore, the exogenous variable in this model was interest rate.

4.9.3 Identification of the long-run structure

It can be seen from Table 4.23 that R_t was a weakly exogenous variable. Thus, the long-run relations were government expenditure, output, indirect tax and price-level functions. Moreover, in this model, there were four cointegration relations. Thus, there were $4 - 1 = 3$ restrictions imposed in each relation. The just-identifying restriction can then be written as follows:

Table 4.24: Just-identifying restriction of the five-variable Model Ti

Variable	$[\beta_1]$	$[\beta_2]$	$[\beta_3]$	$[\beta_4]$
Ti	1	0	0	0
P	0	1	0	0
Y	0	0	1	0
G	0	0	0	1
R	0.11	0.07	0.11	0.11
	(7.80)	(9.80)	(8.60)	(8.40)
Intercept	-11.30	-5.30	-13.60	-12.05
	(-108.70)	(-106.20)	(-153.20)	(-122.19)

From Table 4.24, estimated by OLS, it can be seen that all coefficients were significant at the 95% level of confidence because the $|t - value|$ of all coefficients was more than 1.96. However, for proper specification of cointegration relations, especially in terms of fiscal policy, the restrictions were changed as follows:

Table 4.25: Just-identifying restriction of the five-variable Model Ti reflecting budget sustainability and automatic stabilisation between tax revenue and output

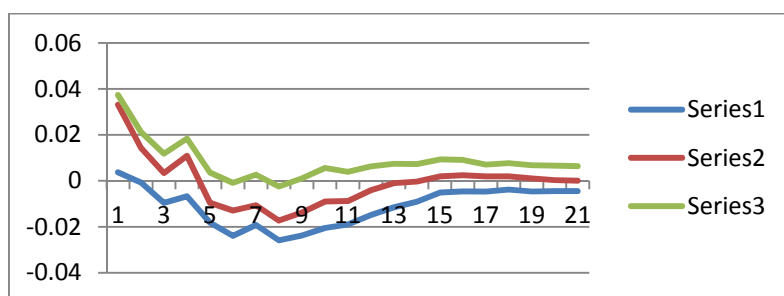
Variable	$[\beta_1]$	$[\beta_2]$	$[\beta_3]$	$[\beta_4]$
Ti	1	0	0	-1
P	0	1	0	0
Y	-1.23	0	1	0
G	(-24.28)	0	0	1
R	0	0.07	0.11	0
Intercept	3.14	(8.74) -5.37	(7.89) -13.69	-0.75
	(4.94)	(-93.50)	(-135.20)	(-18.90)

From Table 4.25, estimated by OLS, the first cointegration relation showed the long-run relationship between indirect tax revenue and output. The second cointegration was the negative relationship between interest rate and price level. The third cointegration was the negative relationship between interest rate and output. The fourth cointegration was the relationship between government spending and indirect tax revenue.

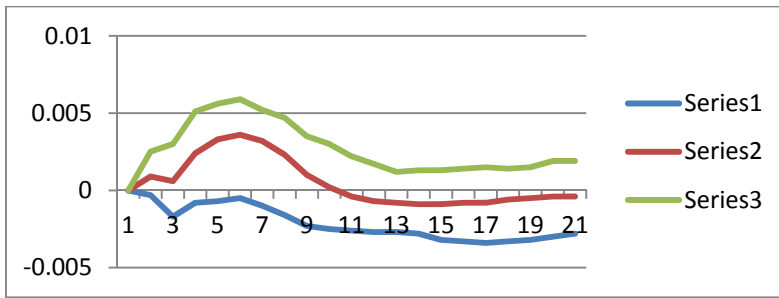
4.9.4 Short-run identification

To illustrate this idea, according to Juselius (2006, p. 280) the ordering of the variables begins with the transitory variables: T_i, P_t, Y_t, G_t, R_t . Refer to equation (4.31); details are given in section 4.6.4.

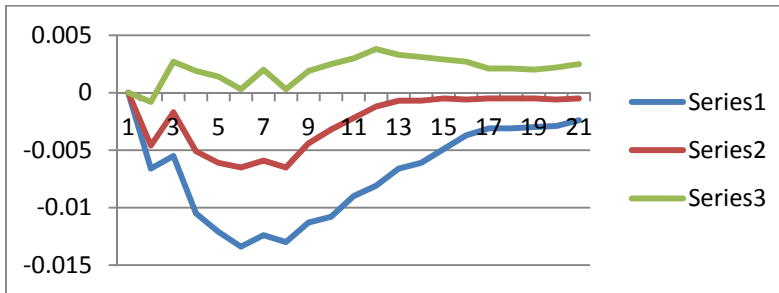
4.9.5 Impulse response functions



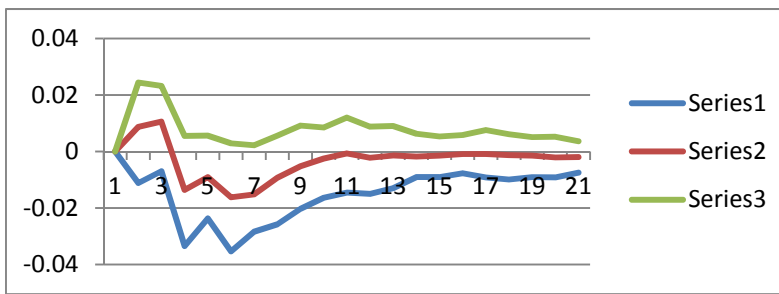
a. The effect of indirect tax on indirect tax



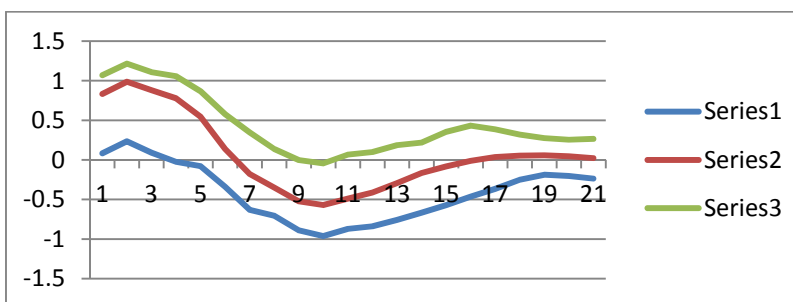
b. The effect of indirect tax on price level



c. The effect of indirect tax on output



d. The effect of indirect tax on government spending



e. The effect of indirect tax on interest rate

Figure 4.4: Impulse response functions of Model Ti

Shocks to indirect tax

As I stated in Chapter 1, this study focuses on the effect of a change in government spending, but results from tax shocks are also reported. The response of GDP to indirect tax in Figure 4.4c indicates that a positive shock from indirect tax had a transitory negative effect on

output, but the effect was significant until only the third quarter after the shock. An increase in indirect tax also had a positive effect on price level, but the effect was insignificant. A positive shock of this tax had a negative effect on interest rate after 1 year.

4.10 Vector Error Correction (VECM) of Model Tp

Before beginning the process, the lag-length test was employed.

Table 4.26: Results of the lag-length test on Model Tp in VECM

Model	LR	FPE	AIC	SC	HQ
Tp model	4	2	2	1	1

There were three possible lag-lengths. Before choosing the lag-length, residual tests were employed for a white-noise process of the residuals.

Table 4.27a: Residual tests of Model Tp in VECM (normality and heteroscedasticity)

Model	Skewness (χ^2)	p-value	Kurtosis (χ^2)	p-value	SK and KU	p-value	Heteroscedasticity (p-value)
Tp model with 4 lag	6.99	0.20	9.92	0.07	16.90	0.07	622.30 (0.25)
Tp model with 2 lag	31.30	0.00	128.80	0.00	160.20	0.00	318.80 (0.21)
Tp model with 1 lag	29.80	0.00	233.20	0.00	263.00	0.00	186.10 (0.02)

Table 4.27b: Residual tests of Model Tp in VECM (autocorrelation of the 1-lag model)

Lag	LM-stat	p-value
1	54.20	0.00

Table 4.27c: Residual tests of Model Tp in VECM (autocorrelation of the 2-lag model)

Lag	LM-stat	p-value
1	24.60	0.48
2	40.80	0.02

Table 4.27d: Residual tests of Model Tp in VECM (autocorrelation of the 3-lag model)

Lag	LM-stat	p-value
1	25.20	0.45
2	22.90	0.58
3	31.70	0.16
4	25.90	0.41

From Tables 4.27a to 4.27d, the four-lag model was chosen because the statistics from the normality test, autocorrelation and heteroscedasticity were better than the others. In the case of the normality test, there was no evidence of non-normality due to skewness and kurtosis in the four-lag model at the 95% level of confidence. In addition, autocorrelation does not exist from lag 1 to lag 4 in the four-lag model at the 95% level of confidence. Lastly, there was no evidence of heteroscedasticity in the four-lag model.

4.10.1 Testing for cointegration

For the cointegration test, the results from the trace test are as follows:

Table 4.28: Determining the cointegration rank and the model

Test statistic	Rank (r)	Model 2	Model 3	Model 4
Trace statistic (critical values)	0	124.00	104.90	129.30
		(76.97)	(67.18)	(88.80)
	1	78.00	69.80	89.70
		(54.08)	(47.85)	(63.86)
	2	45.20	40.40	57.70
		(35.20)	(29.97)	(42.90)
	3	23.60	19.70	28.70
		(20.26)	(15.50)	(25.70)
	4	8.40	5.59	11.30
		(9.16)	(3.84)	(12.50)

Note: Numbers in parentheses are 95% of the critical value of the trace test.

From Table 4.28, at the 95% level of confidence the null hypothesis of four cointegration relations of Model 2 was the first to be accepted ($8.4 < 9.16$). Although it was just borderline accepted, other choices were no better than this. Thus, the trace test points to the four cointegration relations of Model 2 as the favourite model specification.

4.10.2 Testing for weak exogeneity

Because there were four cointegration relations in this model, there was one weakly exogenous variable ($5 - 4 = 1$). The variables as ordered: $\Delta T p_t \rightarrow \Delta P_t \rightarrow \Delta Y_t \rightarrow \Delta G_t \rightarrow \Delta R_t$. Refer to equation (4.24); results of the test are shown below.

Table 4.29: The result of testing restrictions on α (test of weak exogeneity)

Variables	Tp_t	P_t	Y_t	G_t	R_t
Restrictions	$H_0 : \alpha_{11} = \alpha_{12}$ $= \alpha_{13} = \alpha_{14}$ $= 0$	$H_0 : \alpha_{21} = \alpha_{22}$ $= \alpha_{23} = \alpha_{24}$ $= 0$	$H_0 : \alpha_{31} = \alpha_{32}$ $= \alpha_{33} = \alpha_{34}$ $= 0$	$H_0 : \alpha_{41} = \alpha_{42}$ $= \alpha_{43} = \alpha_{44}$ $= 0$	$H_0 : \alpha_{51} = \alpha_{52}$ $= \alpha_{53} = \alpha_{54}$ $= 0$
$\chi^2(v)$	21.90	26.00	21.30	19.20	9.19
(p-value)	(0.00)	(0.00)	(0.00)	(0.00)	(0.06)

From Table 4.29, R_t was a weakly exogenous variable at the 95% level of confidence because the p-value from testing weak exogeneity was more than 0.05. Therefore, the weakly exogenous variable in this model was interest rate.

4.10.3 Identification of the long-run structure

It can be seen from Table 4.29 that R_t was a weakly exogenous variable. Thus, the long-run relations were government expenditure, output, personal income tax and price-level functions. Moreover, in this model there were four cointegration relations. Thus, there were $4 - 1 = 3$ restrictions imposed in each relationship. The just-identifying restriction can therefore be written as follows:

Table 4.30: Just-identifying restriction of the five-variable Model Tp

Variable	$[\beta_1]$	$[\beta_2]$	$[\beta_3]$	$[\beta_4]$
Tp	1	0	0	0
P	0	1	0	0
Y	0	0	1	0
G	0	0	0	1
R	0.14	0.07	0.11	0.12
Intercept	(7.40) -9.80	(9.50) -5.30	(8.42) -13.60	(7.98) -12.01
	(-70.10)	(-99.50)	(-136.60)	(-106.90)

From Table 4.30, estimated by OLS, it can be seen that all coefficients were significant at the 95% level of confidence because the $|t\text{-value}|$ of all coefficients was more than 1.96. However, for proper specification of cointegration relations, especially in terms of fiscal policy, restrictions were changed as follows:

Table 4.31: Just-identifying restriction of the five-variable Model Tp reflecting budget sustainability and automatic stabilisation between tax revenue and output

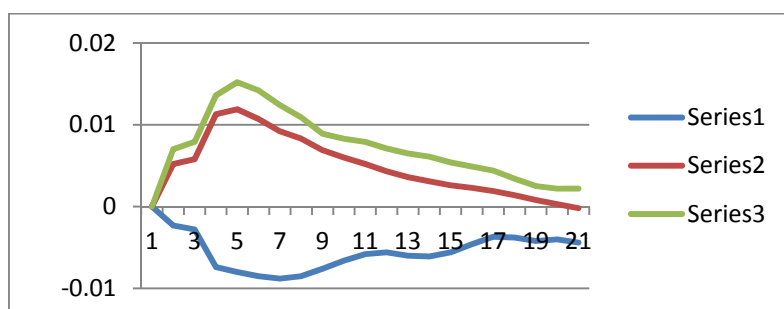
Variable	$[\beta_1]$	$[\beta_2]$	$[\beta_3]$	$[\beta_4]$
Tp	1	0	0	-0.87
P	0	1	0	0
Y	-1.05	0	1	0
G	(29.02)	0	0	1
R	0	0.07	0.11	0
Intercept	7.09	(9.20) -5.30	(8.27) -13.60	-3.57
	(10.03)	(-83.80)	(-121.20)	(-7.98)

From Table 4.31, the first cointegration relation showed the long-run relationship between tax revenue and output. The second cointegration was the negative relationship between interest rate and price level. The third cointegration was the negative relationship between interest rate and output. The fourth cointegration was the relationship between government spending and personal income tax revenue.

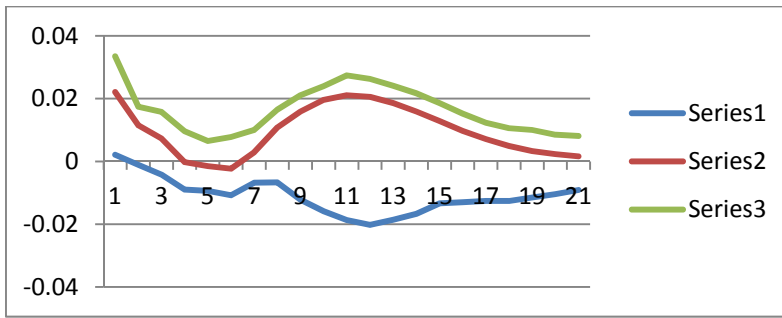
4.10.4 Short-run identification

To illustrate this idea, according to Juselius (2006, p. 280), the ordering of the variables should begin with the transitory variable: Tp_t, P_t, Y_t, G_t, R_t . Refer to equation (4.31); the details of the ordering are given in section 4.6.4.

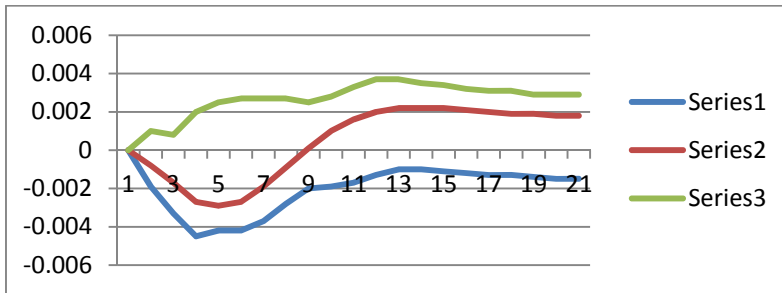
4.10.5 Impulse response functions



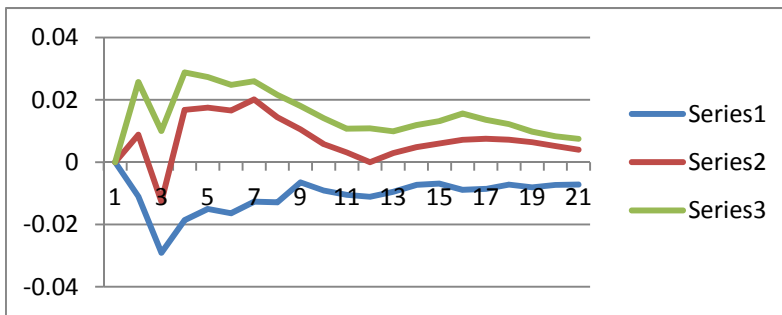
a. The effect of personal income tax on output



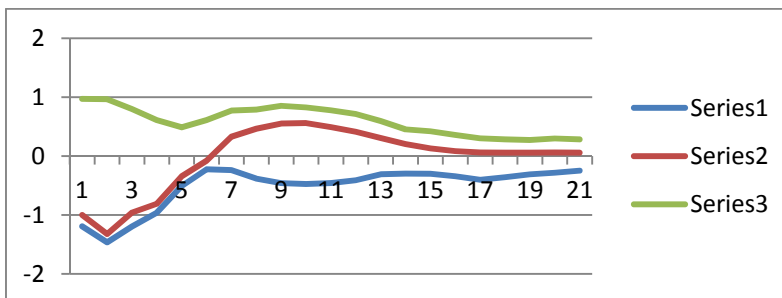
b. The effect of personal income tax on personal income tax



c. The effect of personal income tax on price level



d. The effect of personal income tax on government spending



e. The effect of personal income tax on interest rate

Figure 4.5: Impulse response functions of Model Tp

Shocks to personal income tax

From the response of GDP (Y) to personal income tax in Figure 4.5a above, it could not be surmised that the effect of the positive shock of personal income tax on output corresponded to the EFC idea, even though the output was positive after an increase in personal income tax.

This is because an increase in this tax caused an increase in total government spending for about 20 quarters after the shock. Thus, it was possible that the positive multiplier came from an increase in total government spending, which led to an increase in GDP. The correlation between total government spending and personal income tax revenue at 0.23 was higher than for other taxes; e.g. 0.001 in the case of corporate income tax. Dungey and Fry (2007, p. 4) have argued that “the correlation between taxation revenue and government expenditure is high, and consequently a standard VAR or VECM has difficulty differentiating that an increase in taxes ought to be associated with a fall in GDP.” This was also found by De Castro and De Cos (2006) and by Dungey and Fry (2009). However, the effect of personal income tax shock on output was insignificant. A positive shock on personal income tax also had an insignificant effect on interest rates and prices.

4.11 Vector Error Correction (VECM) of Model Tc

The first step in this model was to test for the lag-length.

Table 4.32: Results of the lag-length test on Model Tc in VECM

Model	LR	FPE	AIC	SC	HQ
Tc model	2	2	2	1	1

From Table 4.32 it can be seen that there are two possible lag-lengths: 2 and 1.

Table 4.33a: Residual tests of the Model Tc in VECM (normality and heteroscedasticity)

Model	Skewness (χ^2)	p-value	Kurtosis (χ^2)	p-value	SK and KU	p-value	Heteroscedasticity (p-value)
Tc model with 2 lags	11.90	0.04	78.80	0.00	90.70	0.00	340.50 (0.06)
Tc model with 1 lag	12.70	0.03	197.90	0.00	210.60	0.00	187.60 (0.02)

Table 4.33b: Residual tests of the Model Tc in VECM (autocorrelation of the 1-lag model)

Lag	LM-stat	p-value
1	54.50	0.00

Table 4.33c: Residual tests of the Model Tc in VECM (autocorrelation of the 2-lag model)

Lag	LM-stat	p-value
1	21.90	0.63
2	28.40	0.28

From Tables 4.33a to 4.33c, the two-lag model was chosen because the statistics of autocorrelation and heteroscedasticity were better than in the others. At the 95% level of confidence there was no evidence of autocorrelation at lag 1 and 2 in the two-lag model. Moreover, heteroscedasticity did not exist in the two-lag model. The next step was to choose an appropriate model.

4.11.1 Testing for cointegration

For the cointegration test, the results from the trace test are shown as follows.

Table 4.34: Determining the cointegration rank and the model

Test statistic	r	Model 2	Model 3	Model 4
Trace test (critical values)	0	178.80	152.90	170.40
	1	(76.97) 111.70	(67.18) 86.50	(88.80) 99.70
	2	(54.08) 67.10	(47.85) 46.40	(77.62) 53.70
	3	(35.20) 27.07	(29.97) 20.20	(47.60) 25.80
	4	(20.26) 7.60	(15.50) –	(25.54) –
(9.16)				

Note: Numbers in parentheses are 95% of the critical value of the trace test.

From Table 4.34, at the 95% level of confidence the null hypothesis of four cointegration relations of Model 2 was the first to be accepted ($7.6 < 9.16$). Thus, the trace test points to the four cointegration relations of Model 2 as the favourite model specification. The next step was to test for weak exogeneity.

4.11.2 Testing for weak exogeneity

Because there were four cointegration relations in this model, there was one weakly exogenous variable ($5 - 4 = 1$). We chose to order the variables as follows: $\Delta Tc_t \rightarrow \Delta P_t \rightarrow \Delta Y_t \rightarrow \Delta G_t \rightarrow \Delta R_t$. Refer to equation (4.24); the results of the weak exogeneity test are shown below.

Table 4.35: The result of testing restrictions on α (test of weak exogeneity)

Variables	Tc_t	P_t	Y_t	G_t	R_t
Restrictions	$H_0 : \alpha_{11} = \alpha_{12}$ $= \alpha_{13} = \alpha_{14}$ $= 0$	$H_0 : \alpha_{21} = \alpha_{22}$ $= \alpha_{23} = \alpha_{24}$ $= 0$	$H_0 : \alpha_{31} = \alpha_{32}$ $= \alpha_{33} = \alpha_{34}$ $= 0$	$H_0 : \alpha_{41} = \alpha_{42}$ $= \alpha_{43} = \alpha_{44}$ $= 0$	$H_0 : \alpha_{51} = \alpha_{52}$ $= \alpha_{53} = \alpha_{54}$ $= 0$
$\chi^2(v)$	44.80	23.60	31.80	23.50	6.62
(p-value)	(0.00)	(0.00)	(0.00)	(0.00)	(0.15)

From Table 4.35, it can be seen that we cannot reject the null hypothesis, as interest rate was a weakly exogenous variable in this model at the 95% level of confidence because the p-value from testing of weak exogeneity was more than 0.05.

4.11.3 Identification of the long-run structure

From the testing for exogeneity it can be seen that R_t was a weakly exogenous variable and Tc_t, P_t, Y_t, G_t were endogenous variables. Thus, the long-run relationships were government spending, price level, corporate income tax and output functions. Moreover, in this model there were four cointegration relations. Thus, there were $4 - 1 = 3$ restrictions imposed in each relation. The just-identifying restriction can therefore be written as follows:

Table 4.36: The just-identifying restriction of five-variable Model Tc

Variable	$[\beta_1]$	$[\beta_2]$	$[\beta_3]$	$[\beta_4]$
Tc	1	0	0	0
P	0	1	0	0
Y	0	0	1	0
G	0	0	0	1
R	0.19	0.05	0.09	0.10
	(6.46)	(8.73)	(7.63)	(6.70)
Intercept	-10.30	-5.45	-13.80	-12.10
	(-45.05)	(-108.30)	(-153.40)	(-105.00)

From Table 4.36 the coefficients estimated by OLS were significant at the 95% level of confidence because the $|t - value|$ of all coefficients was more than 1.96. However, for proper specification of cointegration relations, especially in terms of fiscal policy, the restrictions were changed as follows:

Table 4.37: Just identifying restriction of the five-variable Model Tc reflecting budget sustainability and automatic stabilisation between tax revenue and output

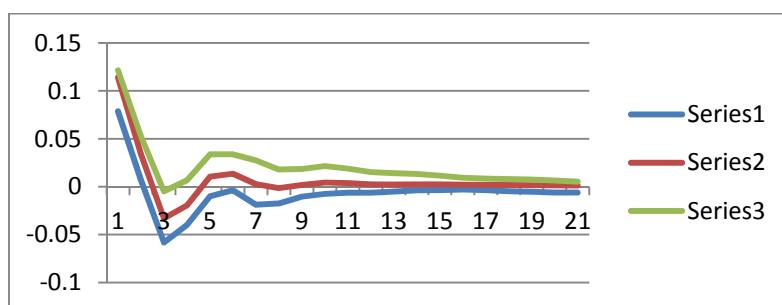
Variable	$[\beta_1]$	$[\beta_2]$	$[\beta_3]$	$[\beta_4]$
Tc	1	0	0	-0.52
P	0	1	0	0
Y	-2.16	0	1	0
G	(-34.04)	0	0	1
R	0	0.05	0.09	0
Intercept	19.50	(9.22) -5.45	(9.32) -13.80	-6.76
	(22.50)	(-109.90)	(-161.30)	(-14.60)

From Table 4.37, the first cointegration relation estimated by OLS showed the long-run relationship between corporate income tax revenue and output. The second cointegration was the negative relationship between interest rate and price level. The third cointegration was the negative relationship between interest rate and output. The fourth cointegration was the relationship between government spending and corporate income tax revenue.

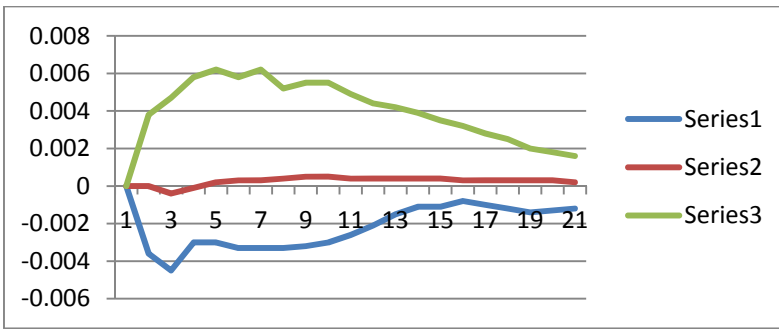
4.11.4 Short-run identification

To illustrate this, according to Juselius (2006, p. 280) the ordering of the variables begins with the transitory variable: $T_{c_t}, P_t, Y_t, G_t, R_t$. Refer to equation (4.31); the explanation of the ordering is given in section 4.6.4.

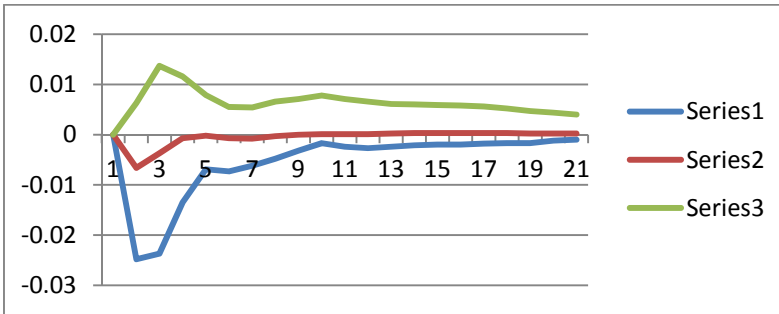
4.11.5 Impulse response functions



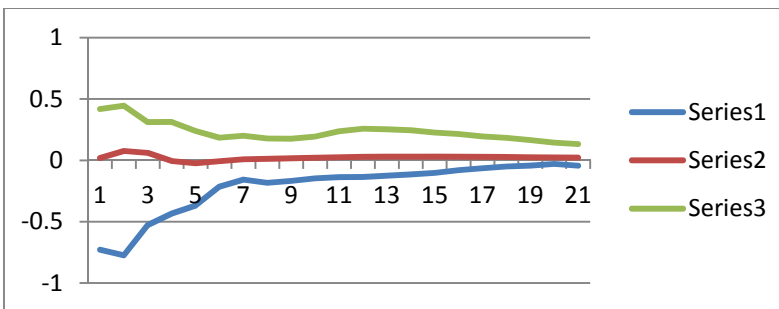
- a. The effect of corporate income tax on corporate income tax



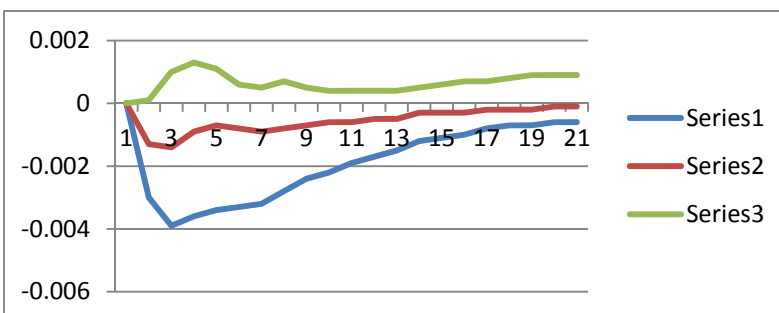
b. The effect of corporate income tax on output



c. The effect of corporate income tax on government spending



d. The effect of corporate income tax on interest rate



e. The effect of corporate income tax on price level

Figure 4.6: Impulse response functions of Model Tc

Shocks to corporate income tax

From the response of GDP to corporate income tax shown in Figure 4.6b, it can be seen that output insignificantly responded to an increase in corporate income tax. The positive shock from this tax also had an insignificant effect on prices and interest rate.

4.12 Vector Error Correction (VECM) of Model Cp

Before beginning the VECM of Model Cp process, the lag-length test was employed.

Table 4.38: Results of the lag-length test in the Model Cp in VECM

Model	LR	FPE	AIC	SC	HQ
Cp model	2	2	2	1	1

There were two possible lag-lengths. Before choosing lag-length, residual tests were employed in order to choose a lag-length that made the residuals a white-noise process.

Table 4.39a: Residual tests of Model Cp in VECM (normality and heteroscedasticity)

Model	Skewness (χ^2)	p-value	Kurtosis (χ^2)	p-value	SK and KU	p-value	Heteroscedasticity (p-value)
Cp model with 1 lag	11.20	0.05	144.50	0.00	155.70	0.00	372.30 (0.00)
Cp model with 2 lag	6.14	0.29	20.20	0.00	26.30	0.00	184.06 (0.03)

Table 4.39b: Residual tests of Model Cp in VECM (autocorrelation of 1-lag model)

Lag	LM-test	p-value
1	53.70	0.00

Table 4.39c: Residual tests of Model Cp in VECM (autocorrelation of 2-lag model)

Lag	LM-stat	p-value
1	32.05	0.15
2	34.40	0.09

From Tables 4.39a to 4.39c, the two-lag model was chosen because the statistic for autocorrelation was better than the other. Autocorrelation did not exist at lag 1 and lag 2 in the two-lag model at the 95% level of confidence.

4.12.1 Testing for cointegration

The results from the trace test were as follows:

Table 4.40: Determining the cointegration rank and the model

Test statistic	Rank (r)	Model 2	Model 3	Model 4
Trace statistic	0	146.90	120.00	137.90
(critical values)		(76.97)	(67.18)	(88.80)
	1	85.00	68.00	83.00
		(54.08)	(47.85)	(63.86)
	2	45.00	39.60	50.80
		(35.20)	(29.97)	(42.90)
	3	24.00	22.00	25.90
		(20.26)	(15.50)	(25.70)
	4	8.00	–	–

(9.16)

Note: Numbers in parentheses are 95% of the critical value of the trace test.

From Table 4.40, at the 95% level of confidence the null hypothesis of four cointegration relations of Model 2 was the first to be accepted ($8 < 9.16$). Thus, the trace test points to the four cointegration relations of Model 2 as the favourite model specification. The next step was to test for weak exogeneity.

4.12.2 Testing for weak exogeneity

Because there were four cointegration relations in this model, there was one weakly exogenous variable ($5 - 4 = 1$). We chose to order the variables as follows: $\Delta T_t \rightarrow \Delta P_t \rightarrow \Delta C p_t \rightarrow \Delta G_t \rightarrow \Delta R_t$. Refer to equation (4.24); the results of the test are shown in Table 4.41.

Table 4.41: The result of testing restrictions on α (test of weak exogeneity)

Variables	T_t	P_t	Cp_t	G_t	R_t
Restrictions	$H_0 : \alpha_{11} = \alpha_{12}$ $= \alpha_{13} = \alpha_{14}$ $= 0$	$H_0 : \alpha_{21} = \alpha_{22}$ $= \alpha_{23} = \alpha_{24}$ $= 0$	$H_0 : \alpha_{31} = \alpha_{32}$ $= \alpha_{33} = \alpha_{34}$ $= 0$	$H_0 : \alpha_{41} = \alpha_{42}$ $= \alpha_{43} = \alpha_{44}$ $= 0$	$H_0 : \alpha_{51} = \alpha_{52}$ $= \alpha_{53} = \alpha_{54}$ $= 0$
$\chi^2 (v)$	11.30	21.20	46.90	16.50	8.10
(p-value)	(0.00)	(0.00)	(0.00)	(0.00)	(0.08)

As shown in Table 4.41, R_t was a weakly exogenous variable in this model at the 95% level of confidence.

4.12.3 Identification of the long-run structure

It can be seen from Table 4.42 that R_t was a weakly exogenous variable. Thus, the long-run relationships were government expenditure, private consumption, tax and price-level functions. Moreover, in this model there were four cointegration relations. Thus, there were $4 - 1 = 3$ restrictions imposed in each relationship. The just-identifying restriction can then be written as follows:

Table 4.42: Just-identifying restriction of the five-variable Model Cp

Variable	$[\beta_1]$	$[\beta_2]$	$[\beta_3]$	$[\beta_4]$
T	1	0	0	0
P	0	1	0	0
Cp	0	0	1	0
G	0	0	0	1
R	0.12	0.06	0.08	0.09
	(5.87)	(8.10)	(6.86)	(6.58)
Intercept	-11.90	-5.46	-13.20	-12.20
	(-73.20)	(-94.90)	(-133.20)	(-104.70)

From Table 4.42, as estimated by OLS, all coefficients were significant at the 95% level of confidence because the $|t - value|$ of all coefficients was more than 1.96. However, for proper specification of cointegration relations, especially in terms of fiscal policy, the restrictions were changed as follows:

Table 4.43: Just-identifying restriction of the five-variable Model Cp reflecting budget sustainability and automatic stabilisation between total tax revenue and output

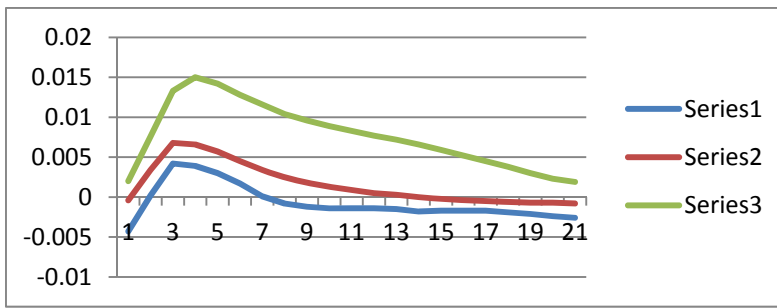
Variable	$[\beta_1]$	$[\beta_2]$	$[\beta_3]$	$[\beta_4]$
T	1	0	0	-0.80
				(-10.70)
P	0	1	0	0
Cp	-1.40	0	1	0
	(-30.50)			
G	0	0	0	1
R	0	0.07	0.08	0
		(9.40)	(9.25)	
Intercept	6.62	-5.40	-13.20	-2.60
	(11.02)	(-98.40)	(-142.00)	(-2.96)

From Table 4.43, the first cointegration relation showed the long-run relationship between total tax and private consumption. The second cointegration was the negative relationship between interest rate and price level. The third cointegration was the negative relationship between interest rate and private consumption. The fourth cointegration was the relationship between government spending and tax revenue.

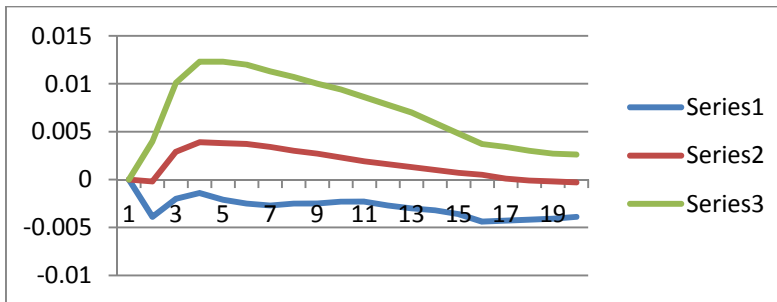
4.12.4 Short-run identification

According to Juselius (2006, p. 280), the ordering of the variables begins with the transitory variable: T_t, P_t, Cp_t, G_t, R_t . Refer to equation (4.31); details of the ordering are given in section 4.6.4.

4.12.5 Impulse response functions



a. The effect of government spending on private consumption



b. The effect of total tax on private consumption

Figure 4.7: Impulse response functions of Model Cp

From Figure 4.7, a positive shock of total government spending temporarily affected private consumption (Cp) in a positive way. With the estimated sample standard innovation of total government spending error term being 0.39, private consumption peaked at the third quarter with a magnitude of 0.7; in other words, an increase in total government spending of 39% raised private consumption by 0.7%. The response then started to decline, and was significant only until the sixth quarter. In the case of total tax, a positive tax shock had an insignificant effect on private consumption.

4.13 Vector Error Correction (VECM) of Model I

The first step in this model was to test for the lag-length.

Table 4.44: Results of the lag-length test in Model I in VECM

Model	LR	FPE	AIC	SC	HQ
I model	2	1	1	1	1

From Table 4.44 it can be seen that there are two possible lag-lengths: 2 and 1.

Table 4.45a: Residual tests of Model I in VECM (normality and heteroscedasticity)

Model	Skewness (χ^2)	p-value	Kurtosis (χ^2)	p-value	SK and KU	p-value	Heteroscedasticity (p-value)
Model I with 1 lag	7.64	0.17	54.00	0.00	61.60	0.00	363.70 (0.00)
Model I with 2 lag	3.63	0.60	27.60	0.00	31.20	0.00	216.40 (0.02)

Table 4.45b: Residual tests of Model I in VECM (autocorrelation in the 1-lag model)

Lag	LM-stat	p-value
1	42.30	0.02

Table 4.45c: Residual tests of Model I in VECM (autocorrelation in the 2-lag model)

Lag	LM-stat	p-value
1	27.80	0.31
2	35.30	0.08

From Tables 4.45a to 4.45c, the two-lag model was chosen because the statistic for autocorrelation was better than the others. There was no evidence of autocorrelation at either lag 1 or lag 2 in the two-lag model at the 95% level of confidence.

4.13.1 Testing for cointegration

The results from the trace test were as follows:

Table 4.46: Determining the cointegration rank and the model

Test statistic	r	Model 2	Model 3	Model 4
Trace test (critical values)	0	143.10	114.40	126.50
	1	(76.97)	(67.18)	(88.80)
		91.20	62.70	73.80
	2	(54.08)	(47.85)	(63.86)
		45.90	38.30	44.10
3	(35.20)	(29.97)	(42.90)	
	22.70	19.40	25.20	
4	(20.26)	(15.50)	(25.70)	
	6.57	–	–	

(9.16)

Note: Numbers in parentheses are 95% of the critical value of the trace test.

From Table 4.46, at the 95% level of confidence four cointegration relations of Model 2 were the first clearly accepted ($6.57 < 9.16$), while the three cointegration relations of Model 4 were just borderline accepted ($25.2 < 25.7$). Thus, the trace test points to the four cointegration relations of Model 2 as the favourite model specification.

4.13.2 Testing for weak exogeneity

Because there were four cointegration relations in this model, there was only one weakly exogenous variable ($5 - 4 = 1$). We chose to order the variables as follows: $\Delta T_t \rightarrow \Delta P_t \rightarrow \Delta I_t \rightarrow \Delta G_t \rightarrow \Delta R_t$. Refer to equation (4.24); the results of the test are shown below.

Table 4.47: The result of testing restrictions on α (test of weak exogeneity)

Variables	T_t	P_t	I_t	G_t	R_t
Restrictions	$H_0 : \alpha_{11} = \alpha_{12}$ $= \alpha_{13} = \alpha_{14}$ $= 0$	$H_0 : \alpha_{21} = \alpha_{22}$ $= \alpha_{23} = \alpha_{24}$ $= 0$	$H_0 : \alpha_{31} = \alpha_{32}$ $= \alpha_{33} = \alpha_{34}$ $= 0$	$H_0 : \alpha_{41} = \alpha_{42}$ $= \alpha_{43} = \alpha_{44}$ $= 0$	$H_0 : \alpha_{51} = \alpha_{52}$ $= \alpha_{53} = \alpha_{54}$ $= 0$
$\chi^2(v)$	19.00	28.90	35.30	20.50	12.00
(p-value)	(0.00)	(0.00)	(0.00)	(0.00)	(0.012)

From Table 4.47 it can be seen that the weakly exogenous variable in this model was interest rate, because the null hypothesis of a weakly exogenous variable of interest rate cannot be rejected at the 99% level of confidence as the p-value was larger than 0.01.

4.13.3 Identification of the long-run structure

From testing for exogeneity, it can be seen that R_t was a weakly exogenous variable and T_t, P_t, I_t, G_t were endogenous variables. Thus, the long-run relationships were government spending, price level, tax and private investment functions. Moreover, in this model there were four cointegration relations. Thus, there were $4 - 1 = 3$ restrictions imposed in each relationship. The just-identifying restriction can then be written as follows:

Table 4.48: Just-identifying restriction of the five-variable Model I

Variable	$[\beta_1]$	$[\beta_2]$	$[\beta_3]$	$[\beta_4]$
T	1	0	0	0
P	0	1	0	0
I	0	0	1	0
G	0	0	0	1
R	0.14	0.07	0.10	0.12
	(7.27)	(11.20)	(3.18)	(9.01)
Intercept	-11.80	-5.40	-11.20	-12.10
	(-84.90)	(-116.60)	(-50.10)	(-123.40)

From Table 4.48, as estimated by OLS, it can be seen that all coefficients were significant at the 95% level of confidence because the $|t - value|$ of all coefficients was more than 1.96. However, to achieve a better specification of cointegration relations, especially in terms of fiscal policy, the restrictions were changed as follows:

Table 4.49: Just identifying restriction of the five-variable Model I reflecting budget sustainability and automatic stabilisation between total tax revenue and output

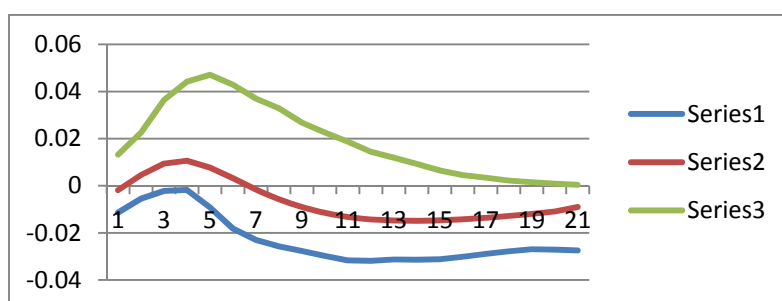
Variable	$[\beta_1]$	$[\beta_2]$	$[\beta_3]$	$[\beta_4]$
T	1	0	0	-0.87
P	0	1	0	0
I	-1.42	0	1	0
G	(-43.40)	0	0	1
R	0	0.07	0.10	0
Intercept	4.12	(11.50) -5.40	(10.40) -11.20	-1.78
	(9.78)	(-117.70)	(-60.50)	(2.23)

From Table 4.49, as estimated by OLS, the first cointegration relation showed the long-run relationship between total tax and private investment. The second cointegration was the negative relationship between interest rate and price level. The third cointegration was the negative relationship between interest rate and private investment. The fourth cointegration was the relationship between government spending and tax revenue.

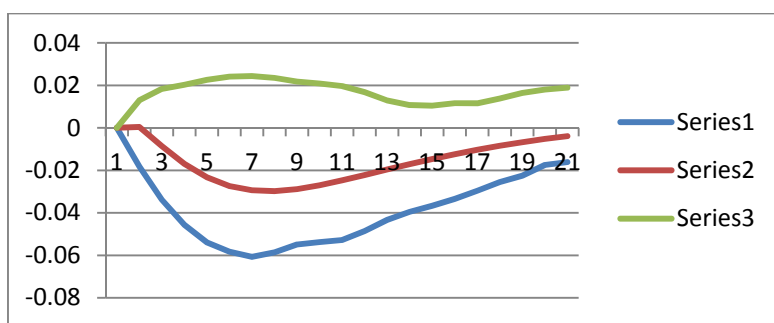
4.13.4 Short-run identification

According to Juselius (2006, p. 280), the ordering of the variables begins with the transitory variable: T_t, P_t, I_t, G_t, R_t . Refer to equation (4.31); details of the ordering are given in section 4.6.4.

4.13.5 Impulse response functions



a. The effect of government spending on private investment



b. The effect of total tax on private investment

Figure 4.8: Impulse response functions of Model I

From the response of private investment to total government spending in Figure 4.8, a positive shock of total government spending increased output until the seventh quarter, while an increase in total tax had a negative effect on output. However, neither the effect from an increase in total government spending nor total tax was significant.

4.14 The effects of fiscal policy during the pre-crisis and post-crisis periods

On 2 July 1997 there was a collapse of the currency in Thailand, which caused a financial crisis. In this study, besides investigating the effect of fiscal policy across the whole period 1988:1–2009:4, the baseline model is also used to examine the effect of an expansionary fiscal policy both before the financial crisis (1988:1–1997:2), and after the financial crisis (1997:3–2009:4).

Table 4.50: Determination of the cointegration rank (pre-crisis period)

Test statistic	Rank (r)	Model 2	Model 3
Trace statistic	0	151.02	65.06
(critical values)		(76.97)	(67.18)

Note: Numbers in parentheses are 95% of the critical value of the trace test.

From Table 4.50, based on the 95% level of confidence, the null hypothesis of the zero cointegration relation of Model 3 was the first to be accepted.

Table 4.51: Determination of the cointegration rank (post-crisis period)

Test statistic	Rank (r)	Model 2	Model 3	Model 4
Trace statistic	0	92.26	75.59	108.80
(critical values)		(76.97)	(67.18)	(88.80)
	1	57.95	41.35	
		(54.08)	(47.85)	

From Table 4.51, based on the 95% level of confidence, the null hypothesis of one cointegration relation of Model 3 was the first to be accepted. The trace test, therefore, points to the one cointegration relation of Model 3 as the favourite model specification.

Despite finding one cointegration relation during the post-crisis period, there was no cointegration relation between variables during the pre-crisis period, which may be because the number of observations for the pre-crisis period (i.e. 38) is lower than the number of observations for the post-crisis period (i.e. 50), so variables would be transferred to first difference and analysed by VAR model in both periods so that it was easy to compare the results between these two periods. Thus, the model consists of first difference of total government spending (DG), first difference of output (DY), first difference of price level (DP), first difference of total tax (DT) and first difference of interest rate (DR).

For the identification method, in this study a Cholesky decomposition, which Uhlig (2005) says is a popular method for identification, was employed.

Consistent with Caldara and Kamps (2008), in this study variables were ordered as follows: total government spending first, output second, price level third, total tax fourth and interest rate last. The total government spending was ordered first because, as Caldara and Kamps (2008, p. 14) state, “movements in government spending, unlike movements in taxes, are largely unrelated to the business cycle. Therefore, it seems plausible to assume that government spending is not affected contemporaneously by shocks originating in the private sector.” Output and price level are ordered before total tax because both could have a contemporaneous impact on the tax base, especially the contemporaneous effect of output on tax (α_{Ty}); i.e. the effect of automatic stabilisers of output on taxes. Finally, interest rate was ordered last because it has no contemporaneous effect on any variable; as Perotti (2004) notes, it takes time for interest rates to affect other variables. Because the different method of the short-run identification (i.e. long-run restriction separating shocks to be transitory and permanent shocks in VECM and identification by contemporaneous restrictions, Cholesky decomposition, in VAR), the ordering of the variables in VAR is different from the ordering of the variables in VECM.

After imposed restrictions, the contemporaneous effect matrix (matrix B_0 , see detail in equation 4.41) would be as follows:

$$B_0 = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ -\alpha_{yg} & 1 & 0 & 0 & 0 \\ -\alpha_{pg} & -\alpha_{py} & 1 & 0 & 0 \\ -\alpha_{Tg} & -\alpha_{Ty} & -\alpha_{Tp} & 1 & 0 \\ -\alpha_{rg} & -\alpha_{ry} & -\alpha_{rp} & -\alpha_{rT} & 1 \end{bmatrix}. \quad (4.38)$$

From matrix B_0 in equation (4.38), the ordering can be explained as follows: (i) total government spending did not react contemporaneously to shocks from any variable (from four zero restrictions in the first row), but it had contemporaneous effects on other variables in the system; (ii) output did not react contemporaneously to other variables except total government spending shock (from three zero restrictions in the second row), but it had contemporaneous effects on all variables except total government spending (from zero restriction in the first row of column two); (iii) price level did not react contemporaneously to total tax and interest rate shocks (from two zero restrictions in the third row), but it was affected contemporaneously by total government spending and output shocks; (iv) total tax did not react contemporaneously to interest rate shocks (from zero restrictions in the fourth row of column five), but it was affected contemporaneously by all remaining shocks; and (v) the interest rate was affected contemporaneously by all shocks in the system, but it could not contemporaneously affect any other variable in the system (from four zero restrictions in column five).

For the lag-length, in the case of the pre-crisis model, all criteria indicated one lag. The reduced-form VAR model for the pre-crisis period, therefore, will contain one lag, as shown in equation (4.39). In the case of the post-crisis model, SC has one lag, HQ two lags and LR, AIC and FPE four lags. However, for the one-lag model, the null hypothesis of no autocorrelation is rejected at the 95% level of confidence. Moreover, there is evidence of non-normality due to kurtosis in the four-lag model. As a result, the VAR model for the post-crisis period will contain two lags, as shown in equation (4.40).

A reduced form of the VAR model for the pre-crisis period was run as the one-lag model, as shown in equation (4.39), while the VAR model for the post-crisis period was run as the two-lag model, as shown in equation (4.40).

$$DX_t = A_1 DX_{t-1} + \mu_t \quad (4.39)$$

$$DX_t = C_1 DX_{t-1} + C_2 DX_{t-2} + \mu_t \quad (4.40)$$

where DX_t = a (5×1) vector containing observations on each of the variables in first difference: DG, DTAX, DY, DP and DR

μ_t = a (5×1) vector of error terms.

VAR in a reduced form could be converted to VAR in a structural form (SVAR); e.g. by pre-multiplying equation (4.39) with a non-singular $p \times p$ matrix B_0 to obtain the so-called structural-form representation (SVAR), as in equation (4.41). The matrix B_0 describes the contemporaneous relation among the variables.

$$B_0 DX_t = B_1 DX_{t-1} + \varepsilon_t \quad (4.41)$$

where $\mu_t = B_0^{-1} \varepsilon_t$, $A_1 = B_0^{-1} B_1$ and ε_t = a (5×1) vector of structural error terms.

Finally, IRFs were as follows.

Response to Cholesky One S.D. Innovations ± 2 S.E.

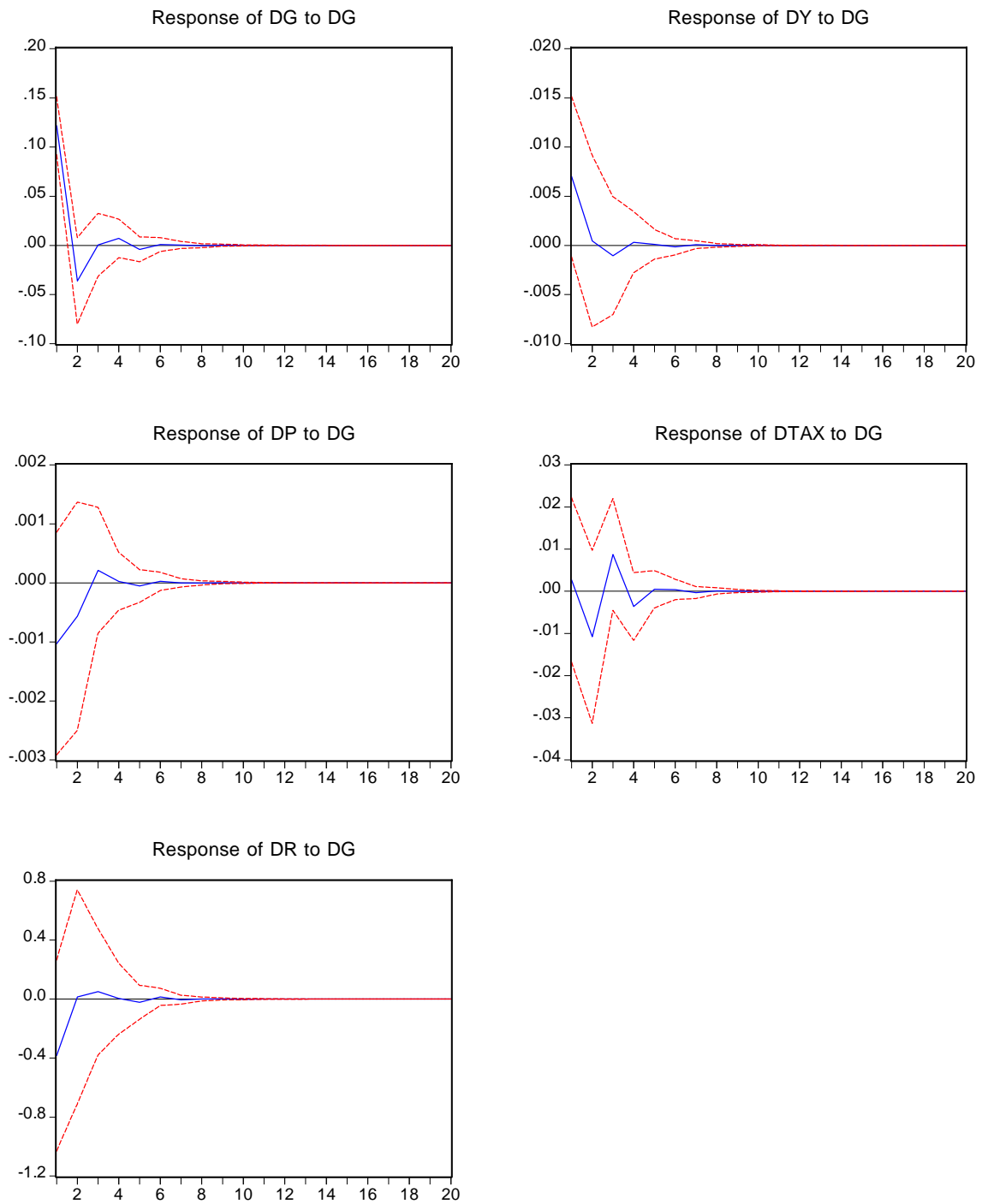


Figure 4.9: Impulse response functions (1988:1–1997:2) for total government spending

Response to Cholesky One S.D. Innovations ± 2 S.E.

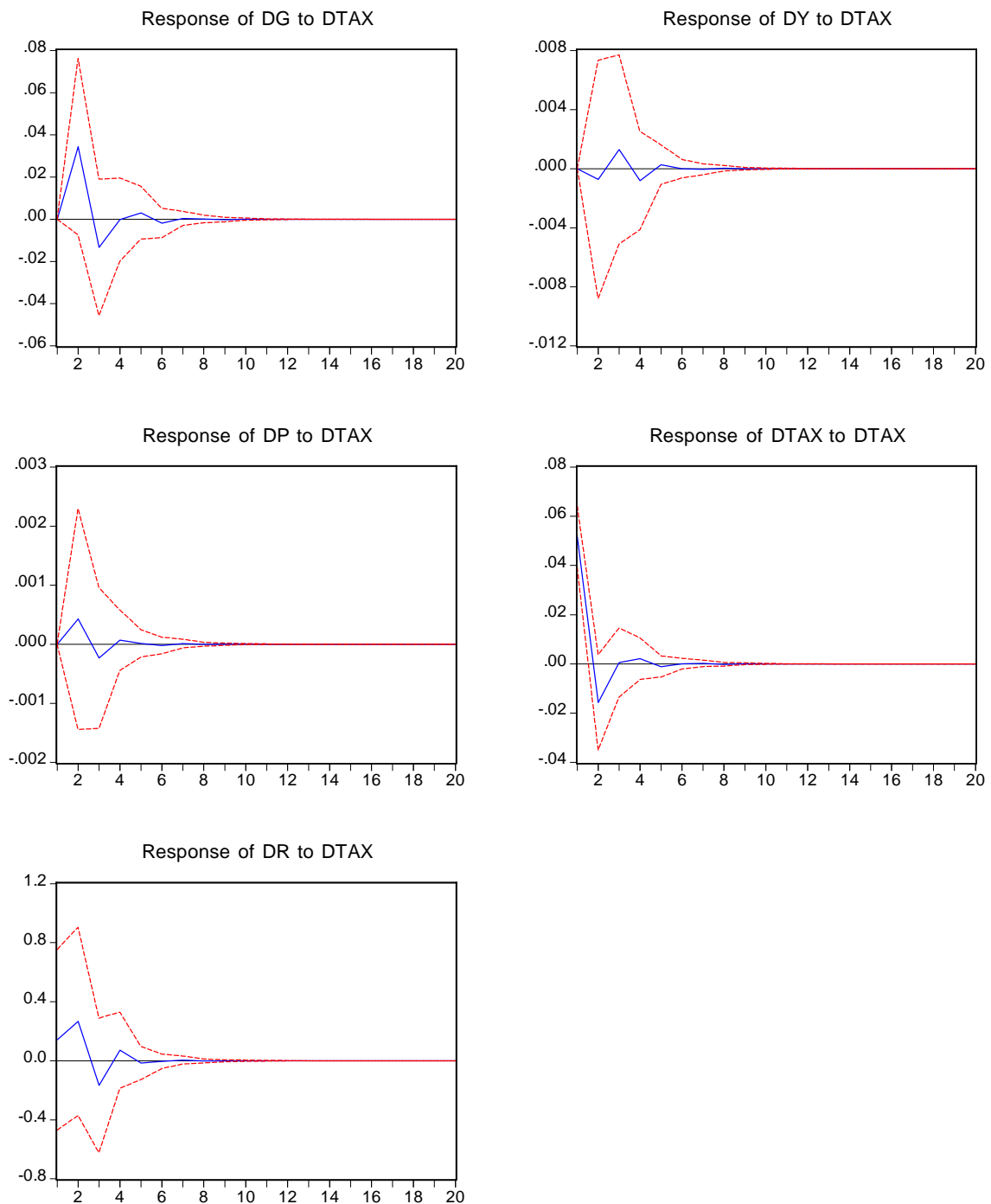


Figure 4.10: Impulse response functions (1988:1–1997:2) for total tax

All the variables used were in logarithm and their differences denoted the rates of change of corresponding variables. Therefore, the values of impulse responses denoted growth rates over a certain period following changes (of a certain magnitude) in the growth rate of fiscal variables; e.g. the response of GDP growth rates (DY) to changes in the growth rate of total government spending (DG) (Hur, 2007). Hur noted that, “The size of innovation to be applied in calculating an impulse response function is set to be 1 standard deviation of the error term”

(2007, p. 10). With the estimate sample standard innovation of total government spending error term at 0.13, the log level variable shocks should be read as a percentage term, so that the shock of total government spending, for example, is 13%.

According to Figure 4.9, GDP growth (DY) was increased by 0.7% from a positive shock of total government spending growth of 13% (DG) in the first quarter. Dividing the magnitude of GDP growth (0.7) by the estimated sample standard deviations of the spending shock term (0.13), one can obtain the elasticity of GDP with respect to fiscal stimuli. Accordingly, a 1% increase in the growth rate of total government spending resulted in an increase in GDP growth by 0.054% at the first quarter. The response then turned negative after the second quarter, consistent with an increase in price (DP). Finally, the response went to zero after eight quarters. From Figure 4.10, total tax shock (DTAX) had only a small effect on the economy. However, from the confidence bands, the effect of both total government spending and total taxation on output was insignificant at the 95% level of confidence: “For the VAR models estimated in first differences, the impulse-response functions are simply accumulated, in order to get impulse response functions in levels” (Arin, 2003, p. 10).

Accumulated Response to Cholesky One S.D. Innovations ± 2 S.E.

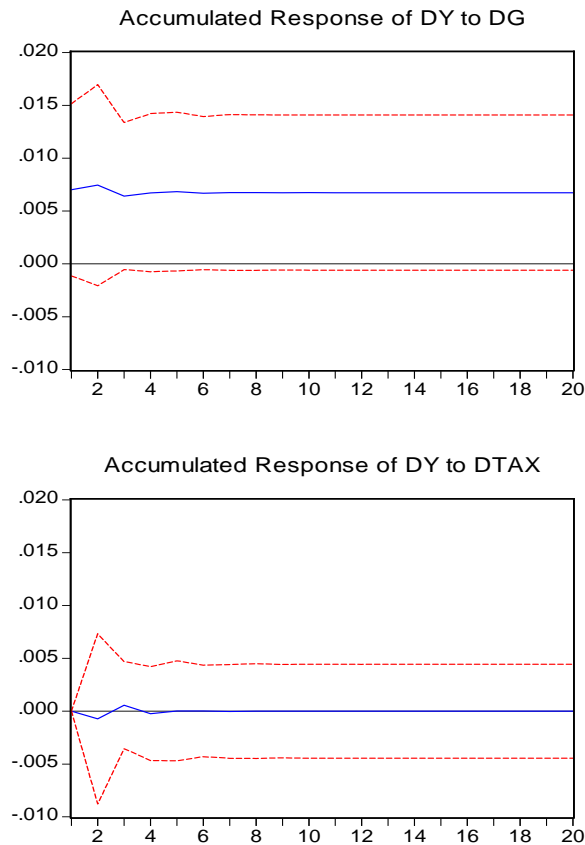


Figure 4.11: Accumulated impulse response functions of the baseline Model in VAR (1988:1–1997:2)

From Figure 4.11, accumulated responses also showed that the effect on the level of GDP of the 1 baht shock to total government spending was positive. The point estimation quickly stabilised at a level of 0.40 baht increased output for 1 additional baht spent by the government. However, the effect was insignificant. In the case of taxation shock, the shock stabilised with zero effect on GDP.

Response to Cholesky One S.D. Innovations ± 2 S.E.

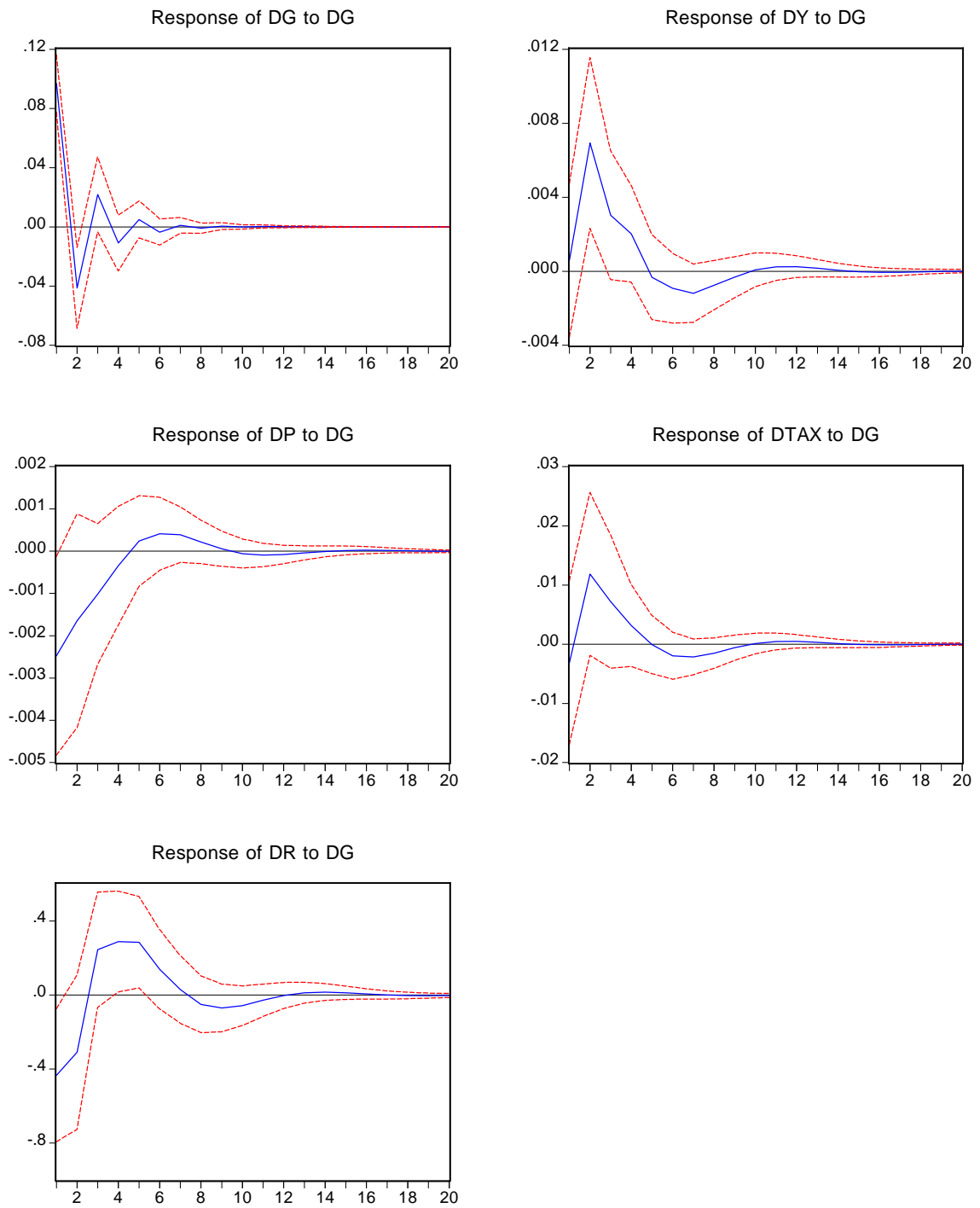


Figure 4.12: Impulse response functions (1997:3–2009:4) for total government spending

Response to Cholesky One S.D. Innovations ± 2 S.E.

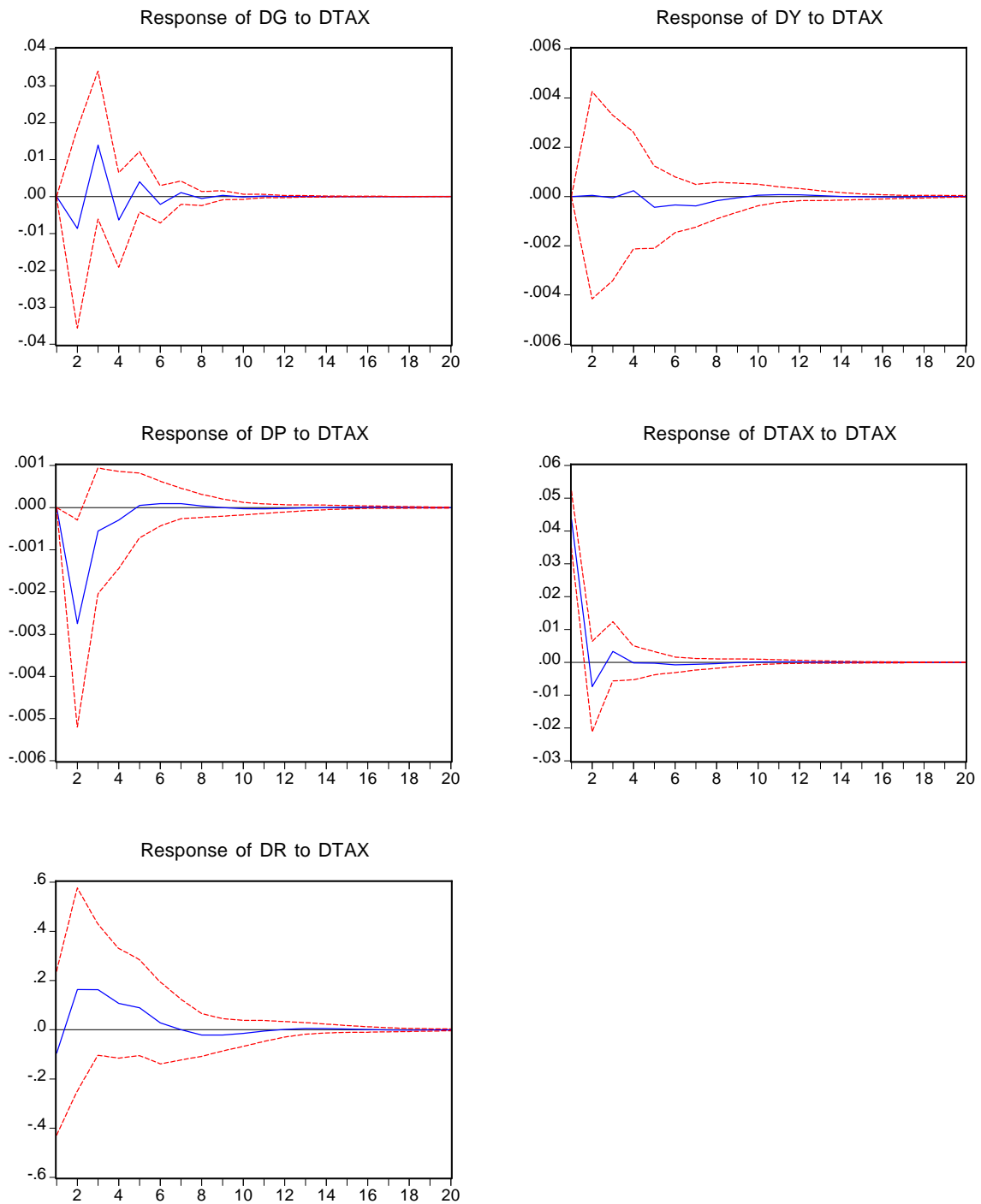


Figure 4.13: Impulse response functions (1997:3–2009:4) for total tax

GDP growth was increased by 0.025% from an increase in the growth rate of total government spending of 1%. The response then peaked at the second quarter with a magnitude of 0.065%, before starting to decline, consistent with increased interest rates, and it turned negative after six quarters. The effect of total government spending on output was significant between the second and the third quarter of the shock. The response finally went to

zero about the 20th quarter. As can be seen from Table 4.13, GDP growth hardly responded to total taxation shock.

Accumulated Response to Cholesky One S.D. Innovations ± 2 S.E.

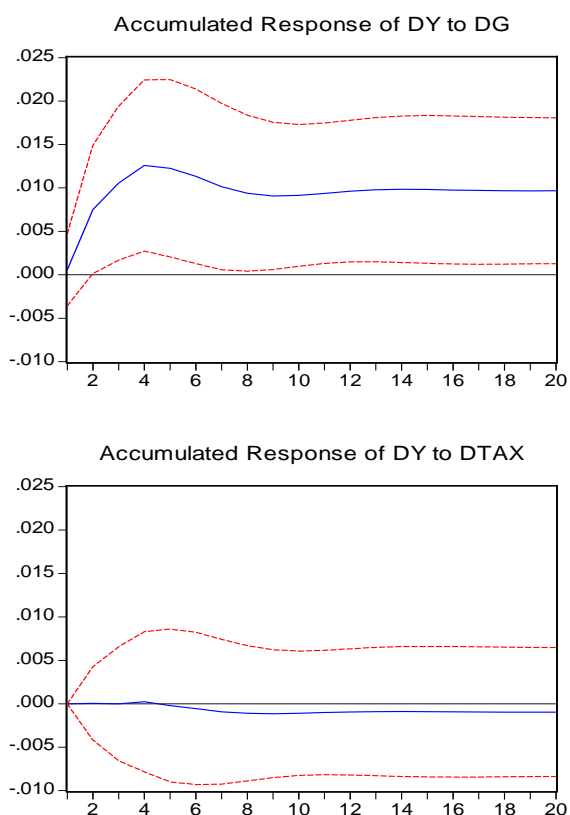


Figure 4.14: Accumulated impulse response functions of the baseline Model in VAR (1997:3–2009:4)

As Figure 4.14 indicates, accumulated responses also showed that the effect on the level of GDP of the 1 baht shock to total government spending was positive and significant. The point estimation stabilised at a level of 0.65 baht greater output for 1 additional baht spent by the government. In the case of taxation shock, the shock stabilised with nearly zero effect on GDP.

In this section we have seen that a positive shock of fiscal policy during the post-financial crisis period seemed to be slightly more effective than during the pre-financial crisis period (i.e. a post-crisis accumulative multiplier of 0.65 compared to a pre-crisis accumulative multiplier of 0.40). This was not surprising since after the crisis the government placed more importance on fiscal policy to stimulate the economy, which can be seen from the ratio of government spending to GDP during the post-crisis period (16.5% GDP), which was slightly higher than that during the pre-crisis period (15% GDP).

4.15 Summary

This chapter analysed the effects of fiscal policy shocks on the Thai economy, as measured by GDP. In constructing the VECM, the first task was to identify the long-run structure, which involved tests for cointegration and weak exogeneity. This was followed by the identification of the short-run structure, based on which IRFs were obtained and used to evaluate the effects on the economy of fiscal policy shocks.

As we saw in Chapter 2, there are many ways to identify structural shocks, such as the recursive method (Cholesky decomposition), long-run restrictions (e.g. Blanchard & Quah, 1989; KPSW, and Park, 1990. In the case of long-run restrictions, the KPSW method was better than the others because it can be used for the model that has more than one common trend, while the others cannot. The identification in this study was in line with the procedure used by King et al. (1991) and Juselius (2006), whereby restrictions for mutually uncorrelated shocks were imposed and separations were made between permanent and transitory shocks. According to Fisher et al. (1995), structural shocks with permanent effects can be sources of common stochastic trends. The number of common trends equalled the number of variables minus the number of cointegrating relations, while the number of structural shocks that have transitory effects was equal to the number of cointegrating relations in the model. The baseline model in this study consisted of five variables with four cointegration relations (four transitory shocks) and one permanent shock (one common trend). It was found that shocks to both government expenditure and tax can be considered transitory.

This study had three main objectives. The first was to investigate the effects of changes in total tax and total government spending on output (including its components, private consumption and private investment) and on crowding out variables (interest rate and price level). The results from the baseline model show that an increase in total government spending had a positive contemporaneous transitory effect on GDP. With an impact multiplier of 0.1, an increase in total government spending of 1 baht caused a 0.1 baht increase in GDP in the first quarter. The multiplier then peaked at the second quarter, equal to 0.17, before it started to decline, consistent with a crowding out effect because of an increase in the price level and interest rate after the third quarter of the shock.

Finally, the effect of total government spending remained significantly positive until the sixth quarter. Positive total tax shocks had a positive effect on output in the first five quarters before turning negative, but the effect was insignificant. For changes in total taxation and total government spending on the private sector (private consumption and private investment), a

positive shock in total government spending had a significant positive effect on private consumption until the sixth quarter, while private consumption insignificantly responded to an increase in total tax. Private investment responded negatively to a positive total tax shock, while it was increased by the positive shock of government spending, but the effect was insignificant.

The second objective was to investigate the effects of changes in different types of government spending and taxation on the economy. It was found that an increase in capital spending boosted GDP more than did an increase in current spending. The impact multiplier for current spending was about 0.09, but the impact multiplier for capital spending was approximately 0.50; i.e. an increase in current and capital spending of 1 baht raised output by 0.09 and 0.50 baht, respectively. In terms of the effect from taxation by type, a positive shock of indirect tax had a negative effect on GDP, and the effect was significant in the first three quarters after the shock, while the effect of an increase in corporate income tax on output was insignificant. However, the fiscal multiplier was positive after a positive shock to personal income tax, which was plausible because an increase in personal income tax caused an increase in government spending, which led to an increase in GDP, but the effect was insignificant.

The third objective was to investigate the duration of the effect of changes in taxation and government spending on the economy. It was found that shocks from both total government spending and capital spending could have only a transitory significant effect on output – about the first six quarters after the shock. The positive shock from other kinds of fiscal policy, but not a shock from indirect tax, could not significantly affect output.

After investigating the effects of fiscal policy before and after the financial crisis, the results supported the idea that an expansionary fiscal policy could be used as an effective tool to stimulate Thailand's economy. This can be seen from the larger multiplier of the total government spending during the post-crisis period, where the government placed more importance on fiscal policy, compared to the smaller multiplier during the pre-crisis period.

Chapter 5

Conclusions

5.1 Introduction

This chapter presents a summary of the thesis and draws conclusions about how fiscal policy affects the Thai economy, especially GDP. Section 5.2 summarises the whole thesis. Section 5.3 focuses on the empirical results from the study, and section 5.4 discusses policy implications of the research findings. The limitations of the study are given in section 5.5, and suggestions for further study are given in section 5.6.

5.2 Summary of the thesis

In this study the purpose was to investigate the effects of fiscal policy on variables in both the product and money markets. The investigation was carried out by examining the effects of changes in government spending and taxation, by type, on GDP, the components of GDP, the price level and the interest rate.

This study used quarterly macroeconomic data from Thailand, which included 12 variables for the period 1988:1–2009:4. In Chapter 2 I looked at controversies relating to the effect of fiscal policy, from the theoretical level through to the empirical level. From the review of the literature, the effects of an expansionary fiscal policy on GDP in Thailand were found to be positive in most studies in the case of a total government spending shock. Nevertheless, considering government spending by type, there is still controversy about the effect of current spending and capital spending; for example, some studies found that an increase in capital spending increased output more than an increase in current spending, while some found the opposite.

In Chapter 3, the use of fiscal policy to stimulate Thailand's economy through budget deficit almost every year since 1997 was discussed. The government placed more importance on current spending than on capital spending, and indirect tax was the main revenue for the government, followed by corporate income tax and personal income tax, respectively.

In Chapter 4 the effects of fiscal policy on the economy were studied, using eight models. First, the baseline model was used to investigate the effect of changes in total government spending and total tax on output, price level and interest rate. The second and third models were employed to investigate the effect of changes in current spending and capital spending,

respectively, on output, price level and interest rate. The next three models focused on the effects of indirect tax, personal income tax and corporate income tax on the variables under study. The last two models examined the effects of changes in total government expenditure and total tax on private consumption and private investment, respectively.

After eliminating seasonal effects from all the quarterly data and transforming them into logarithms, the ADF test was employed to test for stationarity of the data. The testing outcomes suggested that all the variables were $I(1)$, and so a VECM was employed to test for cointegration relations among the variables. Since cointegration relations were found, the VECM served as a vehicle to analyse the effects of fiscal policy.

Identification in VECM involved identifying the long-run and short-run structures; the former was to find the stationary long-run relation in the model, and the latter involved separating disturbances into transitory and permanent shocks. Permanent shocks were defined as the residuals of weakly exogenous variables. Once the short-run structure was identified, the impulse response functions became available for policy analysis.

5.3 Empirical results

The first objective was to investigate the effect of changes in total government spending and total tax on output, private consumption, private investment, price level and interest rate. Theoretically, output can remain stable and respond positively or negatively to an increase in total government spending. However, many studies have found a positive response of output to a positive shock in total government spending (e.g., Blanchard & Perotti, 2002; Fatas & Mihov, 2001; Dungey & Fry, 2009). However, negative responses have also been found (e.g. Barry & Devereux, 2003; Giavazzi & Pagano, 1990). In Thailand, Chainakul (2002) and Charoenkittayawut (2001) found that the effect of an increase in total government spending on output was positive. In contrast, Chang et al. (2002) found that output hardly responded to changes in total government spending.

In this study it was found that an increase in total government spending positively affected output. The magnitude of the peak fiscal multiplier was about 0.17 in the second quarter; i.e. an increase in total government spending of 1 baht resulted in an increase in output of 0.17 baht. Price levels and interest rates also positively responded to a positive shock in total government spending, although they negatively responded at the beginning (in the first three quarters), as found in many studies employing U.S. data (e.g. Burriel et al., 2009; Caldara & Kamps, 2008; Favero & Giavazzi, 2007).

A negative response of output to an increase in total tax has generally been found in many studies (e.g. Blanchard & Perotti, 2002; Caldara & Kamps, 2008). However, positive responses from an increase in total tax were also found by Dungey and Fry (2009) and Tubtimtong et al. (2009). In this study it cannot be concluded that the effect of a positive shock in total tax corresponds to the German view of expansionary fiscal contraction (EFC), even though the output response was positive (though insignificant) for the first five quarters after the shock. Because a positive shock in total tax also resulted in an increase in total government spending, it is possible that the positive response of output resulted from the increase in total government spending. It was observed that the total tax multiplier became negative after the fifth quarter (though, again, this was insignificant) after the positive effect of total government spending disappeared. Accordingly, it is possible that the effect of a positive shock in total tax was offset by an increase in total government spending, corresponding to the Keynesian idea that the multiplier of government spending is larger than that from tax (Keiser, 1967). This result also supports Sangsubhan and Basri (2012), who claimed that an expansion in government spending can increase output more than a reduction in tax in Thailand. This is also in line with De Castro and De Cos (2006).

Finally, both private consumption and private investment responded positively to an increase in total government spending, though this was insignificant in the case of private investment, as found in many studies employing Thai data (e.g. Chainakul, 2002; Charoenkittayawut, 2001). However, an increase in total government spending crowded out private investment later (though this was insignificant), as found by Fakthong (2006). In the case of an increase in total tax, private consumption responded positively, but private investment responded negatively to the shock, as found in many studies employing U.S. data (e.g. Badinger, 2006; Burriel et al., 2009). However, the effect of total tax on both private investment and private consumption was insignificant.

The second research objective examined the effects of government spending and tax, by type, on output, price level and interest rate. Many studies using Thai data have found a positive effect of output from an increase in capital spending (e.g. Suwanrada, 1999; Sriboonma, 1999). Some studies investigated the result from both capital and current spending. Yongpitayapong (2004) found that the multipliers of an increase in current spending and capital spending were the same, at 1.33. In contrast, the present study found that the effect from capital spending was larger than the effect from current spending, which is supported by Vorasangasil (2008), with a peak fiscal multiplier for capital spending of about 0.60 in the second quarter, while the peak fiscal multiplier for current spending was about 0.09 in the first

quarter. Moreover, the positive effect of output from an increase in current spending was insignificant.

In the case of taxation shock by type, some studies have found that output responded negatively to an increase in personal income tax shock (e.g. Arin & Koray, 2005, 2006). However, Arin (2003) found that output responded positively to a positive personal income tax shock in Japan. In the present study it could not be concluded that the effect on output of a positive shock to personal income tax corresponded to the EFC viewpoint, although the response of output was positive for 20 quarters after the shock, though insignificant. Since total government spending also responded positively to a positive (though insignificant) shock from personal income tax until the 21st quarter after the shock, it is possible that an increase in output came from an increase in total government spending, or that the effect of an increase in total government spending offset the effect of an increase in personal income tax, as found in the case of total tax shock. This is possibly because the tax base of personal income tax in Thailand is very narrow. Furthermore, a positive shock in personal income tax also raised the price level and interest rate, though insignificantly, consistent with the positive multiplier after the shock.

In terms of the indirect tax and corporate income tax shocks, De Castro (2003) and Arin and Koray (2005) found a negative effect of these positive shocks on output. In contrast, positive multipliers from these shocks were found in Canada by Arin and Koray (2006), and in Canada, Germany and Italy by Arin (2003). In the present study, output responded negatively to a positive shock from indirect tax, while the response of output to corporate income tax was insignificant.

The third research objective was to examine the duration of the effects of fiscal policy shocks. The positive shocks from total government spending and capital spending significantly affected output for about the first six quarters, while the positive output from an increase in current spending remained for a shorter time (until the third quarter), but it was insignificant. This contrasts with the work of Vorasangasil (2008), who found that the effect from current spending was longer. However, in her study only data after the financial crisis were employed, and during that period capital spending was largely focused on improving old facilities, such as streets and buildings (Vorasangasil, 2008). This is why the effect of capital spending in her study disappeared earlier. In the case of tax, an increase in all kinds of tax, except indirect tax, did not have a significant effect on output, while an increase in corporate income tax had a significant negative effect on output until the third quarter after the shock.

5.4 Some policy implications

These analyses provide results that can help policy makers in Thailand to design fiscal policy. There are contrasting ideas about the effect of fiscal policy in both theory and empirical evidence. Chang et al. (2002) and Tubtimtong et al. (2009) have stated that an expansionary fiscal policy in Thailand insignificantly affected output, but the response of output was positive to an increase in government spending in Hsing, 2003, Songtragoolsak, 2002, Vorasangasil, 2008, and Winothai, 2004. The present study shows that an expansionary fiscal policy can have positive impacts on output (though quite small impacts in the case of total government spending, and insignificant in the case of current spending), and private consumption, corresponding to the findings of Hsing (2003), Songtragoolsak (2002), Vorasangasil (2008) and Winothai (2004). Moreover, from the fiscal multipliers during the pre-crisis period and the post-crisis period (see section 4.14), it can be seen that an attempt to stimulate the economy by increasing the ratio of government spending to GDP during the post-crisis period seemed to yield an effective result. This implies that it is possible to use fiscal policy to stimulate the economy. However, there are a few observations worth making.

First, each kind of tax and government spending results in a different effect on the economy. For example, the positive effect of capital spending on output is stronger and longer than the effect of current spending. Moreover, an increase in some taxes, such as indirect tax, clearly yielded negative effects on output, while the result from an increase in personal income tax and total tax did not. As a result, the kind of spending and taxation should be considered as it can be misleading to use only total tax and total spending to judge fiscal policy.

Second, from the results using VECM, the multipliers from an increase in total government spending and current spending are quite low, even the peak multiplier of 0.17 and 0.09 for total government spending and current spending, respectively, compared to the peak multiplier of capital spending at 0.6. This implies that improving the effectiveness of using fiscal policy should be the focus, especially in the case of total government spending and current spending. In particular, the central government should encourage local government to spend more effectively.

The central government has tried to give more decision-making to local government, as can be seen from the Act of Distribution in 1999 (see Appendix B). For example, from 2001 to 2006 the revenue of local government was at least 20% of the revenue of the central government. Since 2007 the ratio of the revenue of local government to the revenue of central government has increased to at least 25%. Because the main revenue of local government

comes from payments from central government, when an act determines that the revenue of local government must be increased, the central government must increase spending on local government. It is therefore important for the central government to coordinate with local government to ensure that local government sets policies consistent with the central government; for example, when the central government uses an expansionary fiscal policy to stimulate the economy, local government should spend the money received from central government instead of depositing that money in commercial banks (see Appendix B), otherwise the expansionary fiscal policy will be less effective.

Third, in the past the government has spent a large amount on current budget that was mostly wages and salaries. Before the crisis the ratio of capital spending to total government spending was increasing until it was just over 40% in 1997. However, after the crisis this ratio decreased, and it is still at a low level (just below 20% in 2009). However, as can be seen from the VECM, an increase in capital spending can influence output higher and longer than an increase in current spending. Capital spending can influence productivity and the confidence of the private sector after the government invests, which quickly stimulates the expenditure of the private sector. This implies that the ratio of capital spending to total government spending should be increased if the government wants to increase the positive impact on output from an expansionary fiscal policy, because capital spending can affect capital accumulation, which is important for the growth of the economy.

Fourth, from the results in Chapter 4 it appears that an expansionary fiscal policy can increase GDP and its components at the cost of increasing the interest rate and price level. Consequently, the government should collaborate with the Bank of Thailand so that monetary policy (see Appendix D) is compatible with fiscal policy, and the positive effect of an expansionary fiscal policy can be stronger because the crowding out effect is reduced.

5.5 Limitations

In Thailand, quarterly data for GDP and its components (private consumption and private investment) are available only from 1993:1 until the present. As a result, data prior 1993:1 in this study had to be interpolated.

In this study, the variables employed allowed the effect of fiscal policy on variables in money and product markets (GDP and its components, interest rate, and price level) to be revealed. However, fiscal policy could affect other variables, such as wages, which could not be included in the present study.

In this study, tax revenue was used to represent the effect of changes in tax policy. However, as Auerbach and Gorodnichenko (2010, p. 7) have noted, “we would expect the effects of tax policy to work through the structure of taxation (e.g. marginal tax rates) rather than simply through the level of tax revenues,”). As a result, this study focused more on the effect of a government spending shock, although results from tax shocks were also reported.

Finally, fiscal policy is generally announced before it is implemented. However, in the standard fiscal VAR model it is assumed that fiscal policy shocks are unanticipated. Thus, the model might be mis-specified since it is likely that the private sector adjusts its behaviour before fiscal policy is implemented. However, Blanchard and Perotti (2002) addressed this issue with U.S. data by including expectations. Thus, output in t depends not only on current and lagged fiscal policies, but also on the expectation of fiscal policy in $t + 1$. They found that the result of unanticipated and anticipated policy is not substantially different. In addition, Wongpanich (1995), using the hypothesis of Macro-Rational Expectation (MRE), found that an increase in both anticipated and unanticipated fiscal policy yielded positive effects on output in Thailand.

5.6 Suggestions for the future

This study does not investigate the effect of the components of current spending and capital spending. Knowing the effect of each component of current spending and capital spending could improve the effectiveness fiscal policy; e.g. if we know what components of current spending are more effective, we can choose to place more importance on those components so that the multiplier of current spending can be higher. Moreover, total government spending in this study was classified by using the economic distinction between current and capital spending. To understand the effect of fiscal policy better, other classifications of government spending should be examined; e.g. function or ministry (see section 3.3.1).

Second, as mentioned in the limitation section, many theories state that fiscal policy can affect other variables besides those analysed in this study. For example, both classical and Keynesian theories state that an increase in government expenditure can increase nominal wages in the labour market (though not suddenly, in the Keynesian case). In that case, fiscal policy would not affect output in the long run. Furthermore, imports should be considered because they act as leakages, which reduces the expenditure multiplier. It follows that including more variables might result in a better understanding of the effect of fiscal policy on the economy.

With regard to the topic of anticipated fiscal policy in the limitations section, because this study analysed the effect of unanticipated fiscal policy, further study could be improved by including expectations of fiscal policy in the system.

Finally, after the crisis, besides focusing on spending from budgetary funds, the government has paid more attention to non-budgetary funds. Seeing how non-budgetary funds affect Thailand's economy would be an interesting topic for further study.

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Appendix A

Fiscal Sustainability Framework

A.1 Objective

According to Pinto et al. (2007, own translation), a fiscal sustainability framework is a set of fiscal rules (specific indicators and targets) that can bring about fiscal discipline. It was first employed in 2001. A government can use this framework as a guideline for preparing annual budgets and formulating fiscal policies and other measures.

A.2 Development of fiscal sustainability framework

Table A1: Public debt/GDP under a fiscal sustainability framework

Year	Level of public debt/GDP
2001–2002	< 60
2003	< 55
2004–2008	< 50
2009–present	< 60

Source: Fiscal Policy Office

Appendix B

Local Government

B.1 The Relationship between central and local government

According to Pewkhao (2007, own translation), after the crisis, the Thai central government has given more power to local government. This can be seen from the Act of Distribution 1999, which determined that the ratio of local government to central government revenue must be at least 20% by 2001. Since 2007 this ratio has been increased to 25%. However, the main revenue of local government comes from payments from the central government. As a result, the central government has to increase spending on local government. This expenditure is questionable because it has been found that a large proportion of local governments deposit the funds in commercial banks. Moreover, the amount of net deposit has increased almost year by year since 2001.

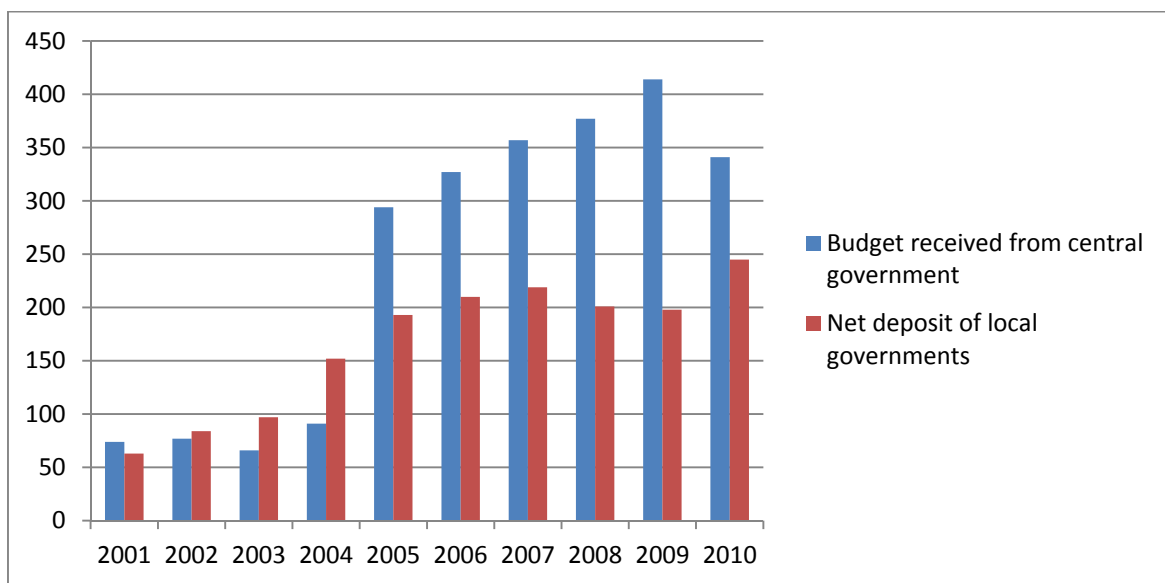


Figure B1: Budget to local governments

Unit: Billions of baht
Source: ThaiPublica.org

Appendix C

Fiscal Multiplier

The fiscal multiplier is the ratio of a change in output (ΔY) to a change in a fiscal variable, such as government spending (ΔG). Depending on the time frame considered, different multipliers can be employed (Spilimbergo, Symansky, & Schindler, 2009).

$$\text{The impact multiplier} = \left(\frac{\Delta Y(t)}{\Delta G(t)} \right).$$

The impact multiplier is used to measure the ratio of the change in output to a change in government expenditure at the time when the shock occurs (Ilzetzki, Mendoza, & Vegh, 2011).

$$\text{The multiplier at some horizon } N = \left(\frac{\Delta Y(t+N)}{\Delta G(t)} \right).$$

$$\text{The multiplier is defined as the largest multiplier over any horizon } N = \left(\max \frac{\Delta Y(t+N)}{\Delta G(t)} \right).$$

According to Hur (2007), the size of shock to be applied in calculating an impulse response function is set to 1 standard deviation of each error term. Dividing the responses of GDP to the change of tax revenue and the government spending by the estimated sample standard deviations of shock terms, one can obtain the elasticity of GDP with respect to fiscal stimuli, which can in turn be converted into a series of fiscal multipliers. For example, the multiplier of government spending can be derived by multiplying the fiscal elasticity by the ratio of output to government spending (Spilimbergo et al., 2009).

Appendix D

Thailand's Monetary Policy

The Bank of Thailand Act, B.E. 2485 (1942), while not a clear statement about monetary policy, did give the Bank's court of directors power to set the Bank Rate, which was the interest rate under the Bank's lender-of-last-resort facility (BOT, n.d.). Monetary policy can influence short-term aggregate demand. The central bank uses the short-term interest rate to influence longer-term interest rates (Waiquamdee, 2008). Generally, fiscal and monetary policy are coordinated; e.g. if expansionary measures are called for, it is unlikely that the monetary authorities will allow interest rates to rise very much (Laokulrach, 2011).