A Study on Macroeconomic Effect of Fiscal Policy by Sign Restrictions VAR

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Abstract

We use sign restrictions to identify fiscal policy for a small open economy in the Taiwanese case. We follow Mountford and Uhlig(2009) and Ho and Yeh(2009) to identify aggregate supply shock, monetary policy shock, aggregate demand shock, and government spending shock. We find that the response of private consumption to government spending shock is positive. Government spending will induce crowding-out effect in private investment in the short run, but will increase private investment in the midterm and long run. Government spending shock also induces short-term interest rate increase, so that foreign capital flows into domestic country to make real effective exchange rate increase and then trade balance decrease. When we divide government spending into government consumption spending and government investment spending, Government consumption spending shock has significant effect on real GDP, but government investment spending seems not contribute to real GDP too much.

Key words: small open economy · structural VAR · sign restrictions · fiscal policy shocks

JEL: E62 · H61 · J24
1. Introduction

Macroeconomists generally agree that monetary policy can lower inflation and stabilize the business cycles. However, the effectiveness of fiscal policy on stimulating economy remains to be doubtful. As the world enters recession as a result of the financial crisis in 2007, many countries have introduced stimulating policies. The effectiveness of fiscal policy once again is broadly discussed, especially during this zero-bound interests rate period. The effectiveness of fiscal policy then has become the center of attention towards researchers and policy makers.

Taiwanese government usually employ expansionary fiscal policy during the economic downturn to stimulate the economy. For example, the Executive Yuan introduce the “8100, Taiwan Start” policy in 2001 when the world economy is hit by the tech bubble in the United States that leads to a economic downturn throughout the world. Taiwan also suffer in terms of a negative growth of GDP. Moreover, the Executive Yuan bring out the “Stimulating Infrastructure Investment Plan” that runs for four years with 500 billion NT dollar, raise the income tax deductable allowance, lower the corporate income tax and provide tax exemption for new investment for the first five years to cope with the financial crisis in 2008. The goal is to increase the domestic demand, create new jobs and stimulate economy. Therefore, how effective the fiscal policy works is being carefully scrutinized.

However, how should the effectiveness of the fiscal policy be evaluated? How do we know if the increase of government expenditure has actually stimulated the economy? What are the effects of tax cut on macro economy? How do the effects of the fiscal policy being delivered and transferred?

The common measurement of monetary policy: Structural Vector Autoregressive, SVAR is widely used to evaluate the overall effectiveness of the fiscal policy on
macro economy. In order to make the SVAR model meaningful, some identification restrictions have to be added to the reduced form Vector Autoregressive, VAR model to identify structural shocks. Some of the methods to evaluate the shocks of the fiscal policy are: adding recursive structure to the VAR model and use the Choleski decomposition to identify the fiscal policy shocks. This way it can eliminate contemporaneous relation among variables, for example: Fatás and Mihov (2001), or use the institutional information to regulate the parameter matrix to identify the policy shocks. Blanchard and Perotti (2002) employ the taxation, transfer payment, taxing period, fiscal policy decision implementation lags to develop the automatic response to the economic system in order to identify the fiscal policy shocks. Another alternative is to use Ramsey and Ramsey’s (1989) Narrative Approach to apply on the fiscal policy analysis. Adding dummy variables to the VAR model to capture the active response from a large scale and one time tax or government expenditure to identify the fiscal policy shocks. For example, the documentations from Ramsey and Shapiro (1998), Eidelberg, Eichebaum and Fisher (1999; 2003) employ the dummy variables method to capture the military arsenal expansion of the Korea War and Vietnam War as well as the expansionary fiscal policy of the Regan regime. However, the above methods are criticized by the fact that the identification restriction is not clear enough or ad hoc.

1 Blanchard and Perotti (2002) think this method is suitable for fiscal policy evaluation for two reasons: (1). Unlike monetary policy, there are many variables in fiscal policy. Output stabilization is the predominant reason, in other words, many fiscal shocks are resulted externally (for output) (2). The implementation lags for fiscal policy decision and implantation compared to monetary policy means that fiscal policy to unexpected economic activities is less or without discretionary responses in a lengthy period of time (for example: in one quarter) (discretionary responses) –

2 The choice for fiscal policy variables reflects the researchers’ initial point of views. Blanchard and Perotti (2002) believe the fiscal policy makers affect the aggregate demand through government revenue or government spending changes to further affect the real output.
This paper intends to employ the Sign Restrictions by Mountford and Uhlig (2009) to identify fiscal policy shocks. The Sign Restrictions identify fiscal shocks by imposing Sign Restrictions into the impulse response function instead of directly imposing linear relation on contemporaneous relation between error terms and structural shocks of reduced form VAR model. The Sign Restrictions does not require the number of shocks to be equal to the number of variables. The advantage of this method is to specify the less sign restrictions according to the sign set which most scholars agree on impulse response functions and leave variables which researchers more care about for data to answer.

Mountford and Uhlig (2009) believes that there are three main difficulties for VAR model to identify the fiscal policy: 1. It should be clarified to see whether fiscal policy shocks are resulted from the shocks themselves or from the shocks by fiscal variables to other factors, for example, the automatic response from business cycles or monetary policy shocks. 2. The meaning of fiscal policy shocks has to be defined. 3. There may be a lagging period between the announcement of the fiscal policy and the actual date of its implementation. The announcement may already have impact on the macro economy before the fiscal policy takes place, therefore the use of Sign Restrictions to determine the fiscal policy shock is advocated.

Whether it is in theoretical or empirical literature, the conclusion on macroeconomic effect of fiscal policy is varied, especially to the economic variables such as private consumption, private investment, real wages and employment. In theory, Baxter and King’s (1993) neo-classical Real Business Cycle model, RBC takes the hypothesis that there exists an infinitely-lived Richardian agent and his/her consumption decision is subjected to his/her own intertemporal budget constraints. When government increases its spending and finances it by lump-sum taxes, the present value of income after tax will decrease which results a decrease in wealth that
reduces consumption\textsuperscript{5}. In addition, the labor supply will increase at the given wages level. When in equilibrium, the real wage will decrease, employment will rise and output to increase. If the rise of employment can sustain, the marginal productivity of capital thus will rise, which causes an increase in investment (Gali et al., 2007). In contrast, the traditional IS-LM model views the consumption as a function of contemporaneous disposable income instead of a function of the lifetime income. Therefore when government increases its spending, consumption will increase accordingly. Under the hypothesis that supply of money is fixed, short-term interests rate should rise and consequently private investment to decrease.

In empirical studies, Blanchard and Perotti (2002) have found that government spending shocks do have a positive impact on the output and the government spending multiplier is close to one as they study the effect of the United State fiscal policy after Wars; government revenue (net tax) shocks’ impact on output is negative. An increase of government spending will encourage consumption, but government spending and net tax shocks affect private investment in a negative way. Fatás and Mihov (2001) reach the similar conclusion as they use the Narrative approach to isolate exogeneous events like the Korea War, Vietnam War and the development of military arsenals during the Regan period (Ramey and Shapiro (1998), Edelberg et al. (1999), Burnside et al. (2004) that the results are not similar. An increase in short-term government spending causes the durable goods consumption to decrease and the consumption of non-durable goods to decrease slightly. Investment on construction will dramatically lower while the non-construction investment to rise. Romer and Romer (2007) construct the shocks for government revenue caused by the changes of regulated taxing structure from the Economic report of the president.

\textsuperscript{5} Please refer to Aiyagari el al. (1990), Baxter and King (1993), Christiano and Eichenbaum (1992), Fatás and Mihov (2001).
The conclusion is that an increase in government revenue from tax will cause the GDP, consumption and investment all to fall.

Most studies focus on the influence of the economic impact by fiscal policy in the closed economy and lack studies in the open economy besides Monacelli and Perotti (2006), Ravn et al. (2007). The theory on the impact of fiscal policy in an open economy extends the IS-LM model to the Mundell-Fleming model which predicts that an increase in government spending will increase consumption. Due to the fact that when government spending increases the aggregate demand, the short-term interests rate will rise to further attract foreign capital to inflow to increase the demand of the local currency hence finally result an appreciation of nominal exchange rate. Because of the price rigidity, nominal exchange rate appreciation will cause the real exchange rate to appreciate. The studies that Monacelli and Perotti (2006) on Australia, Canada, England and the United States have proved that an increase in government spending does increase output, consumption, trade deficit that leads to a real exchange rate depreciation.

In Taiwan, Huang Ming-Shaw (2007) has used the VAR model to verify the effectiveness of Taiwanese fiscal policy with variables including government revenue, government spending, real GDP, price level and nominal interest rate. The government revenue and expenditure means the income and expenditure of different levels of government. The price level means the GDP deflator. The interests rate refers to the prime lending rate. The sample is taken from Q1 of 1967 to Q3 of 2005. The study has shown that an increase of government spending shocks does stimulate the growth of GDP in the short-term, but the number turns to negative since the sixth quarter and finally it reaches near zero. Government revenue shocks have a positive impact on the GDP and the impact on real GDP is greater than government spending shocks on the GDP. Moreover, government revenue has a closed and positive
relationship to government spending. In addition, it can be concluded that real GDP is not greatly affected by the fiscal policy byvariance decomposition of real GDP variables.

This paper constructs a small open economy VAR model, using and the Sign Restrictions to identify fiscal policy shocks and to evaluate the macroeconomic effect of Taiwanese fiscal policy. The study has shown that an increase in government expenditure shock has a positive impact on the consumption, a negative impact on the short-term investment and an encouraging impact on the mid to long term investment. The increase in government expenditure results nominal interests rate to rise, foreign capital to inflow, real exchange rate to increase and causes trade surplus to lower. An increase in government expenditure initially will cause real GDP to fall but once it generates domestic investment in the mid to long term, real GDP will be positively impacted. To observe in more detail, it can be concluded that government consumption spending shocks have significant impact on real GDP but it is limited for government investment spending shocks to real GDP.

The order of this paper is as below: the first section is the introduction, the second section to discuss about the information on the changes on government revenue and spending in Taiwan over the years, the third section to describe the model specification as well as the identification of the Sign Restrictions, the fourth section is the empirical results, the fifth section discusses the different component of government spending and final section is the conclusion of this paper.

2. Historical Data Analysis

Figure 1 is the trend of government spending and income from 1981 to 2008. Government spending is defined as government spending plus government investment whereas government revenue refers to the net tax. From figure 1, one can see that
government spending has gone up steadily until Q3 of 1999. In Q2 of 2000, the tech bubble burst in the States puts the economy into a recession and results the GDP to have a negative growth and government spending decreases dramatically. Since Q3 of 1999, government spending tends to lower steadily. Similar to government spending, before Q2 of 2000, except Q1 of 1991, Q3 of 1993, Q4 of 1996 and Q4 of 1999 where net tax decrease substantially from the revision of the taxation law, government revenue tends to rise steadily. Government revenues in Q2 of 2000 and 2003 are in a downturn. Overall, government spending and government revenue tend to steadily rise before 2000 which shows that the government takes a balanced budget fiscal policy. After 2000, one can observe that government spending tends to decrease whereas government revenue steadily rises.

Figure 2 shows the proportion of government spending on GDP and the growth rate of GDP. The ratio of government spending in GDP from 1981 to 1987 is in a downturn trend and it turns a upward trend from 1987 to 1992. However, it turns a downward trend since 1992 on a yearly basis again and the magnitude is greater in this period compared to the ratio between 1981 to 1987. In addition, in Q3 of 1982, Q3 of 1985, Q2 of 1990, Q4 of 1995 and Q3 of 2001, government spending in GDP substantially increase which indicates the economy is in a recovering stage. Government spending in GDP tends to lag in Q3 of 1985 and Q3 of 2001. Compared to the severe downturn of economy in Q3 of 2001, the increase of government spending in GDP relatively is smaller. In the rising economy in Q1 of 1984, Q2 of 1987 and Q1 of 2000, government spending in GDP decreases with the slowdown of economy follows. The figure shows the government spending does seem to reflect the business cycles.
Figure 1: Government Spending and Government Revenue Trend

Figure 2: Trend of Government Spending in GDP and Trend of the GDP Growth rate

Figure 3 demonstrates the trend of government revenue in GDP and GDP growth rate. From 1981 to 1986, government revenue in GDP decreases whereas from 1986 to 1990, it becomes an uptrend. From 1990 to 2003, government revenue in GDP continue to slide until 2003 the ratio gradually turns upward on a yearly basis.
Besides in Q2 of 1990 and Q3 of 1992, government revenue does not seem to reflect the business cycles in an significant way.

Figure 3: Trend of Government Revenue in GDP and Trend of the GDP Growth rate

3. Research Design

3.1. Model Specification and Identification by Sign Restrictions

This study refers to Mountford and Uhlig’s (2009) to build up a small open economy VAR model. The variables include government spending, government revenue, real GDP, private consumption, private investment, trade balance, GDP deflator, M2, short-term nominal interests rates and real effective exchange rates. The sample periods are from Q1 of 1981 to Q3 of 2008. The model includes four lags with no constant or a time trend. The Bayesian approach is used to estimate the VAR model. The advantage of the Bayesian approach is to use more clear ways in

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7 The VAR model that does not include constant number and trend of time may have misspecification problem, but does obtain a steadier result.
concept to draw the error bands for impulse responses. Normal-Wishart’s prior possibility is to set the parameter matrix and the variance matrix so the posterior possibility belongs to Normal-Wishart as well. Drawing 1000 times for the posterior possibility from the reduced form VAR model and every posterior possibility sample has to pass the following Sign Restrictions identification for the structural shocks. To demonstrate the results, show the impulse responses to structural shocks including the 33th, 50th and 67th percentile of the posterior possibility distribution in the error bands for impulse responses.

The research focuses on the impact of the fiscal policy shocks by Sign Restrictions instead of the Sign Restrictions itself. Please refer to the reference for the detail introduction of the Sign Restrictions11. With regard of the identification of the Sign Restrictions on the structural shocks, the research refers to Mountford and Uhlig (2009) and Ho and Yeh’s (2009) method to determine the negative aggregate supply shocks, tight monetary policy shocks, negative aggregate demand shocks and expansionary fiscal policy shocks. The fiscal policy shocks include government spending shock and government revenue shock. Figure 1, the Sign Restriction is to determine the shocks. The Sign Restrictions limits the shock response to every shock before and after K quarter. This paper hypothesizes that K=4, therefore the limiting periods are k=0,1,…,414.

Before one can conclude the response of fiscal policy shocks, aggregate supply shocks, aggregate demand shocks and monetary policy shocks have to be separated first then the three shocks with fiscal policy shocks are to be orthogonal. Due to the fact that government revenue may decrease as a result of economic downturn, if

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9 Refer to Sims and Zha (1999)
10 Refer to the discussion on Sign Restrictions by Paustian (2007) and Fry and Pagan (2007).
11 This paper also uses K=0 and K=2, as well as the samples from Q1 of 1981 to Q4 of 1999 and Q1 of 1990 to Q3 or 2008 to analyze. In order to be brief, readers are welcomed to ask for the analysis result.
business cycle shocks which may come from aggregate supply or aggregate demand is not controlled, misinterpretation may occur so the accuracy of the result is greatly affected.

The definition of aggregate supply shocks is the negative aggregate supply shocks, which means when aggregate supply shocks happen, real GDP and government revenue decrease for four quarters. Price level on the other hand to rise for four quarters. According to the traditional economic theory, when a negative shock takes place, real GDP will fall and price level will rise while government revenue and real GDP both fall to eliminate the impact of automatic response\textsuperscript{16}. What is noticeable is the fact that limitation of aggregate supply shocks fall with respect to government revenue and output is an important hypothesis to determine the fiscal policy shocks: government revenue generated from aggregate supply side business cycle causes output and government revenue to vary in the same direction.

A tight monetary policy shock is to hypothesize short-term nominal interests rate to rise for four quarters while M2 and price level to fall for four quarters when a shock occurs. The same hypothesis has to apply to require monetary policy shocks and aggregate supply shocks to be orthogonal. Ho and Yeh (2009)\textsuperscript{18} point out that the traditional monetary policy only works in a closed economy, not suitable to employ in a small open economy\textsuperscript{19}. Therefore they state that the “correct” identification to evaluate monetary policy shocks in recessionary economic period is, to put into Sign Restrictions’ term, to hypothesize that expansionary monetary policy does not result a fall in short-term nominal interests rate and foreign reserve increases for a certain

\textsuperscript{16} Mountford and Uhlig (2009) do not limit the price of goods because they do not distinguish whether the shocks of economy cycles are from aggregate supply or aggregate demand.

\textsuperscript{18} Ho and Yeh (2009) conclude that tight monetary policy shocks, positive aggregate supply shocks and negative non-monetary aggregate demand shocks.

\textsuperscript{19} Small and opened economic entities always act actively to control short-term nominal interests rate and exchange rate, usually by lowering interests rate or purchasing foreign currencies to provide the liquidity needed on the market. (Berument, 2007)
period of time when a shock occurs. Ho and Yeh’s (2009) method can avoid the three myths in the VAR literature: the Liquidity puzzle which means monetary aggregate rises as interests rate rises (Leeper and Gordon, 1992); the Price puzzle which states that a tight monetary policy shock causes price level to go up instead of drops (Sims, 1992); the Exchange rate puzzle which points out that a tight monetary policy drives exchange rate to depreciate instead of an appreciation (Grill and Roubini, 1995). The identification in this paper, except for some situation in mid to long term time frame that price puzzle occurs, other than that almost the three puzzles mentioned above can be avoided. In addition, in order to easily compare with the literature, Mountford and Uhlig’s (2009) monetary policy shock setting is maintained.

The negative aggregate demand hypothesizes that when a shock occurs, real GDP, government revenue, price level and short-term nominal interests rate to fall for four quarters and the negative aggregate demand shock has to be orthogonal with aggregate supply shocks and monetary policy shocks. Again, government revenue and real GDP decline in the same direction in order to avoid aggregate demand shocks that cause real GDP decline to further lead to the automatic response of government revenue decrease. Furthermore, the traditional theory points out that negative aggregate demand shocks come with a decline in short-term nominal interests rate which can differentiate monetary policy shocks.

The above analysis is to filter the impact of aggregate supply shocks, monetary policy shocks and aggregate demand shocks on the fiscal policy variables. This paper will focus on the impact the fiscal policy shocks have on macro economic variables such as real GDP, trade balance, private consumption, private investment, price level, interests rate and exchange rate. Hence these variables are not limited by the Sign Restrictions so can be answered by data through identifying the structural shocks. Take monetary policy shocks as an example, because other combination of shocks
may have the same result the monetary shocks have, it is necessary to identify other shocks to ensure the result is accurate. Identifying expansionary fiscal policy shocks is to limit the impulse response of the fiscal variables and requires aggregate supply shocks, monetary policy shocks and aggregate demand shocks to be orthogonal. This paper mainly identifies one type of fiscal policy shocks: the government spending shocks. The identification is that when a shock occurs, the reaction of fiscal variable continues for four quarters. The limitation is to exclude the transitory shocks of fiscal variables, for instance, government spending increases for one to two quarters when a shock occurs but starts to decline afterwards.

**Chart 1: Sign Restrictions Identification**

<table>
<thead>
<tr>
<th>Shock Types</th>
<th>Gov’t Spending</th>
<th>Gov’t Revenue</th>
<th>Real GDP</th>
<th>Private Consumption</th>
<th>Private Investment</th>
<th>Trade Balance</th>
<th>GDP Deflator</th>
<th>M2</th>
<th>Interests Rate</th>
<th>Real Exchange Rate</th>
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<td>Aggregate Supply Shock</td>
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<td>Aggregate Demand Shock</td>
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<td>Spending Shock</td>
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### 3.2. Explanation of Data

This paper studies the data in Taiwan from Q1 of 1981 to Q3 of 2008. The macroeconomic variables include: real GDP, trade balance, private consumption and private investment. Monetary variables include: GDP deflator, short-term nominal interests rate, M2 and real effective exchange rate. Fiscal variables include: government spending and government revenue. The real side data is taken from the Quarterly National of Economic Trend by the Statistic department of the Executive Yuan. Trade balance is defined as the difference between import and export in GDP and private investment is the fixed capital less the governmental fixed capital.
Short-term nominal interests rate is replaced by overnight Libor rate. The data for nominal interests rate and M2 is from the Financial Statistics Monthly Republic of China from the Central Bank. The real effective exchange rate uses the narrow real effective exchange rate from BIS.

The fiscal variables, according to Blanchard and Perotti (2002), due to the fact that government revenue and government spending both have impact on GDP, the two variables are not independent. To estimate one’s impact one must consider about the other variable, therefore it is necessary to break up government’s budget into two variables which are government spending and government revenue. Government spending includes: government’s purchase on goods and services which means the sum of government spending and government investment. Government revenue variables are total tax revenue less transfer payment. Total tax revenue includes direct and indirect taxes. Transfer payment includes interest payment. Tax revenue thus refers to net taxes.

In order to compare to other literature, this paper takes Blanchard and Perotti’s definition. Government spending takes government final consumption as the leading example whereas government investment refers to government fixed capital as the leading example. Net taxes refers to the actual weighted average tax revenue in the monthly fiscal statistic report as the leading example. All variables except short-term nominal interests rate, M2 and real effective exchange rates.

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22 There are two types of real exchange rates according to the BIS, narrow and broad. The narrow rate includes the data from 27 economic entities from 1964 and the broad rate includes the data from 52 economic entities from 1994. Use 2000 as the basis point, consider the time change to trade data’s moving weighted average that focuses on manufacturing trade volumes and apply double weighting to capture the trade volume on both sides as well as the third country market competition. Since price of goods is taken into consideration, it can reflect the true value of local currency to foreign currencies. Looking at the changes of absolute data, if the real exchange rate index rises during a certain time frame the local currency depreciates, then the local currency actually appreciates with respect to foreign currencies. Vise versa.

24 The choice for fiscal policy variables reflects the researchers’ initial point of views. Blanchard and Perotti (2002) believe the fiscal policy makers affect the aggregate demand through government revenue or government spending changes to further affect the real output.
exchange rates, take per capita data after X11 seasonal adjusted quarters and realize it by dividing with GDP deflator and then take logization. The definition of variable and its source are explained in the appendix. In addition, by adapting Blanchard and perotti’s (2002) definition of government spending variable as government’s final spending and investment is to isolate the automatic response of government spending to business cycles. This way, government spending variable will not include transfer payment which will automatically anti-business cycles.

4. Empirical Results

4.1. Identifying Structural Shocks

Figure 4 illustrates government spending shocks graphs from figure 4 and 5 and government revenue shocks from the shocks of moving average for four quarters. by using Sign Restrictions. The variables for government spending shockuctuate greatly, therefore the graphs from figure is the identified structural shocks after moving average for four quarters. The three lines represent the impulse responses in the 33th, 50th and 67th percentile out of 1000 samples of posterior possibility for fiscal policy shocks (government spending shocks).

It is impossible to predict future incidents such as earthquakes, typhoons, foot and mouth disease, SARS, change of regime or new tax cut when government plans for next year’s budget. When these unexpected incidents happen, government has to increase or decrease the budget depends on the situation or find special budgetary funds (Lin Shan Kai and Lai Hui Tze (2009)). Therefore this paper will study the additional or reduced budget over the years to represent the actual government spending shocks and compare with the government spending shocks by Sign Restrictions. The government spending shocks by the Sign Restrictions are positive during 1987-1988 and 1991-1992 which refer to the first and second special
budgetary spending for the second highway in Northern Taiwan. The government spending shocks turn to negative from 1993 to 1995 as government emphasizes on “control spending to maintain a healthy budget” and employs the “cost down for central government budgetary spending” in hope to eliminate unnecessary spending and save cost. At the same time, the government looks into the six year development plan and reduce from 775 to 633 items and lowers the total cost from 8,860 billion to 2,900 billion NT dollars and reduce the special budgetary spending for major transportation infrastructure spending phase one and two for 102 billion NT dollars.

During the 1995-1997 positive shocks span, there are the special budget for advanced fighting jets purchase, major transportation infrastructure phase three budget, foot and mouth disease special budget…etc. The 2001-2001 positive shocks is resulted from the special budget for 912 earthquake construction plans. The 2003-2004 positive shocks are from the special budget for SARS and its relief programs while the 2005-2006 positive shocks come from the expansionary public investment budget.

4.2. Impulse Response to Negative Aggregate Supply Shocks

Figure 5 is the impulse response to negative aggregate demand shocks. The response from the chart represents the 33th, 50th and 67% percentile of impulse response routes from posterior possibility out of 1000 sample units. These routes represents the shocks patterns of the posterior possibility which are also the confidence bands of impulse response. The straight lines on the Q4 in the graph means the shocks identified by the Signs Restrictions, therefore it is the impulse response by the Sign Restrictions for the area from Y-axis to this straight line. The identified negative aggregate supply shocks is that real GDP and government revenue will fall for four quarters while price level rise for four quarters. Due to the fact that it
is not limited for the impulse response after four quarters, these responses continue to steadily occur. From Figure 3, when a negative aggregate supply shock within one standard deviation occurs, real GDP will fall for 0.11% and in the long term it stays at -0.06% and the negative response continues. When the shock happens, the government revenue's response to the shocks initially falls to 0.67%, rises to quarter three then continues to fall to -0.58% in quarter six before rising up despite the fact that it still remains in the negative territory. The response of GDP deflator rises 0.07% when a shock happens and turns steadily to negative after the tenth quarter.

This paper focuses on the impulse response for the variables that are not limited by the Sign restrictions. A negative aggregate supply shock within one standard deviation causes the government spending to fall by 0.18% and goes up in the second and third quarter, despite the fact that the numbers are still negative, the mid to long term negative reaction steadily remains in approximately -0.24%. What is interesting is that the response of government spending to negative aggregate supply shocks does not reflect the anti-business cycle from negative aggregate supply shocks. Rather, government cash flow reduces hence government spending decreases when economy enters a recession caused by aggregate supply shocks. An important note is that this paper defines government spending by Blanchard and Perotti’s (2002) definition as government consumption spending plus government investment spending. The reason to define this way is to avoid the automatic response for government spending resulted by business cycle. Therefore, government spending variables do not include the transfer payment for automatic counter business cycle.

The response of private consumption first to fall by about 0.13%, followed by a slight rise from quarter two and seven and remains to be negative for the mid to long term quarter of time. The response of private investment to aggregate supply shocks initially yet insignificantly rises to 0.10%, then it follows to the lowest point which is
about -0.40% in quarter four. After that it starts to have a U shape rebound and remains at around -0.12 in mid to long term. The response of trade balance initially slightly rises to 0.08% and the first quarter reaction is -0.05% which is not significant either. After quarter two, it turns positive followed by back and forth reactions to both positive and negative territory. The response of short-term nominal interests rate’s initially reaction is 0.01% then starts to decline steadily into negative ground. M2’s response initially falls by 0.04% and continues to fall to negative territory due to monetary policy’s possible counter reaction of business cycle. M2 M2’s negative response comes from rise of price level resulted from negative aggregate supply shocks. The response of real effective exchange rate follows short-term nominal interests rate to fall by 0.01% then continue to fall on a steady pace.

4.3. Impulse Response to Tight Monetary Policy Shocks

Figure 6 is the impulse response to tight monetary policy shocks. The definition of monetary policy shocks is to limit monetary policy shocks and aggregate supply shocks to be orthogonal, therefore the shocks represents the unexpected monetary policy shocks which refers to the parts that are not explained for the systematic reactions of aggregate supply shocks. Tight monetary shocks hypothesizes that short-term nominal interests rate goes up, M2 falls and price level falls for four consecutive seasons. From figure 6, a monetary policy shock within one standard deviation causes short-term nominal interests rate to go up by 24.7 basis points and stays positive until quarter twenty five before it turns negative. M2 falls by about 0.07% when a shock happens then the negative response steadily continues. GDP deflator falls by 0.04% initially and falls to the lowest point which is -0.06% in quarter three before turning positive from negative territory in quarter seven.

This paper focuses on the responses of variables that are unlimited by Sign Reactions. The response of real effective exchange rate and short-term nominal
interests rate react the same way to rise 0.28\% when a shock happens. The positive response continues to quarter twenty one then it starts have negative reactions. occurs and it reaches to the lowest point of -.019\% in quarter seven. The scope of the responses small and insignificant. The negative response continues to happen which echoes with Ho and Yeh’s (2009) negative result of real GDP to tight monetary policy shocks. Trade balance’s response varies according to short-term nominal interest rate fluctuation. When a monetary shock happens, negative response significantly occur and a V shape is developed in quarter three, six and nine and turns slight positive after quarter thirty two. Government spending’s response to monetary policy shocks initially goes up 0.04\% and continues to quarter twenty before going to negative grounds. Government revenue’s response is volatile but insignificant. Initially it falls by about 0.23\%, then rises to 0.18\% in quarter one and falls to 0.05\% in quarter two, quarter three it goes back to 0.19\%, after quarter five it steadily stays at -0.08\% and finally it continues to drop further after quarter thirteen.

4.4. Impulse Response to Negative Aggregate Demand Shocks

Figure 7 refers to the impulse response to negative aggregate demand shocks. Negative aggregate demand shocks is defined by hypothesizing that real GDP, government revenue, GDP deflator and short-term nominal interests rates fall for four quarters when a shock occurs. From figure 7, a negative aggregate demand shock within one standard deviation causes real GDP to fall by about 0.15\%, reaches to the lowest point to -0.19\% in quarter one, turns positive but insignificant after quarter seven and continues to the last quarter. Government revenue’s response to negative aggregate demand shocks is similar to real GDP’s which falls by about 0.58\% when a shock occurs, reaches to the lowest point of -0.77 in quarter one, turns positive after quarter eight and continues the last quarter. GDP deflator’s response is to fall 0.06\% initially, reach the lowest point of -0.10\% in quarter two, continue the negative
reaction until quarter thirty seven before turning positive again. Short-term nominal interests rate reacts in a similar fashion to GDP deflator that it falls by 0.20% initially, reaches to the lowest level of -0.29%, continues to remain negative until quarter twenty six then starts to turn positive despite the fact that the scope is still insignificant.

With respect to the parts that are not limited by the Sign Restrictions, the response of private consumption falls by 0.15%, continues to rise modestly and the level of reaction is small and close to zero from quarter twelve to twenty four. After quarter twenty four it turns from negative to positive and continues to swap between negative and positive territories. Private investment initially falls by around 0.43%, reaches to the lowest point of -0.81% before starting to turn up and climbs back to almost zero from quarter seven. Real effective exchange rate has similar response as short-term nominal interests rate that it falls by 0.09% first, reaches to the lowest point of -0.20% in quarter five, continues to be negative before turning positive in quarter twenty eight. Trade balance reacts according to real exchange rates’ response that it goes up by about 0.10% initially, forms a peak around quarter two, continues to have positive reaction before turning negative in quarter thirty. M2 initially slightly declines, starts to turn positive from quarter two significantly and continuously. Government spending has a negative response to negative aggregate demand shocks. When a shock happens, it drops by about 0.12% and continues to quarter twenty three then starts to be positive. Similar to the response of negative aggregate demand shocks, the response of government spending to negative demand shocks does not reflect counter business cycle.

4.5. Impulse Response to Expansionary Government Spending Shocks

Figrue 9 shows the impulse response to expansionary government spending
shocks. The identifying method is to require aggregate supply shocks, monetary policy shocks, aggregate demand shocks to be orthogonal and government spending increases for consecutive four quarters. From figure 8, like the identification this paper sets by Sign Restrictions, a government spending shock within one standard deviation rises to 0.30%, falls and rebounds to form a V shape in quarter two, stays positive until it reaches close to zero in quarter forty. Other variables which are not limited by the Sign Restrictions, the response of government revenue to government spending shocks initially rises by 0.08% then starts to decline. It turns negative insignificantly in quarter one and two but turns positive from quarter three until quarter twenty two when it turns negative again. It can be concluded that government spending shocks are shocks that are to balance the budget from the fact that government spending and government revenue have the similar response pattern to government spending shocks.

The main focus variable: the response of real GDP within one standard deviation, initially rises by about 0.03%, starts to decline and turn negative in quarter three before turning positive again from quarter seven for a lengthy period of time. The response of Private consumption declines by about 0.04% first, then approaches zero for the following three quarters, turns positive after quarter four and remains this way steadily. The response of private investment first declines by approximately 0.18%, reaches a peak in quarter two then starts to fall, drops to the lowest point of -0.25 in quarter five, rebounds to turn negative to positive from quarter eight in a significant and prolonged fashion. From the observation, one can conclude that government spending shocks have the Crowding-out effect on private investment and encourages private investment in mid to long term which eventually brings out the Crowding-in effect. The response of trade balance begins to rise insignificantly by 0.02% then starts to fall from quarter two to the last quarter and always remains negative.
Government spending shock does have a crowding-out effect on trade balance. The response of GDP deflator is significant and continuous. M2 only has a slight response of -0.01% to start which is not significant, turns positive from quarter three until approaching to zero after quarter thirty eight. Short-term nominal interests rate has positive but not stable response where an upside down V shape is developed in quarter three, two smaller peaks in quarter seven and eight and a V shape in quarter nine. The rest of the quarters generally speaking have positive, significant, stable and continuous responses. Finally, real exchange rate has positive and continuous responses.

In general, government spending shocks do stimulate private consumption. Initially it has a short-term crowding-out effect on private investment but an encouraging effect in mid to long-term. These two results echo the conclusion that the neo-Keynes theory has on private consumption and private investment. In addition, as government spending shocks occur, short-term nominal interests rate rises which attracts foreign capital to inflow, increases the demand for local currency, appreciates nominal exchange rates as well as real exchange rate. Furthermore it makes trade deficit worse so one can conclude that government spending shocks have the Crowding-out effect on trade balance in a large and significant fashion. Lastly, Underexisting the Crowding-out effect on short-term private and the effect of the crowded out trade balance, government spending shocks are able to stimulate real GDP in short-term but turns negative from quarter three. However, the reactions do turn positive in mid to long-term. Huang Ming-Shaw’s (2008) research suggests that government spending shocks do have encouraging and stimulating effects on GDP in the short-term but turns negative from positive since quarter six and eventually reaches close to zero. In addition, Monacelli and Perotti (2006) and Ravn et al. (2007) have studied the data of government spending effect from Australia, Canada, England
and the United States. The finding concludes an increase in government spending does increase output and consumption; however, trade balance will be worsening and the real exchange rate to depreciate. This paper on the other hand, finds that real exchange rate appreciates.

4.6. Fiscal Policy Multiplier

Researchers often use the scale of multiplier to compare effects of fiscal policies. The ratio for a change in GDP over an initial change of a fiscal variable in a certain period of time is defined as the multiplier (such as Blanchard and Perotti, 2002; Canova and Pappa, 2007). Mountford and Uhlig (2009) defines as below:

\[
\text{GDP multiplier} = \frac{\text{GDP response}}{\text{Initial Fiscal Policy Shocks}} \quad (\text{the ratio that fiscal policy variables to GDP})
\]

This paper takes Blanchard and Perotti’s (2002) fiscal policy variables definition, applies Mountford and Uhlig’s (2009) analytic method and compares the fiscal policy multipliers from the two researches. Chart 2 is the government spending multiplier chart.

With respect to government spending shocks, Mountford and Uhlig’s (2009) government spending multiplier is less than Blanchard and Perotti’s (2002), but the maximum government spending multipliers for both researches happen in quarter one which means when a shock occurs, maximum government spending multipliers appear before gradually decrease over time. This paper has a different finding that the maximum government spending multipliers appear in quarter thirty five. When a shock occurs, the government spending multiplier is only 0.39 and it gradually increases over time.

<table>
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<th>Chart 2</th>
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### Lee et al.

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### Mountford and Uhlig

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### Blanchard and Perotti (2002)

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## 5. Other Government Spending Shocks

This paper defines government spending as government’s consumption spending and government investment spending to replace government spending variables in order to find out the response of government consumption spending shocks and government investment spending shocks.

Figure 9 shows the impulse response to government spending shocks. It is also necessary to require government consumption spending shocks to be orthogonal with aggregate supply shocks, monetary policy shocks and aggregate demand shocks. Government consumption spending shock assumes government consumption spending increases and the shocks continue for four quarters. From the figure, one can find that government consumption spending rises by 0.35% by a government consumption spending shock within one standard deviation and the positive response continues in mid to long-term. The variables that are not limited by the Sign Restrictions like government revenue drop by insignificant 0.01%, turn positive after quarter two and become negative after quarter thirty four. Real GDP’s response to government consumption spending shocks is to rise by 0.04% initially and stays around 0.11% in mid to long-term. Private consumption first slightly drops by 0.04%,
turns positive after quarter two and continues to be positive. Private investment lowers by 0.20% initially and the negative response stays volatile in the short-term, becomes positive after quarter seven and stays at around 0.17% in mid to long-term period of time steadily. Trade balance’s response begins with a rise of 0.06%, falls to negative territory and continues to be negative in mid to long-term steadily. Although M2’s response shows in a negative fashion to government consumption spending shocks initially, it turns positive after quarter three. Price level also responses positively to government consumption spending shocks. The impulse response of short-term interests rate slightly lowers by 0.02% which is not significant, the positive response fluctuates before quarter ten and the positive response gradually eases after quarter fifteen. Real effective exchange rate consistently has positive response to government consumption spending shocks.

Figure 10 is the impulse response to government investment spending shocks. The definition of government investment spending shocks is the same as the government consumption spending shocks. From the figure, one can see that the response to a government investment spending shock within one standard deviation rises by 0.47%, continues the positive until quarter twenty two and eventually reaches close to zero. Variables that are not limited by the Sign Restrictions like government revenue rise by 0.04% then turns negative by 0.15%, becomes positive again after quarter three before turning to negative territory again until quarter eighteen. Read GDP’s response does not change much and fluctuates around zero. The error band in 33% and 67% consist of zero which shows that real GDP indeed does not react much to government investment spending shocks. Private consumption initially drops by 0.07% and turns positive consistently after quarter six. Private investment lowers by 0.28% first and turns to a positive response after quarter seventeen despite the fact that the scale is not big. Trade balance’s response goes up
by about 0.03% and turns to negative after quarter three consistently. Price level in short-term stays negative and turns positive response after quarter four. M2 initially also responses in a negative fashion, turns positive after quarter two until quarter thirty five where the response becomes negative again. Short-term interests rate responses positively for the first ten quarters with significant fluctuation and turns negative after quarter thirty two. Real effective exchange rate besides quarter three which drops slightly generally speaking reacts positively. It turns to a negative reaction after quarter thirty five.

Compare to government investment spending shocks, the response to government consumption spending shocks is milder initially but last longer. This paper focuses on real variables; governments consumption spending shocks and government investment spending shocks both have stimulating effects on private consumption. Government consumption spending shocks have a better and more significant effect on private consumption. In the short-term, government consumption spending shocks and government investment spending shocks both create the crowding-out effect on private investment but the crowding-out effect of government investment spending shocks (-0.27%) is greater than the crowding-out effect of government consumption spending shocks. In the long-run, government consumption spending can encourage private investment (the Crowding-in effect) but government investment spending does not have a significant impact on long-term private investment. Government consumption spending shocks and government investment spending shocks both drive nominal short-term interests rate and real exchange rate to go up which creates a crowding-out effect to trade balance that leads to a decrease in trade balance. Moreover, government consumption spending shocks have substantial effect on stimulating real GDP whereas government investment spending shocks have limited positive impact on real GDP.
6. Conclusion

We use sign restrictions to identify fiscal policy for a small open economy in the Taiwanese case. We follow Mountford and Uhlig(2009) and Ho and Yeh(2009) to identify aggregate supply shock, monetary policy shock, aggregate demand shock, and government spending shock. We find that the response of private consumption to government spending shock is positive. Government spending will induce crowding-out effect in private investment in the short run, but will increase private investment in the midterm and long run. Government spending shock also induces short-term interest rate increase, so that foreign capital flows into domestic country to make real effective exchange rate increase and then trade balance decrease. When we divide government spending into government consumption spending and government investment spending. Government consumption spending shock has significant effect on real GDP, but government investment spending seems not contribute to real GDP too much.
Figure 4

Structural Government Spending Shocks
Impulse Responses to Business Cycle Shocks

Figure 5
Impulse Responses to Monetary Policy Shocks

Figure 6
Impulse Responses to AD Shocks

Figure 7
Impulse Responses to Government Spending Shocks

Figure 8
Figure 9. Government Consumption Spending Shocks
Figure 10. Government Investment Spending Shocks
Reference

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