UNIVERSITY OF
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ANALYSING THE EFFECTS OF FISCAL POLICY AND ASSESSING ITS SUSTAINABILITY

By

KWANG JO JEONG

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Department of Economics
Business School
The University of Birmingham
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ABSTRACT

This thesis presents three empirical analyses related to the macroeconomic effects and sustainability of fiscal policy. Using a sequence of econometric models, three key issues concerning fiscal policy are examined.

The first issue is related to the transmission mechanism for fiscal policy shocks in Korea. VAR models are employed to evaluate the macroeconomic effects of fiscal policy shocks on GDP and the labour markets. The second issue is the sustainability of government debt in three selected countries (Korea, the United Kingdom, and the United States). Several different approaches, such as Johansen's cointegration tests, ARDL bounds tests, and Bohn's fiscal reaction function tests, are employed to check the existence of long-run equilibrium between the variables. The third issue is concerned with the effects of fiscal consolidation on macroeconomic activity. A dynamic panel GMM model is used to examine whether fiscal consolidation has positive effects on GDP and a panel probit model is used to investigate the main determinants of the successful fiscal consolidation that reduce the debt-to-GDP ratios.

The main findings of the thesis are as follows. First, government spending has a positive effect on output and its components. In particular, current government spending has a negative effect on private consumption, while capital government spending has a positive effect. When it comes to the labour market, each type of government spending has a positive effect. However, capital government spending is likely to boost the labour market more effectively than current government spending. Meanwhile, a net tax rise causes a significant fall in output but shows ambiguous effects on the labour market. Second, according to the results of Johansen's cointegration tests and ARDL bounds tests, there is a cointegrating

relationship between the variables in Korea and the US, but not in the UK. That means fiscal policy in Korea and the US is sustainable, while fiscal policy in the UK is not. A modified Bohn's tests, which estimate the response of primary surplus to government debt, also support the above conclusion. Third, the estimation results show that fiscal consolidation is not likely to be expansionary in terms of GDP growth. The results also show that fiscal consolidation in time of high debt-to-GDP ratios, the spending-base, or high sovereign risk has fewer negative effects on economic growth than fiscal consolidation in time of low debt-to-GDP ratios, the tax-base, or low sovereign risk. The economic growth rate, government spending-based fiscal consolidation, low long-term interest rates, and higher sovereign risk have significant effects on reducing debt-to-GDP ratio. By contrast, the results suggest that the size of fiscal consolidation, exchange rates, and unemployment rate have positive but statistically insignificant effects on reducing debt-to-GDP ratio.

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ABBREVIATIONS

ABFC	Action-Based Fiscal Consolidation
AIC	Akaike Information Criteria
ADF	Augmented Dickey-Fuller unit root test
ARDL	Autoregressive Distributed Lag
BEA	Bureau of Economic Analysis in the US
BFI	Blanchard Fiscal Impulse
BOK	Bank of Korea
CAPB	Cyclically Adjusted Primary Balance
CRS	Constant Returns to Scale
DOLS	Dynamic Ordinary Least Square
ECB	European Central Bank
ECM	Error-Correction Model
FCE	Fiscal Consolidation Episodes
FE	Fixed Effect panel model
FILPs	Fiscal Investment and Loan Programmes
GDP	Gross Domestic Product
GFS	Government Finance Statistics
GMM	Generalised Method of Moment
HP filter	Hodrick-Prescott filter
HQ	Hannan-Quinn information criteria
IBC	Inter-temporal Budget Constraint
IFS	International Financial Statistics
IID	Independent and Identically Distributed
IIR	Institutional Investor Ratings
ILO	International Labour Organization
IMF	International Monetary Fund
I(n)	Integrated order of n

KPSS	Kwiatkowski, Phillips, Schmidt and Shin
KRW	Korean Won
LHS	Left-Hand Side
LR	Likelihood Ratio
MOEL	Ministry of Employment and Labour
MOSF	Ministry of Strategy and Finance (in Korea)
NPC	Non-Ponzi Condition
NPF	National Pension Fund
NPIs	Non-Profit Institutions
OECD	Organisation for Economic Co-operation and Development
OLS	Ordinary Least Square
PD	Primary Deficit
PP	Philips-Peron unit root test
PPP	Purchasing Power Parity
PS	Primary Surplus
RBC	Real Business Cycle
RE	Random Effect panel model
RHS	Right-Hand Side
S.E	Standard Error
SIC	Schwarz's Information Criterion
SVAR	Structured vector autoregressive
TC	Transversality condition
TS	Total Surplus
UECM	Unrestricted Error-Correction Model
UNR	Unemployment Rates
VAR	Vector Autoregressive
VECM	Vector Error-Correction Model
WEO	World Economic Outlook
Δ	Changes or first differences

CHAPTER 1

INTRODUCTION

Chapter 1. Introduction

1.1 Motivation and Research Questions

The macroeconomic effects of fiscal policy shocks and the sustainability of public debt have long been fundamental issues addressed by macroeconomic researchers and fiscal policy makers; and these issues have become the focus of new attention since the great recession of 2008. Most advanced countries have used stimulus packages to boost the economies in recession since 2008. Apart from quantitative easing monetary policy, many governments have relied on active fiscal policy, such as government spending and tax exemption, to address the global economic turmoil.

However, these large-scale expansionary fiscal policies have faced a strong challenge due to the steep rise in the fiscal deficit and the government debt. For instance, many Eurozone countries, such as Greece, Spain, Portugal, Italy, and Ireland, suffered a fiscal crisis following the financial crisis in 2008. So, by early 2010, certain countries were starting to think about an exit from expansionary fiscal policy. As an exit strategy, many European countries chose to implement fiscal austerity measures to address the fiscal crisis, even though there was a concern that macroeconomic activity might be harmed and the unemployment rate might remain high for a while. After a number of years of large budget deficits and rapid public debt-to-GDP ratio rises, many countries, such as the UK, Denmark, and Ireland, claimed that the stability of public debt was necessary for a sustainable economic growth and recovery from economic recession in the long run. This idea was supported by economists such as Alesina and Adagna who thought immediate deficit reduction was a

necessary precondition of economic growth. Alesina and Adagna (2010) insist that today's deficit becomes tomorrow's debt, which causes fiscal crisis, including government defaults, and there can be no sustained economic growth without balancing the government budget.

But, huge concerns about the effectiveness of European countries' fiscal consolidation policies have been raised by many economists (Krugman, 2010; Baker, 2010). For instance, Krugman (2010) strongly disagrees with the idea that the fiscal consolidation will have an expansionary effect and argues that non-Keynesian effects are based neither on evidence nor on careful analysis. He criticises fiscal consolidation in a recession period with such words as 'the austerity debacle', 'the myth of austerity' and 'Europe's economic suicide'. Baker (2010) thinks that the deficit should be tightened eventually, but that timing is the important thing. He argues that shrinking a deficit by cutting government spending or raising taxes in a serious economic recession causes a much deeper recession by reducing aggregate demand.

Based on the above background, this research focuses on the issues of fiscal policy. In doing this, it addresses crucial questions concerning the effects of fiscal policy shocks and the sustainability of public debt using an empirical approach. The main research questions are as follows. (1) Can a government's expansionary fiscal policy improve recessionary economic condition in a country? (2) If so, is it possible for a government to increase government spending permanently to boost its economy without ever having to worry about its public debt-to-GDP ratio? (3) Does fiscal consolidation have an expansionary effect on economic activity? (4) If fiscal consolidation is a necessary evil to reduce the public debt, what are the main determinants to decrease the public debt-to-GDP ratio?

1.2 Short Reviews of the Literature

1.2.1 Theoretical Views

As for the effects of fiscal policy shocks, the definitive facts about these effects have not yet been established from a theoretical point of view. Meanwhile, two main theoretical views have been put forward: the new Keynesian approach and the neoclassical approach.

As a response to government spending shocks, the new Keynesian approach predicts an increase in private consumption and in the real wage, while the neoclassical approach predicts the opposite. These quite different conclusions are due mainly to assumptions which are based on different perceptions of reality. The neoclassical approach assumes perfectly competitive markets, perfectly flexible prices, constant returns to scale (CRS) in production function, and no credit constraints. A temporary or permanent bond-financed increase in government consumption raises the same amount of discounted value in future taxes under inter-temporal government budget constraints (Baxter and King, 1993). A negative wealth effect caused by the increase in future taxes reduces private consumption and raises labour supply[1]. The shift out of labour supply causes a decline in the real wage with a given labour demand curve. By contrast, the new Keynesian approach assumes nominal price rigidities and monopolistically competitive firms in good markets. These features cause firms to increase labour demand when there is extra government consumption, which produces additional output. The increase in labour demand raises the real wage, which triggers an increase in private consumption, based on a 'rule-of-thumb consumers[2]' assumption (Galí *et al*., 2003).

[1] It assumes that people choose to work harder with reducing consumption to address the increase in future taxes.
[2] According to 'the rule-of-thumb consumers' assumption, many consumers spend within a budget constraint of labour income without using credit markets. Therefore, the increase in the real wage raises private consumption.

As for net tax shocks, most economists agree that higher tax rates may cause a decrease in economic output, and lower growth rates in the short term. But, in the long term, there are several different views on the growth effects of net tax shock. For instance, Lucas (1990) and Zou (1996) insist that fiscal policies have no long-run growth effects, whereas Rebelo (1991), Jones *et al*. (1993), and Hendricks (1999) argue that higher taxation has permanent negative effects on economic growth and the elimination of distorting taxes raises growth rate significantly.

Lastly, there exists a similar theoretical controversy about the effects of fiscal consolidation. The neoclassical view suggests 'non-Keynesian effects': that is, that the fiscal consolidation stimulates economic activity even in the short run. The non-Keynesian effects can be explained by several channels, such as wealth effects, confidence effects, and spill-over effects. For example, the reduction in the interest rate caused by government spending cuts can stimulate private investment directly, and lead to an increase in private consumption indirectly through a positive wealth effect[3] in the private sector (Giavazzi and Pagano, 1990). The expectation of a future tax decrease owing to government spending cuts may also increase private consumption and investment (Bertola and Drazen, 1993). The increase in the confidence of investors after credible fiscal consolidation may enhance private investment as well. Moreover, public sector wage cuts may lead to wage cuts in the private sector, which is called a spill-over effect in the labour market. This finally increases competiveness due to the labour cost reduction and improves productivity in the private sector, which results in a GDP increase. By contrast, the new Keynesian view casts doubt on the theoretical support for the non-Keynesian effects mentioned above and insists that fiscal consolidation inevitably

[3] The low interest rate may increase the wealth of the private sector by reducing the burden of interest payment.

contracts aggregate demand and reduce GDP. This view maintains that if an economic performance gets better after government spending cuts or tax rises, it is due to a pick-up in the business cycle or more expansionary monetary policy taking place at the time. For example, Krugman (2010) strongly denies the expansionary effects of fiscal austerity measures and insists that the fiscal reductions will lead European countries into further economic decline and the higher unemployment rate. Baker (2010) and Cottarelli and Keen (2012) also support Krugman's idea that too rapid and extreme fiscal consolidation would damage economic growth directly.

In terms of the sustainability of public debt, theoretically, this can be explained through the equation of the inter-temporal budget constraint (hereafter IBC). According to the IBC, public debt is sustainable if it is on a trajectory such that the expected present value of future primary surpluses equals the initial public debt. This is based on the condition that the expected present value of the future stock of public debt finally converges to zero (Afonso and Rault, 2010).

1.2.2 Empirical Evidence

The aforementioned theoretical rationales would be more convincing if they were supported by some empirical evidence. As for the effects of fiscal policy shocks, there are two streams of empirical research. The first explores the effects of fiscal expansion, and the second explores the macroeconomic effects of fiscal consolidation. The results of empirical studies vary depending on the methodology used to identify discretionary fiscal policy shocks. As for the sustainability of public debt, there are three strands of empirical studies based on the unit root tests, the cointegration tests, and Bohn's fiscal reaction function test.

There are two main approaches to identifying discretionary fiscal expansion: the structural vector autoregression (hereafter the SVAR) approach; and the narrative approach.

The SVAR approach identifies discretionary (exogenous) fiscal policy shocks by imposing restrictions on the model based on economic theory or institutional features. This makes it possible to estimate the size and persistence of fiscal policy effects by using impulse response functions avoiding the theoretical debate. This approach has been widely used due to these advantages, despite the results being highly sensitive to the assumptions or information used. To address the criticism that the SVAR approach is likely to identify fiscal shocks which are not actually exogenous, the narrative approach has been suggested. The narrative approach tries to identify abnormal fiscal events that can be safely regarded as exogenous fiscal shocks. For example, three large post-WW2 military build-ups (1950Q3, the Korean War; 1965Q1, the Vietnam War; and 1980Q1, the Reagan build-up) in the US are used as dummy variables (Ramey and Shapiro, 1997). However, these military build-ups also have some limitations in that they are not frequently experienced episodes, except in the US, and a few military build-ups cannot properly capture the effect of fiscal spending in the years leading to the military build-ups. Once a number of non-fiscal shocks hit the economy during the time of military build-up, the analysis of the narrative approach may lead to totally different results. Moreover, the usage of dummy variables values for each shock equally does not seem to make sense.

Likewise, there are two main approaches to identifying fiscal consolidation: the approach based on the cyclically-adjusted primary balance (CAPB); and the approach based on policy action. The CAPB-based approach identifies fiscal consolidation episodes using changes in the CAPB which may reflect policymakers' decisions to adjust taxes and

government spending. Most of the literature (Alesina and Perotti, 1995; Giavazzi and Pagano, 1996; Alesina and Ardagna, 1998, 2010, 2012; Afonso, 2010) has used this approach, even though there are some differences in defining the changes to the CAPB. Recently, some literature has cast doubt on the reliability of the CAPB-based approach. The main criticisms are that it can be affected by asset price cycles (Girouard and Price, 2004), one-off measures which do not reflect the overall policy stance (Von Hagen and Wolff, 2006), and measurement issues surrounding the output gap (Guichard *et al*., 2007). To address the shortcomings of the CAPB-based approach, the policy action-based approach (or narrative approach) is used to identify fiscal consolidation episodes (IMF, 2010; Leigh *et al*., 2011). This approach identifies fiscal consolidation episodes directly from historical documents such as budget reports, presidential speeches, central bank reports and congressional reports.

Empirical studies of the sustainability of public debt have been developed to find the proper way of satisfying IBC. Most of the early literature tries to test the stationarity of public debt by using unit root tests (Hamilton and Flavin, 1986; Wilcox, 1989). After that, cointegration tests between government expenditures and revenues were been widely used (Trehan and Walsh, 1991, 1998; Hakkio and Rush, 1991; Quintos 1995). However, more recently, Bohn (1991, 2007) suggests an alternative test, casting doubt on the validity of traditional sustainability tests, such as unit root tests and cointegration tests[4]. He focuses on finding out whether governments react by adjusting their primary surplus to match the changes in public debt, assuming that public debt is sustainable if the primary surplus increases when the public debt picks up.

[4] Bohn insists that the sustainability of the debt by itself cannot provide decisive evidence on sustainability and the lack of cointegration between the variables does not prevent the series' consistency with IBC.

1.3 Focus of Study and Methodology

This thesis presents three empirical studies related to the macroeconomic effects of fiscal policy and the sustainability of public debt. Using a sequence of empirical models, three key issues concerning fiscal policy are examined and the policy implications of the empirical findings are also suggested.

Chapter 3, the first empirical study, relates to the transmission mechanism for expansionary fiscal policy shocks in Korea. In particular, a three variable SVAR model, based on Blanchard and Perotti (2002), is applied to measure the magnitudes of fiscal multipliers with aggregated fiscal data following fiscal policy shocks. Then, considering the limitations of estimating the effects of aggregated data with a SVAR model, an extended VAR model is used to evaluate the macroeconomic effects of disaggregated fiscal data.

Chapter 4, the second empirical study focuses on the sustainability of public debt in the three selected countries (Korea, the UK, and the US), and several different models, such as Johansen's cointegration tests, ARDL bounds tests, and Bohn's fiscal reaction function tests, are employed to estimate the long-run equilibrium between the variables.

Chapter 5, the third empirical study, measures the effects of fiscal consolidation on economic activity. Two sub-issues are investigated: the existence of expansionary fiscal consolidation, and the main determinants of successful fiscal consolidation. The analysis uses panel data from 18 OECD countries. Dynamic panel data analysis is used to confirm whether fiscal consolidation has positive effects on GDP growth, and a panel probit model is used to find the determinants of successful fiscal consolidation that reduces the public debt.

1.4 Contributions

This thesis discusses the macroeconomic effects of fiscal policy shocks and the sustainability of fiscal policy. The central questions are whether various fiscal policy shocks have promoted economic activity or caused it to contract, and how to measure the sustainability of public debt without error. As might be expected, there are no definitive answers to such grand questions, but meaningful insights have been found to guide effective policy decision-making and further research in the future.

The third chapter contributes to mapping in detail the transmission mechanism for fiscal policy shocks in Korea. There has not been any major study of the effects of fiscal policy shocks using emerging market data like that of Korea. Moreover, many of the debates on fiscal policy shocks in Korea have focused only on the GDP effects of aggregated fiscal variables without thinking of the labour market effects. However, it is of great importance to see the macroeconomic effects (including the labour market) of disaggregated fiscal variables in order to undertake more sophisticated and elaborate fiscal policy decision-making. The loss of effective estimation and testing power caused by using aggregated fiscal variables can be extremely large (Orcutt *et al.*, 1968). We have to pay attention to the labour market to check whether the government spending shocks do have positive effects on employment and wages, which finally enhance the welfare of the private sector. There exists the possibility of jobless recovery after the fiscal policy shocks. Recovery without creating job in the economy can devalue the effectiveness of fiscal policy. So, the third chapter tries to shed light on the intrinsic transmission mechanism for fiscal policy shocks by categorising fiscal variables into their sub-components. Moreover, this chapter extends the scope of the effects of fiscal policy

shocks by adding labour market variables, along with GDP. In other words, this chapter contributes to the literature by estimating the macroeconomic effects of both aggregated and disaggregated fiscal policy shocks on GDP and the labour market. The central message of this chapter is that different components of government spending and revenues have different effects on macroeconomic variables.

The fourth chapter contributes several points to the development of the debate on the sustainability of public debt. First, considering the existence of non-stationary variables in the model, the ARDL bounds tests are added to investigate the cointegrating relationship between the variables, which is essential to secure the sustainability of public debt. Second, the original Bohn's fiscal reaction function model is modified using dynamic ordinary least squares (DOLS) methodology in order to consider non-stationary data and to avoid the spurious regression problem. Finally, by examining the sustainability of public debt using various methods, the robustness of the empirical study is greatly improved.

The fifth chapter contributes to uncovering the effects of fiscal consolidation on GDP growth and the main factors responsible for successful fiscal consolidation. This chapter investigates whether fiscal consolidation can boost depressed economies. In particular, it estimates the effects of fiscal consolidation considering the role of several factors, such as the debt-to-GDP ratio, the composition of fiscal consolidation, and sovereign risk. This chapter also investigates the conditions under which a fiscal consolidation is effective in reducing public debt using an extended panel dataset from 18 OECD countries and a longer time period: from 1978 to 2011. It is notable that, unlike many previous studies, this chapter addresses the endogeneity problem in the analysis by using a dynamic panel data analysis model.

1.5 Organization of Chapters

This thesis consists of six chapters, and is organised as follows. The first chapter introduces the thesis and sets the scene for the three main research chapters. After suggesting the motivation for the research, short reviews of the literature and the methodologies are given in sequence. The focus of the study in each chapter and its contributions to the literature are also mentioned. The second chapter sheds light on the Korean economy, focusing on economic development, the size of government finance and fiscal soundness. Most of the indicators described in this chapter will be used in the three main empirical chapters. The third chapter analyses the transmission mechanism of fiscal policy shocks to macroeconomic activity in Korea. The fourth chapter reviews the sustainability of public debt in three selected countries - Korea, the UK, and the US. The fifth chapter presents the macroeconomic effects of fiscal consolidation and the main factors responsible for successful fiscal consolidation – those which decrease the debt-to-GDP ratio. Finally, the last chapter concludes the thesis with key findings and implications for fiscal policy making, mentioning the limitations of the research and indicating directions for future study.

CHAPTER 2

REVIEW OF THE KOREAN ECONOMY

Chapter 2. Review of the Korean Economy

2.1 Introduction

According to World Development Indicators (2011), Korea ranks fifteenth in the world economy by nominal GDP and twelfth by purchasing power parity (PPP). It has been a member of the OECD since 1996. Despite the lack of natural resources, being a small territory, and having a tiny domestic market, Korea has achieved impressive economic growth and extensive social development out of the ashes of the Korean War in 1950.

The most significant factor in the country's rapid economic growth is the adoption of an export-oriented economic strategy. Active fiscal policy has played a significant role in this process as well. At the same time, many efforts have been made to maintain fiscal soundness to avert a possible sovereign default risk. As of 2010, the level of government debt in Korea is one of the lowest among the OECD countries.

This chapter describes the main economic variables, which will be used later in the empirical analysis. That is, it sheds light on the development of the main macroeconomic indicators and fiscal policy factors in the Korean economy. This analysis covers the period from 1972 to 2010. The datasets are collected mainly from the International Financial Statistics (IFS) and Government Finance Statistics (GFS) of the International Monetary Fund (IMF), the Ministry of Strategy and Finance (MOSF), and the Bank of Korea (BOK).

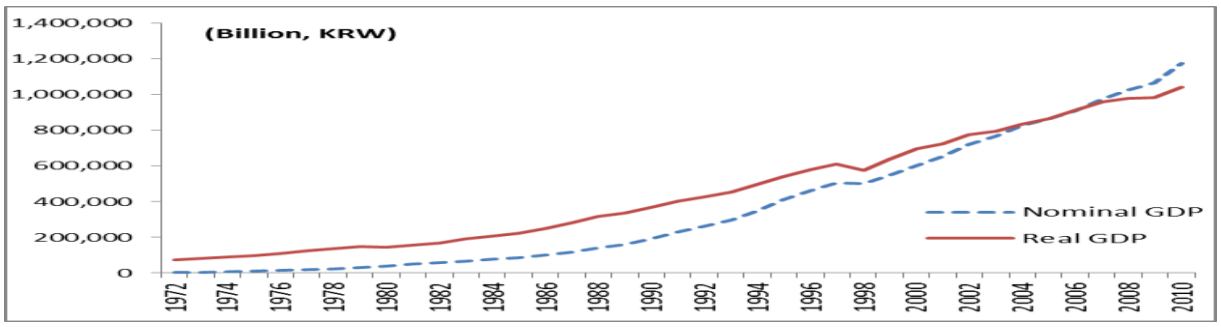
The rest of this chapter is organized as follows. Section 2.2 discusses economic development of Korea. Section 2.3 and 2.4 show the structure and size of government finance. Section 2.5 considers the fiscal soundness of Korea. Section 2.6 shows episode of fiscal consolidation. Section 2.7 concludes.

2.2 Economic Development of Korea

2.2.1 The Trend of GDP

In the last four decades, Korea has achieved tremendous economic growth. It has grown from one of the poorest countries in the world in the mid-twenty century, after the Korean War, into a global economic player with a solid industrial base. Korea has experienced a very high level of economic growth. Figure 2.1 shows that real GDP has increased significantly during the last four decades.

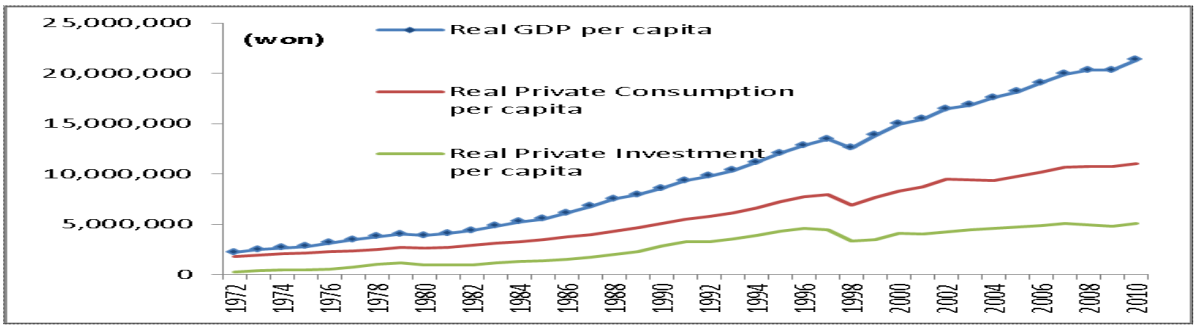
Figure 2.1 Trend of GDP in Korea



Note : Real GDP transformed from nominal GDP by dividing with IMF's GDP deflator (2005=1)

Figure 2.2 illustrates changes in the sub-components of GDP: private consumption and investment in real terms. These decreased significantly in the 1997 Asian Financial Crisis and the 2008 Global Financial Crisis.

Figure 2.2 Real GDP per capita and its components



2.2.2 GDP Growth

GDP growth rates in Korea have been fairly positive except for three periods - 1980, 1997, and 2009 - during the last four decades.

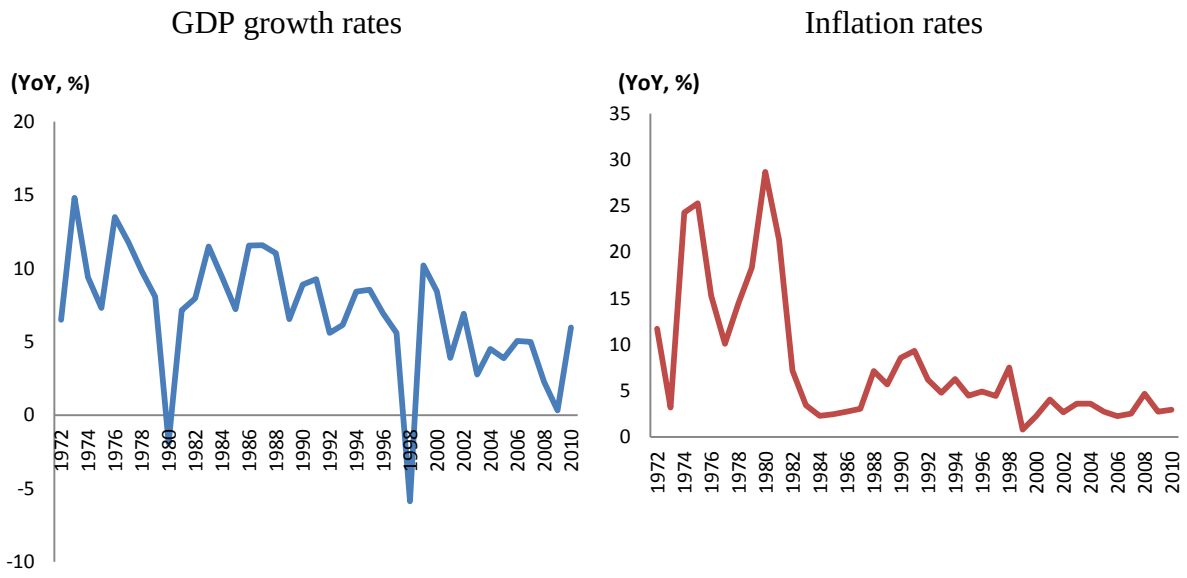
The main reason for negative growth in 1980 was the second oil shock at the end of 1978. Before the Asian Financial Crisis in 1997, the Korean economy maintained a strong and stable economic growth.

After several Asian currencies were depreciated by the attack of speculators in 1997, the Korean economy also suffered national bankruptcy and experienced a bailout by the IMF. As a result, the GDP growth rate in 1998 plummeted to an all-time low, -5.9 per cent. However, the Korean economy picked up very quickly due to strenuous efforts by both the public and the private sectors. After recovery from the crisis in 1997, the Korean economy achieved a strong continuous growth in GDP from the early 2000s onwards.

The Korean economy maintained stable growth up to the Global Financial Crisis in 2008, when it too suffered significant difficulties. But, unlike most other advanced countries, Korea was able to minimize the damage by timely and active stimulus packages and strong domestic consumption. So, the Korean economy rebounded to a pre-crisis level with an annual growth rate of six per cent in 2010.

As for the inflation rates, they have kept decreasing despite international oil price rises. Since 2009, inflation has remained quite stable, at around a modest two per cent. This is mainly due to the government’s efforts to stabilize price.

Figure 2.3 GDP Growth Rates and Inflation Rates



2.3 Structure of Government Finance

Fiscal activity by the Korean central government is implemented in two ways – through the budget account and through the various funds (See Table 2.1).

The budget consists of one general account and eighteen special accounts. The general account uses non-earmarked taxes and non-tax revenue for general-purpose spending such as social welfare, education, transportation and defence. On the other hand, the special accounts are established to include particular programmes (e.g., procurement, the postal service) or specific resources (e.g., transportation tax, registration fees).

Funds are similar to special accounts in their role, but greater operational discretion is given to the ministries and agencies that manage them.

Table 2.1 Structure of Government Financial Accounts

(30th.Dec. 2010)

<table>
<tr><th></th><th colspan="2">Budget</th><th rowspan="2">Funds</th></tr>
<tr><th></th><th>General Account</th><th>Special Accounts</th></tr>
<tr><td>Number</td><td>1</td><td>18</td><td>63</td></tr>
<tr><td>Details</td><td>
<table>
<tr><th>Revenue</th><th>Expenditure</th></tr>
<tr><td>▪Personal Income tax
▪Corporate Income tax
▪Value-Added tax
▪Customs Duties
▪Transport Tax
▪Other taxes
▪Non-tax revenues</td><td>▪Social welfare
▪Education
▪Transportation
▪Defence
▪General Public Administration
▪Agriculture, Forestry, and Fisheries
▪Others</td></tr>
</table>
</td><td>
<table>
<tr><td>Enterprise Special Accounts (5)</td><td>▪Grain Management
▪Procurement
▪Executive Agencies
▪Postal Service
▪Postal Savings</td></tr>
<tr><td>Other Special Accounts (13)</td><td>▪Transportation Facilities
▪Agriculture and Fisheries
▪Balanced National Development
▪Energy and Natural Resources
▪Others</td></tr>
</table>
</td><td>
<table>
<tr><td>Fiscal Programme Funds (51)</td><td>▪National Housing, National Pensions, Government Employees' Pensions, etc.</td></tr>
<tr><td>Financial Programme Funds (12)</td><td>▪Repayment of Deposit Insurance Fund Bond, Credit Guarantee, Export Insurance, etc.</td></tr>
</table>
</td></tr>
</table>

Source: Ministry of Strategy and Finance

2.4 Size of Government Finance

Table 2.2 shows the contents of government expenditure and revenue. By these two factors, the size of the Korean government finances can be measured.

Table 2.2 Contents of Government Revenue and Government Expenditure

Item	Contents	
Government Revenue	▪ Tax revenue ▪ Non-tax revenue	▪ Capital revenue ▪ Grants
Government Expenditure	▪ Current spending ▪ Capital spending	▪ Net lending including net acquisition of equities

2.4.1 Size of Government Expenditure

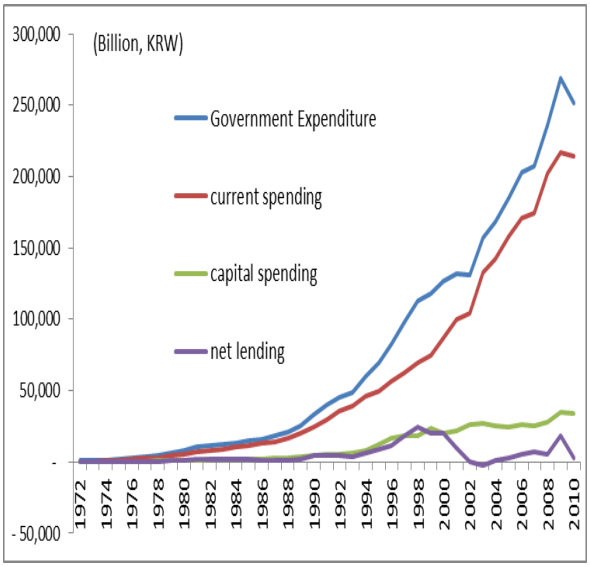
2.4.1.1 Outline of Government Expenditure

The expenditure of central government consists of current spending, capital spending, and net lending. Current spending is composed of purchase of goods and services, interest payments, and subsidies and other current transfers.

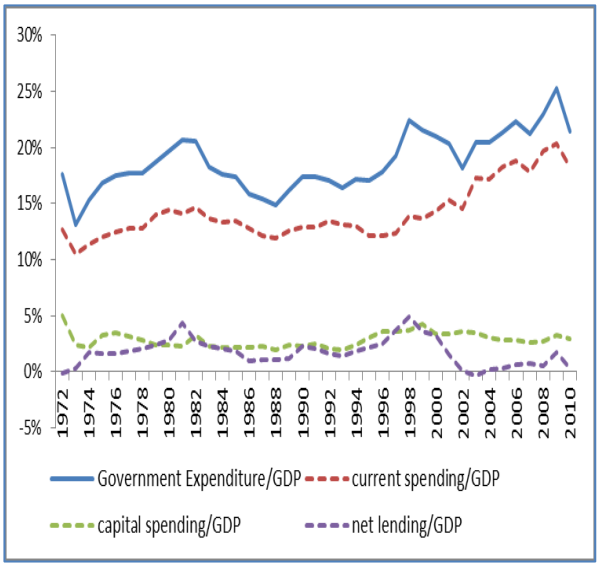
The combined government expenditure of the budget and funds has been held to within 25 per cent of GDP during the last four decades. This is mainly due to the Korean government's effort to refrain from its direct intervention in the market and to promote private sector-led growth. It is notable that the GDP ratio of government expenditure rose immediately after economic crises such as the Asian Financial Crisis in 1997 and the Global Financial Crisis in 2008; and current government spending takes the biggest portion of total government expenditure (Figure 2.4).

Figure 2.4 Government Expenditure in Korea

Nominal value



GDP ratio



2.4.1.2 Details of Government Expenditure[5]

In the 1960s and 1970s, the Korean government set high targets for both economic growth and national security, and increased government expenditure in areas related to these. In 1962, economic growth was targeted by the Korean government's first five-year national economic development plan.

In the 1970s, fiscal investment and loan programmes (FILPs) played a crucial role in encouraging both infrastructure investment and industrial development. By the time the fourth five year national economic development plan (1977-1981) was launched, FILPs were financing 34 per cent of total government spending.

The 1980s saw a decline in direct investment by the government and a rise in private-sector-led growth. At this point, in order to combat inflation, the government embarked on a strong programme of fiscal deficit reduction by implementing spending cuts. The deficit was wiped out, and in 1987 there was the first budget surplus for 17 years.

By the 1990s, as a result of fiscal consolidation that had continued through the 1980s and a rapid rise in per capita income, Korea's roads, airports, and other areas of social infrastructure were proving inadequate. To counteract these effects of its previous lack of public spending, the government decided to substantially increase investment in infrastructure. However, by the end of the 1990s, the Korean economy's significant dependence on exports had made it vulnerable to financial crises elsewhere in the world. In 1997, four decades of growth in the economy ended with the Asian Financial Crisis. The Korean government had to undertake a painful restructuring, which involved the financial,

[5] This part is mainly extracted from 'Fiscal Management and Mid-term Framework in Korea (2010)'.

corporate, labour market, and public sectors of the economy. Accompanying these reforms, expansionary monetary and fiscal policies were adopted in 1998 and 1999 to ensure that domestic demand was maintained.

In 2000, as the financial crisis drew to a close, the Korean government re-focused its policy away from promoting economic recovery towards dealing with a fiscal imbalance. The policy of investment in infrastructure was rationalized and there was consolidation of various welfare programmes that had been expanded to soften the effects of the financial crisis. By 2002, a strong improvement in revenues from a fast growing economy and savings achieved by spending cuts had led to the restoration of fiscal soundness.

The management of Korea's finances changed significantly in the 2000s, with the government introducing the National Fiscal Management Plan, top-down budgeting, and performance management between 2004 and 2006. These initiatives were embodied in the National Finance Act[6], which became law in 2006.

In 2008, Korea suffered the effects of the Global Financial Crisis. In order to deal with this, a large spending increase was introduced in the budget for 2009, with spending being front-loaded onto the first half of the year for maximum impact. In April 2009, further government finance was made available, which meant that the budget for that year was the largest in Korean history. This large budget was accompanied by aggressive tax cuts, and the two measures quickly brought about an increase in government debt. However, the government expenditure-to-GDP ratio was gradually brought down due to the Korean government's strong intention to reduce fiscal deficit and ensure private sector-led growth.

[6] This Act covered the matters related to national finances, including all aspects of the government budget. Its aim was to create the financial framework in which financial performances get better and fiscal operations become more transparent.

2.4.2 Government Revenue

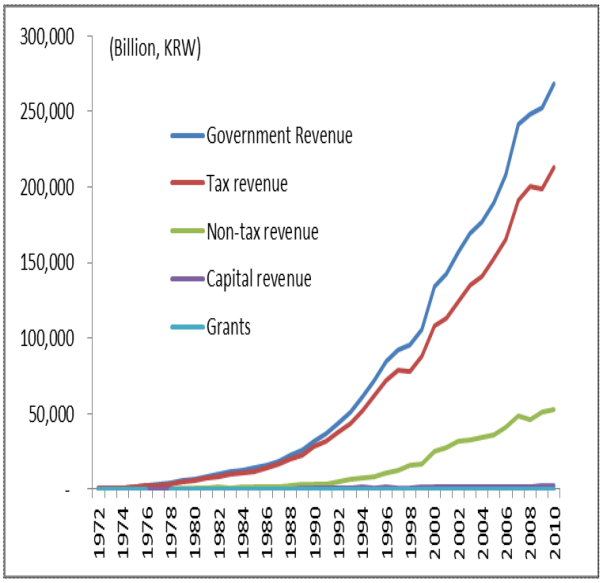
2.4.2.1 Outline of Government Revenue

Government revenue consists of tax revenue, non-tax revenue, capital revenue, and grants. Figure 2.5 illustrates the changes in government revenue during the last four decades. In terms of GDP ratio, government revenue shows a gradual increase, even though there are some ups and downs in several periods.

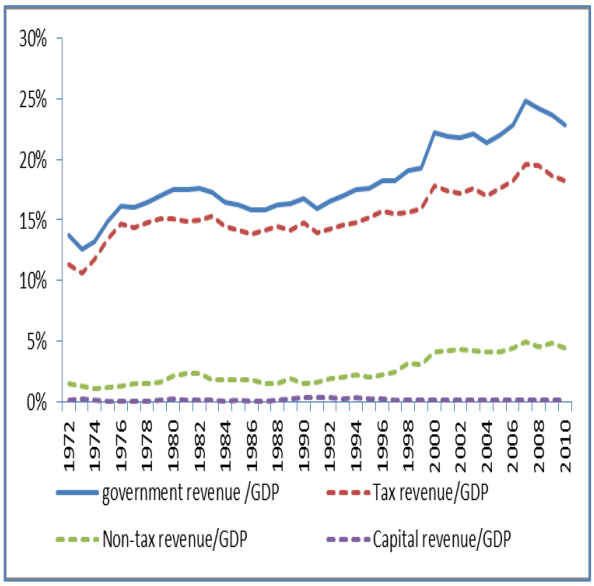
Judging by the left-hand side figure, tax revenue decreased significantly right after the Asian Financial Crisis in 1997 and the Global Financial Crisis in 2008. As for the composition of government revenue, the share of tax revenue and non-tax revenue is roughly 80 and 20 per cent, respectively.

Figure 2.5 Government Revenue in Korea

Nominal value



GDP ratio



2.4.2.2 Details of Government Revenue (focus on tax revenue in Korea) [7]

Korea's modern tax system was established by the first Government of Korea, which took power in 1948. The Tax Law Committee was set up to ensure the smooth running of the modern tax system, first of all during the Korean War (1950-1953), and then in the ensuing peacetime. In the latter period, the system was modified in order to ensure economic growth.

Until the 1970s, Korea's economy grew rapidly, based on developing international trade and cheap imported energy and raw materials. However, the 1970s saw the rise of global inflation, and this interrupted the rise of Korea's economy. During these years, it was frequently necessary to put in place fiscal measures that would help the Korean economy withstand external shocks. Taxable income and tax allowances were redefined at regular intervals to encourage the contribution to the economy of medium and low-income earners. Corporation tax too was adjusted to provide an increased incentive for Korea's heavy industries, including its increasingly important chemical industries.

In the late 1970s and early 1980s, significant rises in the price of oil and a recession in industrialized countries brought about a steep decline in the Korean gross national product (GNP), and a sharp rise in inflation. Despite the incentives of the 1970s, Korea's domestic economy had slowed significantly, and in 1980 the country suffered a poor harvest. Through 1981 and 1982, the government made every effort to stabilize domestic prices and increase exports. Growth, however, remained elusive and, when it occurred, was volatile. The Korean government had the means to stabilize prices, but it was becoming apparent that the Korean economy had developed to a point where the effects of direct government intervention were becoming less important as a factor influencing growth. What was needed from then on was a

[7] This part is based on a book 'Korean Taxation 2009' which is published by MOSF of Korea.

gradual liberalization of the domestic market. In response to this need, the government embarked on reductions in tax incentives for some essential industries. In 1982, the education tax was introduced to raise revenue that would be used to improve the public educational system.

Following this difficult period in the early 1980s, the Korean government focussed on stimulating recovery from the global recession and encouraging growth. At this point, corporation tax and income tax were lowered, and presumptive taxes on dividends were relaxed, in order to strengthen businesses and help them improve their financial health. In addition, to help those on low incomes improve their financial health, tax credits were increased. In this way, over the years 1984 to 1987, the tax laws were revised as part of the government's strategy to promote the economic recovery.

Further important tax reforms were implemented between 1989 and the early 1990s, following a worsening situation in the Korean domestic economy, which began in the second half of 1988 and affected exports, prices, employment, output and the balance of payments. These tax reforms provided investment incentives relating to manufacturing, services facilities and new technological development, and the aim was to raise productivity and improve the industrial structure. They included the simplification of the personal and corporate income tax system and the reduction in tax rates.

In the mid-1990s, the Korean government created a more sophisticated tax system based on a mix of lower tax rates and a broader tax base. This was combined with efforts to stimulate the economy by lessening government intervention and encouraging market competition.

A new round of economic reforms resulted from the financial crisis of late 1997. With these reforms, government spending was significantly increased to respond to the demands of corporate restructuring and the needs of the unemployed. This rising expenditure led to a rapid increase in the budget deficit – an increase that could not be covered by any increase in tax revenue. Indeed, tax increases were ruled out due to the expanded tax exemptions and tax rate reductions granted by the government to encourage both foreign and domestic investment and to stimulate consumption.

However, the government made a lot of effort to broaden the tax base. One tax measure taken by the government was to raise tax rates on items that were unlikely to be sensitive to the effects of the economic crisis: items such as cigarettes, petroleum and diesel. Meanwhile, a proportional withholding tax was substituted for the progressive taxation of interest income. As a result of these measures, tax revenue began to increase at the beginning of the 2000s.

Finally, in order to stimulate the economy and promote mid- and long-term growth, a reform carried out in 2003 included tax incentives totalling one billion dollars. Corporate tax rates were lowered to relieve the burden of corporation tax, and tax incentives were provided for small and medium-sized companies so as to encourage their entrepreneurship. At the same time, speculative real estate transactions were countered by raising the capital gains tax on property. From 2005 until the Global Financial Crisis of 2008, the total tax revenue increased each year, largely as a result of broadening the tax base by phasing out non-taxable benefits, tax reductions and tax exemptions, and also by making increased efforts to identify hard-to-trace income.

2.5 Fiscal Soundness of Korea

2.5.1 The Size of Fiscal Balance and Government Debt

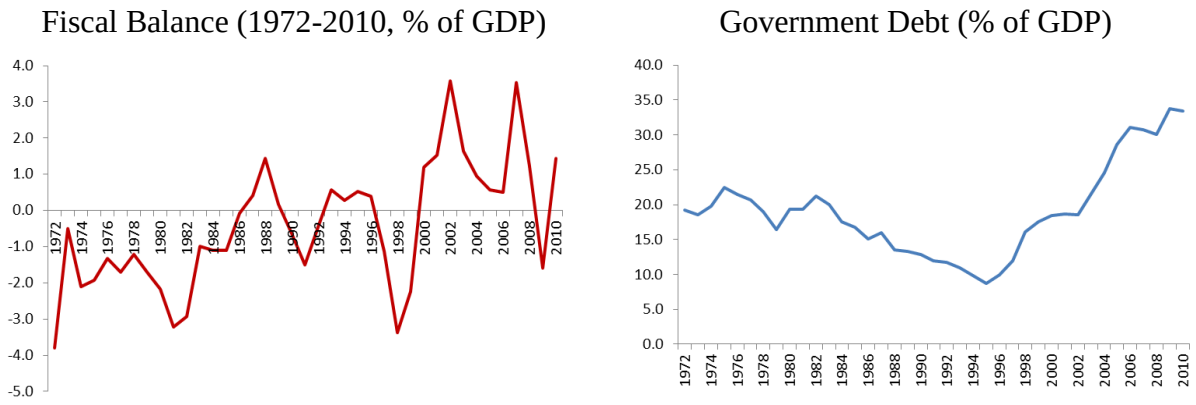
Figure 2.6 shows the time series of the Korean government's fiscal balance and government debt from 1972 to 2010. Fiscal balance means a consolidated budget balance, which is calculated by total government revenue minus total government spending. Korea recorded a consolidated budget deficit (total deficit) of 3.4 per cent of GDP in 1998, the biggest annual fall since 1972. The consolidated budget balance[8] became positive from 2000 and peaked at 3.6 per cent of GDP in 2002, remaining positive until 2009. Fluctuations in the consolidated budget balance have increased after the Asian Financial Crisis in 1997. The trend of the primary surplus[9] follows that of the total surplus.

Government debt has increased very fast since the Asian Financial Crisis in 1997, even if it is still comparatively lower than that of other countries. Government debt rose from 19 per cent in the early 1970s to 34 per cent in 2010. The main factors behind the increase in the government debt are persistently rising government spending and the financial costs borne by public funds for restructuring the financial sector after the financial crises in 1997 and 2008. The abrupt rise in the government debt is a burden on the Korean government because of the snowballing interest payment for the debt and this, finally, has disrupted sound economic growth.

[8] Related to consolidate budget balance in Korea, someone argue that it is desirable to exclude the balance of the National Pension Fund (NPF) and the net lending by the government to assess the financial soundness of the government without any overstatement. But, in this chapter, we do include NPF balance and net lending in the consolidated budget balance.

[9] Primary surplus equals total surplus minus interest payment by the government. That is, primary surplus means tax revenues net of non-interest government spending.

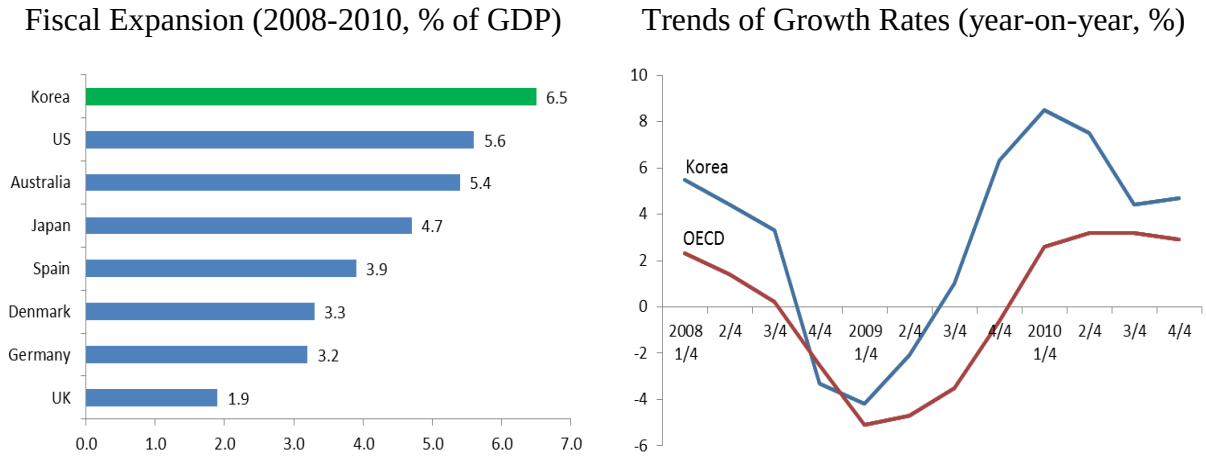
Figure 2.6 Long-Term Trends of Fiscal Balance and Government Debt



2.5.2 Fiscal Situation after the Global Financial Crisis in 2008

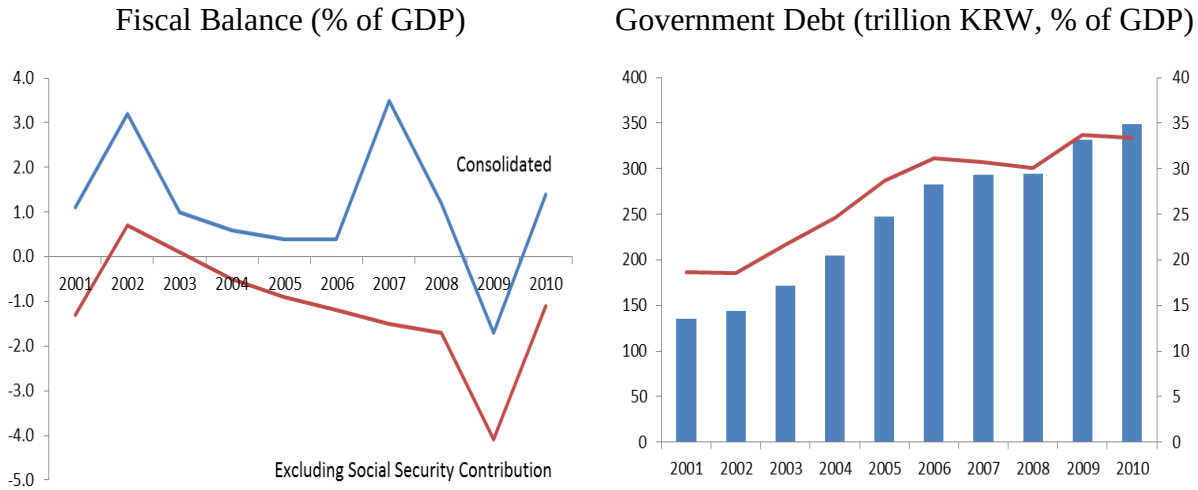
Compared to other countries, Korea successfully achieved an early recovery from the Global Financial Crisis in 2008 by implementing prompt and active fiscal policies. As can be seen in Figure 2.7, the Korean government's fiscal spending to overcome the financial crisis during 2008-2010 was 6.5 per cent of GDP, and this is the largest amount among the major countries. As a result, the Korean economy recovered quickly compared with other major advanced economies (i.e., OECD countries) in 2009.

Figure 2.7 Fiscal Expansion and Trends of GDP Growth Rates



However, the fiscal position became worse because of the considerable fiscal spending. Most countries implemented expansionary policies to overcome the financial crisis in 2008. As a result, their fiscal conditions were weakened. Likewise, expansionary fiscal policy temporarily weakened Korea's sound fiscal position during the process of overcoming the financial crisis. The left-hand side graph in Figure 2.8 shows that the consolidated fiscal balance became negative in 2009. As for the government debt in the right-hand side graph, it increased to 33.4 per cent of GDP in 2010 from 30.1 per cent in 2008.

Figure 2.8 Recent Trends of Fiscal Balance and Government debt



2.5.3 Efforts of Fiscal Soundness Management in Korea

To achieve fiscal strength and secure the sustainability of the public finance, the Korean government has reinforced the fiscal soundness management since mid-2000s. The specific contents of the policy are as follows.

First, to expand the tax base, the government is reorganizing tax exemptions and tax cuts which have negligible effects or have achieved their original purpose. At the same time, it is firmly declining to establish new tax benefits. In addition, the government has adopted the Tax Report Checking System that confirms the adequacy of business income of all self-employed businesses over a certain income level by a licensed tax accountant. The government improves the transparency of tax resources by inducing consumers to use credit cards and cash receipts more extensively.

Second, to enhance government expenditure efficiency, the government has revamped spending standards and has implemented restructuring on projects with low performance or too great a similarity by drastic integration and reorganization. Furthermore, across all stages from planning to evaluation, the government has managed the relevant principles of compliance to accomplish expenditure efficiency.

Table 2.3 The Principles of Compliance in the Government Expenditure Process

Stage	Principles
Planning and Request	Strengthening of the preliminary feasibility study, Substantialization of pre-consultations on large-scale spending, etc.
Formulation	Mandatory submission of off-setting measures for newly launched mandatory spending, Introduction of sunset clauses to government-funded projects, etc.
Execution and Evaluation	Streamlining of fiscal project delivery system including prevention of abundant and fraud recipients, etc.

Source: Ministry of Strategy and Finance (Korea)

2.5.4 Relationship between Government Debt and GDP Growth

It is meaningful to take a look at the relationship between government debt and the GDP growth rate. To do this, both the government debt growth rate and the debt-to-GDP ratio are used, respectively, as a government debt variable. Figure 2.9 shows the results of yearly changes in government debt and the GDP growth rate. There is a clear negative correlation[10] between government debt and the GDP growth rate, regardless of the form of government debt.

Figure 2.9 Comparison of Government Debt and GDP Growth Rate

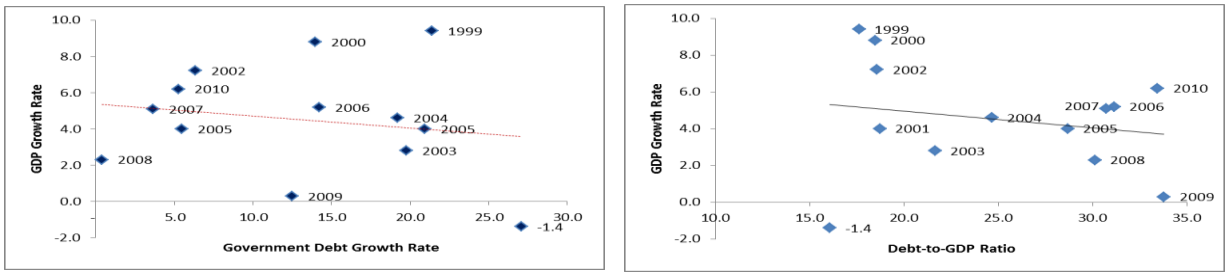


Table 2.4 Trends of GDP and Government Debt

(trillion KRW, %)

Year	GDP		Government Debt		
	Size	Growth Rate	Size	Growth Rate	GDP Ratio
1998	484.1	-1.4	92.6	27.1	16.1
1999	529.5	9.4	112.4	21.4	17.6
2000	603.2	8.8	128.0	14.0	18.4
2001	651.4	4.0	135.1	5.5	18.7
2002	720.5	7.2	143.6	6.3	18.6
2003	767.1	2.8	172.0	19.7	21.6
2004	826.9	4.6	205.0	19.2	24.6
2005	865.2	4.0	248.0	21.0	28.7
2006	908.7	5.2	283.2	14.2	31.1
2007	975	5.1	293.5	3.6	30.7
2008	1026.5	2.3	294.6	0.4	30.1
2009	1065	0.3	331.4	12.5	33.8
2010	1172.8	6.2	348.9	5.3	33.4

Source: Ministry of Strategy and Finance

[10] It is worthwhile to see the causality of this relationship. We deal with this issue in Chapter 4 and Chapter 5.

2.6 Period of Fiscal Consolidation in Korea (2000-2004)

2.6.1 Fiscal Policy

Before the 1997 financial crisis, fiscal policy in Korea had been based on a culture of fiscal prudence. It was common practice in the Korean government not to make spending commitments until revenue had been secured. During the 1990s, the government had consistently reduced government debt, reaching a level of 9 per cent of GDP by 1996. However, the government provided a temporary, but strong, demand stimulus in the wake of the unprecedented economic downturn in 1998. After continuing an expansionary stance until 1999 to address unemployment and provide a social safety net, the government then redirected fiscal policy towards the process of medium-term fiscal consolidation. The government's aim was to reduce the stock of government debt and achieve fiscal balance by 2004. So, the government restrained the growth of nominal spending to at least two per cent below the growth of nominal GDP. To achieve its medium-term goals, the government made efforts to increase its revenues as well. For instance, it phased out tax exemptions, expanded the tax base, and improved tax administration, particularly for the self-employed.

Table 2.5 Main Fiscal Variables of Korea (% of GDP)

Fiscal Consolidation	Before			During				
	1997	1998	1999	2000	2001	2002	2003	2004
Government financial balance	3.0	1.3	2.4	5.4	4.3	5.1	0.5	2.7
Primary balance	2.1	0.2	1.4	4.2	3.4	4.2	-0.4	1.8
Government debt	11.9	16.1	17.6	18.4	18.7	18.6	21.6	24.6
Government expenditure	21.8	24.1	23.2	22.4	23.9	23.6	28.9	26.1
Current spending	16.2	18.2	18.0	17.6	18.9	18.9	19.8	20.6
Government revenue	24.8	25.5	25.6	27.9	28.3	28.7	29.4	28.8
Current revenue	24.4	25.1	25.2	27.5	28.0	28.4	29.0	28.4

2.6.2 Economic Environment

Korean economic growth recovered very quickly after the 1997 economic crisis, maintaining rapid growth during the transition to a more market-oriented and internationally-open economy. This outstanding achievement came in part from progress in restructuring the economy after the Asian Financial Crisis in 1997 and in part from strong external demand, particularly from China. Looked at in detail, the Korean economy went down in 2001 due to a weaker-than-expected recovery in the global economy. In 2002, there was a temporary pick-up of the growth rate because of buoyant consumption and residential construction spending, but the growth rate went down again in 2003 as domestic demand stagnated. Unemployment decreased rapidly to near pre-crisis levels, but not to the same levels. Core inflation rates remained stable within the two to four per cent after 1999. Both short-term and long-term interest rates stabilized after 1999. Moreover, effective exchange rates declined sharply at the beginning of the 1997 crisis, but picked up quickly and remained stable in the aftermath.

Table 2.6 Economic Situation of Korea

Fiscal Consolidation	Before			During				
	1997	1998	1999	2000	2001	2002	2003	2004
Real GDP growth rate	5.6	-5.9	10.2	8.4	3.9	6.9	2.8	4.5
Output gap	3.1	-7.4	-2.7	0.4	-0.7	1.5	-0.2	0.2
Inflation (CPI, % change)	4.4	7.5	0.8	2.3	4.1	2.8	3.5	3.6
Core inflation (% change)	3.4	5.9	0.3	1.9	3.6	2.9	3.1	2.9
Unemployment rate	2.6	6.9	6.6	4.4	4.0	3.3	3.6	3.7
Real short-term interest rate	13.4	15.2	6.8	7.1	5.3	4.8	4.3	3.8
Real long-term interest rate	11.7	12.8	8.7	8.6	6.9	6.6	5.1	4.7
Current account balance/GDP	-1.3	12.0	5.3	2.8	1.7	1.3	2.4	4.5
Nominal effective exchange rate*	106.5	76.7	88.3	94.5	87.3	90.3	89.8	89.8

Note: * A rise in nominal effective exchange rate indicates an appreciation of the Korean won (year 2005=100)
Source: OECD Economic Outlook

2.7 Conclusion and Policy Implication

Korea has achieved impressive economic growth since the Korean War in 1950. Active fiscal policy has played a significant role in this development. Due to persistent efforts, the level of government debt in Korea is one of the lowest among OECD countries (See Appendix 2.1). However, government debt has increased very quickly since the Asian Financial Crisis in 1997. The sharp rise in government debt is a burden to the Korean government because it may be followed by snowballing interest payment to interest-bearing bonds and sluggish economic growth. There is a negative correlation between government debt and GDP growth in Korea. Fiscal consolidation in the early 2000s led public finances into a sustainable path in Korea. From 2000, the government's financial balance and primary balance increased more strongly than before (See Table 2.5). However, government debt did not decline; rather, it continued to reach comparatively high levels. Moreover, the fiscal consolidation undertaken involved a stagnant GDP and nagging unemployment. So, fiscal consolidation seems to have prolonged the recession that began with the Asian Financial Crisis in 1997.

In this context, it is necessary to shed light on the macroeconomic effects of fiscal policy shocks. Moreover, it is meaningful to see if the government debt of one's country is sustainable in the long run, and if it has significant effects on economic activity. Finally, it is useful to investigate the effects of fiscal consolidation drawing on a greater variety of samples from across the world. That is, we can check whether fiscal austerity is effective in boosting recessionary economies using fiscal consolidation episodes from various OECD countries.

CHAPTER 3

THE TRANSMISSION MECHANISM OF FISCAL POLICY SHOCKS IN KOREA

Chapter 3. The Transmission Mechanism for Fiscal Policy Shocks in Korea

3.1 Introduction

It has been an active area of research to analyse the macroeconomic effects of fiscal policy shocks whenever there has been an economic crisis. The Global Financial Crisis in 2008 caused a debate on the impact of fiscal policy shocks once again. There have been many disputes about the theoretical effects of fiscal policy shocks and the explanation of the existing empirical evidence (Perotti, 2008). For example, the new Keynesian models predict that private consumption and the real wage should increase after a government spending shock, while the neoclassical models predict the opposite. This issue is complicated because the stylized facts concerning the effects of fiscal policy shocks have not yet been established, in contrast to the case of monetary policy shocks (Tenhofen *et al*., 2010).

It is of great interest to macroeconomists and policymakers to establish the stylized facts about the macroeconomic effects of fiscal policy shocks. But recent studies have encountered some limitations. First, most research has investigated the effects of fiscal policy using US data, because of the good quality time series data available there and the impact the US economy has on the rest of the world. It is important to consider other countries when undertaking empirical analysis of fiscal policy. Second, many research has concentrated on the effects of aggregated fiscal variables on the macro economy. However, as Orcutt *et al*. (1968) noted, the loss of effective estimation and testing power caused by aggregation can be extremely great. For instance, analysis based on aggregated variables is likely to fail to show the effects of sub-components' variables in detail, and biased results from sub-components'

offsetting movement may lead to inappropriate fiscal decision-making. Examining fiscal policy effects by decomposing fiscal variables provides a much clearer picture of the economic transmission process.

In this context, this chapter focuses on Korea in an attempt to measure the effects of fiscal policy shocks on a newly developed country. It sheds light on the intrinsic transmission mechanism for fiscal policy shocks by decomposing fiscal variables into their sub-components. Moreover, it extends the scope of the effects of fiscal policy shocks on the labour market by adding crucial labour market variables into the model. For instance, the real wage rate and the unemployment rate are used as crucial labour market variables because these factors can reflect the situation in the labour market. The main reason for paying attention to the labour market is to check the possibility of jobless recovery after the fiscal policy has been implemented. If an increase in government spending does not affect the labour market positively - e.g., raising private sector employment - it means that government spending has not been effective in enhancing the welfare of the private sector. This chapter contributes to the debate by adding empirical evidence relating to disaggregated fiscal policy shocks in Korea, one of the outstanding emerging markets, and providing an in-depth analysis of the effects of fiscal policy shocks on the labour market as well as output in Korea.

The remainder of this chapter is structured as follows. Section 3.2 surveys the relevant literature, emphasizing the variety of possible transmission mechanisms for fiscal policy shocks. Section 3.3 explains the research methodology. Section 3.4 describes the data. Section 3.5 gives the empirical results and presents the implications of the results. Finally, section 3.6 draws some conclusions.

3.2 Literature Review

This section surveys both the theoretical and the empirical literature on the macroeconomic effects of fiscal policy shocks.

3.2.1 Theoretical Literature

Even though there are many theoretical studies on the transmission mechanism for discretionary fiscal policy[11] shocks, it is very difficult to find an agreement on the effects of fiscal policy shocks[12]. There are two main and conflicting theories: the neoclassical model, and the new Keynesian model. These theoretical arguments come from different perceptions of reality and offer quite different conclusions based on a couple of assumptions. The theoretical debates between the two views are described for each fiscal policy shock; and then some limitations of the two views are briefly discussed.

First, there are the two main views on the transmission mechanism for government spending shocks. The neoclassical model assumes competitive markets, perfectly flexible prices, constant returns to scale, a separable consumption-leisure utility function, and no credit constraints[13]. Moreover, the neoclassical model assumes that a temporary or permanent bond-financed increase in government spending raises the discounted value of future taxes

[11] Discretionary fiscal policy can be defined as 'intentional changes in government purchases and taxes' in order to stabilize business cycles and affect macroeconomic activity including the labour market. On the contrary, automatic stabilizers are 'automatic changes in taxes and transfer payments' to stabilize business cycles without apparent government actions.

[12] Fiscal policy shocks can be divided into main two types – namely, 'changes in government spending and changes in net taxes' (Blanchard and Perotti, 2002).

[13] In this case, the economic agents are able to borrow and lend in any degree at the market interest rate.

under the IBC by the same amount. The increase in 'the discounted value of future taxes' causes a negative wealth effect, which reduces private consumption and leisure (Baxter and King, 1993). The shift out in the labour supply curve triggers a reduction in the real wage with a given labour demand curve. The rise in employment has a positive effect on output (Fontana, 2009). Moreover, in the neoclassical model, government spending stimulates private investment because it increases the marginal product of capital by shifting out labour supply.

The new Keynesian model has a similar structure to the neoclassical model. In this model, as in the neoclassical model, a bond-financed rise in government consumption increases the discounted value of future taxes, which causes a negative wealth effect. The negative wealth effect reduces private consumption and shifts the labour supply curve outwards. But the new Keynesian model adds another two features: nominal rigidities and monopolistically competitive firms in the goods markets. These features raise the demand for labour, increase the real wage and produce additional output. Moreover, under the 'Rule-of-Thumb Consumers' assumption that many consumers spend within a budget constraint of labour income, without using credit markets, private consumption shows positive responses to government spending shocks[14] (Galí *et al*., 2007).

Second, economists consent that higher tax rates cause a decrease in the level of GDP, and therefore reduce short-run growth rates. But, there are different views on the long-run growth effects of net tax shocks. Lucas (1990) insists that tax changes have no long-run

[14] Instead of rule-of-thumb consumers, Basu and Kimball (2002) integrate a utility function, demonstrating complementarity between consumption and labour, and explaining that labour income is a source of private consumption.

effects on economic growth. On the contrary, Jones *et al*. (1993) and Hendricks (1999)[15] argue that higher tax rates reduce growth rates permanently and the elimination of tax distortion raises growth rate significantly.

However, the two main current theoretical models have several limitations. First, both models assume an inter-temporal government budget constraint to predict the effects of fiscal policy shocks. But, government budget constraint is only a theoretical detail that places no meaningful constraint on policy, because government budgets can go into an explosive debt spiral for a decade or two without any disastrous consequences (Blinder, 2004). Second, both models accept the Ricardian equivalence hypothesis, even though many well-established theoretical arguments contradict it. Those refuting arguments are derived from the umbrella of bequest motives, myopia and precautionary savings by the people.

Under the theoretical limitations mentioned above, empirical analysis is necessary to reconcile these two different theoretical views. That is, it is very important and worthwhile to carry out a detailed empirical study to produce the stylized facts on the effects of fiscal policy shocks.

[15] With an overlapping generation model, Hendricks (1999) finds that the growth effects of tax reforms become trivial than those measured in previous research. However, his results show that the growth effects of tax reforms are still present and non-trivial under any condition.

3.2.2 Empirical Literature

3.2.2.1 Development of Methodology

There have been a number of studies using time series data for the US which examine the effects of fiscal policy on output. Earlier studies such as Barro (1981), Romer and Romer (1993), and Perry and Schultze (1993) estimate a reduced-form equation for output, including several explanatory variables capturing discretionary fiscal policy changes. These earlier studies suffered from an endogeneity problem in measuring the effect of fiscal policy shock on output[16]. As a result, there have been many efforts to identify exogeneous fiscal shocks more accurately. Many studies thereafter have focused on constructing a new methodology to disentangle the exogeneous structural component from the endogenous structural component or automatic component. There have basically been two main empirical methodologies: the narrative approach or dummy variable approach; and the structural VAR (hereafter SVAR) approach.

First, the narrative approach studies a series of post-WW2 'abnormal' fiscal events which can be safely assumed to be exogenous because of their specificity. Ramey and Shapiro (1997) use the narrative approach to identify the political events that resulted in three large military build-ups which had nothing to do with developments in the US domestic economy[17]. Identifying three episodes of sharp rises in military spending (1950Q3, 1965Q1, and 1980Q1), they use these episodes as dummy variables in a regression for GDP. Edelberg

[16] When there is a correlation between a regressor and the error term, the regressor is said to be endogenous; when no such correlation exists, it is said to be exogenous. Endogeneity causes estimates to be biased even asymptotically.

[17] The Korean War, the Vietnam War, and the Carter-Reagan military build-up

et al. (1999) extend this narrative approach by using the same dummies in a VAR framework. Although the narrative approach is a well-established methodology for the identification of fiscal shocks, it has received harsh criticism. Many researchers argue that a few military build-ups cannot properly capture the effects of fiscal spending in the years of these build-ups. This argument does make sense in that once several non-fiscal shocks are allowed to blow the economy in the period of military build-up, analysis produced by the narrative approach may lead to totally different results. So, the utilization of the series is limited to a few countries such as the US. Recently, there has been a new effort to address the drawback of using military build-ups as exogenous government spending shocks in the narrative approach. For instance, Yang *et al*. (2012) propose to identify government spending shocks using data on emergency spending on 'natural disasters' instead of 'military build-ups'. They argue that emergency spending on natural disasters can be more widely used as fiscal shocks in countries beyond the US than military build-ups can (Yang *et al*., 2012).

Second, unlike the narrative approach, many studies identify fiscal policy shocks as the residuals of a SVAR model. This approach imposes some restrictions on the model to identify the exogenous structural component of a government budget. Before a SVAR model is used, several studies apply a simple VAR model to estimate the effects of fiscal policy. Rotemberg and Woodford (1996) identify the reduced-form residuals of a regression of defence purchases as policy shocks. They use these residuals in a VAR to estimate the response of the economy to the policy shocks. Fatás and Mihov (2001) and Favero (2002) use a Cholesky ordering approach, assuming that government spending does not respond to economic changes within a quarter. Meanwhile, Mountford and Uhlig (2002, 2009) analyse the effects of fiscal policy with a VAR approach relying on sign restrictions on impulse

responses. Blanchard and Perotti (2002) firstly use the SVAR model to estimate the effects of fiscal policy shocks. They constructed a SVAR model for the US economy to see the effects of unexpected government spending and tax revenue within the system. With this model, they exploit decision lags in policy making to separate out the automatic response of fiscal policy to GDP. Giodano *et al.* (2007) study the effects of disaggregated fiscal variables on real private GDP[18] in Italy using a SVAR model. Later, Tenhofen *et al.* (2010) investigate the impacts of fiscal policy shocks on the German economy with a SVAR model. They analyse the effects of both aggregated and disaggregated fiscal variables on GDP, including the sub-components: private consumption and investment. Burriel *et al.* (2010) also analyse the effects of fiscal policy on the US economy and the Euro area as a whole with a SVAR model. Following the SVAR model of Blanchard and Perotti (2002), Unal (2011) estimates the dynamic effects of government spending and net tax shocks on prices, interest rates, GDP and its private components, in four OECD countries - the US, Canada, the UK and France - using a SVAR approach.

[18] 'Real private GDP' is defined as 'real GDP minus real government consumption' (Ramey and Shapiro, 1998; Giodano *et al*., 2007)

3.2.2.2 The Effects on Output

There has been a considerable increase in study about the effects of fiscal policy shocks on output, especially research examining the output multiplier, since the Global Financial Crisis in 2008. The empirical findings seem to be quite different depending on the methodology used.

In the narrative approach, the effects of expansionary fiscal policy shocks are estimated by mixing time series data on government spending with a dummy of an abnormal fiscal event in the equation of GDP. Many studies using this approach provide very similar results - that expansionary fiscal policy shocks increase GDP, while decreasing private consumption and the real wage[19]. Ramey and Shapiro (1998) insist that both total GDP and private GDP respond positively to a military build-up for several years, whereas there are decreases in private consumption and the real wage. Edelberg *et al*. (1999) also find similar results to those of Ramey and Shapiro (1998). Recently, Barro and Redlick (2011) have estimated the effects of fiscal policy shocks on GDP growth rate by measuring the multiplier of each fiscal variable. They find that the estimated multiplier for temporary defence spending is around 0.4 contemporaneously, and 0.6 when cumulated over 2 years. They also find that the estimated multiplier for permanent defence spending is higher by around 0.2 than that for temporary defence spending. However, all the estimated multipliers are less than 1, regardless of the property of the spending. Unlike many previous researchers using the

[19] Theoretically, the neoclassical model predicts the GDP rise because of the increased labour supply. And it also argues that if government spending increases, households expect the rise in future taxes, so, they downsize their consumption and increase their labour supply, which finally causes a reduction in the real wage.

narrative approach, Yang *et al*. (2012) find that expansionary fiscal policy shocks increase GDP, private consumption and private investment.

The SVAR approach is an attractive model for finding the dynamic relationship between GDP growth and fiscal policy shocks. Fatás and Mihov (2001) insist that government spending is followed by strong and persistent increases in consumption even though theoretically government spending should increase working hours and lead to a decline in consumption due to a negative wealth effect. In particular, they suggest that compensation of government employees is a highly effective way to boost output and private consumption, while government investment has little effect on output. Blanchard and Perotti (2002) find that government spending shocks increase GDP. As for the sub-components of GDP, private consumption increases following government spending shocks, whereas private investment decreases. The positive reaction of private consumption is hard to harmonize with the neoclassical view of fiscal policy, and the negative reaction of investment is hard to harmonize with the new Keynesian view.

After Blanchard and Perotti (2002), there were many more studies using the SVAR model. Perotti (2004) draws a comparison between the effects of government investment and government consumption. He argues that we cannot guarantee the superiority of government investment shocks over government consumption shocks in enhancing the economy. He insists that government investment is likely to reduce private investment. Holding a different view from supporters of the Golden Rule[20], he tries to provide evidence that the popular

[20] Golden rule supporters insist that a government should borrow money only when it has a special need for investment, not for just consumption. This is based on the idea that government's borrowing may increase the real interest rate, which causes the reduction in private investment, finally leads to a slowdown of GDP growth.

argument for government investment as a growth engine may be wrong[21]. According to Giodano *et al.* (2007), a shock to government purchases of goods and services has sizable effects after three quarters, going to zero after two years, while public wages have no significant effect on output. The results are consistent with those of Tenhofen *et al.* (2010), but are contrary to the findings of Fatás and Mihov (2001). Tenhofen *et al.* (2010) find that aggregated government spending shocks increase output in the short run, whereas the effects of a one-off government spending shock disappear after a few quarters. According to the results of their estimation, private consumption shows positive response to a government spending shock, while private investment does not respond significantly. As for disaggregated government spending, government employment expenditure does not have a significant effect, but government operating expenditure has a clear and persistent positive effect on output. Unal (2011) adds analysis of the effects of net tax components on the economy. He finds that GDP falls in response to net tax increase, while it goes up in response to government spending shocks. He also shows that net tax components affect economic variables differently according to the structure of the economy.

3.2.2.3 The Effects on the Labour Market

There are several recent papers that try to measure the effects of government spending on labour markets, especially on employment. For example, Burnside *et al*. (2004) estimate the effects of a fiscal policy shock on key macroeconomic aggregates including GDP, hours worked, and the real wage. Adopting Ramey and Shapiro's (1998) narrative

[21] Devarajan *et al.* (1996) also insisted that current government spending might have more positive and significant growth effects than capital government spending.

approach and identifying exogenous changes in fiscal policy, they formulate a four-variable VAR model, including three fixed set of variables - GDP, government spending, and labour income tax rates - and a set of extra variables which are added one at a time - hours worked, the real wage, consumption, and investment. They find that the onset of Ramey-Shapiro's government spending episodes leads to an increase in hours worked with a delayed, hump-shaped trajectory, while it leads to a decrease in the after-tax real wage.

Monacelli and Perotti (2008) also measure the effects of fiscal policy shocks on the labour market, focusing on two sectors: the non-financial corporate business, and manufacturing. They adopt both the SVAR approach and Ramey-Shapiro's narrative approach to identify government spending shocks. Based on a six-variable VAR model,[22] they find that when there are fiscal policy shocks, the real product wage rises in both the non-financial corporate business sector and the manufacturing sector, and the real consumption wage also rises by less than 1 per cent point at the peak in both sectors.

Pappa (2009) estimates the effects of fiscal policy shocks on the labour market using the US annual aggregated and disaggregated data covering 48 states from 1969 to 2001. Employing a SVAR model and identifying fiscal shocks by sign restrictions[23], he traces the

[22] The six variables consist of five fixed set of variables and one added variable. The five fixed set of variables are government spending on goods and services, GDP, private consumption, private investment, and the Barro-Sahasakul average marginal tax rate on labour income. One variable is added from the following three variables: the mark-up, the real consumption wage, the real product wage.

[23] 'Sign restriction' methodology assumes that government consumption, investment, and employment must increase GDP and deficits in both of the neoclassical model and the new Keynesian model. The advantages of this methodology are that it is based on theory, it can be used to any frequency data, and it can avoid the endogeneity problem.

effects of fiscal shocks on labour market variables such as employment and the real wage. In the analysis using annual aggregated data, he finds that the rises in government consumption, government investment, and government employment increase both the real wage and employment, at least contemporaneously. The results of estimation using state data are generally consistent with those obtained from aggregated data, except for the case of government employment shocks. That is, the responses of the real wage and employment to government consumption, government investment, and government employment shocks are all positive. But, the response of employment to government employment shocks is insignificant. He suggests that this is caused by substantial heterogeneity of employment response in each state. One third of states show total employment reduction when there are government employment shocks (Pappa, 2009).

Recently, Monacelli *et al*. (2010) studied the transmission mechanism for a fiscal policy shock to the labour market. These researchers also use a SVAR model, adding dummy variables based on actual forecasts following Ramey (2009) or Romer and Romer (2007). They find that an increase in government spending leads to a fall in the unemployment rate multiplier, a significant rise in total hours worked, and a significant rise in the real product wage. They also find that the hours per employed individual change insignificantly and job-finding probability shows a positive response to a government spending shock.

3.3 Methodology

3.3.1 Three-Variable Baseline SVAR Model

As all three variables in the baseline SVAR have a unit root and there are cointegrating relationships between variables (see Section 3.4.3), a vector error-correction model (VECM) or level VAR model can be applied to measure the effects of fiscal policy shocks. However, when estimating a VAR with a number of variables, it is hard to find economically interpretable cointegration vectors (Tenhofen *et al.*, 2010). Therefore, we use a level VAR to measure the macroeconomic effects of fiscal policy shocks.

As we are using a small sample, the number of variables in the VAR model has to be limited. Moreover, in order to compare our estimation results with those of previous literature, we start our analysis with a three-variable SVAR model, following Blanchard and Perotti (2002). The baseline SVAR model consists of three variables[24]: government spending (g_t), net taxes (t_t), and real GDP (y_t). The reduced-form VAR is formulated as follows.

(*3.1*) $X_t = \beta(L)\, X_{t-1} + U_t,$

where X_t is a 3 x 1 vector of endogenous variables, $\beta(L)$ is a 3 x 3 matrix lag polynomial, and U_t is a 3 x 1 vector of reduced-form innovations. U_t is assumed to be normally distributed white noise with a constant covariance matrix $\mathrm{E}(U_t U_t') = \sum_u$. In the baseline SVAR specification, $X_t \equiv (g_t, t_t, y_t)'$, and $U_t \equiv (u_t^g, u_t^t, u_t^y)'$.

[24] All variables are the log of real values per capita. So, price factor is already reflected in the model.

Institutional information is used to impose restrictions on the baseline SVAR model. The VAR model using a *Cholesky decomposition ordering* is added to compare the results with the baseline SVAR. Three dummy variables are included in the model, considering the potential effects of the 1980 economic downturn caused by the 1978 second oil shock, the 1997 Asian Financial Crisis and the 2008 Global Financial Crisis. The 2008 Global Financial Crisis is included as a dummy because it is assumed that the crisis may cause sudden changes in policy and lead to evolution that will last a long time. Lags are used in the autoregressive model to capture the effects of evolution in the variables (Marcellino, 2006).

3.3.2 Extended VAR model

The extended VAR model[25] adds several variables of interest to the baseline VAR. Following the strategy of Burnside *et al*. (2004)[26], the effects on a number of variables are examined by rotating the additional variables in the model. For example, private consumption of non-durables and services (c_t) and private investment (I_t) are included when estimating the effects of fiscal policy shocks on output and its sub-components. Then, one or two variables are drawn in rotation from the following four variables when estimating the effects on the labour market: manufacturing employment (e_t), total hours worked (h_t), the real wage rate (w_t), and the unemployment rate (u_t). In the extended VAR model, a simple *Cholesky decomposition ordering* is used to impose restrictions on the model. This is based on the assertion that for the VAR model with a large number of variables, a *Cholesky decomposition ordering* can deliver almost accurate impulse responses, even though the shocks are anticipated (Mertens and Ravn, 2010; Rafiq, 2013).

[25] We can add other variables related to exports, the exchange rate, the interest rate, and stock market volatility.
[26] They design a VAR model using a fixed set of variables and rotating other variables of interest one by one.

3.4 Data

3.4.1 Data Source and Frequency

3.4.1.1 Data Source

The three-variable baseline SVAR model uses both annual and quarterly data on government spending (g_t), net taxes (t_t) and GDP (y_t). The extended VAR model includes private consumption (c_t), private investment (i_t), and four labour-market-related variables (i.e., manufacturing employment[27] (e_t), total hours worked (h_t), real wage rate (w_t), and the unemployment rate (u_t)). All variables are in the form of the log of real values.

Annual data on fiscal policy, such as government spending and net tax revenues, are obtained from the databases of both the Government Finance Statistics (GFS) of the IMF and the MOSF of Korea. Quarterly data on fiscal policy are obtained from the Ministry of Strategy and Finance (MOSF). The GFS is used to collect government spending data, and missing observations are compensated for by the information offered by the MOSF. GDP is taken from the International Financial Statistics (IFS) of the IMF. Even though the OECD provides GDP and the GDP deflator data, it does not have population data. So, for data consistency, time series data from the IFS is used. The period considered is from 1972 to 2010. Labour market data are obtained from the statistics and database of the International Labour Organization (ILO) and the Ministry of Employment and Labour (MOEL) in Korea. In particular, quarterly Korean labour market data are extracted from the Report on the Labour Force Survey of Establishments produced by the MOEL survey database system.

[27] Following Ramey (2011), manufacturing employment is included as one of the main variables in the labour market because it takes the largest part of total employment in the industry (i.e., 17.1 per cent as of 2008). Even if it does not cover employment of whole economy, it can reflect the situation of the labour market in the major industry.

3.4.1.2 Data Frequency

Many of the studies that use a SVAR model prefer to use quarterly data rather than annual data because the endogeneity problem of discretionary fiscal policy can be removed by using higher-frequency data. It is based on an assumption that discretionary fiscal policy can react to any macroeconomic change at least a quarter later (Blanchard and Perotti, 2002). On the other hand, the assumption supposes that policy makers can adjust fiscal policy in response to unexpected changes in GDP within a year (Auerbach and Gorodnichenko, 2012).

However, this assumption also has its limitation. Because of the difficulty of obtaining quarterly data, quarterly data for the variables are interpolated in many studies, which may cause bias and imprecision in estimation. Moreover, quarterly data used in a SVAR model suffers from a fundamental problem that its estimated shocks are likely to be anticipated by one or two quarters by the private sector (Perotti, 2008). Recognizing this point, Perotti (2008) uses long-run annual data with non-interpolated quarterly data in his analysis, which makes the results of estimation more legitimate and persuasive.

Ramey (2009, 2011) advocates an analysis of fiscal policy using annual data instead of quarterly data to overcome the anticipation problem. Based on annual variables, the estimated government spending shocks have a better chance of being unanticipated if it is assumed that most of government spending movements can be anticipated by one or two quarters. This is supported by the argument that a country's fiscal stance is usually reviewed less frequently because substantive changes in government revenue or spending policy require legislative review as part of the annual budget planning exercise (Romeu and Kawakami, 2011).

In this context, basically, annual data are used in our models to measure the effects of fiscal policy shocks. The annual data sample starts from 1972 and ends in 2010. The main reason for using annual data is based on the idea that fiscal decisions are made on a yearly basis in the budget. That is, even if there is a possibility that supplementary budgets and other policy decisions are implemented several times during one year period, yearly budget includes most of the important policy measures. Quarterly data are also used in a robustness check to see if the results of estimation are consistent with those using annual data analysis. The quarterly data sample starts from the first quarter of 1994 and continues to the fourth quarter of 2010.

3.4.2 Data Description

All the data are in log of real values, and per capita terms are used to remove any bias resulting from demographic factors. Following the definition of fiscal variables in Blanchard and Perotti (2002),[28] fiscal variables, such as government spending and net taxes, are carefully defined.

[28] 'Net taxes' and 'government spending' are chosen as the two fiscal variables based on the belief that, 'in the short run, fiscal policy works mainly through the effects of government spending and taxes on aggregate demand and the effects of aggregate demand on output' (Blanchard and Perotti, 2002, p1332).

3.4.2.1 Government Spending[29]

According to the GFS, the total expenditure of central government consists of current expenditure and capital expenditure. Current expenditure is composed of the purchase of goods and services, interest payments, and subsidies and other current transfers. In this research, government spending is defined as the purchases of goods and services, both current and capital. So, interest payments and subsidies and other current transfers in current expenditure are excluded from the scope of government spending. This alternative definition of government spending is the sum of government consumption and investment, which has been adopted by most recent studies in the literature (Blanchard and Perotti, 2002).

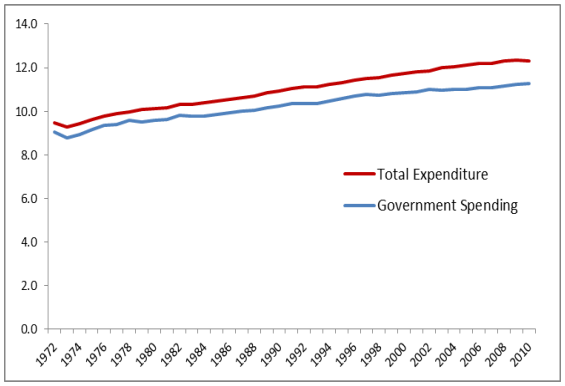
This classification is based on the fact that government spending on goods and services may have different effects from the other ones. That is, government spending on goods and services directly changes the aggregated demand of the economy, while transfers and interest payments make effects via real disposable income, which could be partially saved by households (Burriel *et al*., 2010).

Looking at government spending, current spending has taken a greater proportion than capital spending, except in 1999. Capital spending has shown much wider fluctuations during the last four decades. We can note that capital spending significantly increases during economic crises, such as the 1997 Asian Financial Crisis and the 2008 Global Financial Crisis. This is due to the government's fiscal expansion in the wake of the financial crises. Government spending as a share of GDP has decreased gradually during the last four decades.

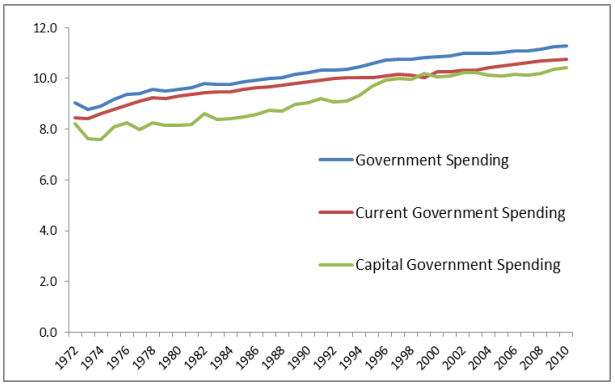
[29] 'Government spending' is defined in order to exclude transfer payments and interest payments, which change over the economic business cycle.

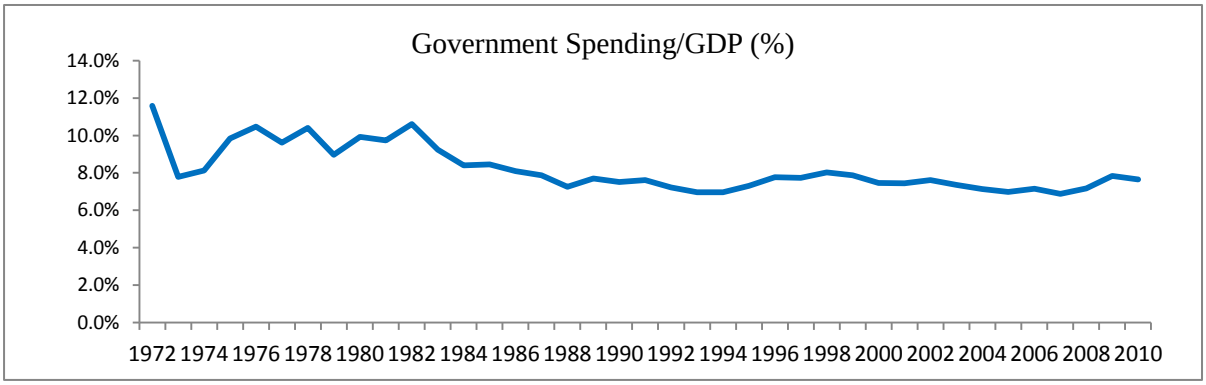
Figure 3.1 Government Spending in Korea

Government Spending



Sub-components of Government Spending





Note: Government spending is in log of real value, and per capita term

3.4.2.2 Net Taxes

Following Blanchard and Perotti (2002), net taxes are defined as 'the sum of personal tax and non-tax receipts, corporate profits tax receipts, indirect business tax and non-tax accruals, and contributions for social insurance, less transfer payments to persons and interest paid by the government. Transfer payments and interest payments are excluded from total current government revenue because they are considered as negative taxes' (Blanchard and Perotti, 2002). For instance, transfer payments are assumed to be redistributed to the private sector and are not regarded as a resource withdrawal from the private (Tenhofen *et al*, 2010).

Table 3.1 Contents of Government Revenue and Government Spending

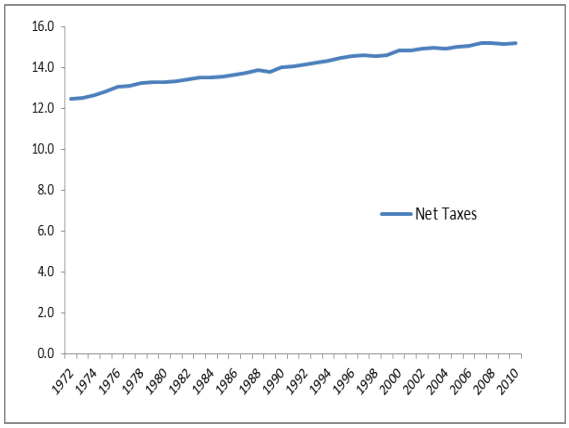
Item	Contents
Total Current Government Revenue	Current taxes receipts + Contributions for government social insurance + Income receipts on assets + Current transfer receipts + Current surplus of government enterprises
Total Current Government Spending	Consumption expenditures + Current transfers + Interest payments + Subsidies - Wage accruals less disbursements

In conclusion, 'net taxes' are defined as 'total current government revenue less current transfers and interest payments on government debt'. 'Current transfers' include 'all expenditure items except public consumption, public investment and interest payments (Burriel *et al*., 2010).

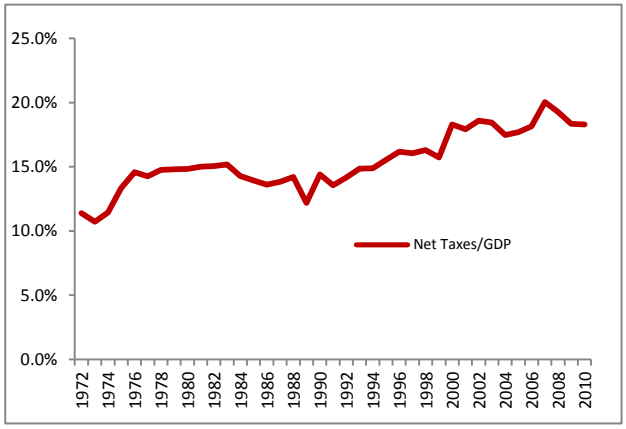
Figure 3.2 illustrates net taxes during the last four decades. As mentioned above, net taxes are measured by subtracting current transfers to households and interest payments from total current government revenue. Net taxes show a gradual increase, even though there are some fluctuations in several periods. For example, net taxes significantly decrease in the late 1980s, due to the huge tax reform to boost the economy. And there were another two big fall of net taxes right after the 1997 Asian Financial Crisis and 2008 Global Financial Crisis. However, the net taxes-to-GDP ratio has gradually increased.

Figure 3.2 Net Taxes in Korea

Net Taxes



Net Taxes/GDP (%)

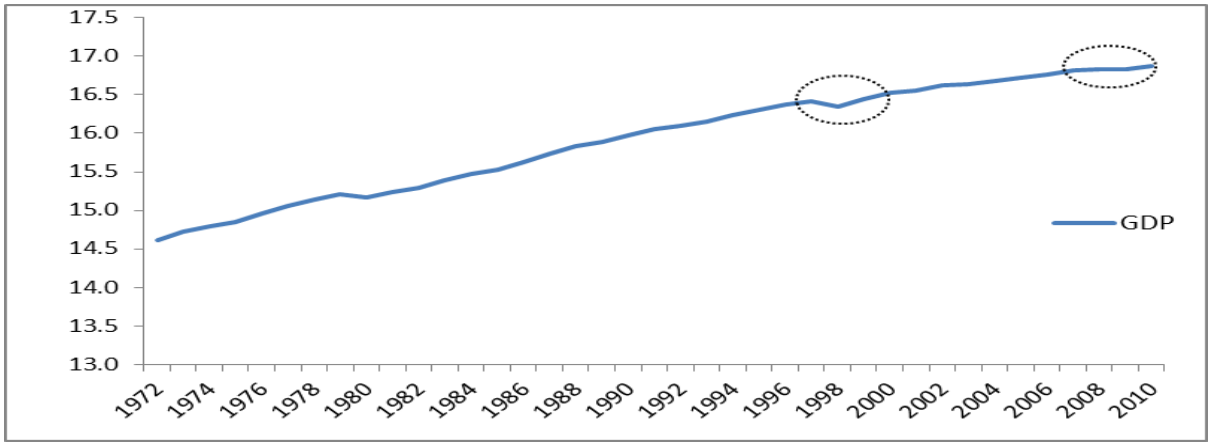


Note: Net Taxes is in log of real value, and per capita term

3.4.2.3 GDP and Its Components

Korea has experienced a very high level of economic growth over the last four decades. Figure 3.3 shows that GDP increased significantly, while there are two reductions, the Asian Financial Crisis in 1997 and the Global Financial Crisis in 2008.

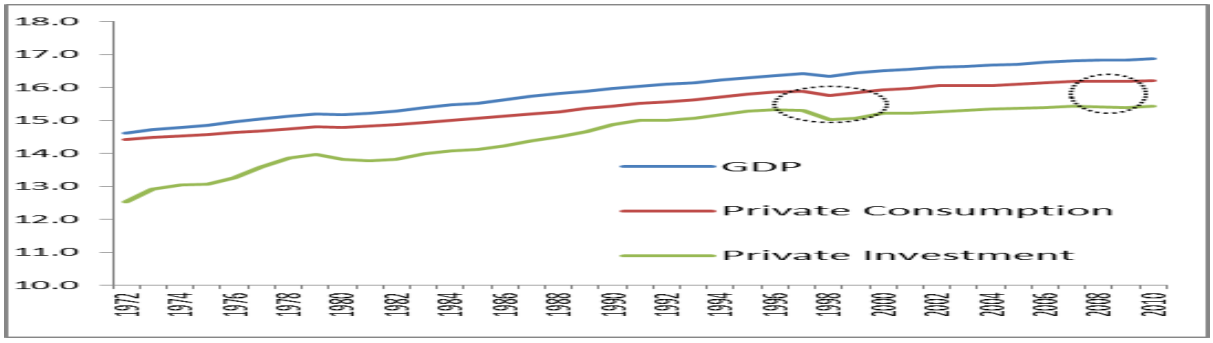
Figure 3.3 GDP in Korea



Note: GDP is in log of real value, and per capita term

Figure 3.4 illustrates the changes in the sub-components of GDP: private consumption and private investment. Private consumption, c_t, is defined as household consumption expenditure, including the consumption of non-profit institutions serving households. Private Investment, i_t, is private gross fixed capital formation, which is calculated as gross fixed capital formation less government capital spending. Both sub-components have upward trends, showing significant decreases in the 1997 Asian Financial Crisis and the 2008 Global Financial Crisis.

Figure 3.4 GDP and Its Components



Note: GDP and its components are in log of real values, and per capita terms

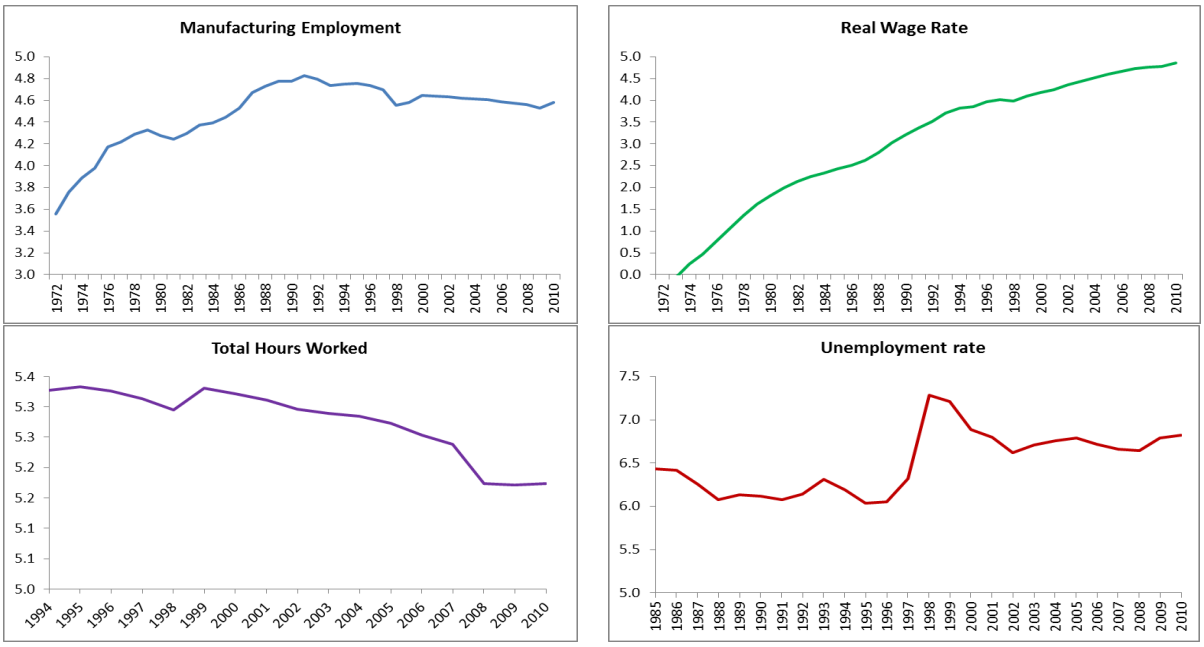
3.4.2.4 Labour Market Variables

The main interest with the labour market is how key variables respond to fiscal policy shocks. Manufacturing employment, e_t, is an index number of full-time equivalent employment in the manufacturing sector with 2005 = 100. It increased significantly up until the early 1990s, peaked in 1991, and has fluctuated around the index number 100 ever since. It is notable that manufacturing employment has decreased three times in the early 1980s[30], in the Asian Financial Crisis in 1997, and in the Global Financial Crisis in 2008. The real wage

[30] In the early 1980s, the global economy experienced a serious downturn due to the second oil shock in 1978.

rate, w_t, is an index number (2005 = 100) which represents wage rate or earnings per worker employed per specified time period (monthly). This is calculated by using the nominal wage and the consumer price index. The second column of Figure 3.5 shows the changing process of the real wage rate, w_t. This has increased in a faster rate, except for the 1997 Asian Financial Crisis and the 2008 Global Financial Crisis. Total hours worked, h_t, is the average for establishments that have five or more employees. This series was obtained by using 28,000 sampled establishments with five or more employees across all industries, excluding the agriculture, fisheries and forestry sectors. Total hours worked, h_t, has decreased continuously since 1994. However, there were two big falls in total hours worked caused by the 1997 Asian Financial Crisis and the 2008 Global Financial Crisis. The unemployment rate of whole economy, u_t, has been quite stable, except for the 1997 Asian Financial Crisis. It is calculated by dividing the number of unemployed by the size of the labour force.

Figure 3.5 Labour Market Variables in Korea



Note: All the variables are in log of real values

3.4.3 Unit Root Tests and Cointegration Tests

3.4.3.1 Unit Root Tests

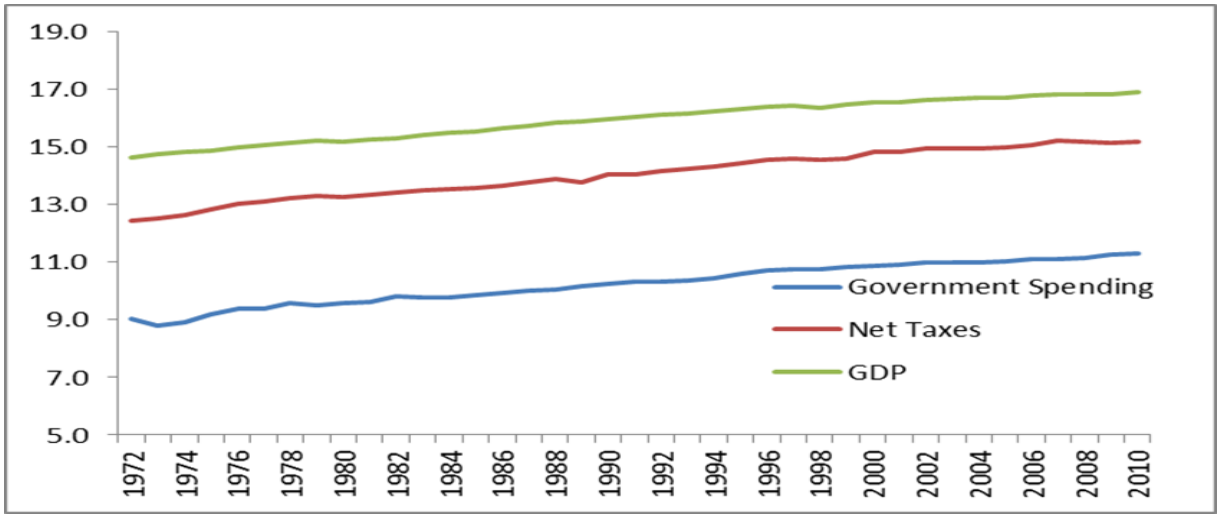
There is the possibility that economic and financial time series may contain at least one unit root[31], being non-stationary; although some series are stationary and some series possibly contain two unit roots. Under this circumstance, using time series data is likely to cause significant errors, such as spurious regression problem. Therefore, as a first step, the stationarity property of any time series used should be checked.

The Augmented Dickey-Fuller (ADF) unit root test and the Kwiatkowski, Phillips, Schmidt and Shin (KPSS) test are used. The ADF test has the null hypothesis of non-stationarity, whereas the KPSS test has the null hypothesis of stationarity. By testing for a unit root using the two methods with different assumptions, the robustness of the unit root tests can be strengthened. In considering Figure 3.6, it is assumed that only GDP has a deterministic time trend, the others have stochastic time trends. So, both a deterministic time trend and an intercept are included in the test equation for GDP, while only an intercept is included in the test equation for other variables, such as government spending and net taxes[32]. The optimal lag lengths are selected as zero using the Schwarz information criterion (SIC).

[31] Technically speaking, 'unit root' refers to the root of the polynomial in the lag operator. 'Unit root' indicates that a given time series is not stationary.

[32] The results of unit root tests are the same even if it is assumed that GDP, government spending and net taxes have the same type of time trend: deterministic time trend or stochastic time trend.

Figure 3.6 GDP, Government Spending and Net Taxes



Note: All the variables are in log of real values, and per capita terms

Table 3.2 displays the results of unit root tests for both the level and the first difference of each of the three variables in the baseline SVAR model. As expected, all of three level variables have a unit root, and so follow a non-stationary process. In other words, we can say that three variables are integrated of order one, i.e. I(1). According to the results of the ADF test, the null hypothesis of non-stationarity for all three level variables cannot be rejected, even at the 10 per cent significance level. The KPSS test rejects the null hypothesis of stationarity for all three level variables, presenting the same information as the ADF test.[33]

After all the level variables have been differenced, no unit root will be found in the first differenced variables. For all the first differenced time series, the null hypothesis of non-stationarity is rejected even at the 1 per cent significance level.

[33] We also performed unit root tests with various options – only intercept, intercept and trend, or neither. In each case, every variable has a unit root and is not stationary.

Table 3.2 Unit Root Tests Results of Baseline VAR Variables

Test statistics / Variables	Levels		First difference		verdict
	ADF	KPSS	ADF	KPSS	
GDP					
Real	-1.988	0.187**	-6.251***	0.142*	I(1)
Log (Real)	-0.648	0.183**	-5.536***	0.102	I(1)
Government Spending					
Real	-2.139	0.757***	-6.773***	0.461*	I(1)
Log (Real)	1.465	0.764***	-6.558***	0.487**	I(1)
Net Taxes					
Real	0.842	0.732**	-6.122***	0.296	I(1)
Log (Real)	-1.767	0.764***	-6.500***	0.325	I(1)

Notes: 1. ***, ** and * denote the rejection of the null at the 1%, 5% and 10% significance levels.
2. In a KPSS test, the spectral estimation is Bartlett kernel and Bandwidth is selected by Newey-West's method.
3. The optimal lag lengths are selected as zero using the SIC.

3.4.3.2 Cointegration Test

Engle and Granger (1987) suggested that a linear combination of a number of non-stationary series can be stationary. These non-stationary time series are said to be 'cointegrated if there is a stable long-run relationship between them by moving together over time even though individually each variable is non-stationary' (Gujarati, 2004). We can say that 'a cointegrating relationship is a long-term equilibrium, because cointegrating variables are able to diverge from their relationship in the short run, but their ties would get back in the long run' (Enders, 2010, p356).

In this context, if there is no cointegration, we can construct a model of stationary variables by taking the first difference of the non-stationary variables. On the other hand, if there is a cointegrating relationship between the variables, we can estimate a level SVAR model without taking any difference on the variables. We conduct cointegration tests in two ways: one is Engle-Granger's residual test, and the other is Johansen's cointegration test.

Firstly, using the ADF test on the logarithm of the ratio of net taxes to government spending, i.e., ln (net taxes / government spending), it is possible to see if there is a cointegrating relationship between the two variables. The null and alternative hypotheses for the unit root test are as follows.

(*3.2*) $H_0 : \hat{u}_t \sim I(1)$ vs. $H_1 : \hat{u}_t \sim I(0)$

Thus, the null hypothesis assumes a unit root, while the alternative hypothesis assumes no unit root. Under the null hypothesis, therefore, a stationary linear combination of the non-stationary variables has not been found. If the null hypothesis is rejected, it can be said that a cointegrating relationship exists between variables.

Figure 3.7 shows the log of net taxes over government spending. According to the ADF test, the null hypothesis is rejected at the 1 per cent significance level. We can conclude that there is a cointegrating relationship between net taxes and government spending.

Figure 3.7 Gap between Government Spending and Net Taxes

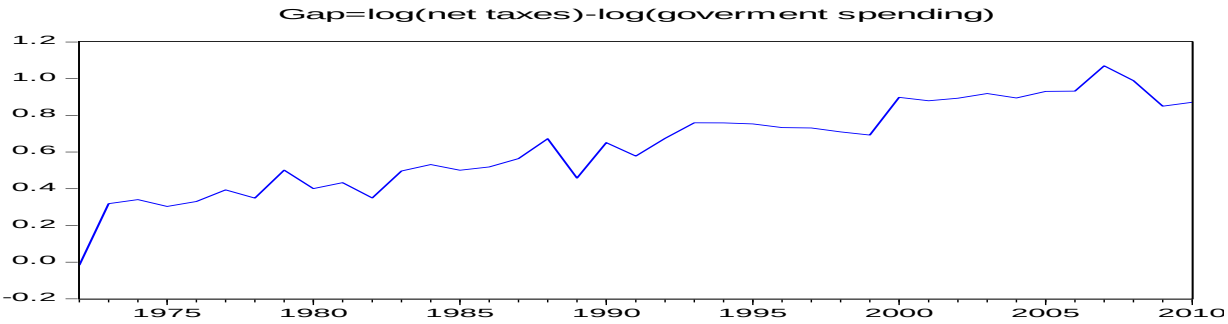


Table 3.3 Unit Root Tests Results of Gap

Test statistics / Variable	Levels		verdict
	ADF	KPSS	
Gap	-6.797***	0.132*	I(0)

Notes: 1. ***, ** and * denote the rejection of the null at the 1%, 5% and 10% significance levels, respectively.
2. Gap = log of real net taxes per capita – log of real government spending per capita
3. In the tests, gap series are tested with both time trend and intercept

Secondly, the issue of cointegration can be examined within the Johansen VAR framework. Although the above Engle-Granger approach is very easy to use, one of its major drawbacks is that it can only estimate one conitegrating relationship between the variables. We have three variables in our model, so more than one linearly independent cointegrating relationship can be witnessed. In this context, it is much more suitable to check the issue of cointegrating ralationship using the Johansen VAR framework.

The baseline SVAR model uses a set of three variables, which are I(1) according to the unit root test above. Before executing Johansen's cointegration test, the appropriate number of lags in the SVAR system should be specified. For this, considering the annual frequency of the data set, we presume that the appropriate number of lags is no more than four. The Akaike information criterion (AIC), Schwarz information criterion (SIC) and Hannan-Quinn information criterion (HQ) suggest a VAR(1) with a constant.

Table 3.4 VAR Lag Order Selection Criteria

Lag	With Constant			No Constant		
	AIC	SIC	HQ	AIC	SIC	HQ
0	-8.913604	-8.780289	-8.867584	NA	NA	NA
1	-14.97668*	-14.44341*	-14.79259*	-14.60811	-14.20817*	-14.47005*
2	-14.79637	-13.86316	-14.47422	-14.65217*	-13.85228	-14.37605
3	-14.83753	-13.50438	-14.37733	-14.57435	-13.37451	-14.16017
4	-14.61043	-12.87733	-14.01217	-14.41633	-12.81655	-13.86409

Note: * indicates lag order selected by the criterion

So, a VAR with 1 lag containing three variables could be set up as follows.

(*3.3*) $$\underset{3x1}{y_t} = \underset{3x3}{\beta_1} \underset{3x1}{y_{t-1}} + \underset{3x1}{u_t}$$

In order to use the Johansen cointegration tests, we have to change the VAR above into a vector error-correction model (VECM) of the form,

(*3.4*) $\Delta y_t = \Pi y_{t-1} + u_t$

where $\Pi = \beta_1 - \mathrm{I}$.

Basically the VECM has variables in the first differenced form on the LHS, and lagged level terms on the RHS. As the model recommended above has only one lag length, it has only lagged level terms on the RHS. Π is a long-run coefficient matrix. The cointegration test between the variables is calculated by considering the rank of the Π matrix via its eigenvalues. The rank of a matrix is equal to the number of its eigenvalues that are different from zero. If the variables are not cointegrated, the rank of Π will be similar to zero (Enders, 2010, pp 385-392).

In the Johansen approach, the trace test (λ_{trace}) and maximum eigenvalue test (λ_{max}) are used to determine the number of cointegrating vectors (*r*).

The statistics for the two tests are as follows.

(*3.5*) $\lambda_{trace}(r) = -T \sum_{i=r+1}^{g} \ln(1 - \hat{\lambda}_i)$ and

(*3.6*) $\lambda_{max}(r, r+1) = -T \ln(1 - \hat{\lambda}_{r+1})$

where T is the number of observations, r is the number of cointegrating vectors under the null hypothesis and $\hat{\lambda}_i$ is the estimated value for the *i*th ordered eigenvalue from the long-run coefficient matrix Π (Enders, 2010, pp 391-392).

'λ_{trace} is a joint test where the null hypothesis is that the number of cointegrating vectors is less than or equal to r against an unspecified or general alternative that there are more than r'(Enders, 2010, p 391). The test statistic λ_{trace}has a sequence of null alternative hypotheses as follows.

H_0:	$r = 0$	vs	H_1:	$r \geq 1$
H_0:	$r \leq 1$	vs	H_1:	$r \geq 2$
	...	...		...
H_0:	$r \leq g - 1$	vs	H_1:	$r = g$

'λ_{max} conducts separate tests on each eigenvalue, and has as its null hypothesis that the number of cointegrating vectors is r against an alternative of r+1' (Enders, 2010, p 391). Therefore, λ_{max} test statistic has null and alternative hypotheses as follows.

H_0:	$r = 0$	vs	H_1:	$r = 1$
H_0:	$r = 1$	vs	H_1:	$r = 2$
	...	...		...
H_0:	$r = g - 1$	vs	H_1:	$r = g$

We keep increasing the value of r until we no longer reject the null hypothesis. The results appear as in Table 3.5. In total, five models are made based on whether an intercept and a trend are included or not. The results across the five types of model and the two types of test are the same, having one cointegrating vector.

Table 3.5 Selected Number of Cointegrating Relations (5 per cent significance level)

Data Trend	None	None	Linear	Linear	Quadratic
Test Type	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
Trace	1	1	1	1	1
Max-Eig	1	1	1	1	1

The results of the cointegration test after selecting 'intercept (no trend) in cointegrating equation and test VAR and 1 lag length' are shown below in Table 3.6.

Examining the trace test, if we look at the first row below the headings, the statistic of 43.72 by far exceeds 29.80 - the critical value of the 5 per cent significance level, and we can reject the null hypothesis of no cointegrating vectors. In the next row, we cannot reject the null hypothesis of at most one cointegrating vector because the trace statistic 14.87 is smaller than 15.49 - the critical value of the 5 per cent significance level. In conclusion, we can say there is one cointegrating vector in our VAR model. The maximum eigenvalue test confirms this result too.

Table 3.6 Johansen Maximum Likelihood Cointegration Test

Trace Test(λ_{trace})				
Number of cointegrating vector	Eigenvalue	Trace Statistic	5% Critical Value	Prob.**
None *	0.541499	43.71886	29.79707	0.0007
At most 1	0.311664	14.86653	15.49471	0.0620
At most 2	0.027923	1.047852	3.841466	0.3060
Maximum Eigenvalue Test(λ_{max})				
Number of cointegrating vector	Eigenvalue	Max-Eigen Statistic	5% Critical Value	Prob.**
None *	0.541499	28.85233	21.13162	0.0034
At most 1	0.311664	13.81867	14.26460	0.0587
At most 2	0.027923	1.047852	3.841466	0.3060

Note: * denotes rejection of the hypothesis at the 5 per cent significance level
**MacKinnon-Haug-Michelis (1999) *p*-values

3.5 Empirical Results

The effects of fiscal policy shocks are estimated by focusing on the responses of output and the labour market, respectively.

3.5.1 The Effects of Fiscal Policy Shocks on Output

3.5.1.1 The Effects of Aggregated Government Spending Shocks on Output

First, the responses of output to aggregated government spending shocks are estimated using the three-variable baseline SVAR model, which includes real government spending (g_t), real net taxes (t_t), and real GDP (y_t). The reduced-form VAR is as follows.

(*3.7*) $X_t = \beta(L)\, X_{t-1} + U_t,$

The reduced-form residuals of government spending and net taxes (u_t^g and u_t^t) is linear combinations of the three components: '(1) the automatic response of government spending and net taxes to innovations in GDP - e.g., unanticipated changes in taxes in response to output innovations for given tax rates, (2) the systematic discretionary response of policymakers to innovations in the other endogenous variables - e.g., tax rate reductions implemented systematically in response to recessions, (3) random discretionary fiscal policy shocks' (Blanchard and Perotti, 2002; Perotti, 2008). So, the relationship between the reduced-form residuals (U_t) and the structural shocks (V_t) can generally be shown in a matrix-form, $BU_t = AV_t$.

(*3.8*) $$\begin{bmatrix} 1 & -\alpha_2 & -\alpha_3 \\ -\beta_1 & 1 & -\beta_3 \\ -\gamma_1 & -\gamma_2 & 1 \end{bmatrix} \begin{bmatrix} u_t^g \\ u_t^t \\ u_t^y \end{bmatrix} \equiv \begin{bmatrix} a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \\ c_1 & c_2 & c_3 \end{bmatrix} \begin{bmatrix} e_t^g \\ e_t^t \\ e_t^y \end{bmatrix}$$

where $U_t \equiv \begin{bmatrix} u_t^g \\ u_t^t \\ u_t^y \end{bmatrix}$, $V_t \equiv \begin{bmatrix} e_t^g \\ e_t^t \\ e_t^y \end{bmatrix}$, $A \equiv \begin{bmatrix} a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \\ c_1 & c_2 & c_3 \end{bmatrix}$, $B \equiv \begin{bmatrix} 1 & -\alpha_2 & -\alpha_3 \\ -\beta_1 & 1 & -\beta_3 \\ -\gamma_1 & -\gamma_2 & 1 \end{bmatrix}$;

A and *B* show the linear relationships between the structural shocks and the reduced-form residuals. V_t is assumed to be orthogonal to each other in order to investigate the impact of an isolated shock.

If restrictions are imposed on the baseline VAR model using *Cholesky decomposition ordering*, matrix equation (*3.8*) is changed into matrix equation (*3.9*).

$$(3.9)\quad \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} u_t^g \\ u_t^t \\ u_t^y \end{bmatrix} \equiv \begin{bmatrix} a_1 & 0 & 0 \\ b_1 & b_2 & 0 \\ c_1 & c_2 & c_3 \end{bmatrix} \begin{bmatrix} e_t^g \\ e_t^t \\ e_t^y \end{bmatrix}$$

The ordering is assumed to be as follows: government spending first, net taxes next and GDP last.

Meanwhile, if restrictions are imposed on the baseline VAR model using *institutional information*, matrix equation (*3.8*) is changed into matrix equation (*3.10*).

$$(3.10)\quad \begin{bmatrix} 1 & 0 & -\alpha_3 \\ 0 & 1 & -\beta_3 \\ -\gamma_1 & -\gamma_2 & 1 \end{bmatrix} \begin{bmatrix} u_t^g \\ u_t^t \\ u_t^y \end{bmatrix} \equiv \begin{bmatrix} a_1 & a_2 & 0 \\ b_1 & b_2 & 0 \\ 0 & 0 & c_3 \end{bmatrix} \begin{bmatrix} e_t^g \\ e_t^t \\ e_t^y \end{bmatrix}$$

The variance-covariance matrix of reduced-form innovation has six elements, while the equation (*3.10*) has nine coefficients to be identified. So, some restrictions should be imposed on the coefficients to make a system of equation (*3.10*) identified. The first restriction is $\alpha_3 = 0$. Following Blanchard and Perotti (2002), we define government spending as the sum of government consumption and government investment. So, transfer

payments and interest payments, which will vary over the business cycle, are excluded from government spending in our study. As automatic stabilisers on the spending side operate through transfers, it can be assumed that there is no automatic feedback from changes in GDP to government spending (Blanchard and Perotti, 2002)[34]. The next restriction is the value of the elasticity[35] $\beta_3 = 1.09$. This figure is based on the estimation of Kim *et al*. (2009)[36]. The last restriction is $a_2 = 0$, which is drawn by assuming that government spending decisions come first. If government spending decisions come before any other variables, then a change in tax decisions has no effect on government spending[37].

Now, matrix equation (*3.10*) can be written as follows.

$$(3.11)\quad \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & -1.09 \\ -\gamma_1 & -\gamma_2 & 1 \end{bmatrix} \begin{bmatrix} u_t^g \\ u_t^t \\ u_t^y \end{bmatrix} \equiv \begin{bmatrix} a_1 & 0 & 0 \\ b_1 & b_2 & 0 \\ 0 & 0 & c_3 \end{bmatrix} \begin{bmatrix} e_t^g \\ e_t^t \\ e_t^y \end{bmatrix}$$

The effects of aggregated government spending shocks on GDP are similar regardless of the identification method: *Cholesky decomposition ordering* or *institutional information*.

Figure 3.8 shows the impulse responses of GDP to government spending shocks in the three-variable baseline SVAR model. It shows that when using *Cholesky decomposition ordering*, the positive effects of government spending shocks on GDP are significant at the

[34] Progressive income taxes also may play a role as an automatic stabiliser on the revenue side.

[35] β_3 is defined as $\Sigma\, \eta_{T_i,B_i}\eta_{B_i,X}\frac{T_i}{T}$ where T=$\sum T_i$ is the level of net taxes, η_{T_i,B_i} is the elasticity of the i^{th} category of net taxes to its own tax base and $\eta_{B_i,X}$ is the elasticity of the tax base of the i^{th}category of net taxes to GDP (Blanchard and Perotti, 2002).

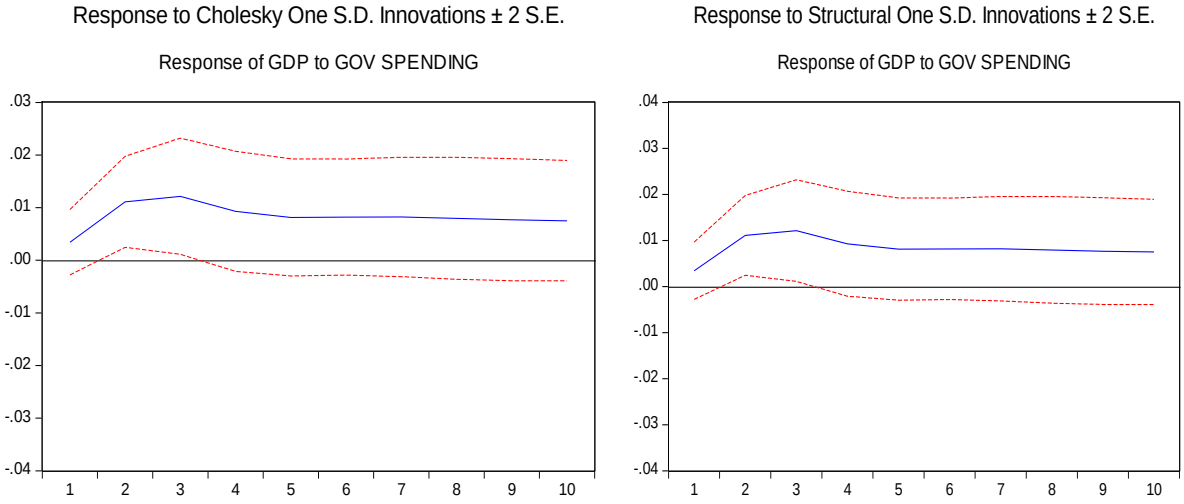
[36] According to the national fiscal management plan (2009) of Korea, the value of the elasticity is 1.12. The results are similar to those using value of 1.09.

[37] Korea government designs its spending for the next fiscal year based on anticipated revenue. Therefore, successive changes in taxes are not likely to affect government spending in the fiscal year.

two standard error confidence bands for about three years after the shocks. When using *institutional information* restrictions, the estimated results of $BU_t = AV_t$ *are* as follows.

$$(3.12)\quad \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & -1.09 \\ -0.08 & 0.05 & 1 \end{bmatrix} \begin{bmatrix} u_t^g \\ u_t^t \\ u_t^y \end{bmatrix} \equiv \begin{bmatrix} 0.05 & 0 & 0 \\ 0.01 & 0.06 & 0 \\ 0 & 0 & 0.02 \end{bmatrix} \begin{bmatrix} e_t^g \\ e_t^t \\ e_t^y \end{bmatrix}$$

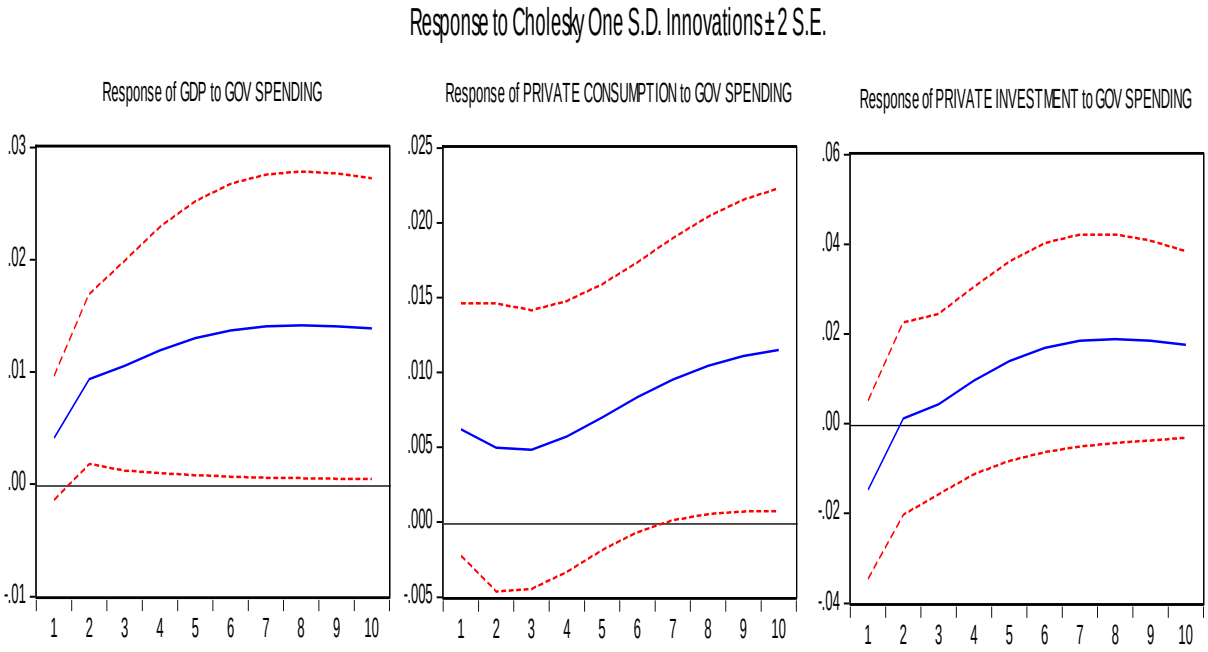
Figure 3.8 The Responses to Aggregated Government Spending (Baseline SVAR)



Second, the responses to aggregated government spending shocks are estimated using an extended five-variable VAR model that includes government spending, net taxes, GDP, private consumption and private investment. *Cholesky decomposition ordering* is used.

Figure 3.9 shows impulse responses from the five-variable VAR model. GDP, private consumption and private investment all display positive responses to aggregated government spending shocks. The response of GDP is significant, but the responses of the sub-components of GDP (i.e., private consumption and private investment) are trivial and insignificant. The results of impulse responses are generally consistent with the forecasts from the standard new Keynesian approach.

Figure 3.9 The Responses of GDP to Aggregated Government Spending



3.5.1.2 The Effects of Disaggregated Government Spending Shocks on Output

This section investigates the effects of sub-components of fiscal policy on output, private consumption and private investment. To do so, the five-variable VAR model is extended to a six-variable VAR model by splitting government spending into two components.

3.5.1.2.1 The Effects of Current and Capital Government Spending Shocks

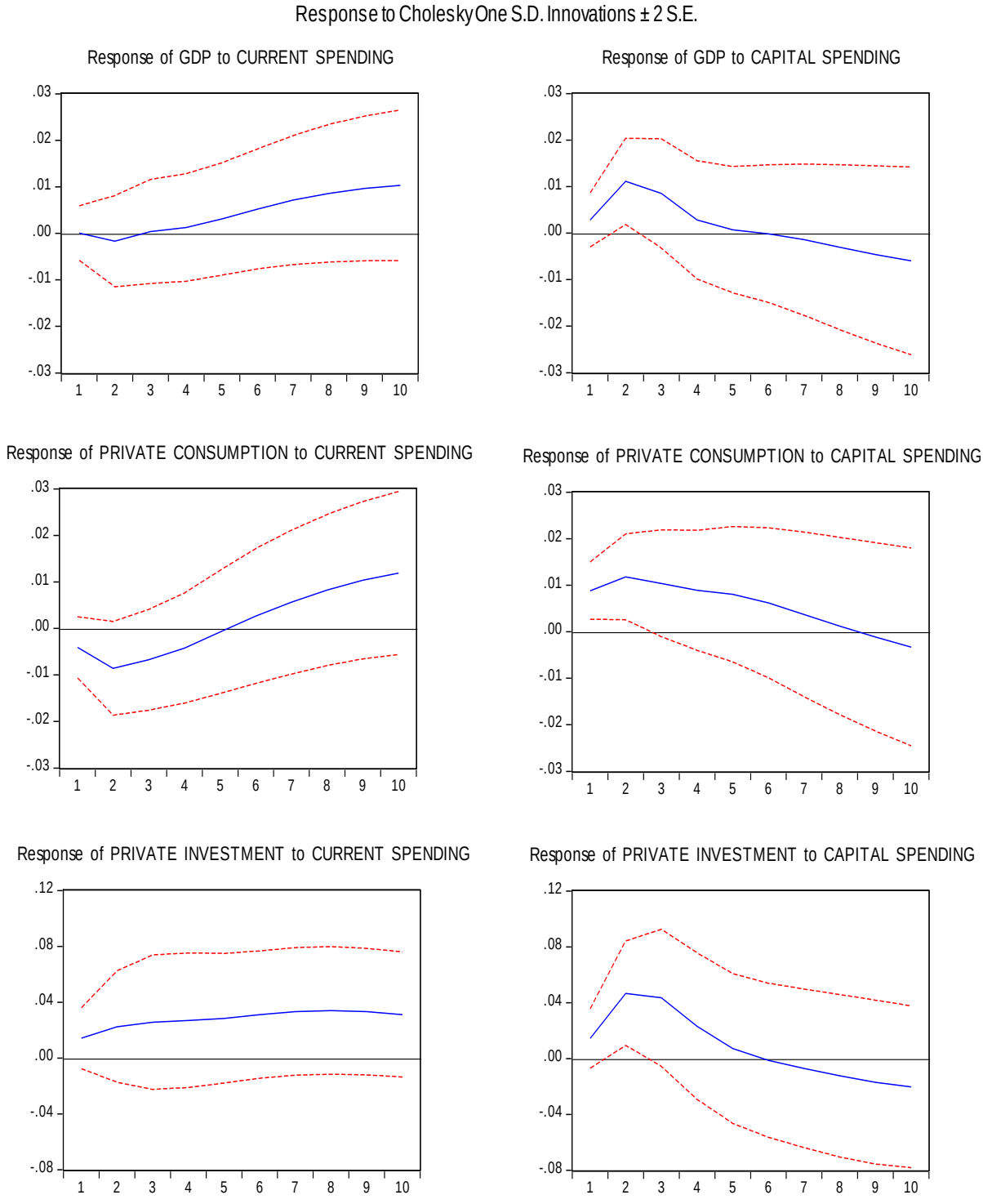
First, aggregated government spending is split into current government spending and capital government spending[38]. In the six-variable VAR model, aggregated government spending is dropped and replaced by current government spending and capital government spending.

[38] This is based on the economic classification of government spending in the GFS.

As shown in Figure 3.10, sub-components of aggregated government spending have different effects on GDP and its components. After a current government spending shock, GDP shows a slightly negative response for about two years. Private consumption decreases for about five years, turning into a positive trend thereafter. On the other hand, private investment increases after a current government spending shock, but only to an insignificant extent. In conclusion, the responses to a current government spending shock are negative and insignificant. The results suggest that current government spending crowds out private consumption for the time being, but it generates a motive for higher private investment. Unlike the results for a current government spending shock, the responses of all macro-economic variables to a capital government spending shock are positive and significant. A capital government spending shock has positive effects on GDP and its components: private consumption and private investment. The positive effects are small but significant. Through this, it can be conjectured that the positive effects on GDP and its components of total government spending stem from the effects of capital government spending rather than those of current government spending.

It should be noted that private consumption responds differently to capital government spending shocks and current government spending shock. The negative response of private consumption to a current government spending shock is not consistent with the new Keynesian predictions that government spending boosts private consumption and private investment. The positive response of GDP to a capital government spending shock is in line with theoretical predictions by Baxter and King (1993), who found significant and positive output multipliers for government investment depending on the productivity parameter of public capital (Tenhofen *et al*., 2010).

Figure 3.10 The Responses of GDP to Current/Capital Government Spending



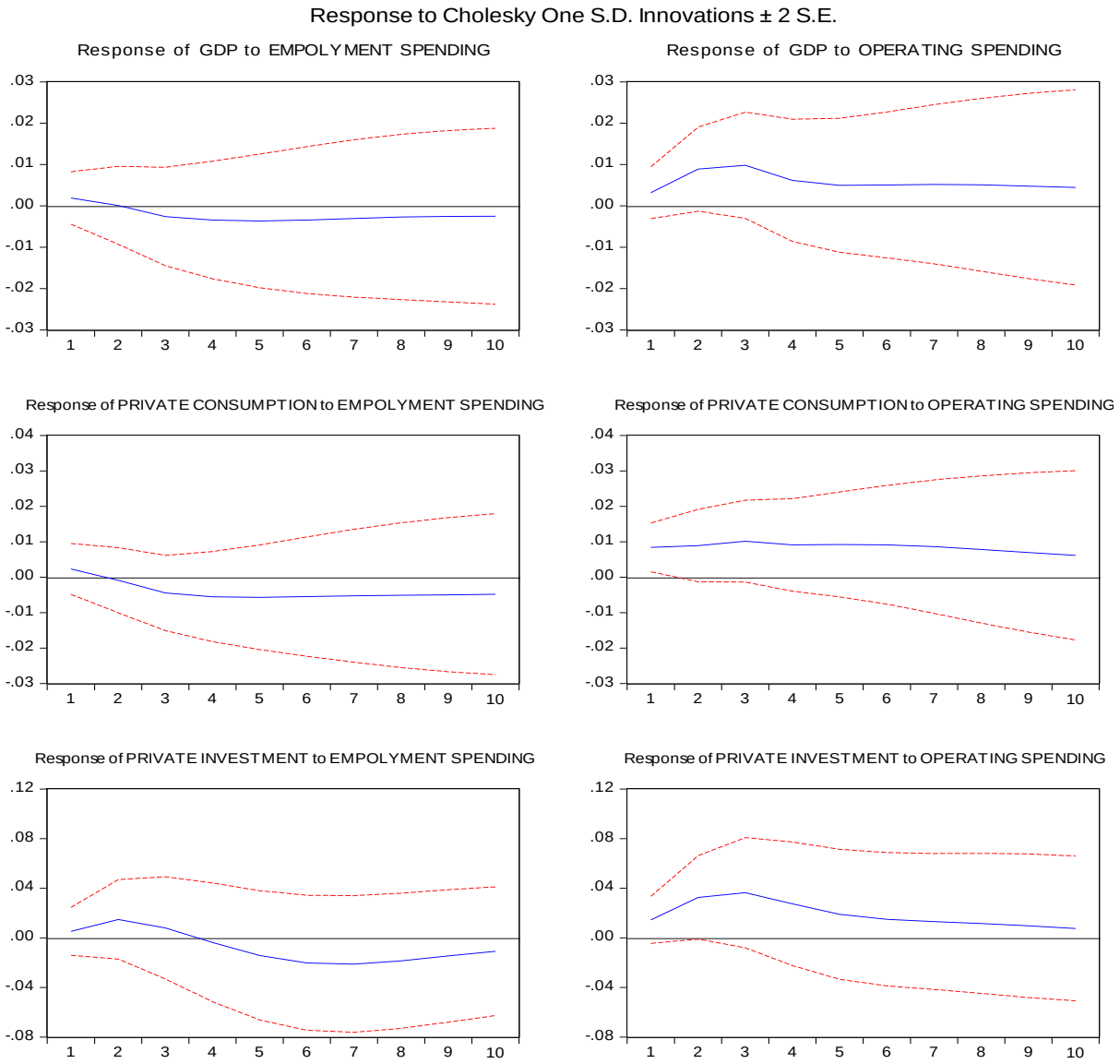
3.5.1.2.2 The Effects of Government Employment and Operating Spending Shocks

Next, aggregated government spending is split into government employment spending (government wages and salaries) and government operating spending (consisting of other purchases of goods and services plus government capital formation). Concerning the effects of government employment spending, there are opposite empirical evidences in the previous literature. Therefore, it is meaningful to measure the effects of a government employment spending shock on the economy in Korea. In a six-variable VAR model, aggregated government spending is dropped and replaced by government employment spending and government operating spending. An assumption that the two sub-components of aggregated government spending have a zero exogenous elasticity is added. In conclusion, the six-variable VAR model includes government employment spending, government operating spending, net taxes, GDP, private consumption, and private investment.

Figure 3.11 shows that the two sub-components of aggregated government spending have different effects on GDP and its components. Concerning the effect on GDP, government employment spending has a positive but small effect on GDP, lasting only about two years. Meanwhile, government operating spending has positive effects on GDP for a long time. In terms of the effects on sub-components of GDP, it can be said that government employment spending increases both private consumption and investment, but the effect is insignificant and fades in two or three years. Government operating spending does have positive and significant effects on both private consumption and private investment, and this is comparatively long-lasting in hump-shaped manner. This result is likely to be caused by capital government spending shocks in government operating spending.

Our empirical results for the effects of disaggregated government spending are consistent with the findings of Giodano *et al.* (2007) and Tenhofen *et al*. (2010), who insist that the compensation of public employees is not effective in stimulating the economy. Therefore, our results contrast to those of Fatás and Mihov (2001), who report that compensation of public employees is a highly effective way of boosting private consumption and output.

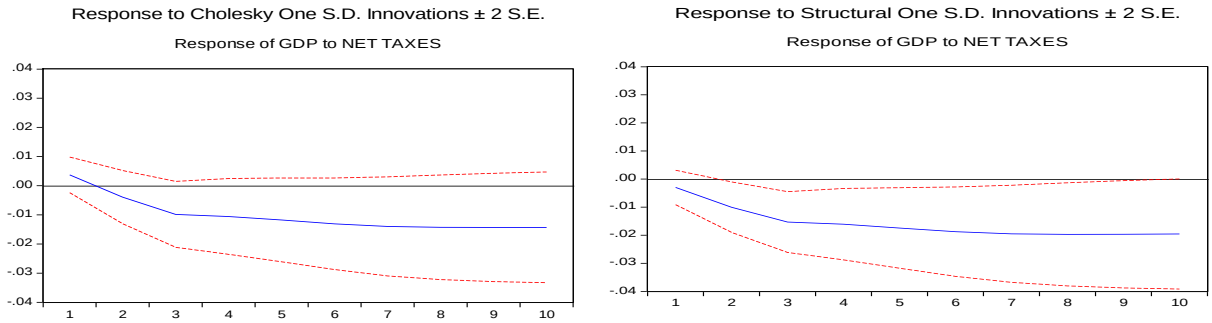
Figure 3.11 The Responses of GDP to Government Employment/Operating Spending



3.5.1.3 The Effects of Net Tax Shocks on Output

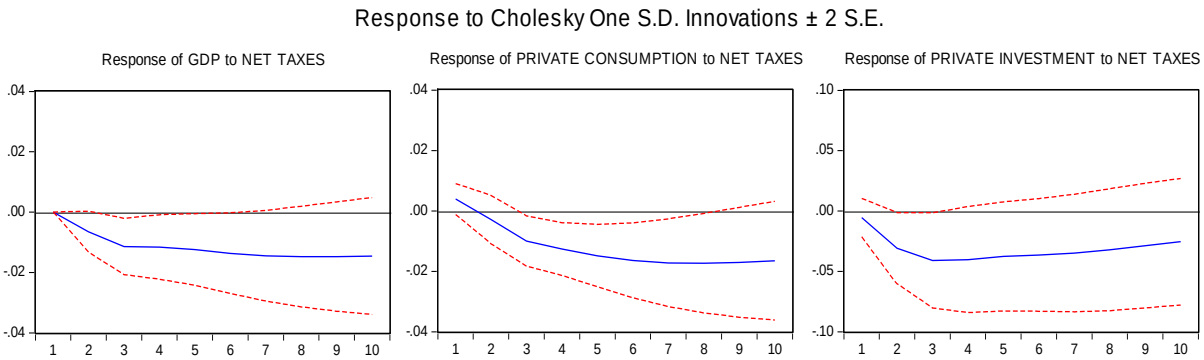
Now, the effects of net tax shocks are estimated using the same methodology as above. First, the impulse responses of GDP are measured using the three-variable baseline VAR model, identifying net tax shocks with *Cholesky decomposition ordering* and *institution information* restrictions. Figure 3.12 shows the impulse responses to the net tax shocks, where GDP responds negatively to net tax shocks, regardless of the identification method.

Figure 3.12 The Responses of GDP to Net Tax Shocks (Baseline VAR)



Second, the responses to net tax shocks are estimated using the five-variable extended VAR model. As shown in Figure 3.13, GDP and its two sub-components (private consumption and private investment) respond negatively to net tax shocks. The negative effects are quite significant according to the two standard error confidence bands.

Figure 3.13 The Responses of GDP to Net Tax Shocks (Extended VAR)



3.5.2 The Effects of Fiscal Policy Shocks on the Labour Market

3.5.2.1 The Effects of Aggregated Government Spending Shocks on the Labour Market

As can be seen from the theoretical literature review, there are big differences in views on the effects of fiscal policy shocks on the labour market. The neoclassical model predicts a decrease in employment and the real wage, while the new Keynesian model predicts the opposite results, with the assumption of price stickiness or monopolistic competition.

Our baseline specification includes the following variables: government spending, net taxes, GDP, and private consumption. To this fixed set of four variables, each of two labour market variables is added in turn. In our estimation, the four labour market variables can be put into two groups: (1) group 1 - manufacturing employment, e_t, and the real wage rate, w_t, (2) group 2 - total hours worked, h_t, and unemployment rate, u_t.

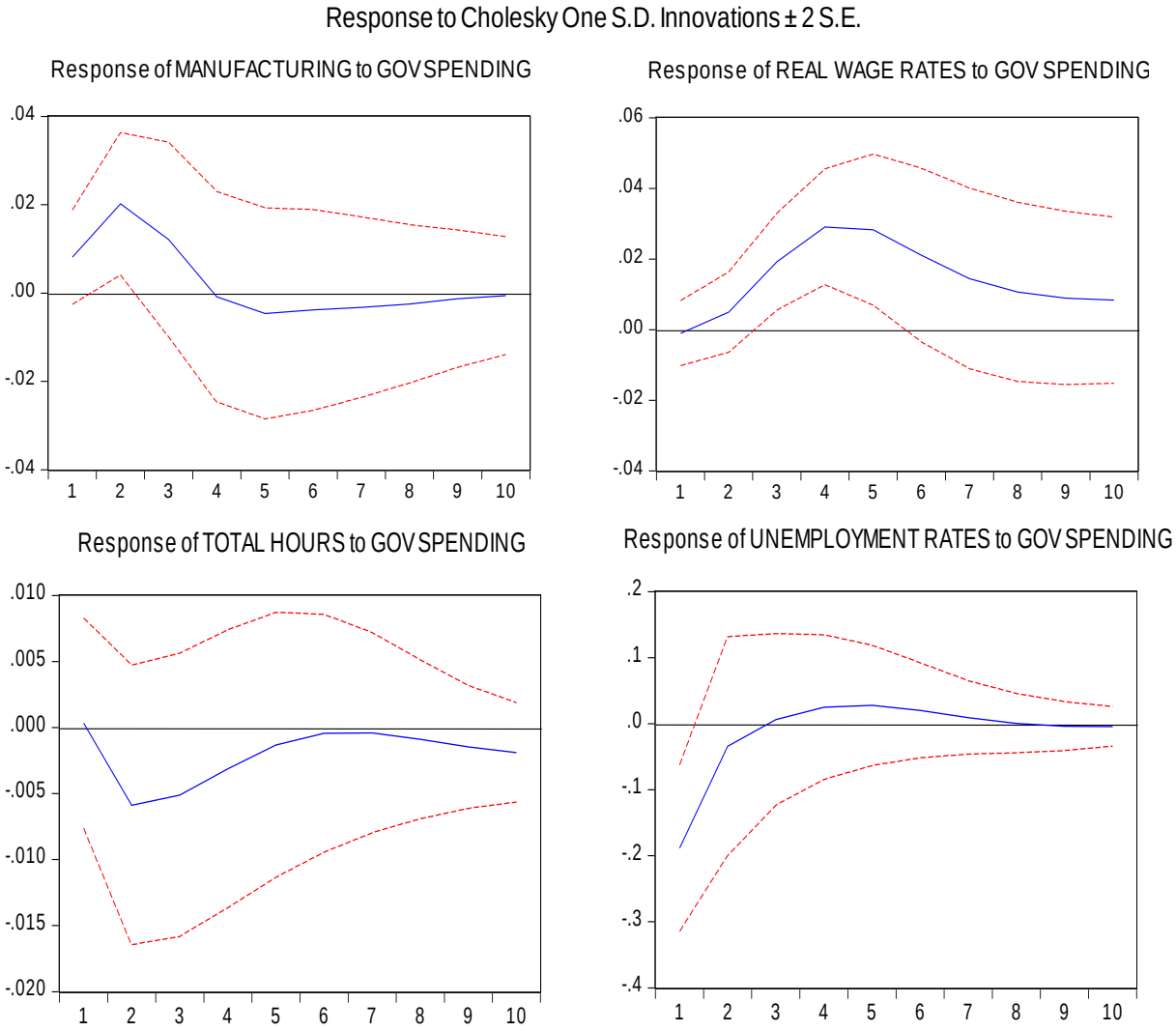
It is possible to estimate responses to a fiscal policy shock of one per cent of GDP from a six-variable VAR model that includes government spending, net taxes, GDP, private consumption, an employment variable and a real wage variable.

Figure 3.14 shows the main results of estimation. The government spending shock is expressed as per cent points of GDP.

According to the results, manufacturing employment responds positively for about four years to a government spending shock. The positive responses are small but significant for the first two years, at the two standard error confidence bands. The real wage rate also

shows positive responses to government spending shocks with an inverted U-shaped trajectory. Like manufacturing employment, the responses of the real wage rate are significant for a while. Total hours worked and unemployment rate fall following government spending shocks. Except for the response of total hours worked, the results are consistent with the theoretical view of the new Keynesian approach where government spending moves the labour supply and the demand curve outwards, raising the real wage.

Figure 3.14 The Responses of the Labour Market to Aggregated Government Spending

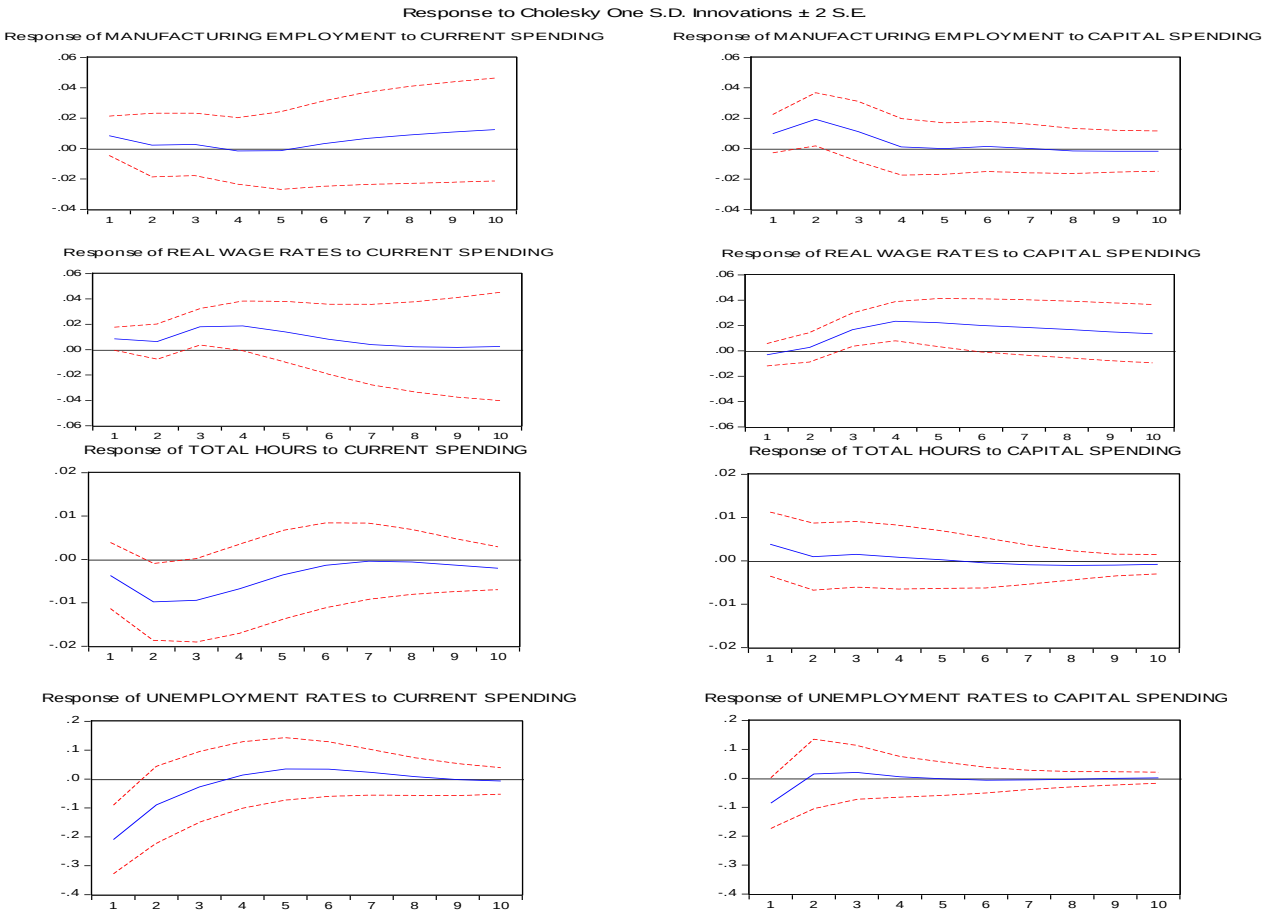


3.5.2.2 The Effects of Disaggregated Government Spending Shocks on the Labour Market

3.5.2.2.1 The Effects of Current and Capital Government Spending Shocks

Now, the effects of disaggregated government spending shocks on the labour market are estimated, which requires a six-variable VAR model. Four fixed set of variables are as follows: current government spending, capital government spending, net taxes, and GDP. Each of two labour market variables is also included, in turn. Figure 3.15 illustrates the impulse responses of the labour market variables to each disaggregated government spending shock.

Figure 3.15 The Responses of the Labour Market to Current/Capital Government Spending



As shown in Figure 3.15, when there is a current government spending shock, unemployment rate and total hours worked fall, while manufacturing employment and the real wage rate rise. It is notable that the real wage rate significantly increases in an inverted U-shaped trajectory after a current government spending shock. In response to a capital government spending shock, unemployment rate falls and the other labour market variables respond positively, as expected. Judging by the results explained above, we can suggest that capital government spending has more positive effects on the labour market in terms of job creation than does current government spending.

3.5.2.2.2 The Effect of Government Employment and Operating Spending Shocks

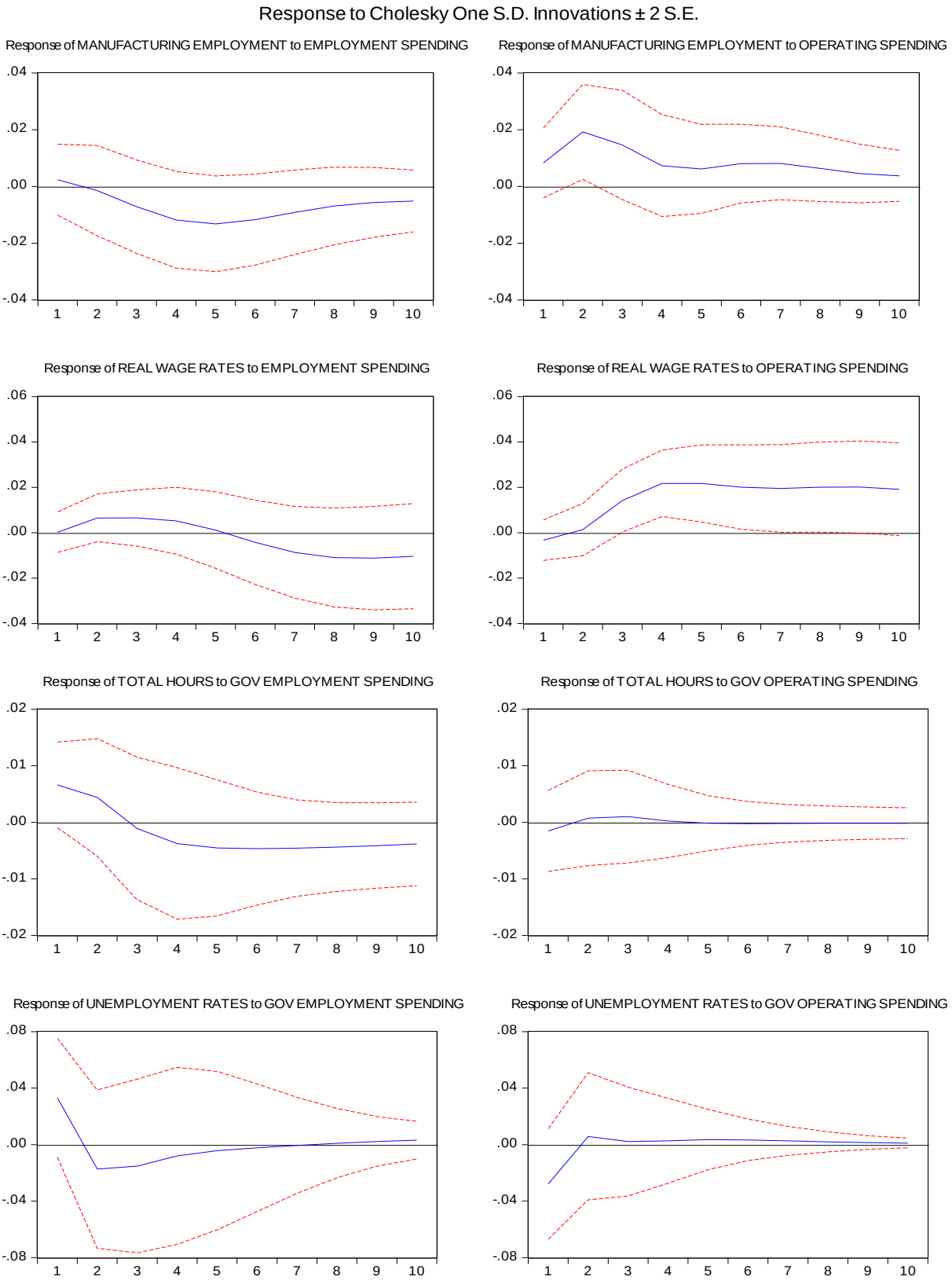
It is meaningful to take a look at the distinction between government employment spending and other government operating spending on the labour market. Therefore, to see the effects of government employment spending shocks on the labour market, two variables should be changed in the six-variable VAR model used in Section 3.5.2.2.1. Current government spending and capital government spending are replaced by government employment spending and government operating spending. Finally, the new six-variable VAR model includes government employment spending, government operating spending, net taxes, GDP, manufacturing employment and the real wage rate. Also, the results of the new six-variable VAR model are estimated after replacing manufacturing employment and the real wage rate by total hours worked and unemployment rate.

Figure 3.16 shows the results of estimation. The first column of Figure 3.16 displays the responses of private manufacturing employment, the real wage rate, total hours worked

and the unemployment rate to a government employment spending shock. The second column shows the responses of the same four variables to a government operating spending shock. Both government spending shocks have a negative wealth effect on the private consumer, which increases manufacturing employment and total hours worked. The positive effects of government employment spending on manufacturing employment are insignificant and disappear quite quickly, becoming negative after a year. A government employment spending shock increases the real wage rate, total hours worked and the unemployment rate but all are insignificant. As for the effects of government operating spending, this spending leads to a significant increase in private manufacturing employment displaying an inverted U-shaped trajectory. As with a government employment spending shock, the real wage rate increases significantly in response to a government operating spending shock. Meanwhile, the responses of total hour worked and the unemployment rate to a government operating spending shock are insignificant.

The results of estimating the VARs are generally consistent with Tenhofen *et al*. (2010), who argue that a government employment spending shock does not have significant effects on the economy. The results contrast with those of Pappa (2005) and Perotti (2008), who find positive responses by private employment and the real wage to a government employment spending shock. According to their research, the responses of private employment are less strong than those of the real wage. Our results are also in line with those of Linnemann (2009). Linnemann makes his estimations using a three-variable VAR with government employment, private employment and GDP as the variables. He finds that private employment responds positively to a government employment shock.

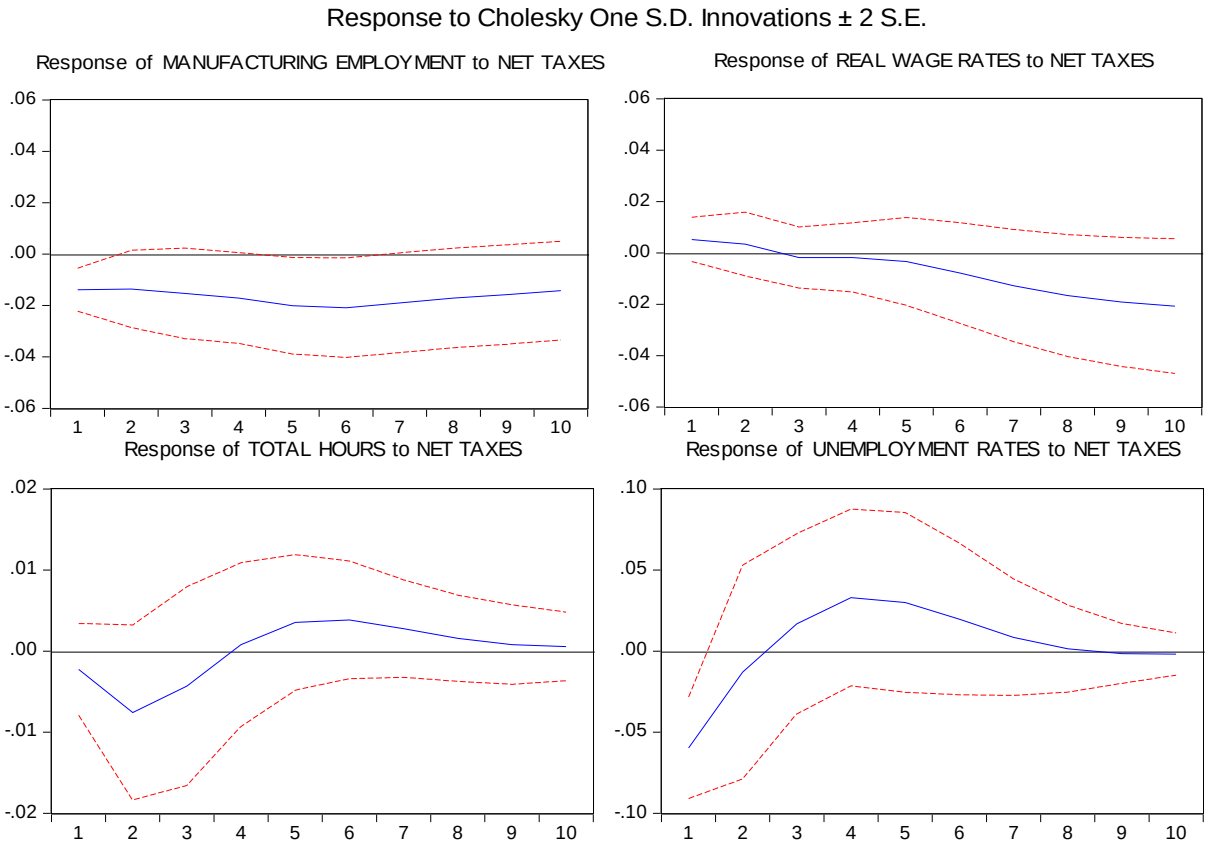
Figure 3.16 The Responses of the Labour Market to Government Employment and Operating Spending



3.5.2.3 The Effects of Net Tax Shocks on the Labour Market

Figure 3.17 shows the impulse response of the labour market variables to net taxes shocks. Unlike a government spending shock, a net tax shock generally has negative effects on the labour market. When there is a net tax increase by one per cent of GDP, manufacturing employment shows a negative and significant response. Total hours worked also responds negatively to a net tax shock, but the responses are insignificant. Meanwhile, the response of the real wage rate to a net tax shock changes from positive to negative, and the response is insignificant. It is notable that the unemployment rate shows a significant decrease for a year after a net tax shock.

Figure 3.17 The Responses of the Labour Market to Net Tax Shocks



3.6 Robustness Checks

This section undertakes a few robustness checks. First, it is checked whether disaggregated government spending has the same effects on GDP regardless of the analysis methodology. So, the effects of disaggregated government spending on the economy are measured using the four-variable SVAR model. Second, the effects of fiscal policy shocks are measured using quarterly data and see whether the results are consistent with those of estimation using annual data. Third, the effects of fiscal policy shocks considering monetary policy are checked. By measuring the effects of fiscal policy shocks with different methodology, different data frequency and control variables, the robustness of the analysis can be strengthened.

3.6.1 The Effects of Fiscal Policy Shocks Using Four-Variable SVAR Model

In a specification of disaggregated government spending in the four-variable SVAR model, we can include both current government spending and capital government spending instead of aggregated government spending in the three-variable baseline SVAR model.

If restrictions are imposed on the four-variable VAR model using *Cholesky decomposition ordering*, the matrix equation is as follows.

$$(3.13)\quad \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} u_t^{gc} \\ u_t^{gi} \\ u_t^{t} \\ u_t^{y} \end{bmatrix} \equiv \begin{bmatrix} a_1 & 0 & 0 & 0 \\ b_1 & b_2 & 0 & 0 \\ c_1 & c_2 & c_3 & 0 \\ d_1 & d_2 & d_3 & d_4 \end{bmatrix} \begin{bmatrix} e_t^{gc} \\ e_t^{gi} \\ e_t^{t} \\ e_t^{y} \end{bmatrix}$$

Meanwhile, if restrictions are imposed on the four-variable SVAR model using *institutional information*, the estimated results, with the matrix form, are shown as follows.

$$(3.14)\quad \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & -1.09 \\ -0.3 & -0.3 & 0.06 & 1 \end{bmatrix} \begin{bmatrix} u_t^{gc} \\ u_t^{gi} \\ u_t^{t} \\ u_t^{y} \end{bmatrix} \equiv \begin{bmatrix} 0.06 & 0 & 0 & 0 \\ 0 & 0.16 & 0 & 0 \\ 0.03 & 0.01 & 0.05 & 0 \\ 0 & 0 & 0 & 0.02 \end{bmatrix} \begin{bmatrix} e_t^{gc} \\ e_t^{gi} \\ e_t^{t} \\ e_t^{y} \end{bmatrix}$$

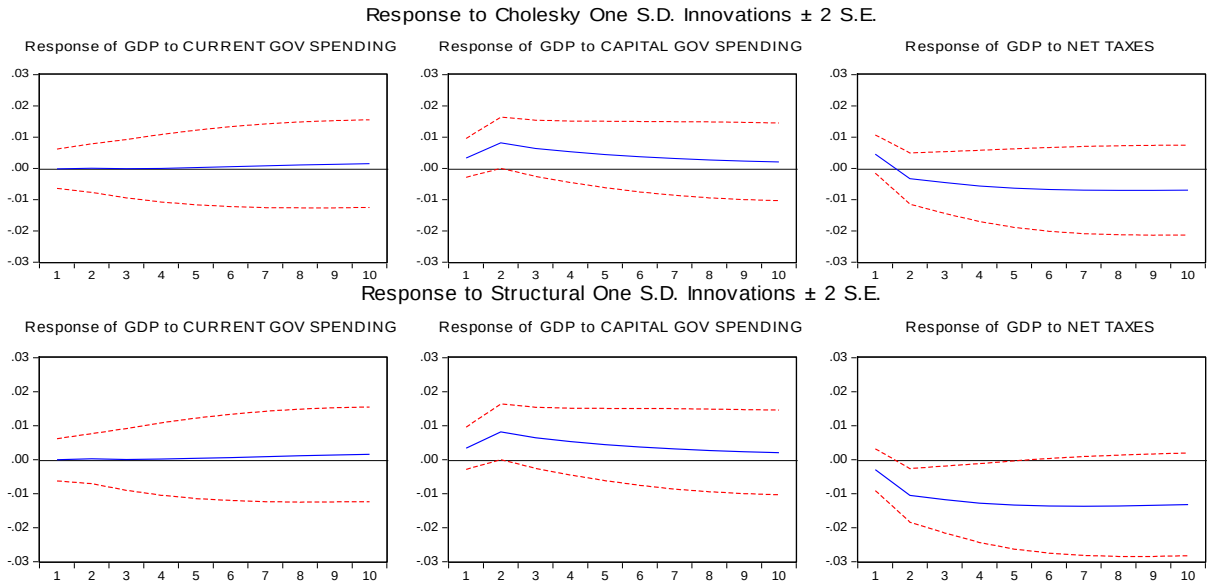
Table 3.7 displays the estimated coefficients of the contemporaneous relationships between the vairalbes. Both current government spending and capital government spending affect GDP positively, but only the effects of capital government spending on GDP are significant. A net tax shock has significant and negative effects on GDP. Meanwhile, shocks on both current government spending and capital government spending have small but significant positive effects on net taxes.

Table 3.7 Estimation of the Effects of Disaggregated Government Spending

	Coefficient	Std. Error	*Z*-statistic	*p*-value
$u_t^{gc} \rightarrow u_t^{y}$	0.10	0.07	1.43	0.11
$u_t^{gi} \rightarrow u_t^{y}$	0.32	0.08	4.01	0.02
$u_t^{t} \rightarrow u_t^{y}$	-0.06	0.06	0.91	0.36
$e_t^{gc} \rightarrow u_t^{t}$	0.03	0.01	3.40	0.01
$e_t^{gi} \rightarrow u_t^{t}$	0.01	0.01	1.70	0.08

Figure 3.18 shows the impulse responses of GDP to both current government spending and capital government spending shocks and net tax shocks. The results are very similar, regardless of the identification methods. Current government spending has positive but weak effects on GDP. Capital government spending has positive and persistent effects on GDP. That is, capital government spending has stronger and longer-lasting effects on GDP than current government spending. These results are consistent with the findings of Blanchard and Perotti (2002), Fatás and Mihov (2001), Burnside *et al*.(2004), Pappa (2009) and Favero and Giavazzi (2007). This strengthens the robustness of the estimation results arrived at using an extended VAR model in Section 3.5.1.2.

Figure 3.18 The Response of GDP to Disaggregated Fiscal Policy Shocks



3.6.2 The Effects of Fiscal Policy Shocks Using Quarterly Data

It is worthwhile looking at the effects of fiscal policy shocks using quarterly data, because many studies use quarterly data. So, we can check the robustness of the estimation by comparing the results with an analysis using a different data frequency. Here, we use quarterly data starting from 1994:1, and ending with 2010:4. The macroeconomic variables in terms of GDP, private consumption and investment are from the IFS of the IMF. The source for the fiscal variables is the MOSF in Korea. The quarterly data include cyclical movements that repeat every quarter. But if we had removed these cyclical seasonal movements from a series and extracted the underlying trend component of the series by seasonal adjustment, as the US Census Bureau's X12-ARIMA procedure does, we might have lost some meaningful information. So, we use raw quarterly data instead of using a seasonally adjusted data set[39].

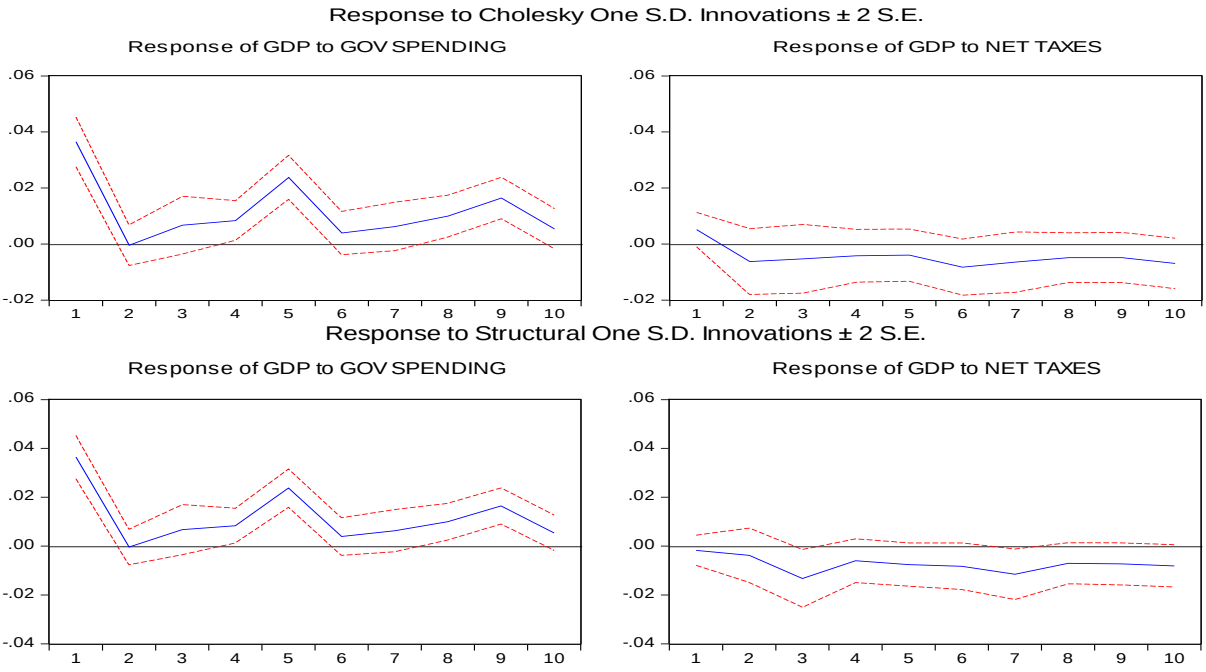
[39] The results are similar in the case of using a seasonally adjusted and linearly detrended data set.

3.6.2.1 The Effects of Fiscal Policy Shocks on Output

3.6.2.1.1 The Effects of Aggregated Fiscal Policy Shocks

To estimate the effects of aggregated fiscal policy shocks on output, a three-variable baseline VAR model is used following Blanchard and Perotti (2002). Figure 3.19 displays the results. The finding is that government spending shocks raise real GDP, but the impact is insignificant. As for the effects of net tax shocks, the graph depicts that output reacts negatively to a net tax increase, but the impact of this is also insignificant.

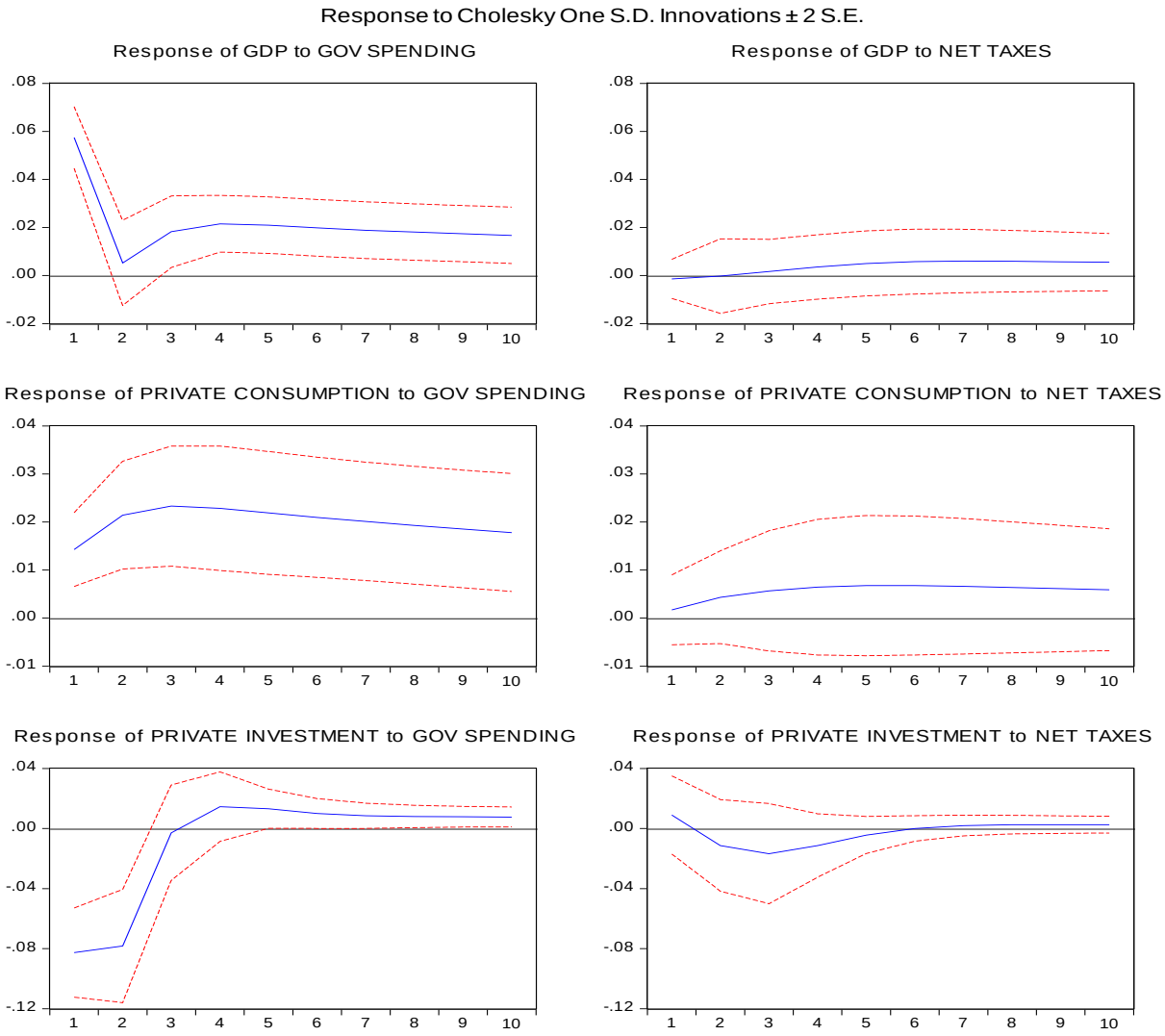
Figure 3.19 The Response of GDP to Fiscal Policy Shocks (Baseline VAR, Quarterly Data)



In order to measure the effects of aggregated fiscal policy shocks on private consumption and private investment, we use a five-variable VAR by adding two main sub-components of GDP (i.e., private consumption and private investment) to the three-variable baseline VAR model. According to Figure 3.20, private consumption increases, while private

investment decreases when faced with government spending shocks. The responses are in line with the previous evidence of Blanchard and Perotti (2002), which shows positive consumption and negative investment responses to government spending shocks. In response to net tax shocks, both private consumption and private investment react insignificantly. The results are also consistent with Blanchard and Perotti (2002). Generally, the results are similar to those based on annual data, except for those that show the effects on private investment of government spending shocks.

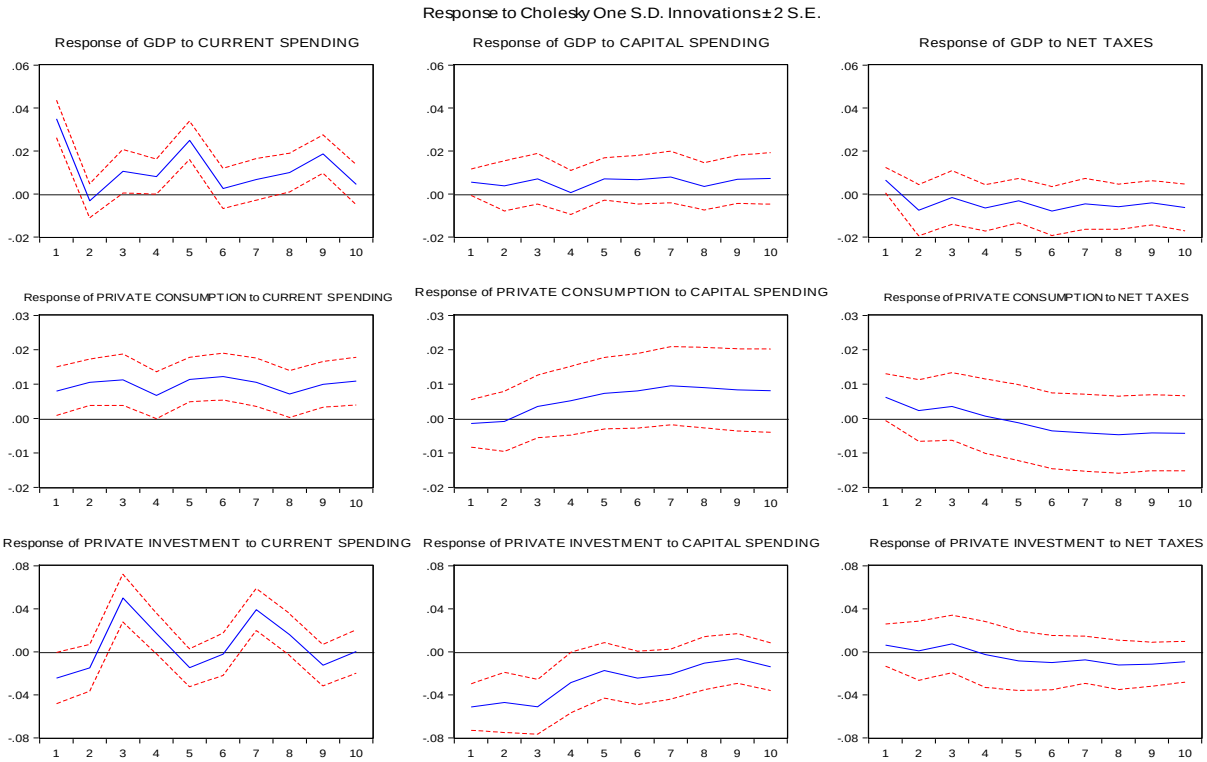
Figure 3.20 The Responses of GDP to Fiscal Policy Shocks (Extended VAR, Quarterly Data)



3.6.2.1.2 The Effects of Disaggregated Fiscal Policy Shocks

The newly established VAR consists of six variables: current government spending, capital government spending, net taxes, GDP, private consumption, and private investment. Figure 3.21 shows the effects of disaggregated government spending shocks and net tax shocks on GDP and its components. Both private consumption and private investment react positively to current government spending shocks. Meanwhile, capital government spending has positive effects on private consumption and negative effects on private investment. The results are similar to those derived from annual data, except for the effects on private investment of capital government spending shocks. These slightly different results might be caused by the considerable difference of sample periods between annual data and quarterly data.

Figure 3.21 The Responses of GDP to Disaggregated Fiscal Policy (Extended VAR, Quarterly Data)



3.6.2.2 The Effects of Fiscal Policy Shocks on the Labour Market

A five-variable VAR model is designed to see the responses of labour market variables to fiscal policy shocks. The five variables consist of three fixed set of variables - government spending, net taxes, GDP - and two extra labour market variables. To see the responses for the four labour market variables, two extra labour market variables are used in an extended VAR model.

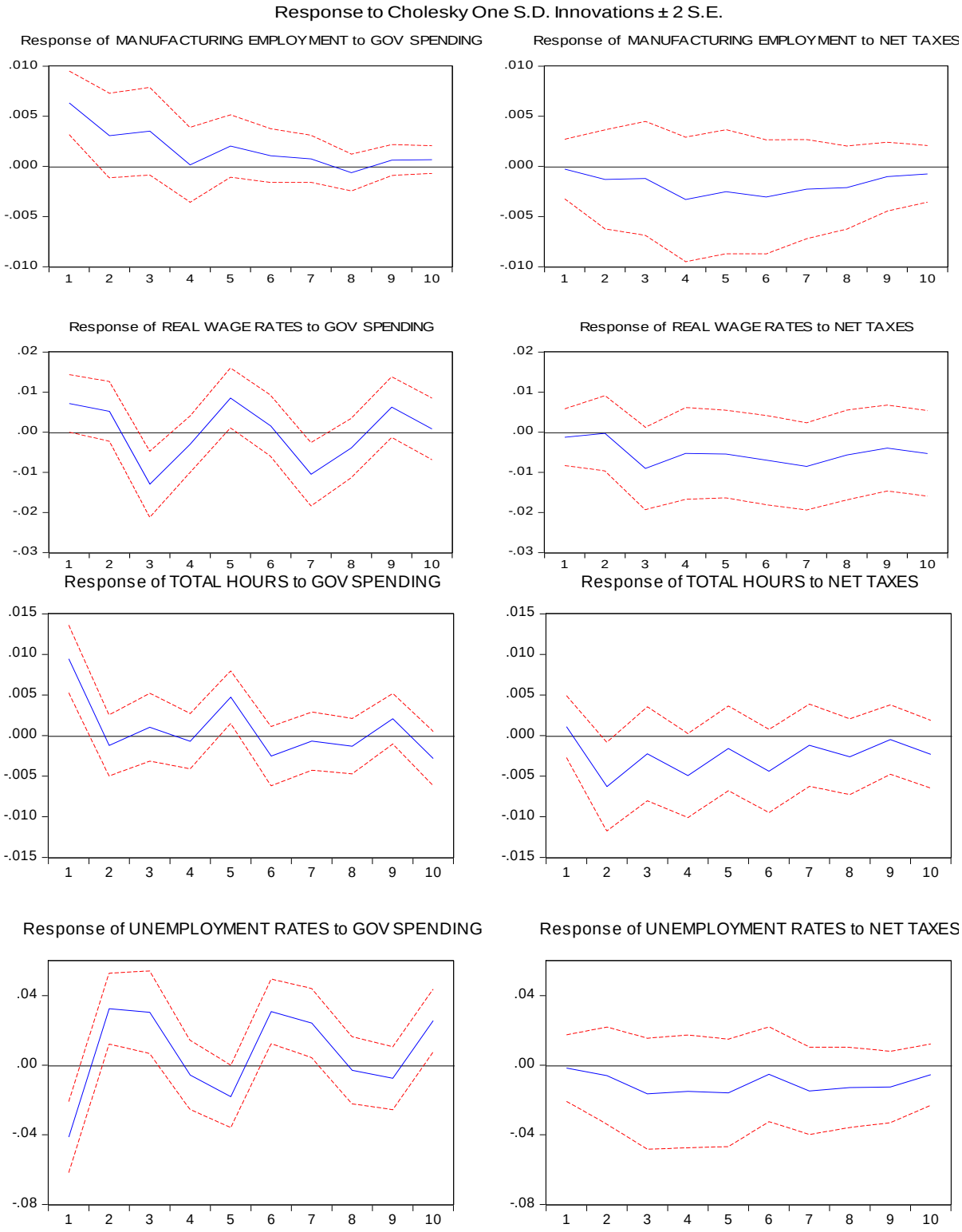
Figure 3.22 displays the responses of four labour market variables to fiscal policy shocks. First, government spending shocks increase private manufacturing employment, the real wage rate and total hours worked, and they decrease the unemployment rate significantly. However, the responses are small and short-lasting. Except for the response of total hours worked, the responses of other variables are the same as those obtained when using an annual data set.

Second, net tax shocks decrease private manufacturing employment, the real wage rate, total hours worked, and the unemployment rate. The results are the same as those of estimation done with annual data.

Based on the results above, we can cautiously suggest that the effects of fiscal policy shocks on the labour market are similar, irrespective of the data frequency and sample periods.

In conclusion, the effect of fiscal policy shocks on economic activity are consistent with the new Keynesian model, which suggests that government spending leads to an increase in GDP, employment and the real wage.

Figure 3.22 The Responses of the Labour Market to Fiscal Policy (Extended VAR, Quarterly Data)

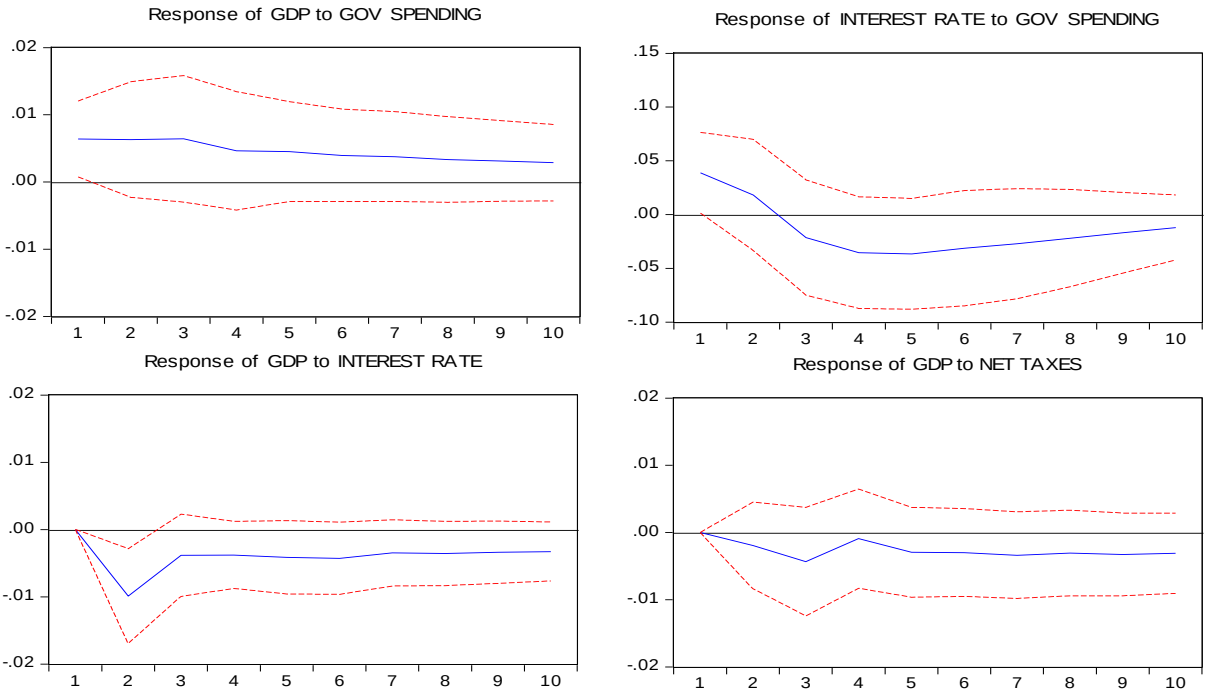


3.6.3 The Effects of Fiscal Policy Shocks Considering Monetary Policy

The effects of fiscal policy shocks depend on the economic situation and also on the character of other economic policy such as monetary policy. That is, the effects of fiscal policy shocks are changeable depending on the strength of the central bank's offsetting reaction. If the central bank tries to offset any rise in real GDP, the effects of fiscal policy shocks are expected to be close to zero. But the results can be totally different if it is not possible, or there is no wish, to offset fiscal policy shocks with monetary policy. If we measure the effects of discretionary fiscal policy without considering monetary policy, these effects can be overestimated. In this context, following Ramey (2011), we measure the effects of fiscal policy by including the long-term interest rate as a control variable in our three-variable SVAR model. The series of interest rates for the time period are secured from the OECD Economic Outlook.

Figure 3.23 illustrates the results of estimation. When we take the interest rate into consideration, the response of GDP to government spending shocks becomes weak compared to that shown on the three-variable baseline SVAR model, but still remains positive. This pattern is probably due to the negative effects of high interest rates on GDP. That is, an increase in the interest rate may cause a reduction in investment, which finally undermines GDP growth. The interest rate responds positively to government spending shocks for two years and then turns into negative. This positive response of the interest rate is consistent with the theory. Figure 3.23 also shows that GDP responds negatively to net tax shocks, even if interest rate is added to the baseline SVAR model. The results are similar when we estimate the model by adding the interest rate into the extended VAR model (See Appendix 3.2).

Figure 3.23 The Response of Macroeconomic Variables to Fiscal Policy Shocks



3.7 Conclusion

This chapter has analysed the effects of fiscal policy shocks on output and on the labour market. By decomposing aggregated fiscal policy variables into disaggregated ones and estimating their effects on the economy, we have tried to provide policy-makers with much clearer information on the effects of economic policy decisions. Identification of fiscal policy shocks has been carried out by imposing restrictions on the VAR model using both *Cholesky decomposition ordering and institutional information*. Various robustness checks have also been carried out to ensure the results.

Aggregated government spending shock has positive effects on GDP and its sub-components (private consumption and private investment) regardless of the analysis methodology. The effects on GDP are significant. However, the effects on sub-components of GDP are relatively small and insignificant at the two standard error confidence bands.

A disaggregated government spending shock shows different effects on GDP and its sub-components. Current government spending has a negative effect on private consumption, while capital government spending has a positive effect on private consumption. From this, it can be inferred that capital government spending has more positive and long-lasting effects on the economy than current government spending[40]. Meanwhile, government employment spending, which accounts for about 50 per cent of current government spending, has positive effects on GDP and its components, but the positive effects are insignificant and short lasting.

As regards the labour market, aggregated government spending shock has positive effects on this. Except for total hours worked, all the other labour market variables (i.e., manufacturing employment, the real wage rate and employment rate) respond positively to aggregated government spending shocks. The results are generally consistent with the view of the new Keynesian approach where government spending moves the labour supply and the demand curve outwards, raising the real wages. Meanwhile, capital government spending shock is likely to boost the labour market more effectively than other types of government spending shock. Government employment spending[41] shock does not have positive effects on the labour market. In this context, it might be the right choice for the Korean government to have increased government spending focusing on capital formation in the wake of the financial crises. As for net tax shocks, the increase in net tax causes a significant fall in output and also shows negative effects on the labour market.

[40] This is in contrast to Devarajan *et al*. (1996) and Perotti (2004) that cast doubt on the superiority of government investment shocks over government consumption shocks in boosting the economy.

[41] According to the definition of GFS, this is government wages and salaries which are included under current government spending.

CHAPTER 4

THE SUSTAINABILITY OF PUBLIC DEBT IN KOREA, THE UK, AND THE US

Chapter 4. The Sustainability of Public Debt in Korea, the UK, and the US

4.1 Introduction

It may hit the spot if policy makers can discover *ex ante* whether the public debt of one's country is sustainable or not, with great precision. Based on that accurate assessment, policy makers are able to establish a proper fiscal policy to address a potential crisis. The sustainability of public debt has once again become a current policy issue as the public debt-to-GDP ratio in many countries has risen markedly due to the 2008 Global Financial Crisis. A capacity to ensure the sustainability of public debt is one of the essential attributes of good macroeconomic policy, along with price stability, low unemployment and balanced economic growth (Wyplosz, 2011). Under some circumstances, using public debt is necessary and effective, even if public debt increases. But, if public debt is not sustainable, it can create serious problems. The accumulation of public debt with continuing budgetary deficits may trigger a need for higher long-term interest rates in order to issue additional sovereign bonds in the markets, which eventually places a heavy burden on a country. So, an efficient government may balance its budget inter-temporally by setting the current market value of public debt equal to the discounted sum of expected future surpluses, because there are limitations on its borrowing and it faces a present-value borrowing constraint (Quintos, 1995).

Despite the increasing importance of the sustainability of public debt, it seems to be quite difficult to define the concept simply and to measure it directly without errors. Therefore, this chapter focuses on defining the concept of sustainability of public debt and finding appropriate methods of calculating public debt sustainability in different countries. Sustainability of public debt is to be examined for three selected countries - Korea, the UK,

and the US - which have different economic conditions[42]. By applying various econometric methods, a possible measurement error can be removed or minimized and the robustness of the estimating results may be achieved.

The sustainability of public debt in the three selected countries is examined using the following tests: (1) Johansen's cointegration tests between the variables, such as the dependent variable and independent variables, (2) An Autoregressive Distributed Lag (ARDL) bounds tests to check the existence of cointegrating relationship between the variables, and (3) A modified Bohn's tests with a fiscal reaction function[43] to investigate whether the primary surplus responds positively to changes in public debt. This chapter will contribute on several points to developing the debates on the public debt sustainability. First, as well as Johansen tests, ARDL bounds tests are added to investigate a long-run relationship between the variables, which is essential to secure sustainable public debt. Second, considering the existence of non-stationary variables in the derived model, Bohn's original model of fiscal reaction function is modified using dynamic ordinary least squares (DOLS) methodology.

The remainder of this chapter is organized as follows. Section 4.2 reviews previous literature. Section 4.3 explains several econometric methodologies. Section 4.4 describes the data, including some stylized facts about fiscal variables in each country. Section 4.5 presents empirical results. Finally, Section 4.6 concludes.

[42] Countries are selected by taking into account the comparability, representativeness and feasibility of the data. Many previous studies on debt sustainability use US data. The US represents countries over $40,000 per capita GDP, the UK represents countries between $30,000 and $40,000 per capita GDP, and Korea represents countries under $30,000 per capita GDP. In particular, Korea also represents rising nations in terms of economic growth, and the UK represents advanced countries that suffer from a recent rapid rise in debt. Time series data for the three countries are more available and credible than for other countries.

[43] Even if the debt-to-GDP ratio is declining, it is difficult to say that the decline is due to sensible policy design. So, it is worthwhile exploring how governments react to the accumulation of debt in difficult economic circumstance. The fiscal reaction function designed by Bohn measures whether governments do corrective actions when the debt-to-GDP ratio begins to rise (Bohn, 1998). This is the real value of Bohn's tests.

4.2 Literature Review

4.2.1 Theoretical Approach

4.2.1.1 The Definition of Public Debt and Government Deficit

The definition of public debt varies a great deal according to its usage. Public debt in this chapter is defined as debt owed by the general government[44]. That is, we narrow down the definition of public debt to one of debt related to the general government[45], which includes the state and local government. In this context, government debt is the same term as public debt.

Public debt consists of internal debt which is owed to domestic lenders within the country and external debt which is owed to foreign lenders. Another classification of public debt can be done by the duration of repayment. In this point of view, public debt is not homogeneous. That is, the duration of short-term debt is usually one year or less, that of long-term debt is more than ten years, and that of medium term debt falls between former two boundaries.

On the other hand, the annual government deficit refers to the difference between total government revenue and expenditure in a single year, that is, it shows the increase in debt over a particular year.

[44] Central government, states or provincial governments, and municipal or local governments are included in the general government sector.

[45] Within the general government sector, central government consists of the institutional unit(s) of central government plus those non-market non-profit institutions (NPIs) that are controlled by central government.

4.2.1.2 The Concept of the Sustainability of Public Debt

As the sustainability of public debt is a forward-looking concept, it cannot be assessed with certainty (Wyplosz, 2011). It is worth defining the concept of the debt sustainability in order to discuss the sustainability of particular policies encountered in practice even though the definition might be imprecise.

Since the sustainability of public debt was first suggested by Domar (1944), major theoretical developments of the concept have been advanced by Barro (1974, 1979), and Bohn (1991, 1995, 2007). Domar (1944) finds that the faster GDP grows, the lighter will be the burden of government debt. He argues that the sustainability of public debt should be secured by increasing GDP rather than merely by reducing public debt. Barro (1974, 1979) provides theoretical explanations of the determinants of government deficits by re-examining the Ricardian equivalence theorem. He shows that a government can temporarily increase a deficit in the short and medium term in order to smooth the tax rate over time and minimize the distortionary effects of taxation. He insists that as long as the government satisfies the IBC, the debt policy is sustainable regardless of the existence of a short-term deficit. Bohn (1991) argues that even if the interest rate on government bonds may be below the growth rate of the economy, fiscal policy is sustainable only when the government satisfies the IBC, which depends on the probability distribution of fiscal variables across states of nature.

The IMF's definition of a sustainable public debt is as follows: 'a debt is sustainable if it satisfies the solvency condition without a *major correction*, *given the costs of financing* (IMF, 2002, p5)'. Debt solvency is accomplished when the present value of future primary

surpluses[46] is expected to be large enough to reimburse the debt, the principal and the interest. That is, debt solvency is obtained when the current debt does not exceed the present discounted value of future revenue minus non-interest expenditure (Wyplosz, 2011). The IMF definition of sustainability asks two more difficult qualifications for solvency. The first qualification is *'no major correction'* in the primary balance[47]. There should not be severe expenditure cuts or a large revenue increases. The other one is *'no increase in the cost of financing'*. Considering that financing costs are so changeable and unpredictable over time, the IMF definition of sustainability is vague (Wyplosz, 2011).

So, it is reasonable to define the sustainability of public debt as a debt solvency condition, as mentioned above. That is, we can say that a fiscal policy satisfies the sustainability of public debt if the present value of future primary surpluses is expected to equal the initial debt. This result is based on the condition that the present discounted value of the future stock of debt is expected to converge to zero. Therefore, the sustainability of public debt rules out Ponzi schemes[48] in which debt is continually rolled over (Trehan and Walsh, 1988, p208). In this context, the concept of sustainability of public debt can be described in two steps as follows.

[46] 'Primary surplus' equals tax revenues net of non-interest government spending.

[47] 'Primary balance is government net borrowing or net lending excluding interest payment on consolidated government liabilities'.

[48] 'Ponzi schemes' are namely cheating investment operations where returns of investment are paid to existing investors with the funds of new investors. Ponzi schemes usually lure new investors by offering higher returns than any other investment agency. Sometimes, Ponzi schemes encourage existing investors to 'roll over' promised payments by offering higher investment returns.

4.2.1.2.1 Single Period Government Budget Constraint

The analysis of the public debt sustainability can be undertaken from the budget identity that links the deficit to non-interest government spending, G_t, tax revenues, R_t, and public debt, D_t. The flow of government budget constraint for a single period, *t*, can be written as follows.

$$(4.1)\quad G_t + (1 + i_t)D_{t-1} = R_t + D_t,$$

where G_t is the nominal non-interest government expenditure - that is, the primary government expenditure, R_t is the nominal government tax revenue (excluding seigniorage[49]), D_t is the gross stock of public debt at the end of period *t*, and i_t is the nominal interest rate of the public debt issued for the previous period. The equation (*4.1*) can be rewritten as (*4.2*):

$$(4.2)\quad D_t = G_t - R_t + (1 + i_t)D_{t-1}$$

where $G_t - R_t$ is the primary deficit. The stock of public debt at time *t* (D_t) is the sum of pre-existing public debt (D_{t-1}) with its interest payment ($i_t D_{t-1}$) and primary budget deficit ($G_t - R_t$).

Public debt *per se* is not enough to measure the financial burden. Instead, the public debt-to-GDP ratio can be a proper indicator of the financial burden because GDP is the basis of redemption of a public debt.

[49] The reduction in the deficit by money-financing of the central bank is ruled out here because it will ultimately lead to high inflation that is not accepted by economic players.

Generally speaking, the form of ratio to GDP is much more useful to interpret the relationships between the variables, because an analysis based on ratio to GDP can effectively reflect the situation of growing economies. That is, by using GDP ratio data, growth trends can be eliminated. Moreover, it can address potential heteroscedasticity problems that may happen when level data are used (Bohn 1991, p344). In this context, we can rewrite (*4.2*) to (*4.3*) by dividing (*4.2*) by nominal GDP (=$P_t y_t$). P_t is the GDP deflator and y_t is the real GDP.

$$(4.3)\ \frac{D_t}{P_t y_t} = \frac{(G_t - R_t)}{P_t y_t} + \frac{(1+ i_t)D_{t-1}}{P_t y_t} = \frac{(G_t - R_t)}{P_t y_t} + \frac{(1+ i_t)P_{t-1} y_{t-1}}{P_t y_t}\frac{D_{t-1}}{P_{t-1} y_{t-1}}$$

$$= \frac{(G_t - R_t)}{P_t y_t} + \frac{(1+ i_t)}{(1+ \pi_t)(1+ g_t)}\frac{D_{t-1}}{P_{t-1} y_{t-1}}$$

$$= \frac{(G_t - R_t)}{P_t y_t} + \frac{(1+ r_t)}{(1+ g_t)}\frac{D_{t-1}}{P_{t-1} y_{t-1}}$$

where $1 + i_t$ equals $(1 + r_t)(1 + \pi_t)$, $g_t = \frac{y_t - y_{t-1}}{y_{t-1}}$ is a real GDP growth rate, and $\pi_t = \frac{P_t - P_{t-1}}{P_{t-1}}$ is an inflation rate.

(*4.3*) can be simplified as following equation (*4.4*).

$$(4.4)\ \ d_t = pd_t + \frac{(1+ r_t)}{(1+ g_t)} d_{t-1}$$

where $d_t = \frac{D_t}{P_t y_t}$ and $pd_t = \frac{(G_t - R_t)}{P_t y_t}$.

It is worthwhile taking a brief look at debt dynamics. We can obtain a change of the debt-to-GDP ratio by subtracting d_{t-1} from both sides of (*4.4*).

(*4.5*) $\Delta d_t = pd_t + \frac{(r_t - g_t)}{(1+g_t)} d_{t-1}$

Based on equation (*4.5*), we can infer that the debt-to-GDP ratio increases when the primary deficit-to-GDP ratio (pd_t) increases or the real interest rate (r_t**)** is larger than the GDP growth rate (g_t). It is notable that if the GDP growth rate is large enough compared to the interest rate ($r_t < g_t$), a government can operate a primary deficit without increasing the debt-to-GDP ratio. This means that considerable or frequent primary deficits might not directly result in an unsustainable fiscal policy (Bohn, 1998, p960). Moreover, in a situation that the real interest rate is larger than the GDP growth rate ($r_t > g_t$), even the primary surplus (pd_t < 0) cannot ensure the decrease or stability of the debt-to-GDP ratio (Bohn, 1998, p960).

As Bohn (1988) suggests, whenever the interest rate of one's economy exceeds its growth rate, the debt accumulation process becomes seriously unstable. On the other hand, when the interest rate is lower than the growth rate, the debt-to-GDP ratio is stable and sustainable[50]. However, in the long run, the latter argument is unrealistic because growth rate is likely to be caught up by the real interest rate (Wyplosz, 2011, p18). In the short run, the lower interest rate than growth rate allows many countries to run down the debt-to-GDP ratio.

[50] The real interest rate can be lower than the growth rate while one's economy grows rapidly (e.g., China over the last decade) or while one's economy is experiencing accelerating inflation (Wyplosz, 2011, p18).

4.2.1.2.2 The Inter-Temporal Budget Constraint (IBC)

The IBC can be created by rewriting equation (*4.1*) for the subsequent periods and solving the single period government budget constraint equation forward recursively.

$$(4.6)\ D_t = \sum_{s=1}^{\infty} \frac{R_{t+s} - G_{t+s}}{\prod_{j=1}^{s}(1+i_{t+j})} + lim_{s\to\infty} \prod_{j=1}^{s} \frac{D_{t+s}}{(1+i_{t+j})}$$

The crucial element in the IBC is the second term of the right-hand side of the equation (*4.6*). When the limiting value of $\prod_{j=1}^{s} \frac{D_{t+s}}{(1+i_{t+j})}$ equals zero ($\lim_{s\to\infty} \prod_{j=1}^{s} \frac{D_{t+s}}{(1+i_{t+j})} = 0$)[51], the present value of the existing stock of nominal public debt (D_t) will be the same as the present value of future primary surpluses. If we assume that the nominal interest rate (i_t) is stationary, with a mean of *i*, E_t can be defined as follows.

$$(4.7)\ E_t = G_t + (i_t - i)D_{t-1}$$

Assumption (*4.7*) implies the following.

$$D_t - D_{t-1} = G_t - R_t + i_t D_{t-1} = E_t - R_t + iD_{t-1}.$$

The present value borrowing constraint becomes as follows.

$$(4.8)\ D_t = \sum_{s=1}^{\infty} \frac{R_{t+s} - E_{t+s}}{(1+i)^s} + lim_{s\to\infty} \frac{D_{t+s}}{(1+i)^s}$$

[51] If the limit term does not converge to zero, the government is bubble-financing its expenditures, financing for the old matured bonds by issuing new bonds to market (if the government can finance its deficit by issuing new sovereign bonds without any limit, it can be said that the government uses a sort of Ponzi scheme).

A sustainable fiscal policy needs to ensure that the present value of the stock of public debt ($\lim_{s\to\infty} \frac{D_{t+s}}{(1+i)^s}$) goes to zero as *s* goes to infinity, which means the absence of Ponzi games[52]. Under a no-Ponzi condition like this, the present value of future primary surpluses is equal to the current values of the stock of public debt (Afonso and Rault, 2010).

As mentioned before, it is much more useful to express all the variables in terms of ratios of GDP.

$$(4.9)\ \frac{D_t}{P_t y_t} = \frac{(G_t - R_t)}{P_t y_t} + \frac{(1+i_t)D_{t-1}}{P_t y_t} = \frac{(G_t - R_t)}{P_t y_t} + \frac{(1+r_t)}{(1+g_t)}\frac{D_{t-1}}{P_{t-1} y_{t-1}}$$

Assuming the real interest rate to be stationary, with a mean of *r*, and a constant real GDP growth rate of *g*, the budget constraint is given as follows.

$$(4.10)\ d_t = \sum_{s=1}^{\infty}\left(\frac{1+g}{1+r}\right)^s [\rho_{t+s} - e_{t+s}] + lim_{s\to\infty}\left(\frac{1+g}{1+r}\right)^s d_{t+s},$$

where $d_t = \frac{D_t}{P_t y_t}$, $\rho_t = \frac{R_t}{P_t y_t}$, $e_t = \frac{E_t}{P_t y_t}$. We assume $r > g$ because if the long-run growth rate of GDP exceeded the long-run interest rate, sustainability of fiscal policy would not be an issue. When $r > g$, it is necessary to introduce a solvency condition. Equation (*4.10*) leads to (*4.11.b*) if the no-Ponzi condition (*4.11.a*) is satisfied. We can describe equation (*4.11.a*) as the 'transversality condition (TC)'[53]. The TC implies that fiscal policy will be sustainable if the present value of future primary surpluses, as a ratio of GDP, matches the

[52] Under the condition of Ponzi games, a government can refinance its debt by continuously issuing new bonds without redeeming the debt.

[53] West's (1984) study of stock price volatility refers to a condition analogous to (*4.11*) as the 'transversality condition' (Hamilton and Flavin, 1986, p7).

inherited stock of public debt under the no-Ponzi condition. The TC and IBC can be written as follows.

(*4.11.a*) $lim_{s\to\infty}\, d_{t+s}\,(\frac{1+g}{1+r})^{s} = 0,$

(*4.11.b*) $d_t = \sum_{s=1}^{\infty}(\frac{1+g}{1+r})^{s}[\,\rho_{t+s} - e_{t+s}].$

One implication of the IBC (*4.11.b*) is that all public debt should be returned by equal present value of future primary surpluses.

In a similar fashion, we can say that successive primary budget deficits can be sustainable as long as the real growth rate g exceeds the real interest rate *r* (Domar, 1944). In a dynamically inefficient economy, where $r < g$, government can run a Ponzi-scheme permanently. For instance, if we impose $d_t = d_{t+s}$ (i.e., the debt-to-GDP ratio is constant), equation (*4.10*) can be rearranged as follows.

(*4.12*) $d_t[1 - (\frac{1+g}{1+r})^{s}] = \sum_{s=1}^{\infty}(\frac{1+g}{1+r})^{s}[\,\rho_{t+s} - e_{t+s}]$

The left-hand side of (*4.12*) is negative, because $d_{\mathrm{t}} > 0$ and $[1 - (\frac{1+g}{1+r})^{s}] < 0$. As a result, the right-hand side (i.e., the present value of primary surpluses) should be negative for the equality to hold. This means that a government can run permanent primary deficits with the debt-to-GDP ratio holding constant.

4.2.2 Empirical Studies

In the empirical literature on public debt sustainability, there have basically been three main approaches. The first is based on the univariate time series properties of public debt: that is, applying unit root tests. The second is based on the long-run relationship between two variables (bivariate approach): that is, applying cointegration tests. Both approaches suggest possible ways to test the sustainability of public debt under the IBC. Unit root tests and cointegration tests provide useful tools for gaining insight into the long-run implications of public debt. Finally, the last approach is the estimation of fiscal reaction function, i.e., applying Bohn's test.

4.2.2.1 Unit Root Tests

Hamilton and Flavin (1986) undertake stationarity test of the primary budget surplus as a sufficient condition for sustainable fiscal policy. Starting with TC, they test the null hypothesis of no-Ponzi condition (NPC) [$\lim_{s\to\infty} d_{t+s}\,(\frac{1}{1+r})^s = 0$] against the alternative of the existence of a speculative term [$\lim_{s\to\infty} d_{t+s}\,(\frac{1}{1+r})^s > 0$]. At first, they assume a constant interest rate and a constant violation of the IBC (i.e., $A_0 > 0$) using equation (*4.13*) as follows.

(*4.13*) $d_t = \sum_{s=1}^{\infty}(\frac{1}{1+r})^s[\,\rho_{t+s} - e_{t+s}] + (\frac{1}{1+r})^{-t}A_0$,

where $A_0 \equiv \frac{D_0}{P_0 y_0} - \sum_{s=1}^{\infty}(\frac{1}{1+r})^s[\,\rho_s - e_s]$, $d_t = \frac{D_t}{P_t y_t}$, $\rho_t = \frac{R_t}{P_t y_t}$, $e_t = \frac{E_t}{P_t y_t}$.

They argue that the null hypothesis of the IBC is valid if and only if $A_0 = 0$. When $A_0 = 0$, d_t will be stationary because $\sum_{s=1}^{\infty}(\frac{1}{1+r})^s\,[\rho_{t+s} - e_{t+s}]$ follows a stationary process. This means that the debt policy is sustainable if $d_t \sim$ I(0) and $\sum_{s=1}^{\infty}(\frac{1}{1+r})^s\,[\rho_{t+s} - e_{t+s}] \sim$ I(0).

These researchers adopt a non-stochastic constant positive *ex post* real interest rate ($r_{t+n} = r > 0$) in the model. Based on empirical unit root tests, they conclude that the US government's deficit and the stock of debt are stationary. This result means that postwar US deficits are largely consistent with the idea that the government budget should be well-balanced in present-value.

But the credibility of the results for the stationarity of the deficit and the debt are very weak. They reject the hypothesis of a unit root only by adopting a 10 per cent significance level. If the 5 per cent significance level is selected, the unit root hypothesis cannot be rejected. And tests of long-run behaviour on the basis of 22 years of annual data may be expected to have low power (Trehan and Walsh, 1988). Moreover, their study has several limits because the research is restricted to non-stochastic fluctuations in real interest rates (which are assumed *ex-post* constant and positive) and does not consider the structural breaks in fiscal debt policy.

Wilcox (1989) develops Hamilton and Flavin (1986)'s work, deriving the condition for sustainable fiscal policy which suggests that the discounted value of public debt should converge to zero in the infinite future. Contrary to many previous tests, he allows for stochastic variation in the real interest rate. He avoids assumptions about the expected real rate process by discounting government debt back to a fixed reference date (1960) using *ex-post* real rates and examining the behaviour of the resulting discounted debts series. Unlike Hamilton and Flavin (1986), Wilcox (1989) argues that the IBC can be satisfied even if the undiscounted value of the debt is I(1) because the non-stationarity of the debt might just reflect the fact that deviations of the debt from the future primary surpluses might last into the

long run, but not permanently. He defines a sustainable fiscal policy as one that would lead the forecast trajectory for the discounted value of the debt to zero under the indefinite time horizon. Moreover, he finds a significant structural change in the US fiscal policy in 1974, and concludes that the IBC was satisfied before 1974, but not after 1974. The results are contrary to the conclusions of Hamiltion and Flavin (1986).

4.2.2.2 Cointegration Tests

After Wilcox (1989), many studies have used alternative tests based on a cointegrating relationship between government spending and revenue (See literature such as Trehan and Walsh, 1988, 1991; Hakkio and Rush, 1991; Quintos, 1995). This test is based on the following hypothesis. When total government spending (inclusive of interest payment on debts) and tax revenue all are I(1), if their linear combination is I(0), then the two variables are moving close each other, which satisfies the IBC condition.

Before Trehan and Walsh (1988, 1991), most studies had examined the relationship between net-of-interest expenditure and revenue, that is, the behaviour of the net-of-interest deficit. However, Trehan and Walsh suggest a cointegration test between total government spending (inclusive of interest payment on debts) and tax revenue. The stationarity of the deficit inclusive of interest payments ($g_t + rd_{t-1} - \tau_t$) is both necessary and sufficient for the government's inter-temporal budget balance. If expenditure including interest ($g_t + rd_{t-1}$) and tax revenue (τ_t) are cointegrated with a cointegrating vector (1 -1), then the IBC is satisfied. Through this test, they find that the US government's budget is consistent with the IBC condition. After showing the limitation of Dickey-Fuller unit root tests on ($g_t + rd_{t-1} - \tau_t$), they adopt the Engle-Granger approach to test the inter-temporal budget balance

instead. According to the Engle-Granger tests, government expenditure including interest payments and government revenues are cointegrated because the residuals obtained from the regression of $g_t + rd_{t-1}$ on τ_t is stationary. Moreover, by using Stock-Watson tests (1988), they provide stronger evidence that the US government's budget is balanced over time.

Hakkio and Rush (1991) extend Trehan and Walsh's approach. Their model is similar to Trehan and Walsh's (1991) model, because they assume that fiscal policy can be sustainable if total expenditure ($GG_t = G_t + r_t D_{t-1}$)[54] and tax revenue (τ_t) are I(1) respectively , and the two series are cointegrated with the vector (1, -1). That is, if GG_t and τ_t are cointegrated with vector (1, -1), the two series cannot drift too far apart because their difference ($GG_t - \tau_t = \varepsilon_t$) is stationary. However, their study is different from previous ones on several points. First, unlike previous studies (e.g., Haug, 1991; Smith and Zin, 1991), they allow for fluctuations in the interest rate by using stochastic and stationary real interest rates (i.e., $r_{t+n}\ are\ iid\ with\ (r, \sigma^2), r > 0$). Of course, a stationarity restriction on the real interest rate is not a good approximation to the true data generating process. Second, as well as testing the cointegrating relationship between real government spending and revenue, they also examine normalized real government spending and revenue using real GNP and population to take a growing economy into consideration. Third, they impose an exogenous structural break. Based on this, they use several different sample periods to test the view that deficits have become a problem only in specific periods. For instance, they test for cointegrating relationships over the whole sample (from 1950:2 to 1988:4) and over sub-

[54] Total expenditures (GG_t) denotes total government spending on goods and services, transfer payments, and interest payments on debt ($G_t + r_t D_{t-1}$). G_t is the value of government purchases of goods and services plus transfer payments.

samples that run from 1964:1 to 1988:4, and from 1976:3 to 1988:4, respectively. There is a cointegrating relationship between GG_t and τ_t using the whole sample, but no cointegration in the sub-samples. That is, Hakkio and Rush find that while the US government's inter-temporal budget is balanced for the period from 1950 to 1988, this is not the case for the sample periods beginning in 1964 and 1976.

Quintos (1995) tries to refine and extend the concept of the sustainability condition. In addition to a strong sustainability condition, he introduces a 'weak' sustainability condition. Under the strong sustainability condition, which is suggested by Hamilton and Flavin (1986), Trehan and Walsh (1988) and Hakkio and Rush (1991), the present value of expected future debts converges to zero at an infinite point because of the cointegrating relationship between revenue and with-interest expenditure. He shows that with the weaker condition, cointegration is not a necessary but a sufficient condition for a strict interpretation of deficit sustainability. The weak sustainability condition also allows the present value of expected future debts to converge to zero, but at a slower rate than the strong version does. According to the weak sustainability condition, when the total deficit ($\Delta D_t = G_t + i_t D_{t-1} - \tau_t$) process is integrated or even mildly explosive, which means D_t ~ I(2) *or* ΔD_t ~ I(1), the deficit will still be sustainable as long as the growth rate of debt does not exceed the growth rate of the economy. In summary, Quintos calls the D_t ~ I(2) case 'weak' sustainability, as distinct from 'strong' sustainability in the case of D_t ~ I(1). As for the structural break, it is notable that, unlike Hakkio and Rush and Wilcox, who choose structural breaks exogenously, Quintos picks the break endogenously using a sequential Chow tests with I(1) processes. He identifies the endogenous structural breaks at 1975:2 and 1980:4, and supports Hakkio and Rush and Wilcox's conclusion that cointegration holds only for the pre-break period.

However, with the concept of a 'weak' sustainability condition, he also shows that the deficit can be sustainable even in the post-break period, although the strong deficit sustainability condition of Hakkio and Rush (1991) is not satisfied. He finds that the US fiscal debt is sustainable even though there is no cointegrating relationship between total government spending ($G_t + i_t D_{t-1}$) and tax revenues (τ_t) in the 1970s and 1980s. This conclusion is based on the fact that the debt processes satisfy 'weak' sustainability conditions even though they fail to meet 'strong' sustainability conditions.

4.2.2.3 Bohn's Fiscal Reaction Function Test

Bohn (1991) casts doubt on the validity of the above mentioned traditional sustainability tests (e.g., unit root tests and cointegration tests). He points out that the traditional sustainability tests explicitly or implicitly assume that the rate of return on government debt is 'on average' above the rate of economic growth, which does not hold in the long-term period.

He insists that a cointegration test between government expenditure (g_t) and tax revenues (τ_t) does not provide proper information about sustainability. Related to this, Bohn has no faith in the idea that the stationarity of debts or deficits by itself can provide decisive evidence of sustainability (Bohn, 1991, p20). He thinks that the judging a policy to be unsustainable on the basis of unit root and cointegration tests is inappropriate. In line with this thinking, Bohn (2007) argues that standard unit root and cointegration tests are not adequate methods to estimate the sustainability of public debt. He proves that if the relevant debt variable is stationary after any finite number of differencing operations (i.e., a debt series is integrated of order m ($D_t \sim I(m)$) for any finite $m \geq 0$), then debt satisfies TC and

debt, tax revenues, and government spending satisfy the IBC. He also proves that the IBC is satisfied if tax revenues and with-interest government expenditure are difference-stationary of an arbitrary order, without any cointegration requirement (Bohn, 2007, p1838). He thinks all the cointegration conditions suggested by previous studies are sufficient for the TC but far stronger than necessary. In other words, he thinks a lack of cointegration between variables does not prevent a series' consistency with the IBC (Bohn, 2007, p1843).

Against this backdrop, Bohn derives a new fiscal reaction function and implements it to check the sustainability of government policy. This new methodology is based on the corrective reaction of adjusting a primary surplus in response to changes in debt. It is notable that his test model does not rely on a relationship between interest rates and growth rates. In other words, it does not require government bond returns or safe interest rates above the economic growth rates (Bohn, 1991, p9). The baseline fiscal reaction function is as follows.

(*4.14*) $s_t = \rho \cdot d_t + \alpha \cdot Z_t + \varepsilon_t = \rho \cdot d_t + \mu_t,$

where $s_t (= \rho_t - e_t)$ is the primary surplus, $\rho_t = \frac{R_t}{GDP_t}$ is tax revenues divided by GDP, $e_t = \frac{E_t}{GDP_t}$ is non-interest government spending divided by GDP, $d_t = \frac{D_t}{GDP_t}$, Z_t is a set of other determinants of the primary surplus such as cyclical components of output and temporary government spending, ε_t is an error term, and $\mu_t = \alpha \cdot Z_t + \varepsilon_t$. He uses the variables scaled by GDP to avoid potential distortion by the series' severe heteroscedasticity levels.

As for the determinants(Z_t) of the non-debt components of a primary surplus, Bohn (1998) adopts Barro's (1979, 1986) tax smoothing model[55], extracting main two variables - the level of temporary government spending (*GVAR*) and a business cycle variable (*YVAR*) - as control variables. By doing this, he tries to address potential problems of omitted variables bias. Finally, equation (*4.14*) can be rewritten as the following equation (*4.15*). If the debt (d_t) and the primary surplus (s_t) are both non-stationary while μ_t is stationary, a simple regression of s_t on d_t can be interpreted as a cointegrating regression without having to model the μ_t process explicitly. On the other hand, if s_t and d_t do not have unit roots, a regression of s_t on d_t must be estimated with a simple ordinary least squares (OLS) methodology.

$$(4.15) \quad s_t = \alpha_0 + \rho \cdot d_t + \alpha_G \cdot GVAR_t + \alpha_Y \cdot YVAR_t + \varepsilon_t,$$

where $GVAR_t \equiv (g_t - g_t^*)/y_t, YVAR_t \equiv (1 - y_t/y_t^*) \cdot (g_t^*/y_t)$, g_t^* is normal real government spending, $g_t - g_t^*$ is temporary real government spending, y_t is current real GDP, y_t^* is trend real GDP, $1 - y_t/y_t^*$ is a temporary shortfall of output, and g_t is current real government spending.

Based on this linear model, Bohn (1998) suggests that one can find direct evidence for corrective action[56] by examining the response of the primary non-interest budget surplus

[55] Barro's tax smoothing model considers an optimizing government that minimizes the cost of taxation by smoothing marginal tax rates over time. So, tax smoothing suggests that temporary government expenditure and temporary declines in GDP (e.g., in the tax base) trigger higher than normal budget deficits. (Bohn, 2005, p28) According to this theory, the tax rate should be designed on the basis of permanent non-interest government expenditure, while transitory expenditure fluctuations should be financed by issuing government bonds. That is, the key point of tax smoothing hypothesis is that tax rate should depend only on permanent government spending and on the level of public debt. (Bohn, 1998, p951)

[56] Reducing non-interest government expenditure or raising tax revenues are good examples of corrective action.

(s_t) to changes in the debt-to-GDP ratio (d_t). That is, he points out that a strictly positive and at least linear response of the primary surplus to changes in the debt-to-GDP ratio turns out to be sufficient to guarantee a sustainable fiscal policy.

Going beyond the linear model, Bohn (1998) also examines potential nonlinearities in the relationship between the primary surplus and the debt-to-GDP ratio. He tries to find out whether or not primary surplus responds more sensitively when the debt-to-GDP ratio are particularly high. By adding powers of d_t, such as $(d - \bar{d})^2$ and $(d - \bar{d})^3$, and estimating the model, he finds that the marginal response of primary surplus to the changes in debt is significantly positive. Moreover, he shows that the marginal impact of debt-to-GDP ratio on the primary surplus increases as the debt-to-GDP ratio mounts. This means that the marginal response of primary surplus to debt is insignificant at low debt-to-GDP ratio, whereas it is significant at higher debt-to-GDP ratio. Since then, there have been several other studies supporting Bohn's argument. For instance, Sarno (2001) confirms the non-linear feature of debts dynamic by using a smooth transition autoregressive model. Judging from the findings of Bohn (1998), standard univariate unit root tests may have little power to reject the null hypothesis of a unit root for the debt-to-GDP ratio.

Bohn's test also has its limitation in providing a reason for the continuous increase in public debt in the advanced countries from 1970 to the early 1990s (Persson and Tabellini, 2000). Moreover, Bohn's test does not reflect the fact that governments' primary deficits are likely to be affected by changes in the political systems and the decision- making processes.

4.3 Methodology

Three different methodologies are used to analyse the sustainability of fiscal policy. The first is unit root tests for the related variables. The second is cointegration tests, which include Johansen's cointegration tests and the autoregressive distributed lag (ARDL) bounds tests. The last is Bohn's test of the fiscal sustainability. All the tests focus on fiscal stability from a long-run perspective.

4.3.1 Unit Root Tests

Firstly, Augmented Dickey-Fuller (ADF) tests and Phillips-Perron (PP) tests are undertaken on the levels and first differenced data[57]. All the variables are denoted both in real terms and in ratios to GDP. The ADF and PP tests examine the null hypothesis of a unit root against a trend-stationary alternative[58]. These unit root tests are criticized for their bias towards non-rejection of the null hypothesis of a unit root in the presence of structural breaks and low power for near-integrated processes. The Zivot and Andrews (1992) tests are added, which allow for endogenously determined structural break in the series. This test determines the structural break by utilizing a grid search over a range of possible breakpoints and choosing the year when the unit root *t*-statistic is minimized (Lusinyan and Thornton, 2012).

[57] Many economic and financial time series show trending behaviour or non-stationary properties in the mean. Thus, it is necessary to remove trends from the data or to transform them to a stationary form prior to analysis. Unit root tests are performed to examine the non-stationary properties of macroeconomic and financial time series before making an empirical analysis.

[58] The PP test is robust with regard to heteroscedasticity but ignores autocorrelation beyond a fine lag window. The ADF test includes an autoregressive correction but ignores heteroscedasticity (Bohn, 2005, p11).

4.3.2 Cointegration Tests

4.3.2.1 Johansen's Cointegration Tests

Several cointegration tests can be used to see if there is cointegration between variables and to find the number of cointegrating relationships. Engle-Granger tests, which examine the stationarity of the residual of a regression, can be used to test the former issue. If the residuals do not have a unit root through these tests, it means that there is evidence supporting the existence of a cointegrating relationship between the variables, because the linear combination is stationary. Meanwhile, Johansen's cointegration procedure can be used to find the number of cointegrating relationships between the variables.

In a first step, Engle-Granger (1987) tests[59] can be applied to see if there is a cointegrating relationship between total government expenditure-to-GDP ratios and total government revenue-to-GDP ratios. This method is based on the OLS residuals from the cointegrating regression for each country and examines the null hypothesis of no cointegration. If there is a cointegrating relationship, that implies the consistency of the fiscal policy with the IBC (Prohl *et al*., 2009)[60]. In the second step, Johansen cointegration tests can be conducted to examine the number of cointegrating relationships. Johansen (1988) and Johansen and Juselius (1992) suggest the method with which to test the number of cointegrating relationships and to determine whether a group of non-stationary time series are cointegrated or not. Johansen's cointegration tests are widely used in the case of multivariate

[59] Engle-Granger tests are based on the premise that if two processes which are integrated of order 1 are cointegrated, then the residuals obtained from regressing one on the other should be stationary.

[60] Alternatively, we can test the cointegrating relationship between the ratios of government debt to GDP and primary surplus to GDP. The results are exactly the same.

analysis, because this test is an extended version of the Dickey-Fuller unit root test for the multivariate case. There are two types of cointegration rank test statistics - trace statistics and maximum eigenvalue statistics – which use procedures developed by Johansen.

4.3.2.2 Autoregressive Distributed Lag (ARDL) Bounds Tests

In the case of non-stationary variables, the standard OLS regression may cause a spurious regression problem[61], which produces incorrect inferences. In this situation, it is necessary to check whether there is cointegrating relationship between the variables. Several cointegration tests exist; Engle and Granger's (1987) two-step approach, Johansen's (1991) VAR cointegration test approach, and Pesaran *et al.*'s (1996, 2001) Autoregressive Distributed Lag (ARDL) bounds test approach.

Among these tests, the ARDL bounds test approach has advantages over the Johansen's approach and Engle and Granger's approach. Engle and Granger's two-step approach can be used only when all the variables are integrated of the same order, I(1). If the variables are mixed with different orders of integration – e.g. I(1) and I(0), the ARDL bounds tests should be used because it can examine the cointegrating relationship between variables that have different orders of integration. Unlike Engle and Granger's approach, the ARDL bounds tests do not have any endogeneity problem. The ARDL bounds tests also have an advantage over Johansen's cointegration tests. First, the ARDL bounds tests make it possible

[61] Spurious regressions can be called 'nonsense correlations'. If two variables are trending over time, a regression of one on the other could have a high R^2 even if the two are totally unrelated. Therefore, if standard regression techniques are applied to non-stationary data, the end result could be a regression that looks good against standard measures, but which is really valueless (Enders, 2010, p196).In regressions of independent random walk variables, the usual *t-ratio* does not possess a limiting distribution but diverges with increasing sample size, thus increasing the probability of incorrect inferences as the sample size increases (Phillips, 1986)

to estimate consistent coefficients for I(0) variables, even in small samples, which Johansen's cointegration tests do not. In this context, Mah (1999) and Narayan (2005) support the robustness and superiority of the ARDL bounds tests against Johansen's cointegration tests. However, there is a weakness in the ARDL bounds test in that it can only be used in a single equation and on the assumption of one cointegrating relationship. In this point, the ARDL bounds test is less general than Johansen's multivariate cointegration test.

Considering the advantages mentioned above, the ARDL bounds test is also applied in this chapter. The ARDL bounds test can be applied as follows. Above all, the following unrestricted error-correction model (UECM) has to be estimated to see if there is a long-run relationship among the variables (Pesaran *et al*., 2001).

$$(4.16)\quad \Delta s_t = \alpha_0 + \alpha_1 t + w_1 \cdot s_{t-1} + w_2 \cdot d_{t-2} + w_3 \cdot GVAR_{t-1} + w_4 \cdot YVAR_{t-1} + \sum_{i=1}^{m} \beta_i \Delta s_{t-i} + \sum_{i=0}^{n} \gamma_i \Delta d_{t-1-i} + \sum_{i=0}^{o} \delta_i \Delta GVAR_{t-i} + \sum_{i=0}^{p} \theta_i \Delta YVAR_{t-i} + \varepsilon_t,$$

where w_i are long-run coefficients; α_0 is an intercept; *t* is a time trend; β_i, γ_i, δ_i, and θ_i are short-run coefficients; and ε_t is an error term. The appropriate number of lag lengths is selected by the AIC.

To investigate the long-run relationship, following Pesaran *et al*. (2001), an *F*-test (Wald test) is used. Pesaran *et al*. (2001) provide an asymptotic critical values for two set bounds - the lower critical bound (LB) and the upper critical bound (UB). LB is based on the assumption that all the variables in the ARDL model are I(0), while UB is based on the assumption that all the variables in the ARDL model are I(1). If the *F*-statistic is higher than the UB critical value, the null hypothesis of no cointegration is rejected, which means the existence of a long-run equilibrium relationship between the variables. On the other hand, if

the *F*-statistic is less than the LB critical value, the null hypothesis of no integration cannot be rejected. If the *F*-statistic is between the UB and LB critical values, it is difficult for the test to give a conclusion on the existence of a cointegrating relationship between the variables (Pesaran *et al*., 2001).

The null hypothesis of no cointegration is $H_0 : w_1 = w_2 = w_3 = w_4 = 0$ and the alternative one is $H_1 : At\ least\ some\ are\ non\ zero$. If the null hypothesis is rejected, this may be interpreted as showing that there is a cointegrating relationship between the variables; s_t, d_{t-1}, $GVAR_t$, and $YVAR_t$. The equation (*4.16*) is an error-correction version of the ARDL model of order (*m, n, o, p*). It is assumed that the numbers of lags of three independent variables are the same (i.e., *n=o=p*). If the null hypothesis of no cointegration is rejected, the long-run coefficients can be estimated by the following general ARDL model.

$$(4.17)\ s_t = a_0 + \sum_{i=1}^{p} \beta_{1i}\, s_{t-i} + \sum_{i=0}^{q} \beta_{2i}\, d_{t-1-i} + \sum_{i=0}^{r} \beta_{3i}\, GVAR_{t-i} + \sum_{i=0}^{s} \beta_{4i}\, YVAR_{t-i} + \varepsilon_t$$

4.3.3 Modified Bohn's Test

The main goal of Bohn's test is to see if governments adjust their primary surplus to changes in government debt. The equation (*4.18*) of Bohn's test is actually a fiscal reaction function, which is theoretically based on Barro's (1979, 1986) tax smoothing hypothesis. Bohn's test is based on the idea that fiscal policy is sustainable if governments undertake corrective action in response to changes in public debt by adjusting their primary surplus rather than taxation.

$$(4.18)\ s_t = \alpha_0 + \rho \cdot d_{t-1} + \alpha_G \cdot GVAR_t + \alpha_Y \cdot YVAR_t + \varepsilon_t = \alpha_0 + \rho \cdot d_{t-1} + \mu_t,$$

where $s_t(=\rho_t - e_t)$ is the primary surplus, $\rho_t = \frac{R_t}{GDP_t}$ is tax revenues divided by GDP, $e_t = \frac{E_t}{GDP_t}$ is non-interest government spending divided by GDP, d_t=$\frac{D_t}{GDP_t}$ is the ratio of D_t to GDP, D_t is the year-end market value of a government's public debt, exclusive of holdings by central government and trust funds or the central bank (Barro, 1986, p203). The additional variables can be defined as $GVAR_t \equiv (g_t - g_t^*)/y_t$, $YVAR_t \equiv (1 - y_t/y_t^*) \cdot (g_t^*/y_t)$, g_t is current real government spending, g_t^* is normal real government spending exclusive of interest payments, $(g_t - g_t^*)$ is temporary real government spending, y_t is current real GDP, y_t^* is trend real GDP, and $(1 - y_t/y_t^*)$ is a temporary shortfall in output. ε_t is an error term (Barro, 1986, pp198-199). Following Bohn (1998, 2005), control variables *GVAR* and *YVAR*[62] are included in equation (*4.18*) as the non-debt determinants of the primary surplus. Long-term trend series, such as g_t^* and y_t^*, can be obtained by implementing a HP filter (Details of a HP filter is given in Section 4.5.4).

It is necessary to explain more about $GVAR_t$ and $YVAR_t$ theoretically. For the variable $GVAR_t$, debt-to-GDP ratio rises when there is an increase in temporary real government spending $(g - g^*)$. Empirically, temporary government spending occurs during wartime via the unusually high military build-up. It is negative rather than zero during peacetime (Barro 1986, p200). That is, the debt-to-GDP ratio tends to fall during peacetime, and rise sharply during the (infrequent) large wars.

[62] *GVAR* and *YVAR* indicate temporarily high government expenditure and recession in the economy, respectively. A primary surplus may respond to these factors (Bohn, 1998).

For the variable $YVAR_t$, the debt-to-GDP ratio rises when real output (y) is below 'normal output (y^*)' – that is to say, when y/$y^* < 1$. However, if there are permanent shifts in the level of output, it is difficult to measure the temporary shortfall in output[63].

Bohn's original test has its limit, in that equation (*4.18*) is estimated with a simple OLS methodology, regardless of the order of integration of each variable. If the variables are all stationary I(0), then OLS can be used to estimate the coefficients of the equation (*4.18*). However, if some of the variables are non-stationary I(1)[64], then OLS should not be used because of a spurious regression problem. To avoid a spurious regression problem, Stock and Watson's (1993) DOLS is employed to estimate the equation. Stock and Watson DOLS model is specified as follows.

$$(4.19) s_t = \alpha_0 + \rho \cdot d_{t-1} + \alpha_G \cdot GVAR_t + \alpha_Y \cdot YVAR_t + \sum_{j=-q}^{r} \delta_j \Delta\, d_{t-j} + \varepsilon_t ,$$

where q is the lead length, and r is the lag length.

Leads and lags in a DOLS model play a role in making its stochastic error term orthogonal to all past innovations in the stochastic regressors. In this estimation, lead and lag length is specified automatically by using the AIC.

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[63] To address this problem, Barro (1986) uses the unemployment rate, U_t, as a proxy variable for the shortfall in output, $(1 - y_t/y_t^*)$. According to his argument, this variable will be useful even in the case of permanent shifts in the level of output. He assumes a stable relationship between the shortfalls in output and the deviation of the unemployment rate from a fixed natural rate of unemployment as follows. $(1 - y_t/y_t^*) = \lambda(U_t - U_t^N)$, where U_t^N is the natural unemployment rate. Then, he calculates *YVAR*. $YVAR_t \equiv (U_t - U_t^N) \cdot (g_t^*/y_t)$, where U_t is the unemployment rate for the total labour force (Barro 1986, p205).

[64] In our model, s_t and d_t are non-stationary I(1), whereas $GVAR_t$and $YVAR_t$ are stationary I(0) (See 4.5.4).

4.4 Data Description and Some Stylized Facts

4.4.1 The Properties of the Data

The sample countries used are Korea, the UK and the US. The main data sources are the IMF[65], the Organisation for Economic Co-operation and Development (OECD), the United Nations (UN), the World Bank, official government homepages and the central bank of each country[66]. Annual data are used. Taking into consideration the availability of the variables, the sample period begins in 1972 and ends in 2010. During this period, even though there may have been two structural breaks - the Asian Financial Crisis in 1997 and the Global Financial Crisis in 2008, there is no reason to separate or exclude these structural breaks from the data period as a whole to avoid distortion.

Both expansion and contraction periods are considered at the same time in order to examine the relationship between public debt and primary surplus. We use GDP scaled time series data to reflect the effects of economic growth on fiscal variables. The GDP scaled time series provides more credible information about the fiscal series than raw real data, because it is likely to eliminate growth trends and potentially possible heteroscedasticity (Bohn, 2005, p14). The GDP ratio data also may give a better view of a government's fiscal policy than a real data by reducing standard deviation of the data (Bohn, 2005, p2).

[65] To be more precise, the main data sources are the IFS, GFS and WEO.

[66] UK: the UK Debt Management Office, HM Treasury, National Savings & Investments, the Bank of England and the Office for National Statistics; US: the United States Department of Commerce, the Bureau of Economic Analysis (BEA), the United States Treasury; Korea: the Ministry of Strategy and Finance (MOSF), the Bank of Korea (BOK)

Government debt (d_t) is the debt owed by a general government, which covers both central government[67] and state or local government sectors. It is notable that government debt is a burden of the taxpayers indirectly because the government extracts its revenue from much of the population. Government revenue (τ_t) and non-interest government expenditure (g_t) are taken from the unified budget (consolidated fiscal balance), which includes social security and other trust fund accounts as well as transfers (Bohn, 1998, p2). Total surplus (ts_t) refers to the difference between government revenue and expenditure in a single year, that is, the decrease of debt over a particular year. Primary surplus (s_t) is the difference of government revenue and non-interest government expenditure.

4.4.2 Some Stylized Facts about Fiscal Variables

4.4.2.1 Korea

Government expenditure in Korea has fluctuated showing a trend of gradual rise. It was between 17 per cent and 20 per cent until the Asia Financial Crisis in 1997; it then jumped up to 22.4 per cent in 1998 and has stayed above 21 per cent, reaching a peak of 25.3 per cent in 2009 to boost a depressed economy. Government expenditure, despite the government's involvement in the activities of the private sector, is relatively low compared to that of the UK and the US.

[67] Central government consists of the institutional unit(s) of a central government plus those non-market non-profit institutions (NPIs) that are controlled by the central government.

As for government revenue, owing to the constant efforts of the Korean government to raise revenue, it has significantly increased from 13 per cent in the early 1970s to 25 per cent in 2007. But it has decreased since 2008 because of the sluggish economic growth.

Korea recorded a consolidated budget deficit (total deficit) of 3.4 per cent of GDP in 1998, the biggest annual fall since 1972. But, the consolidated budget balance became positive from 2000 and peaked at 3.6 per cent of GDP in 2002, remaining positive until 2009. Fluctuations in the consolidated budget balance have increased after the Asia Financial Crisis in 1997; but the trend of the primary surplus[68] has been the same as that for the total surplus. Generally speaking, the consolidated budget balance[69] of Korea is in a better condition than that of the other countries such as the UK and the US.

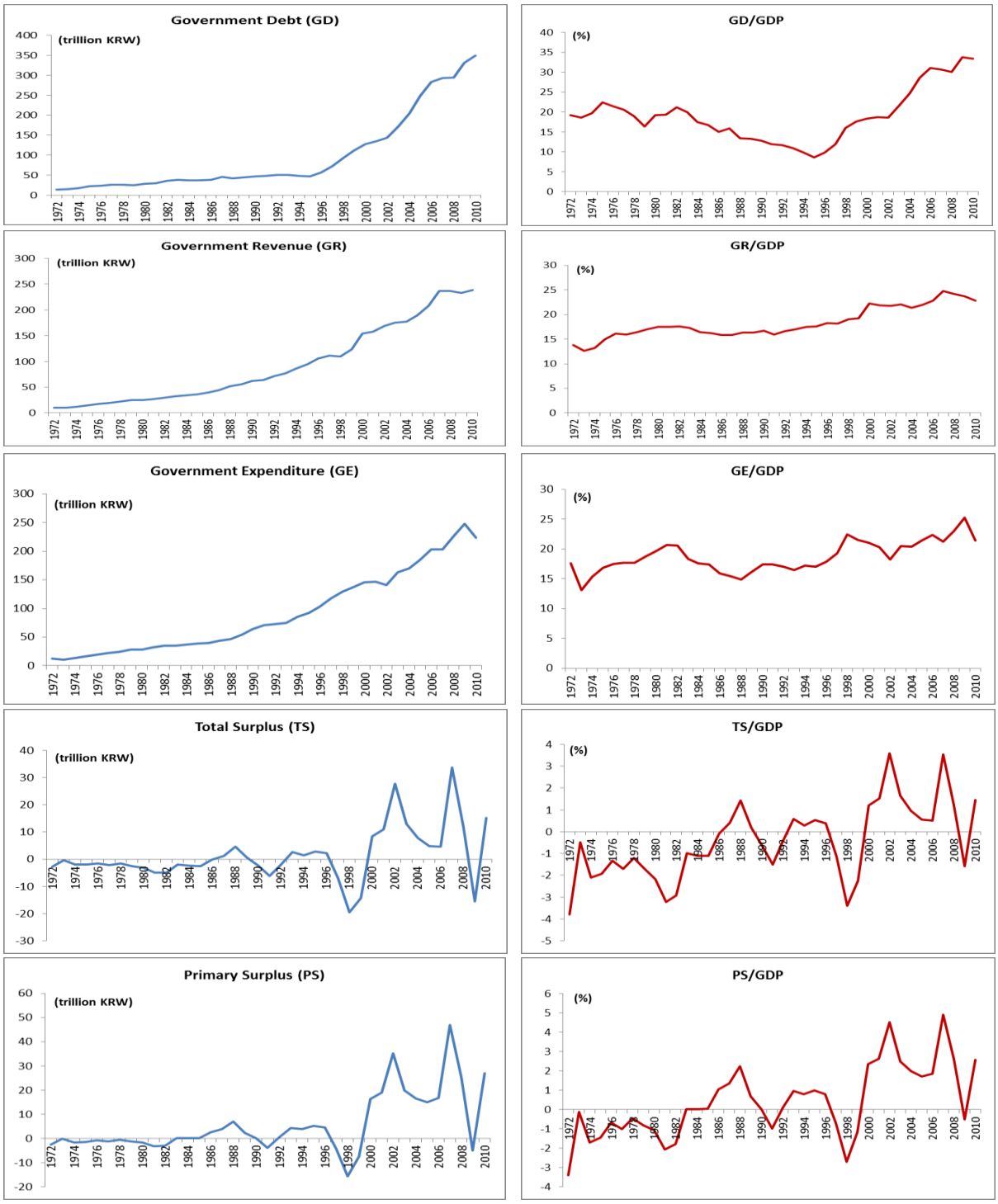
Government debt has increased very fast during these periods, even though its ratio to GDP is still comparatively lower than that of other countries. It has increased from 19 per cent of GDP in the early 1970s to 34 per cent of GDP in 2010. The main factor responsible for the increase in government debt is a persistently rising government spending and the financial cost to public funds of restructuring the financial sector after the two financial crises in 1997 and 2008. The abrupt rise in government debt is a burden to the Korean government because of the snowballing interest payment on debt, and this has eventually disturbed the country's sound economic growth.

[68] Primary surplus equals total surplus minus interest payment by the government.

[69] In relation to the consolidated budget balance in Korea, it has been argued that it is desirable to exclude the balance of the National Pension Fund (NPF) and net lending by the government to avoid any overstatement in assessing the financial soundness of the government. But, in this chapter, we do include NPF balance and net lending in the consolidated budget balance in order to compare the results of the three countries using the same standards.

Figure 4.1 The Main Fiscal Variables of Korea

Real value GDP ratio



4.4.2.2 The United Kingdom

Figure 4.2 shows the trends in the main fiscal variables during the last four decades in the UK. The main feature on the revenue side for the UK was the decline in revenue in the late 1980s and the early 1990s and in the 2008 global economic crisis, followed by a rapid increase thereafter. The UK government revenue and expenditure generally display a high degree of co-movement over the sample period. The series have not diverged markedly, so there seems to be no need to take account of possible structural breaks in fiscal policy.

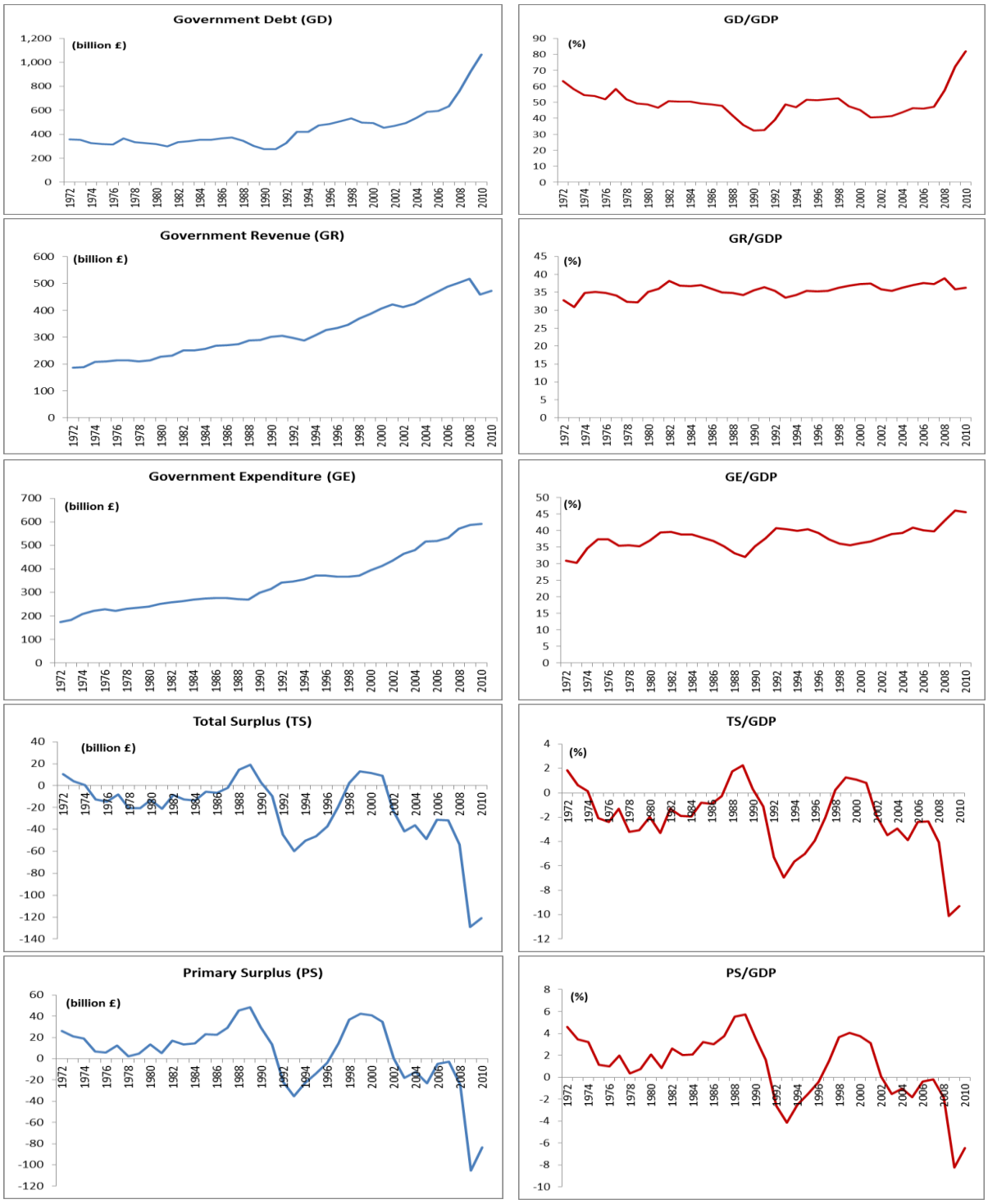
As for government expenditure, there are the three marked periods of increase in government spending – in the early 1980s, the late 1980s / early 1990s, and the 2008-2009. These periods of rapid growth mainly reflect downturns in the economy, which led both to a shrinking GDP and to higher cyclical government expenditure. In the early 1980s and in the second half of the 1990s, government spending declined as the economy strengthened; but it picked up again during the final years of the sample period because of a structural increase in social benefits and pension payments (Emmersen *et al*., 2003). During this period, there existed some degree of 'displacement effect[70]' as government spending did not decrease that much even after the economic downturns finished.

After the Global Financial Crisis in 2008, the UK government put up a massive amount of public funds to bail out the banking sector. Thereafter, government debt soared and fiscal soundness declined drastically.

[70] Peacock and Wiseman (1961, 1979) mention this concept pointing out that government spending is likely to fall back after wars but to level much higher than those of pre-war. They suggest that wars loose constraints on politicians' preference to raise taxes as much as they want and offer excuse of higher level of non-military spending once war finishes. Change of expectations of public regarding government's provision also contributes to the increase in non-military spending after war.

Figure 4.2 The Main Fiscal Variables of the United Kingdom

Real value (billions, £) GDP ratio (%)



4.4.2.3 The United States

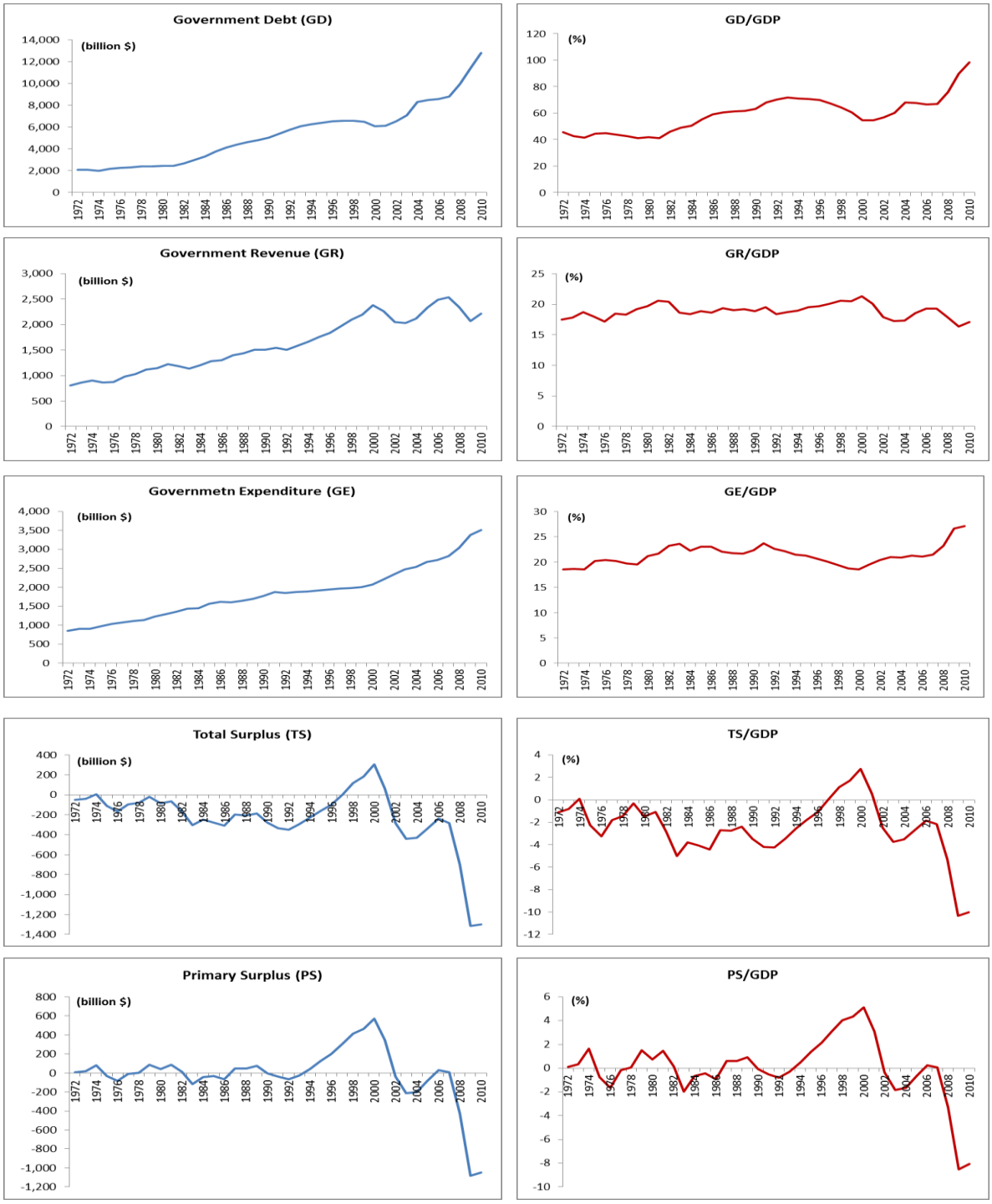
Historically, the US government debt has increased during wars and recessions, but the debt has subsequently decreased. In recent decades however, as can be seen in Figure 4.3, large budget deficits and increases in debt have occurred at the same time, which has led to concern about the long-term sustainability of the federal government's fiscal policies.

The US government revenue has not changed significantly. On the other hand, the government expenditure has fluctuated much more than revenue. In particular, there were substantial increases during the early 1980s, the early 1990s and from 2008 to 2010 (the aftermath of the Global Financial Crisis in 2008). As a result, government debt shows a huge increase from 40 per cent of GDP in the early 1970s to 100 per cent of GDP in 2010.

Government debt rose rapidly in the 1980s. The main reason of this was that Ronald Reagan's economic policies lowered tax rates and increased military spending, while in Congress the Democrats blocked attempts to reverse spending on social programmes. In 1990s, due to the decreased military spending and increased taxes (in 1990, 1993 and 1997) of the Clinton administration, government debt fell dramatically. However, in the early 2000s, debt picked up again due to the Bush tax cuts and increased military spending caused by wars pursued in the Middle-East. It is notable that there was a huge increase in government spending in the aftermath of the Global Financial Crisis in 2008, which led to a considerable increase in government debt.

Figure 4.3 The Main Fiscal Variables of the United States

Real value (billions. $) GDP ratio (%)



4.5 Empirical Results

4.5.1 Unit Root Tests

The necessary first step in testing whether government debt is sustainable is to determine the time series properties of the fiscal variables. To this end, two sets of unit root tests - ADF and PP tests - are used to examine the stationarity properties of the levels and first differences of the fiscal variables. Moreover, Zivot-Andrews (1992) tests for the unit root null hypothesis with a structural break are applied as well. Zivot-Andrews tests assume the null hypothesis as I(1) with one endogenously determined structural break. The fiscal variables consist of government expenditure net-of-interest (g_t) , total government expenditure including interest payment ($g_t + rb_{t-1}$), government revenue (τ_t), total surplus (ts_t), primary surplus (s_t) and government debt (d_t).

The results of different unit root tests for the variables of the three countries are shown in Table 4.1. Narrowing down the analysis of the variables scaled by GDP, all the tests are done for levels, first differences and second differences.

The results can be summarized in four points. First, the series of government debt-to-GDP in all three countries are I(1), with the results being the same when a structural break is considered using Zivot-Andrews test. That is, the series in levels behave like unit roots processes, while for the first differences the unit root can be strongly rejected in all three countries. Second, the series of total government expenditure, non-interest expenditure and government revenue are I(1) both in levels and when considered as a ratio to GDP in all three countries. Third, as for the surplus (or deficit), the results are similar between countries.

Both total surplus and primary surplus follow I(1) in all three countries. Fourth, in the case of $GVAR_t$ and $YVAR_t$, unit root tests reject the null hypotheses of the unit root. So they are all in a stationary process, I(0).

Table 4.1 The Results of Unit Root Tests of Fiscal Variables

A. Korea

Variables \ Test	Levels		1st difference		2nd difference (ADF)	Zivot-Andrews	Verdict
	ADF	PP	ADF	PP			
Government Debt (d_t)	-0.23 (1)	0.11	-4.30***(0)	-4.30***	-8.90***	-2.02	I(1) :All
Total expenditure ($g_t + rb_{t-1}$)	-1.81 (0)	-1.81	-6.83***(0)	-6.83***	-6.60***	-4.28	I(1) :All
Non-interest expenditure (g_t)	-1.97 (0)	-1.97	-7.11***(0)	-7.07***	-6.82***	-4.68*	I(1) :All
Total revenue (τ_t)	-0.77 (0)	-0.74	-5.81***(0)	-5.81***	-4.71***	-3.51	I(1) :All
Total surplus (ts_t)	-2.63(1)	-3.38**	-5.13***(3)	-13.03***	-6.03***	-4.64*	I(0) :PP, ZA I(1):ADF
Primary surplus (s_t)	-2.93*(0)	-2.94*	-5.76***(1)	-13.88***	-5.94**	-4.64*	I(1) :All
Temporary government expenditure ($GVAR_t$)	-3.91***(3)	-5.11***	-3.81***(3)	-8.34***	-4.47***	-4.86**	I(0) :All
Cyclical shortfall in GDP ($YVAR_t$)	-3.47**(0)	-3.29**	-5.55***(1)	-11.79**	-6.48***	-5.33**	I(0) :All

Notes: 1. *, ** and *** denote the rejection of the null hypothesis at the 10%, 5% and 1% significance levels, respectively.
2. The numbers in parentheses are the number of lagged differences based on AIC (maximum number of lag=12).
3. The null hypothesis of the ADF and PP tests is I(1). The null hypothesis of the Zivot-Andrews test (maximum lag=12) is I(1) and alternative is I(0) with one structural break. All series are tested with an intercept.

B. United Kingdom

Variables \ Test	Levels		1st difference		2nd difference (ADF)	Zivot-Andrews	Verdict
	ADF	PP	ADF	PP			
Government Debt (d_t)	-1.20 (1)	-1.23	-3.30**(0)	-3.30**	-8.72***	-1.24	I(1) :All
Total expenditure ($g_t + rb_{t-1}$)	-3.25**(1)	-1.73	-3.98***(0)	-3.68***	-6.62***	-4.88*	I(0) :ADF, ZA I(1) :PP
Non-interest expenditure (g_t)	-2.91*(1)	-1.55	-5.08***(1)	-3.56**	-5.54***	-5.02**	I(0) :ADF, ZA I(1) :PP
Total revenue (τ_t)	-2.93*(0)	-2.73*	-6.59***(0)	-7.29***	-5.13***	-4.12	I(1) :All
Total surplus (ts_t)	-2.47 (1)	-1.93	-4.77***(0)	-4.77***	-8.04***	-3.00	I(1) :All
Primary surplus (s_t)	-2.19 (1)	-1.58	-4.84***(0)	-4.85***	-7.62***	-3.22	I(1) :All
Temporary government expenditure ($GVAR_t$)	-4.09***(1)	-3.29**	-4.89***(0)	-4.76***	-8.82***	-4.61*	I(0) :All
Cyclical shortfall in GDP ($YVAR_t$)	-4.29***(1)	-2.64**	-5.41***(1)	-5.23***	-6.82***	-4.75*	I(0) :All

C. United States

Variables \ Test	Levels		1st difference		2nd difference (ADF)	Zivot-Andrews	Verdict
	ADF	PP	ADF	PP			
Government Debt (d_t)	-0.43 (1)	0.47	-2.53*(0)	-2.43*	-5.35***	-4.56	I(1) :All
Total expenditure ($g_t + rb_{t-1}$)	-1.57 (1)	-0.81	-4.35***(0)	-4.35***	-7.69***	-1.73	I(1) :All
Non-interest expenditure (g_t)	-1.07 (1)	0.34	-4.43***(0)	-4.42***	-6.28***	-0.78	I(1) :All
Total revenue (τ_t)	-3.29**(1)	-2.26	-5.11***(0)	-5.45***	-5.04***	-4.69	I(0) : ADF I(1) : PP, ZA
Total surplus (ts_t)	-2.40 (1)	-1.26	-4.34***(1)	-4.09***	-5.47***	-4.19	I(1) :All
Primary surplus (s_t)	-2.15 (1)	-1.06	-4.40***(1)	-4.22***	-4.91***	-4.00	I(1) :All
Temporary government expenditure ($GVAR_t$)	-3.50**(1)	-3.12**	-5.04***(1)	-7.72***	-8.53***	-4.54*	I(0) :All
Cyclical shortfall in GDP ($YVAR_t$)	-4.49***(1)	-2.68**	-5.02***(0)	-5.81***	-7.30***	-4.70*	I(0) :All

4.5.2 Johansen's Cointegration Tests

Even if each individual fiscal variable is non-stationary, a model imposing a stationary linear combination between variables can produce meaningful results. Therefore, the long-run properties of time series, which implies the presence of a cointegrating relationship should be tested. As all the GDP ratio series are at most I(1), Johansen's cointegration tests can be applied.

It should be noted that a standard cointegration-based sustainability test regards the absence of a cointegrating relationship between total government revenue ($tr_t = \tau_t$) and total government expenditure ($te_t = g_t + rb_{t-1}$) as evidence of a lack of long-run sustainability of fiscal policy[71].

Firstly, before using Johansen's cointegration tests, the test for the VAR lag structure needs to be carried out in order to know the appropriate number of lag lengths in the model. By employing a multivariate information criterion, the lag order of each country can be determined. Table 4.2 shows the results of the test for the lag structure. According to the results, the lag order of Korea is one, while that of the UK and the US is two.

[71] Alternatively, we can test the cointegrating relationship between government debt (d_t) and primary surplus (ps_t). The results of estimation are exactly the same.

Table 4.2 The Results of the Test for VAR Lag Order Selection

A. Korea

Lag	With constant			No constant		
	AIC	SIC	HQ	AIC	SIC	HQ
0	8.547379	8.636256	8.578059	n.a.	n.a.	n.a.
1	5.799805*	6.066436*	5.891846*	5.774295*	5.952049*	5.835656*
2	5.907529	6.351915	6.060931	5.949602	6.305110	6.072323
3	5.904419	6.526558	6.119181	5.984060	6.517322	6.168142
4	5.934119	6.734013	6.210242	6.083411	6.794427	6.328854

B. United Kingdom

Lag	With constant			No constant		
	AIC	SIC	HQ	AIC	SIC	HQ
0	-9.845794	-9.756917	-9.815113	n.a.	n.a.	n.a.
1	-11.49908	-11.23245*	-11.40704	-11.41828	-11.24053	-11.35692
2	-11.66892*	-11.22453	-11.51551*	-11.59765*	-11.24214*	-11.47493*
3	-11.59690	-10.97476	-11.38213	-11.50889	-10.97563	-11.32481
4	-11.54280	-10.74290	-11.26667	-11.45037	-10.73935	-11.20492

C. United States

Lag	With constant			No constant		
	AIC	SIC	HQ	AIC	SIC	HQ
0	-11.49770	-11.40883	-11.46702	n.a.	n.a.	n.a.
1	-13.16711	-12.90048*	-13.07507	-13.08583	-12.90807*	-13.02447
2	-13.34472*	-12.90034	-13.19132*	-13.20551*	-12.85000	-13.08279*
3	-13.15375	-12.53161	-12.93898	-12.98889	-12.45563	-12.80481
4	-13.14173	-12.34184	-12.86561	-12.97114	-12.26013	-12.72570

Notes : 1. * indicates lag order selected by this criterion

2. AIC: Akaike information, SIC: Schwarz information, HQ: Hannan-Quinn information criterion

According to the Johansen approach, the trace test (λ_{trace}) and maximum eigenvalue test (λ_{max}) are used to determine the number of cointegrating vectors (*r*). The two test statistics are as follows.

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{g} \ln(1-\hat{\lambda}_i) \quad (4.20)$$

and

$$\lambda_{max}(r, r+1) = -T \ln(1-\hat{\lambda}_{r+1}) \quad (4.21)$$

where *T* is the number of observations, *r* is the number of cointegrating vectors under the null hypothesis and $\hat{\lambda}_i$ is the estimated value for the *i*th ordered eigenvalue from the long-run coefficient matrix (Enders, 2010, pp 391-392).

'λ_{trace} is a joint test where the null is that the number of cointegrating vectors is less than or equal to *r* against an unspecified or general alternative that there are more than *r*' (Enders, 2010, p 391). The test statistic λ_{trace}has a sequence of null alternative hypotheses as follows.

H_0:	$r = 0$	vs	H_1:	$r \geq 1$
H_0:	$r \leq 1$	vs	H_1:	$r \geq 2$
	...	...		...
H_0:	$r \leq g-1$	vs	H_1:	$r = g$

'λ_{max} conducts separate tests on each eigenvalue, and has as its null hypothesis that the number of cointegrating vectors is *r* against an alternative of *r*+1' (Enders, 2010, p 391). Therefore, the λ_{max} test statistic has null and alternative hypotheses as follows.

H_0: $r = 0$ vs H_1: $r = 1$

H_0: $r = 1$ vs H_1: $r = 2$

... ...

H_0: $r = g - 1$ vs H_1: $r = g$

It is necessary to keep increasing the value of *r* until we no longer reject the null hypothesis. The results appear below in Table 4.3. Five models are implemented based on whether an intercept and a trend are included or not. But the results across the five types of model and the type of test ('trace' or 'max' statistics) are the same, indicating one cointegrating vector.

Table 4.3 Selected Numbers of Cointegrating Relations (10 per cent significance level)

Data Trend	None	None	Linear	Linear	Quadratic
Test Type	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
A. Korea					
Trace	1	1	1	0	2
Max-Eig	0	0	1	1	2
B. United Kingdom					
Trace	0	0	0	0	2
Max-Eig	0	0	0	0	0
C. United States					
Trace	0	1	1	0	2
Max-Eig	0	1	1	0	0

The results of the cointegration tests after selecting 'intercept (no trend) in cointegrating equation and test VAR and 1 or 2 lag length' are displayed in Table 4.4.

As for Korea, if we look at the first row under the headers, the trace test statistic of 14.55 narrowly exceeds 13.43 - the critical value of the 10 per cent significance level; and so the null of no cointegrating vector is rejected. In the next row, the null of at most 1 cointegrating vector cannot be rejected because the trace statistic 2.09 is smaller than 2.71 - the critical value of the 10 per cent significance level. In conclusion, it can be argued that there is one cointegrating vector in the VAR model of Korea, and the maximum eigenvalue test confirms this result. For the US, as for Korea, the trace test and maximum eigenvalue test indicate one cointegrating vector at the 10 per cent significance level. However, in the case of the UK, the results are a little bit different. Examining the trace test, as can be seen in the first row after the headers, the test statistic of 13.42 is marginally smaller than 13.43 - the critical value of the 10 per cent significance level, and so the null of no cointegrating vectors cannot be rejected. As a consequence, it can be suggested that there is no cointegrating vector in the VAR model for the UK. The maximum eigenvalue test has the same result as that of the trace test - no cointegrating vector.

Based on unit root tests and Johansen's cointegration tests, we reach a conclusion that the Korean and US governments' inter-temporal budgets are balanced. That is, the fiscal policies of two countries are sustainable for the period from 1972 to 2010, while the UK government's inter-temporal budget is not balanced, which means that the fiscal policy of the UK is not sustainable.

Table 4.4 The Results of Johansen's Cointegration Tests

A. Korea

Trace test(λ_{trace})				
Number of cointegrating vector	Eigenvalue	Trace Statistic	10 % Critical Value	Prob.**
None *	0.285835	14.55325	13.42878	0.0689
At most 1	0.055114	2.097549	2.705545	0.1475
Maximum eigenvalue test(λ_{max})				
Number of cointegrating vector	Eigenvalue	Max-Eigen Statistic	10 % Critical Value	Prob.**
None *	0.285835	12.45570	12.29652	0.0947
At most 1	0.055114	2.097549	2.705545	0.1475

B. United Kingdom

Trace test(λ_{trace})				
Number of cointegrating vector	Eigenvalue	Trace Statistic	10 % Critical Value	Prob.**
None	0.280865	13.42560	13.42878	0.1001
At most 1	0.042306	1.556185	2.705545	0.2122
Maximum eigenvalue test(λ_{max})				
Number of cointegrating vector	Eigenvalue	Max-Eigen Statistic	10 % Critical Value	Prob.**
None	0.280865	11.86942	12.29652	0.1156
At most 1	0.042306	1.556185	2.705545	0.2122

C. United States

Trace test(λ_{trace})				
Number of cointegrating vector	Eigenvalue	Trace Statistic	10 % Critical Value	Prob.**
None *	0.323970	16.82835	13.42878	0.0313
At most 1	0.061340	2.342179	2.705545	0.1259
Maximum eigenvalue test(λ_{max})				
Number of cointegrating vector	Eigenvalue	Max-Eigen Statistic	10 % Critical Value	Prob.**
None *	0.323970	14.48617	12.29652	0.0461
At most 1	0.061340	2.342179	2.705545	0.1259

Notes: 1. * denotes rejection of the hypothesis at the 10% significance level
2. **MacKinnon-Haug-Michelis (1999) *p*-values.

As a model of economic and financial time series which have a cointegrating relationship, the vector error-correction model (VECM)[72] can be used to look at both the long-run and the short-run effects between total government revenue and total government expenditure. The VECM is a two-step method. In the first step, the cointegrating relationship between total government revenue and total government expenditure is estimated by using the OLS method for each individual country. The estimated parameters of variables explain the long-run relationship of cointegrating equations. In a second step, the lagged residual from the regression in the first step is added as one part of the explanatory variable to estimate the VECM model. That is, the VECM is estimated by using the residual from the OLS as an error-correction term implied by the cointegrating equation. Thus, the VECM with two lags (VECM(2)) of two variables tr_t and te_t is as follows.

$$(4.22) \qquad \Delta tr_t = C_1 + \sum_{i=1}^{2} \alpha_{1i} \Delta tr_{t-i} + \sum_{i=1}^{2} \beta_{1i} \Delta te_{t-i} + \gamma_1 \delta_{t-1} + \varepsilon_{1t}$$

$$\Delta te_t = C_2 + \sum_{i=1}^{2} \alpha_{2i} \Delta tr_{t-i} + \sum_{i=1}^{2} \beta_{2i} \Delta te_{t-i} + \gamma_2 \delta_{t-1} + \varepsilon_{2t},$$

where δ_{t-1} ($\equiv tr_{t-1} - c - \theta te_{t-1}$) is the error-correction term, θ is the coefficient of the cointegrating vector given by $tr_t = \mathrm{c} + \theta te_t + \varepsilon_t$. ε_{1t} and ε_{2t} are the error terms. The coefficients, γ_1 and γ_2, show the effect of the error-correction term. The coefficients, $\alpha_{ji\ \ j=1,2}$ and $\beta_{ji\ \ j=1,2}$ indicate the short-run response of the lagged variables.

[72] The advantage of the VECM is that the super-consistency of the estimator of cointegrating relationship allows the application of the standard tests on significance of the coefficients in the regression because all variables in the model are stationary (Toda and Phillips, 1993). The trade-off of this approach is that only the existence and the sign of the long-run effect can be examined, and its magnitude cannot be interpreted (Canning and Pedroni, 1999).

The results of the estimated coefficients from the VECM(2) of equation (*4.22*) are presented in Table 4.5. For Korea, the lagged differences in total government revenue ($\Delta tr_{t-i,\ i=1,2}$) or total government expenditure ($\Delta te_{t-i,\ i=1,2}$) do not have significant individual effects on changes in current total government revenue (Δtr_t) or in total government expenditure (Δte_t) in the short run. In other words, the coefficients of the cross-lagged terms are not significant in affecting changes in current government revenue and expenditure. On the other hand, the error-correction term (EC_{t-1})[73] plays a significant role in raising current total government expenditure (Δte_t). The sign of the speed-of-adjustment coefficient of EC_{t-1} is in accordance with convergence toward a long-run equilibrium. It can be interpreted that a temporary increase in total government revenue in the previous period, causing disequilibrium in the long-run relationship between government revenue and expenditure, is likely to lead to the augmentation of total government expenditure in the current period. On the other hand, the disequilibrium of the long-run fiscal balance, caused by the total government expenditure shock in the previous period, does not have any significant effect on changes in current total government revenue.

The US case can be interpreted in the same way. An increase in total government expenditure for the previous term (Δte_{t-1}) has a significantly negative effect on changes in current total government revenue (Δtr_t). Likewise, the EC_{t-1} has a significantly negative effect on changes in current total government revenue (Δtr_t). It can be interpreted that if there is a temporary increase in total government revenue in the previous term, short-run adjustments may be made by decreasing current total government revenue. The EC_{t-1} also has a positive effect on changes in current total government expenditure, but the effect is not significant.

[73] EC_{t-1} is the lagged value of the residual from the equilibrium relationship using tr_t as a dependent variable.

Table 4.5 Estimates of the VECM(2)

A. Korea

1) Cointegrating relationship

$$tr_t = 1.58^{***}\, te_t - 0.11$$

[-6.58837]

EC(Error-Correction Term) $\equiv tr_{t-1} - 1.58te_{t-1} + 0.11$

2) VECM(2) estimates

Regressors \ Dependent variables	Δtr_t	Δte_t
Constant	0.002491 [1.50025]	-0.000389 [-0.15772]
Δtr_{t-1}	0.046029 [0.24343]	0.064978 [0.23164]
Δtr_{t-2}	-0.063889 [-0.33944]	0.165975 [0.59440]
Δte_{t-1}	0.016528 [0.11694]	0.378149* [1.80336]
Δte_{t-2}	0.110590 [0.88672]	0.076331 [0.41254]
EC_{t-1}	-0.001965 [-0.02223]	0.401178*** [3.05910]

B. United States

1) Cointegrating relationship

$$tr_t = 0.013\, te_t + 0.19$$

[-0.07413]

EC(Error-Correction Term) $\equiv tr_{t-1} - 0.013\, te_{t-1} - 0.19$

2) VECM(2) estimates

Regressors \ Dependent variables	Δtr_t	Δte_t
Constant	0.000374 [0.29344]	0.001726 [0.99577]
Δtr_{t-1}	0.299299 [1.66606]	0.001178 [0.00483]
Δtr_{t-2}	0.112568 [0.63245]	0.053128 [0.21962]
Δte_{t-1}	0.239921 [1.43471]	0.334063 [1.73672]
Δte_{t-2}	0.089131 [0.47488]	-0.094241 [-0.36944]
EC_{t-1}	-0.505705*** [-3.33569]	0.024952 [0.11662]

Notes: 1. The corrected *t*-statistics are in [ ] (Enders, 2010, p427).

2. The sample spans are from 1972 to 2010.

3. ***, ** and * denote that the estimated coefficients are significant at the 1% , 5% and 10% levels, respectively.

4. EC_{t-1} denotes estimated cointegrating residuals from cointegrating vector.

4.5.3 ARDL Bounds Tests

The results of the bounds tests are shown in Table 4.6. Four variables (s_t, d_{t-1}, $GVAR_t$, and $YVAR_t$) are considered in this bounds tests. After selecting the appropriate number of lag lengths using the AIC, *F*-statistics are calculated to investigate a cointegrating relationship.

Table 4.6 *F*-statistics for Testing the Existence of a Cointegrating Relationship

Country	Symmetric lags / No. of variables[1]	1	2	Cointegration
Korea	4	5.47** <6.93 >	3.67 <7.59>	Yes
UK	4	1.82 <7.99>	0.65 <8.04>	No
US	4	5.00** <11.41>	3.90 <11.48>	Yes

Notes: 1. The critical value bounds are given in Pesaran *et al*.(2001), Table CI(v) (unrestricted intercept and unrestricted time trend). The lower bound(FL) and upper bound(FU) are as follows:

significance	10%		5%		1%	
No. of variables	FL	FU	FL	FU	FL	FU
3	3.47	4.45	4.01	5.07	5.17	6.36
4	3.03	4.06	3.47	4.57	4.40	5.72
5	2.75	3.79	3.12	4.25	3.93	5.23

If F > FU, the null of no-cointegration between 4 variables can be rejected; if F < FL, the null cannot be rejected, and thus no long-run relationship exists. If FL<F<FU, the inference is inconclusive.

2. ***, ** and * denote the rejection of the null at the 1%, 5% and 10% significance levels, respectively.

3. The numbers in < > are the value of AIC, the shaded columns denote the best specification suggested by AIC.

In the case of Korea, the AIC suggests that the most appropriate number of lags is 1 and the calculated *F*-statistics exceed the upper critical bound at the 5 per cent significance level. So the null hypothesis of no-cointegration can be rejected at the 5 per cent significance level. In conclusion, we can conclude that there is a cointegrating relationship between the variables for Korea.

By applying the same steps to the other two countries, the UK and the US, we can select the most appropriate number of lag lengths and check whether or not a cointegrating relationship exists. The AIC suggests that the models with 1 lag are the most appropriate in both countries. According to the results of the bounds tests, there is no cointegrating relationship between the variables in the case of the UK, while a cointegrating relationship exists in the case of the US.

Now that there is a cointegrating relationship between the variables in Korea and the US, we can estimate the long-run coefficients of the two countries based on the following ARDL model specifications.

$$(4.23)\quad s_t = a_0 + \sum_{i=1}^{p} \beta_{1i}\, s_{t-i} + \sum_{i=0}^{q} \beta_{2i}\, d_{t-1-i} + \sum_{i=0}^{r} \beta_{3i}\, GVAR_{t-i} + \sum_{i=0}^{s} \beta_{4i}\, YVAR_{t-i} + \varepsilon_t$$

The estimation results of long-run coefficients are shown in Table 4.7. The signs of the coefficients are mostly in line with economic theory[74]. The primary surplus responds positively to government debt in a significant manner in both Korea and the US, although the effects are not that large. For instance, the results illustrate that a 1 per cent increase in debt induces an increase in the primary surplus of around 0.1 per cent in Korea and 0.01 per cent in the US. And, the coefficients on temporary government spending are significantly negative at the 5 per cent or 10 per cent significance level in the two countries. The coefficients for temporary output shortfall are also negative but insignificant.

[74] According to Barro's tax smoothing theory, temporary government expenditures (*GVAR*) and temporary declines in GDP (*YVAR*) may cause higher budget deficits, which means a decrease in primary surplus.

Table 4.7 Estimates of the Long-run Coefficients in ARDL Model

$$s_t = \beta_0 + \beta_1 d_{t-1} + \beta_2 GVAR_t + \beta_3 YVAR_t$$

Dependent variable: s_t	Coefficient	
Explanatory variables	Korea	US
Intercept(β_0)	-2.56** (0.02)	-2.52(0.30)
Government debts(β_1)	0.10***(0.00)	0.01**(0.03)
Temporary government spending(β_2)	-2.05**(0.02)	-4.40*(0.08)
Temporary output shortfall(β_3)	-0.83(0.55)	-3.24(0.19)
F-statistics	47.09*** (0.00)	115.49*** (0.00)
Adjusted R^2	0.918	0.965

Notes: : 1. The Newey and West HAC covariance is used. The Newey and West corrected *t*-statistics are used.
2. ***,** and * denote the rejection of the null at 1%, 5% and 10% significance, respectively, and the numbers in ( ) are *p*-values.
3. The number of lags in the ARDL specification is determined by the AIC. ARDL order of (1,0,0,0) for the two countries

The goodness of fit of the ARDL model is relatively high. To confirm this, four diagnostic tests are implemented: (1) the Ramsey regression specification error test (RESET) for general misspecification, (2) the Breusch-Godfrey test for serial correlation in residuals, (3) the Breusch-Pagan test for heteroscedasticity in residuals, and (4) Jarque-Berra test for normality of residuals. The ARDL model passes all diagnostic tests for misspecification error with incorrect functional form, serial correlation in residuals, heteroscedasticity in residuals, and normality in residuals.

Table 4.8 The Results of Diagnostic Tests

Diagnostic test	Statistics	Korea	US
Model specification	*F*-statistic of Ramsey RESET test	$F(1,27)=2.12$ (0.140)	$F(1,27)=0.003$ (0.954)
Normality	χ^2-statistic of Jarque-Berra test	$\chi^2(2)=4.112$ (0.124)	$\chi^2(2)=3.457$ (0.178)
Serial correlation	*F*-statistic of Breusch-Godfrey test	$F(1,27)=0.274$ (0.605)	$F(1,27)=0.133$ (0.178)
Heteroscedasticity	*F*-statistic of Breusch-Pagan test	$F(9,28)=0.657$ (0.739)	$F(9,28)=0.494$ (0.865)

Note: The numbers in ( ) are *p*-values.

4.5.4 Modified Bohn's Test

As the variables that we consider are mixed with different orders of integration, e.g. I(0) and I(1)[75], modified Bohn's DOLS models are used to estimate the effects of government debt on primary deficit.

$$(4.24)\ s_t = \alpha_0 + \rho \cdot d_{t-1} + \alpha_G \cdot GVAR_t + \alpha_Y \cdot YVAR_t + \sum_{j=-1}^{1} \delta_j \Delta\, d_{t-j} + \varepsilon_t\,,$$

where $GVAR_t \equiv (g_t - g_t^*)/y_t, YVAR_t \equiv (1 - y_t/y_t^*) \cdot (g_t^*/y_t)$, g_t is current real government spending, g_t^* is normal real government spending, $g_t - g_t^*$ is temporary real

[75] The summary of the unit root tests is shown in the table below. As for s_t and d_t, ADF and PP tests cannot reject the null hypothesis of a unit root, meaning that s_t and d_t are in non-stationary process I(1). On the contrary, in the case of $GVAR_t$ and $YVAR_t$, ADF and PP tests reject the null hypothesis of a unit root, so they are in stationary process I(0).

The table shows the properties of the variables in modified Bohn's tests.

Variable	Definition	Measurement	ADF/PP Unit root tests	
s_t	Primary surplus scaled by GDP	$\rho_t - e_t$ ρ_t is real government revenue divided by real GDP; e_t is real non-interest government expenditure divided by real GDP	KOR	I(1)
			UK	I(1)
			US	I(1)
d_t	Government debt scaled by GDP	D_t/y_t D_t is real government debt; y_t is real GDP	KOR	I(1)
			UK	I(1)
			US	I(1)
$GVAR_t$	Degree of temporary real government expenditure	$(g_t - g_t^*)/y_t$ g_t and g_t^* are real government expenditure and its trend, respectively	KOR	I(0)
			UK	I(0)
			US	I(0)
$YVAR_t$	Degree of cyclical shortfall in GDP	$(1 - y_t/y_t^*) \cdot (g_t^*/y_t)$ y_t and y_t^* are real GDP and its trend, respectively	KOR	I(0)
			UK	I(0)
			US	I(0)

government spending, y_t is current real GDP, y_t^* is trend real GDP, and $1 - y_t/y_t^*$ is a temporary shortfall in output (Barro, 1979, pp948-949; Barro, 1986, pp198-199; Bohn, 1998, p951; Bohn, 2005, p28).

Temporary or cyclical components are obtained using the Hodrick-Prescott (HP) filter. The HP filter is a smoothing method that is widely used to obtain a smooth estimate of the long-term trend component of a series – e.g., g_t^* and y_t^*. It extracts a non-linear trend component from the time series by minimizing a weighted average of the variability in the trend and its deviations from actual data. For example, the HP filter chooses y_t^* to minimize following function *L*.

$$(4.25)\quad L = \sum_{t=1}^{T}(y_t - y_t^*)^2 + \lambda \sum_{t=2}^{T-1}((y_{t+1}^* - y_t^*) - (y_t^* - y_{t-1}^*))^2,$$

where y_t and y_t^* are the logs of observations and trend respectively, *T* is the number of observations and λ is a smoothing parameter. The larger λ, the smoother the trend and finally the bigger the cyclical component[76].

The results of DOLS estimation on the equation (*4.24*) are presented in Table 4.9. Estimation results show that the primary surplus of Korea and the US responds positively to

[76] The HP filter, which decomposes a given time series into a trend component and a cyclical component by solving an optimization problem, is used to detrend the data although it is often remarked that the HP filter may generate spurious cyclical patterns. The figure 100 is applied for λ in the equation (6.2) because annual data are used in this chapter (see Hodrick and Prescott (1980) and Fisher *et al*. (1996)). When the variables are I(1), detrending with a linear time trend may be better than detrending with the HP filter. But, for time series data which have the characteristics of dynamic growth patterns, detrending with the HP filter may be more useful than detrending with a linear time trend because the HP filter is not a fixed filter but a flexible detrend method.

an increase in government debt. The results imply that the fiscal policies of Korea and the US have historically been sustainable. On the other hand, there is no significant positive response of the primary surplus to the increase in government debt in the UK. This result implies that the UK fiscal policy has not been sustainable.

Table 4.9 DOLS Estimation Results: Determinants of the Primary Surplus

**Dependent variable: primary surplus* s_t

Coefficient / Country	α_0	ρ	α_G	α_Y	R^2	Adj.R^2	S.E.	D.W
Korea	-0.9127 (-1.02)	0.0838* (1.76)	-0.9012** (-2.37)	-0.3287 (-0.53)	0.74	0.65	0.76	1.83
UK	0.0089 (0.26)	0.0022 (0.03)	-0.0056 (-0.97)	-0.0134 (-1.11)	0.88	0.81	0.01	1.79
US	-0.0082 (-1.03)	0.0359** (2.71)	-0.0036 (-0.45)	-0.0119 (-1.54)	0.94	0.86	0.01	1.80

Notes: 1. The Newey and West corrected *t*-statistics are noted in ( ). The DOLS standard errors (S.E.) are corrected for heteroscedasticity and serial correlation using the Newey and West (1987) procedure.
2. ***, ** and * denote that the estimated coefficients are significant at the 1%, 5% and 10% levels, respectively.
3. Leads and lags are fixed with 1 respectively.

4.6 Conclusion

For most countries, the total amount of government debt has risen sharply in the recent years after the Global Financial Crisis in 2008. This renewed interest in the problem of the public debt, i.e., the sustainability of public debt, all over the world. This chapter has estimated the fiscal sustainability for Korea, the UK and the US using three different methodologies.

According to standard Johansen's cointegration tests, there is a cointegrating relationship between total government spending and total government revenue in Korea and the US, but not in the UK[77]. It is notable that the long-run relationship between government spending and revenue in the US is very weak compared to that in Korea. The ARDL bounds tests give similar results to those of the Johansen's cointegration tests. And, finally, modified Bohn's tests with DOLS, which estimate the response of primary surplus to government debt, also support the conclusions of the other methodologies.

Based on the results of the various estimations above, we can suggest that policy makers should seriously consider consolidated budget planning, i.e., tightening up austerity measures in the face of sharp and speedy rises in government debt in order to secure the sustainability of public debt. However, it is equally important for a government to be careful when implementing austerity measures at a time of economic crisis, because sudden austerity measures can lead to a domestic demand reduction and further economic decline.

[77] We have to think why the situation in the UK is different. There can be several possibilities: (1) Capital government spending in the UK was not very productive, (2) The sources of revenue via taxation were not adequate, (3) Public debt was channelled into government consumption rather than government investment, (4) Financial crisis affected the UK labour market more adversely than in Korea and the US.

CHAPTER 5

THE EFFECTS OF FISCAL CONSOLIDATION

Chapter 5. The Effects of Fiscal Consolidation

5.1 Introduction

The Global Financial Crisis in 2008 caused large government deficits and, as a result, led to an increase in government debt. The main reason for the large government deficits is the mix of a slowing economy and an increasing need for government spending. Many counties are currently trying to find a balance between existing current crisis policy and returning to a sustainable path for public finances without hurting an economic recovery based on the hypothesis of expansionary fiscal consolidation. Not all countries have accepted this expansionary fiscal consolidation hypothesis, and there is still a strong disagreement over the necessity for harsh and abrupt austerity measures.

Historically, there have been consistent efforts to provide the evidence in favour of expansionary fiscal consolidation. The possibility of 'non-Keynesian expansionary effects' resulting from restrictive fiscal policies was first raised by Barro (1974), who introduced the concept of 'Ricardian Equivalence'. This issue drew much more interest after Giavazzi and Pagano (1990) provided evidence of expansionary fiscal consolidation in Denmark (1983-86) and Ireland (1987-89). Since then, many studies have followed in an attempt to find robust evidence of the transmission channels of expansionary fiscal consolidation[78].

Several examples have recently been observed that trigger doubt about the appropriateness of fiscal consolidation and raise suspicion that these activities undermine the economy. In the aftermath of the Global Financial Crisis in 2008, the UK began a fiscal austerity programme to reduce its deficit from the third quarter of 2010. Conservative politicians in the UK argued that fiscal consolidation could enhance growth, and they

[78] Sutherland (1997) insisted that fiscal expansion had a contractionary effect on economy in time of higher debt.

underlined the need to avoid rising debt costs as a key motivation in undertaking this. However, in the last quarter of 2011 and the first quarter of 2012, the UK suffered from the first double dip recession for 37 years. The economy of the UK unexpectedly slumped by 0.2 per cent of GDP in the first quarter of 2012. This followed a fall of 0.3 per cent in the final quarter of 2011. The situation of Ireland was similar to the UK. Ireland began reducing its fiscal deficit at the end of 2008. At the time, the IMF projected a 1 per cent growth for 2009. But the result was, on the contrary, a 10 per cent decline (Weisbrot and Montecino, 2010).

In this context, this chapter reviews the theoretical and empirical literature that has investigated the conditions under which fiscal consolidation is effective in enhancing economic growth and reducing public debt (or fiscal deficit). After that, empirical estimations are undertaken to see if fiscal consolidation can boost a depressed economy, and to find out the main determinants of successful fiscal consolidation using the newest econometric methods and panel datasets from 18 OECD countries. To do this, a policy action-based approach, proposed by the IMF (Leigh *et al.*, 2011), is used to determine fiscal consolidation episodes in the OECD countries, and the concept of debt-to-GDP ratio is used to identify successful fiscal consolidation episodes. Moreover, unlike many previous studies, this chapter addresses the endogeneity problem in the analysis by using a dynamic panel GMM model. In this way, the chapter will contribute to uncovering the effects of fiscal consolidation on economic growth and the main factors of successful fiscal consolidation.

The chapter is organized as follows. Section 5.2 reviews the theoretical and empirical literature on the effects of fiscal consolidation. Section 5.3 describes identification of fiscal consolidation and model specification. Section 5.4 explains the data. Section 5.5 shows empirical results. Section 5.6 tests the robustness of the results. Section 5.7 concludes.

5.2 Literature Review

5.2.1 Theoretical Approach

Keynesian analysis insists that fiscal consolidation inevitably leads to a contraction of aggregate demand and reduces GDP. It disagrees with the non-Keynesian effects that fiscal austerity is necessary to overcome the economic crisis even if the world's economy remains deeply depressed. Keynesians argue that if an economy performs well following government spending cuts, this is actually because the business cycle has picked up, or because government monetary policy happens to be more expansionary at the time.

Over the last two decades, there has been dissent from the Keynesian view described above. Using the cases of Denmark and Ireland, Giavazzi and Pagano (1990)[79] suggest that fiscal consolidation can be expansionary, because the GDP of these two countries increased after fiscal tightening. Alesina and Ardagna (2010, 2012) also show that spending-based reduction has caused a smaller recession, and sometime caused growth in GDP.

There are several channels to explain how fiscal consolidation may not be recessionary or may sometimes be expansionary. Theoretically, expansionary effects of fiscal consolidation can go through both the demand and the supply side (Figure 5.1).

On the demand side, the first channel is a rapid reduction of interest rates. If a government reduces its spending and gets the deficit down, people worry less about the future and apply a lower risk premium to the country's government debt. That is, a reduction in the interest rate can stimulate aggregate demand through both private investment (McDermott

[79] Blanchard (1990) extrapolates from Giavazzi and Pagano's analysis to suggest that fiscal consolidation can raise investment, aggregate demand and output.

and Wescott, 1996) and private consumption, due to the positive wealth effect in the private sector (Giavazzi and Pagano, 1990). Moreover, a decrease in interest rates can lead to an increase in the values of stocks and bonds, which increases consumers' financial wealth, and triggers a private consumption and investment boom. In this way, fiscal adjustment may have a significant effect on interest rates.

The second channel is taxes. If a government cuts its spending, it gives a signal that future taxes will be lower, or at least not be raised. This expectation of future tax reduction encourages people to increase private consumption and investment (Bertola and Drazen, 1993; Prammer, 2004).

The third channel is depreciation. If the currency of a country is depreciated after a fiscal consolidation, it can improve the country's competitiveness in exports. There is one good example of this phenomenon. When Ireland implemented fiscal consolidation in the 1980s, depreciation followed the fiscal consolidation, which increased the country's competitiveness and resulted in expansionary fiscal consolidation.

Another possibility concerns the effect on investment confidence. There may be a significant effect on investment confidence when a country announces a credible fiscal consolidation[80]. In countries like the US, an increase in confidence among investors is very important for reducing the negative effects of fiscal consolidation. If a government reduces uncertainty about the future course of fiscal policy by demonstrating a clear fiscal and regulatory stance, investors will be less hesitant about putting their money in the country (Alesina and Ardagna, 2010, 2012).

[80] This is opposite to crowing-out effect which decreases private investment caused by expansionary government spending.

On the supply side, the expansionary effects of fiscal consolidation work through the labour market. The first part of this channel is the private-sector wage-depressing effect. That is, if public sector wages are kept down, this may be followed by wage-depressing agreements in the private sector of the economy. This can be called a spill-over effect in the labour market. Finally, this may increase competitiveness, which improves productivity[81].

The second channel is taxes. If a government cuts its spending, it signals tax reductions in the future. This expectation of future tax reductions will encourage employees to increase their labour supply. If employees expect higher taxes in the future, this will discourage them from increasing the labour supply, which can be said to be a distortionary cost of taxation (Alesina and Ardagna, 2010, 2012). In the same vein, an increase in taxation on workers will cause those in the private sector to demand the higher pre-tax real wage. This will mean higher labour unit costs for firms and a considerable loss of competitiveness.

Despite the various types of theoretical support for expansionary fiscal consolidation, as mentioned above, opposition to the idea of non-Keynesian expansionary effects has been growing ever since many countries tried to implement austerity measures early in 2010. For instance, Krugman (2010) strongly disagrees with the idea that fiscal consolidation can have expansionary effects and argues that non-Keynesian effects are not based on either evidence or careful analysis, but on sheer speculation by the policy elite. In Ireland's case in the 1980s, in which government spending cuts and tax increases were followed by economic growth, he points out that Ireland's expansionary fiscal consolidation was not caused by the positive

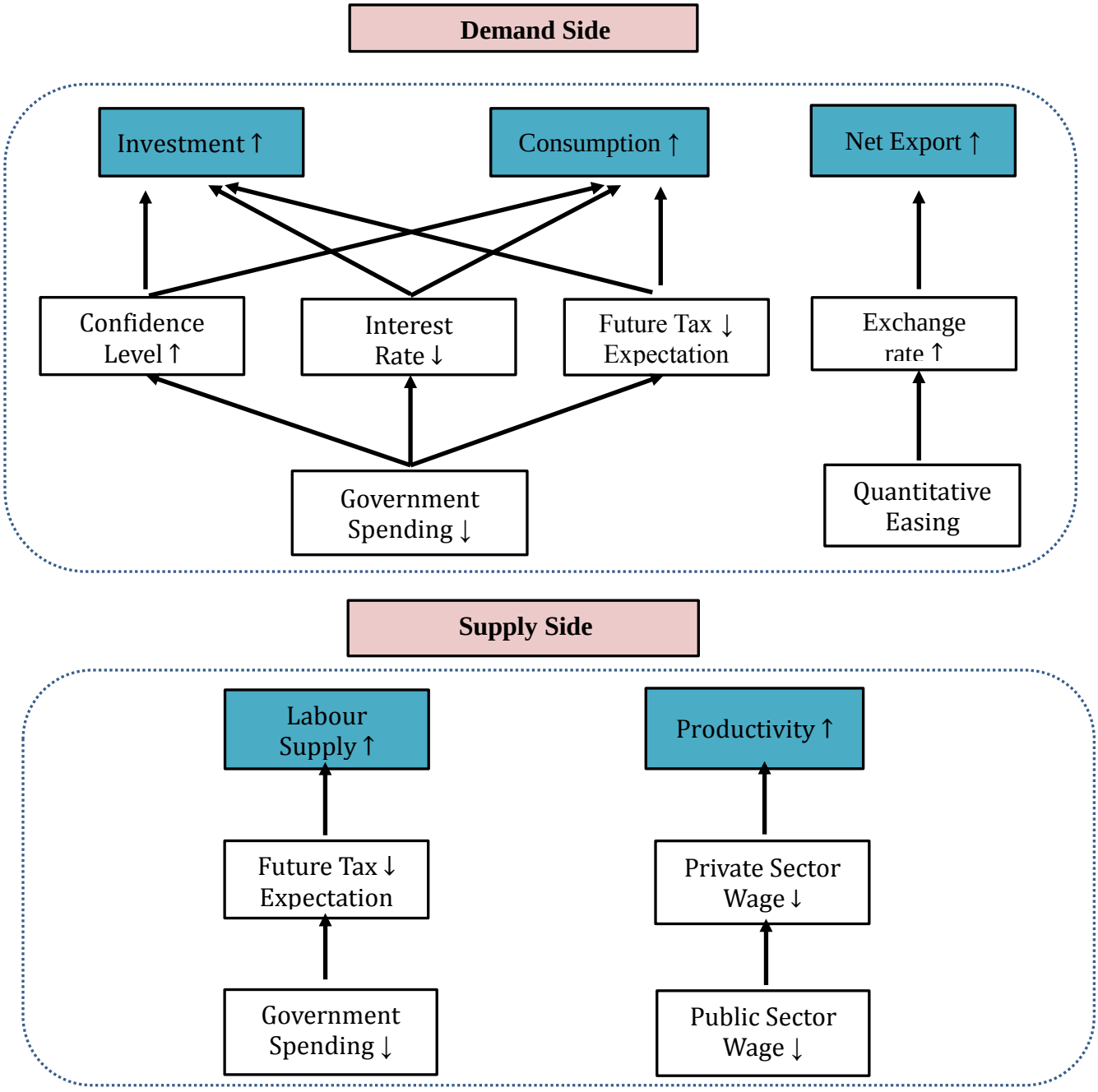
[81] This argument is controversial because there is a big literature going in the opposite direction. For example, Blundell *et al*. (2013) show that the UK's productivity went down when the real wages were reduced during the recession of 2007-11.

effects of fiscal consolidation but by the drastic move from a trade deficit to a trade surplus. Moreover, he insists that because of the austerity measures, Europe's troubled debtor nations are suffering greater economic decline than necessary and confidence is plunging instead of rising. Baker (2010) also insists that fiscal consolidation measures in the US will result in further contraction of the US economy. He argues that while a budget deficit can basically lead to higher interest rates, investment reduction and lower productivity growth when the economy is in a normal condition, it can boost the recessionary economy in both the short term and the long term when the economy is facing a serious downturn. Recently, Cottarelli and Keen (2012) have pointed out that the speed of fiscal consolidation is very important if these are to be effective. They argue that insufficient fiscal consolidation could lead to a loss of market confidence and a fiscal crisis, potentially killing growth; but too rapid and too much fiscal consolidation will hurt growth directly.

As Briotti (2005) mentioned, several assumptions are to be satisfied in the theoretical rationale for non-Keynesian expansionary fiscal consolidation. First, taxes must be distortionary. The larger the tax increases, the larger the distortionary effects are. Under this assumption, the delay of fiscal consolidation may cause great negative effects on future output via consumers' expectation of future tax-rise. On the other hand, timely fiscal consolidation can improve consumers' expectations of future income. Second, consumers should be forward-looking, with rational expectations, and not liquidity-constrained; thus higher expected income can be translated into higher effective demand. Third, fiscal consolidation should win people's credibility. Finally, in order to create optimism, fiscal consolidation must be unexpected (Briotti, 2005, p12). However, we have to point out that even if the existence of non-Keynesian expansionary fiscal consolidation effects is

theoretically reasonable, it is very hard to get empirical evidence because of the difficulty in building credibility with people. In real life, for a government to gain credibility from the people seems to be a particularly slow and difficult process. So, it is necessary to take a look at the results of empirical study, checking the relevance of these theoretical assumptions.

Figure 5.1 Several Channels of Expansionary Fiscal Consolidation (non-Keynesian View)



5.2.2 Empirical Approach

5.2.2.1 Identifying Fiscal Consolidation Episodes

For empirical studies, it is important to identify a correct notion of fiscal consolidation. Due to the arbitrariness of the different definitions of fiscal consolidation episodes, the periods identified as exceptional fiscal consolidation episodes differ from study to study. As the definition and measurement of fiscal consolidation episodes are not fully agreed on, there is no universally accepted methodology for identifying them. Two approaches can be considered in respect of the identification of fiscal consolidation episodes: one is the CAPB-based approach; the other is the policy action-based approach. The CAPB is calculated by taking the actual primary balance (non-interest government revenue minus non-interest government spending) and subtracting the estimated effect of business cycle fluctuations on the fiscal accounts (IMF, 2010). There are three approaches: (1) Hodrick–Prescott filter, (2) Elasticity approach by OECD and IMF, and (3) Blanchard Fiscal Impulse (BFI) (See Appendix 5.1 for details).

5.2.2.1.1 The CAPB-Based Approach

This approach identifies fiscal consolidation episodes by using a statistical concept, which is the change in the CAPB. The CAPB removes two components from the government budget balance: (i) interest payments, which cannot be directly influenced in the short run by government fiscal policies; and (ii) any component of the government balance that is the result of a business cycle (McDermott and Wescott, 1996). It is based on the assumption that changes in the CAPB reflect policymakers' decisions to adjust taxes and government spending. But, depending on the criteria of size and persistence, there are many differences in the ways that change in the CAPB is defined as a fiscal consolidation episode. (See Table 5.1)

Alesina and Perotti (1995) define a fiscal consolidation episode as a year in which the BFI[82] is between -1.5 and -0.5 per cent of GDP, or a year in which the BFI is less than -1.5 per cent of GDP. Giavazzi and Pagano (1996) define fiscal consolidation episodes as years of cumulative changes in the CAPB that are at least 5, 4, 3 per cent points of GDP in, respectively, 4, 3 or 2 years, or 3 per cent points in one year. Alesina and Ardagna (1998) and Giudice *et al*. (2007) define a fiscal consolidation episode as a year in which the CAPB changes by at least 2 per cent points of GDP, or a period of two consecutive years in which the CAPB changes by at least 1.5 per cent points of GDP per year in both years. Alesina and Ardagna (2010) define a fiscal consolidation episode as a year in which the CAPB improves by at least 1.5 per cent points of GDP.

Alesina and Ardagna (2012) consider only multi-year consolidations, allowing for the possibility of small reductions in the primary deficit in a particular year, provided that this happens in a period of consecutive years when there are sizable improvements in the fiscal balance. They define a fiscal consolidation episode as a two-year period when the CAPB improves in each year and the cumulative improvement is at least 2 per cent points of GDP, or a three or more year period when the CAPB improves in each year and the cumulative improvement is at least 3 per cent points of GDP. They use such multi-year criteria to include adjustments that are small but prolonged over several years. On the other hand, Afonso (2010) defines a fiscal episode as a period when either the change in the CAPB is at least one and a half times the standard deviation in one year; or when such a change is at least one standard deviation on average in the last two years.

[82] Blanchard Fiscal Impulse (BFI) = $(g_t(U_{t-1}) - t_t) - (g_{t-1} - t_{t-1})$, where g_t is non-interest government spending of GDP, t_t is total revenue of GDP, and U_t is the unemployment rate. (The detail can be seen in Appendix 5.1)

5.2.2.1.2 Policy Action-Based Approach

Pointing out the shortcomings[83] of the CAPB-based approach, the IMF (2010) and Leigh *et al*. (2011) first use an alternative measure - a policy action-based approach - in identifying fiscal consolidation episodes. This alternative measure is on the same lines as the narrative method pioneered by Romer and Romer (1989) and developed by Ramey and Shapiro (1998), Ramey (2011), and Romer and Romer (2010) for monetary policy and fiscal policy. This approach identifies fiscal consolidation episodes directly from historical documents such as budget reports, presidential speeches, central bank reports and congressional reports, focusing on fiscal policy changes (tax rises or government spending cuts) motivated by the desire to reduce the primary deficit. Fiscal consolidations motivated primarily by restraining domestic demand are not included in the episodes.

The IMF (2010) and Leigh *et al*. (2011) define fiscal consolidation episodes for a sample of 17 OECD countries over the period 1980-2009. Such fiscal consolidation actions are the response to *past* decisions and economic conditions rather than to *prospective* situations (Leigh *et al*., 2011, p4). As a result, they are likely to be uncorrelated with other developments influencing ouput in the short term, so are good for measuring the macroeconomic effects of fiscal consolidation. Recently, there has been an effort to refine the CAPB-based approach by reflecting the advantage of the narrative method. For instance, Yang *et al*. (2012) identify fiscal consolidation episodes by incorporating size, persistence and country-specific heterogeneity into the CAPB-based approach.

[83] It can be affected, for instance, by asset price cycles (Girouard and Price, 2004) and one-off measures (Von Hagen and Wolff, 2006) that do not reflect the policy stance. It is also affected by the measurement issues surrounding the output gap (Guichard *et al*., 2007).

5.2.2.2 Defining Expansionary Fiscal Consolidation Episodes

Alesina and Ardagna (1998) define a period as an expansionary fiscal consolidation episode when the average growth rate of GDP in the period of the fiscal consolidation, and in the two years after, is greater than the average value of the same variable in all episodes of fiscal consolidation. Giudice *et al*. (2007) define a fiscal consolidation as expansionary if the average real GDP growth in each fiscal consolidation year, and in the two years after, is greater than the average real GDP growth in the two years before. Alesina and Ardagna (2010) define a fiscal adjustment episode as expansionary if the average growth rate of real GDP in the first period of the episode, and in the two years after, is greater than the value of seventy fifth percentile of the same variable empirical density in all episodes of fiscal adjustments. Alesina and Ardagna (2012) define a fiscal adjustment period as expansionary if real GDP growth during the adjustment period is higher than the average growth the country experienced in the two years before.

It should be noted that Alesina and Ardagna (2009, 2012) consider multi-year fiscal adjustments as a 'single' episode because the time span chosen for the definition of 'expansionary' and 'success' starts from the first year of the episode. On the other hand, Alesina and Ardagna (1998) and Alesina *et al*. (1998) consider each year of a multi-year period as a single episode. This implies that, in a multi-year episode, some years can be expansionary, but some may be contractionary; some can be successful, but some may be unsuccessful. However, there is no reason to prefer one choice over the other because, despite the different methods of selecting expansionary and successful consolidation episodes that last more than one consecutive year, the results are similar in both cases (Molnar, 2012).

5.2.2.3 Defining Successful Fiscal Consolidation Episodes

Generally, successful fiscal consolidation has been defined based on the degree of the reduction in the debt-to-GDP ratio, even if this is a rather arbitrary definition.

Alesina and Perotti (1995) define a fiscal consolidation as successful if it brings down the debt-to-GDP ratio by at least five per cent points of GDP in the three years following the consolidation episode. Alesina and Ardagna (1998) define a period of fiscal consolidation as successful if (1) in the three years after the fiscal consolidation period, the ratio of the cyclically adjusted primary deficit to GDP is on average at least two per cent points below its value in the last year of the fiscal consolidation period, or (2) three years after the last year of the consolidation period, the debt-to-GDP ratio is five per cent points of GDP below its level in the last year of the consolidation period.

Ardagna (2004) also defines a successful fiscal consolidation as an episode in which the CAPB improves, and two years after, the debt-to-GDP ratio is at least three per cent points lower than in the year of fiscal consolidation. This definition is the same as that of McDermott and Wescott (1996). Alesina and Ardagna (2010) define a period of fiscal consolidation as successful if the cumulative reduction of the debt-to-GDP ratio three years after the beginning of the period is greater than 4.5 per cent points (the value of the twenty fifth percentile of the change in the debt-to-GDP ratio empirical density in all episodes of fiscal consolidation). Again, Alesina and Ardagna (2012) define a period of fiscal consolidation as being successful if the debt-to-GDP ratio two years after the end of the fiscal consolidation is lower than the debt-to-GDP ratio in the last year of the fiscal consolidation.

Table 5.1 Definitions to Identify Fiscal Consolidation Episodes

		Fiscal Consolidation		Successful Fiscal Consolidation		Expansionary Fiscal Consolidation
		Definition1	**Definition2**	**Definition1**	**Definition2**	**Definition**
CAPB - based	Alesina and Perotti (1995)	A year when BFI is -1.5 ~ - 0.5% of GDP	A year when BFI is less than -1.5% of GDP	Three years after the Debt/GDP is at least 5%p lower than that of consolidation period		
	Giavazzi and Pagano (1996)	A period of a year when ∑ΔCAPB is at least 5,4, 3%p of GDP in 4,3,2 years, respectively	A year when ΔCAPB is at least 3%p of GDP in one year			
	McDermott and Wescott (1996)	A year when ΔCAPB is at least 1.5%p over two years, and does not decrease in either of the two years		A year when debt / potential GDP two years after is 3%p lower than the end of the fiscal consolidation		
	Alesina and Perotti (1997)	A year when BFI is less than -1.5% of GDP	A period of two consecutive years when BFI is at least -1.25% of GDP per year	Three years after the CAPB/GDP is at least 2%p lower than that of consolidation period	Three years after the Debt/GDP is at least 5%p lower than that of consolidation period	
	Alesian and Ardagna (1998)	A year when ΔCAPB is at least 2%p of GDP in one year	A period of two consecutive years when ΔCAPB is at least 1.5%p of GDP per year	Three years after the CAPB/GDP is at least 2%p lower than that of consolidation period	Three years after the Debt/GDP is at least 5%p lower than that of consolidation period	The average growth rate of GDP in fiscal consolidation and in the two years after is greater than the average of the same variable in all consolidation episodes
	Alesina *et al*. (2002)	A year when ΔCAPB is at least 2%p of GDP in one year	A period of two consecutive years when ΔCAPB is at least 1.25%p of GDP per year			The average real GDP growth in each consolidation year and in the two years after is greater than the average real GDP growth in the two years before

		Fiscal Consolidation		Successful Fiscal Consolidation		Expansionary Fiscal Consolidation
	Ardagna (2004)			A year when the CAPB improves, and the Debt/GDP two years after is at least 3%p lower than that of fiscal consolidation		
	Guichard *et al.* (2007)	A year when ΔCAPB is at least 1%p of potential GDP in one year	A period of two consecutive years when ΔCAPB is at least 1%p of potential GDP with each more than 0.5%p			
	Giudice *et al.* (2007)	A year when ΔCAPB is at least 2%p of GDP in one year	A period of two consecutive years when ΔCAPB is at least 1.5 %p of GDP per year			The average real GDP growth in each consolidation year and in the two years after is greater than the average real GDP growth in the two years before
	Alesina and Ardagna (2010)	A year when ΔCAPB is at least 1.5%p of GDP		Three years after the Debt/GDP is at least 4.5%p lower than that of the consolidation period		The average growth rate of GDP in the first period of the episode and in the two years after is greater than the value of the 75th percentile of the same variable empirical density in all consolidation episodes
	Alesina and Ardagna (2012)	A two-year period when ∑ΔCAPB is at least 2%p of GDP	A three-or-more-year period when ∑ΔCAPB is at least 3%p of GDP	The Debt/GDP ratio two years after is lower than that of the last consolidation		
Action-based	IMF (2010)	A year when Δ(spending cuts + tax rises) / GDP is bigger than zero				
	Leigh *et al.* (2010)	A year when Δ(spending cuts + tax rises) / GDP is bigger than zero				

5.2.2.4 Empirical Studies

Compared with empirical studies on the effects of expansionary fiscal shocks, there are not many studies on the effects of fiscal consolidation. Generally speaking, when it comes to the effects of fiscal consolidation, the literature is divided into two views: that of the proponents of the Keynesian effects; and that of the proponents of non-Keynesian effects. Here, previous literature is reviewed focusing on the following two points: the existence of expansionary fiscal consolidation; and the determinants of a successful fiscal consolidation.

5.2.2.4.1 Existence of Expansionary Fiscal Consolidation

Based on a conventional Keynesian model, many empirical studies have supported the idea that fiscal consolidation is not expansionary in the short run. That is, they support the standard implication of Keynesian models that government spending cuts or tax rises have a contractionary effect on aggregate demand in the short term (Leigh *et al*., 2011).

Recently, the IMF (2010) examined the effects of fiscal consolidation on economic activity using an action-based approach instead of a CAPB-based approach, and it concluded that fiscal consolidation typically reduced GDP and raised unemployment in the short term. Meanwhile, the IMF underlines that interest rate cuts, a depreciation of the currency and a rise in net exports usually soothe the contractionary impact[84]. Moreover, it insists that fiscal consolidation, in the face of a higher perceived sovereign default risk, is likely to have a less contractionary effect on economic activity.

[84] On the contrary, Ardagna (2004) argues that expansionary fiscal consolidation is not the result of accompanying expansionary monetary policy or exchange rate depreciation.

Likewise, Hernandez de Cos and Moral-Benito (2011) investigate the potential impact of fiscal consolidation on economic growth, considering the endogeneity of fiscal consolidation to GDP. They argue that if there is an endogeneity problem between fiscal consolidation and GDP growth, the positive correlation between fiscal consolidation and GDP growth may be the result of a positive effect from GDP growth to fiscal consolidation instead of the other way around. They conclude that if the endogeneity problem is considered, fiscal consolidation has negative effects on GDP growth in the short run. Based on this result, they argue that the endogeneity bias is chiefly responsible for the non-Keynesian results found in the previous literature.

However, starting with Giavazzi and Pagano (1990) and Bertola and Drazen (1993), a sequence of studies finds that consolidations can be expansionary[85]. Giavazzi and Pagano (1990), in particular, point out the need for an academic debate on expansionary fiscal consolidation. Their study of the effects of fiscal policy in Denmark and Ireland in the 1980s finds that drastic reductions in the cyclically adjusted deficits are followed by above-average economic growth. Since then, many studies have sought to identify whether and under what conditions fiscal contractions can provoke a positive economic response. These empirical studies first identify periods of forceful and sizeable government spending cuts within a panel of OECD countries, and then offer a descriptive analysis of the sample properties of macroeconomic aggregates, such as GDP, before, during, and after the year of the fiscal consolidation episode.

[85] Feldstein (1982) is probably the first to find evidence of the existence of expansionary fiscal consolidation. Showing a negative response of private consumption to a public expenditure shock, he argues that reductions in public expenditure may have expansionary effects on output if they are seen as an indication of future tax cuts.

McDermott and Wescott (1996) also find that fiscal consolidation can have an expansionary effect on economic activity through various channels, such as interest rates and expectations. They insist that fiscal consolidation can reduce interest rate premiums, which promotes private investment; or they can trigger expectations of a falling future tax burden, which encourages consumption and investment, finally supporting economic growth. Estimating a probit model on expansionary fiscal consolidation, Alesina and Ardagna (1998) find that the composition of fiscal consolidation is much more important than its size when it comes to causing fiscal consolidation to be expansionary.

Giudice *et al*. (2007) analyse the main determinants of expansionary fiscal consolidation. By comparing statistics of expansionary vs. non-expansionary fiscal consolidations, they find that the expansionary fiscal consolidations significantly differ from the non-expansionary ones in their composition: the fiscal consolidations based on spending cuts are more likely to be expansionary than those based on tax rises. According to the results of their probit regression model, the composition of fiscal consolidation and the initial value of the output gap play significant roles in making expansionary fiscal consolidation. On the other hand, the size of fiscal consolidation, the initial situation of the value of debt-to-GDP, the interest rates and the exchange rates are not significant factors to explain the success of expansionary fiscal consolidation.

By comparing the difference in basic statistics between expansionary and contractionary fiscal consolidations, Alesina and Ardagna (2012) find that fiscal consolidations based on spending cuts have superior effects on GDP growth to those based on tax rises.

Table 5.2 Determinants of Expansionary Fiscal Consolidation

Literature \ Determinant	GDP growth	Output gap	size	composition	Interest rates	Exchange rates
McDermott and Wescott (1996)	-	-	x	o	o	x
Alesina and Ardagna (1998)	-	-	x	o	-	x
Ardagna (2004)	o	-	x	o	o	x
Giudice *et al*. (2007)	-	o	x	o	x	x
Alesina and Ardagna (2010)	-	-	x	o	-	-
Alesina and Ardagna (2012)	-	-	x	o	-	-
IMF (2010)	o	-	x	x	o	o
Hernandez de Cos and Moral-Benito (2011)	-	x	x	x	x	x

5.2.2.4.2 Determinants of Successful Fiscal Consolidation

A variety of fiscal and economic factors have been identified as potential contributors to successful fiscal consolidation. The following is a brief summary of the literature on the relationship between these factors and successful fiscal consolidation.

Alesina and Perotti (1995) suggest that the size of fiscal consolidation is not strongly related to their success. Rather, these researchers conclude that the composition of fiscal consolidation is what matters if successful fiscal consolidation is to be achieved. In particular, spending cuts in the areas of transfers and government wages have strong effects on reducing debt-to-GDP ratios. Related to the composition of fiscal consolidation, McDermott and Wescott (1996) show some supporting evidence that fiscal consolidation with government spending cuts, especially transfers and government wages, can reduce the debt-to-GDP ratios more successfully than can tax-based fiscal consolidation. This result is in line with the view of Alesina and Perotti (1995).

Afonso and Jalles (2012) assess the determinants of successful fiscal consolidation using both the CAPB-based approach and the action-based approach. They find that fiscal consolidation is likely to reduce debt-to-GDP ratios only if economic growth is strong and the output gap increases. Hernandez de Cos and Moral-Benito (2012) back up the above idea by insisting that economic growth is the only relevant factor for budget deficit reduction.

Alesina and Giavazzi (2012) insist that for successful fiscal consolidation, the composition of austerity (how) is a more important factor than the size of austerity

programmes (how much). This implies that fiscal consolidations achieved through spending cuts are less recessionary than those achieved through tax rises. Furthermore, they also argue that spending-based consolidations accompanied by the right policies, such as easy money policy[86], the liberalisation of goods and labour markets and other structural reforms, tend to be less recessionary or even have a positive impact on growth. In the same vein, Alesina and Ardagna (2010, 2012) argue that fiscal consolidations based on spending cuts are more likely to reduce deficits and debt-to-GDP ratios than those based on tax rises[87]. They also insist that this result is robust, even if the change in the short-term interest rates or the change in the nominal exchange rates is considered as control variables.

Alesina (2012) emphasizes that the focus of discussion about fiscal tightening should be more about the composition, quality and way of achieving fiscal adjustment than about the quantity of fiscal adjustment. For example, cuts in social welfare can be regarded as more effective than cuts in infrastructure maintenance, which cannot be delayed forever. Moreover, cuts in politically more delicate components of the budget, such as public employment and social transfer, can be a good signal of a government's willingness to decrease government spending. In those cases, expectation effects and political credibility effects will trigger expansionary fiscal consolidation. If one focuses only on the amount of fiscal tightening, this may lead some countries into a dangerous situation via a vicious circle of raising taxes, creating a recession, reducing tax revenues, and raising tax rates even more.

[86] Lambertini and Tavares (2005) also support the idea that fiscal consolidation is more likely to succeed when using exchange rate policy simultaneously.

[87] At first, Ardagna (2004) suggested that the success of fiscal consolidation in reducing the debt to GDP ratios depended on the size of consolidation and less on its composition. But later, she changed her opinion on the major determinants of successful fiscal consolidation.

Corsetti and Muller (2012) highlight the fundamental importance of sovereign risk for macroeconomic stability, and insist that fiscal consolidation measures can play an important role in bringing down deficits at a limited cost to economic activity in the situation of high sovereign risk. They also support the idea that fiscal consolidation may well have important unobserved benefits by preventing greater macroeconomic instability, which tends to arise in the presence of high sovereign risk.

Table 5.3 Determinants of Successful Fiscal Consolidation[88]

Determinant / Literature	GDP growth	Output gap	Size	Composition	Interest rates	Exchange rates	Sovereign risk
Alesina and Perotti (1995)	-	-	x	o	-	-	-
McDermott and Wescott (1996)	x	-	o	o	o	x	-
Lambertini and Tavares (2005)	-	-	o	o	-	o	-
Ardagna (2004, 2012)	o	-	o	x	-	x	-
Alesina and Ardagna (2010)	-	-	x	o	x	x	-
Alesina and Ardagna (2012)	-	-	x	o	x	x	-
Hernandez de Cos and Moral-Benito (2012)	o	o	-	o	-	-	-
Afonso and Jalles (2012)	o	o	x	x	-	-	-
Alesina and Giavazzi (2012)	-	-	x	o	-	-	-
Molnar (2012)	o	-	x	o	o	o	-
Corsetti and Muller (2012)	-	-	-	-	-	-	o

[88] Except for these economic-related factors, there can be qualitative variables such as political system and fiscal rules. Molnar (2012) deals with political setting variables (e.g., elections, strong left-leaning government, and strong right-leaning government). Shi and Svensson (2006) also use political variables to examine the relation between elections and fiscal policy.

5.3 Methodology

In this section, two econometric models are described after the identification of fiscal consolidation episodes and a definition of the features of fiscal consolidation.

5.3.1 Identifying Fiscal Consolidation Episodes

The CAPB-based approach has strength in the simplicity and conciseness of its analysis. However, this approach has several possible shortcomings.

First, it suffers from measurement errors that are likely to be correlated with economic developments. Changes in the CAPB may include non-policy changes correlated with other developments affecting economic activity. For instance, a thriving in the stock market enhances the CAPB by augmenting capital gains and cyclically-adjusted tax revenues. Such measurement errors may offset or reduce the shrinking effects of deliberate fiscal consolidation. Second, it ignores the motives behind fiscal actions. There are two principle motives for discretionary fiscal consolidation. One is a desire to reduce the budget deficit in order to improve the government financial situation. The other is a desire to restrain domestic demand for cyclical reasons. The CAPB-based approach includes all fiscal consolidations regardless of their motivation. Therefore, a rise in the CAPB may reflect a government's decision to raise taxes or cut government spending in order to hold back domestic demand and decrease the risk of overheating. In this case, using a rise in the CAPB to measure the effects of fiscal consolidation on economic activity may suffer from 'reverse causality' and may bias the analysis toward finding evidence of an expansionary or successful fiscal consolidation hypothesis (Leigh *et al.*, 2011).

In this context, the action-based approach of the IMF (2010)[89] is used to identify fiscal consolidation episodes.

5.3.2 Model Specification

5.3.2.1 Test for the Existence of Expansionary Fiscal Consolidation

5.3.2.1.1 Baseline Model - A Dynamic Panel Data Analysis with GMM

Panel data analysis is used in the estimation for the following IMF model (2010), as it has the advantage of providing more information, variability, and a greater degree of freedom. In panel data analysis, a dynamic panel data model involving generalized method of moments (GMM) is created to address the endogeneity issue[90] which has been ignored in the previous literature.

The baseline model is shown below. The autoregressive model in growth rates assumes that the estimated size of the action-based fiscal consolidation (*ABFC*) is exogenous and uncorrelated with changes in fiscal policy in all other periods[91].

[89] It should be noted that the two approaches are exposed to the same risks. First, if a country delays fiscal consolidation until the economy gets better, the fiscal consolidation episode will be affected by good economic outcomes. Second, if a country sticks to a deficit-reduction policy and the economy falls into a recession, it may try additional fiscal consolidation measures. This will cause fiscal consolidation to be associated with unfavourable economic outcomes (IMF, 2010, p97).

[90] In the fixed-effects dynamic panel model including lagged values of the dependent variable as regressors, it is known that OLS estimates are inconsistent due to the correlation of the lagged dependent variable with the error term. In this case, Arellano-Bond GMM estimator can be a good alternative method (Biorn and Klette, 1999).

[91] There can still be an endogeneity issue related to the occurrence of fiscal consolidation, because macroeconomic conditions may affect the discretionary policy choices of fiscal authority. However, it should be noted that the budget for the current year is approved during the second half of the previous year and, even

$$(5.1)\quad g_{it} = \sum_{j=1}^{2} \alpha_j g_{i,t-j} + \sum_{s=0}^{2} \beta_s ABFC_{i,t-s} + \gamma_i + \mu_t + v_{it},$$

where g_{it} is the percent change in real GDP, $ABFC_{it}$ is equal to the estimated size of the action-based fiscal consolidation as a per cent of GDP in periods of fiscal adjustment, and zero otherwise, γ_i is a vector of country-fixed effects to capture differences among countries' normal growth rates, μ_t is a vector of year-fixed effects to take account of global shocks, such as shifts in oil prices or the global business cycle, and v_{it} is a mean-zero error term. Subscript *i* indexes countries and subscript *t* indexes years (IMF, 2010, p98).

The αs are autoregressive coefficients capturing the normal dynamics of GDP, while the βs[92] are the direct effects (contemporaneous and lagged) of the action-based measures of fiscal consolidation. Lags capture the delayed impacts of fiscal consolidation on growth. This approach controls for lags of GDP growth to distinguish the effect of fiscal consolidation from that of normal GDP dynamics. The lag order of 2 is selected based on a review of the information criteria and serial correlation properties associated with various lag lengths.

The difficulty of estimating this simple regression model is that the lagged dependent variables are correlated with the error term (v_{it}), even if v_{it} is assumed not to be auto-correlated. So, a dynamic panel data model with GMM estimator can be used to address

though additional measures can be taken during the course of the year, they usually become effective with some delay, toward the end of the fiscal year (Alesina and Ardagna, 2009).

[92] Following the previous panel data literature, the slope homogeneity restrictions ($\beta_i = \beta$, for all i) are imposed on the model to focus on an average estimate of the slope coefficients.

this problem[93]. The equation (*5.1*) is estimated over the entire sample period by dynamic panel GMM and the estimated responses for $ABFC_{it}$ at *t*, *t*+1, *t*+2 are cumulated to measure the effect of a 1 per cent of GDP fiscal consolidation.

A dynamic panel data model with GMM estimator takes first differences to eliminate unobserved country-fixed effects and uses lagged instruments to correct for simultaneity in the first-differenced equations. The resulting equation is as follows.

$$(5.2)\ \Delta g_{it} = \sum_{j=1}^{2} \alpha_j \Delta g_{i,t-j} + \sum_{s=0}^{2} \beta_s \Delta ABFC_{i,t-s} + \lambda_t + \Delta v_{it},$$

The dynamic panel data model contains lagged dependent variables (which are endogenous variables), exogenous variables, country-fixed effects and time-fixed effects. In either the fixed or the random effects cases, the heterogeneity, such as country-fixed effects, can disappear from the model by taking the first differences of the original model above. The time variables μ_t do not disappear by taking first differences. Because the time effect was not restricted initially, $\Delta\mu_t = \lambda_t$ remains an unrestricted time effect, which is treated as 'fixed' and modelled with a time-specific dummy variable.

There are still correlations between the differenced lagged dependent variables, $\Delta g_{i,t-j}$, and the differenced error term, Δv_{it}, in the modified equation. To remove the correlations between the regressors and the differenced error term, the differenced lagged dependent variables ($\Delta g_{i,t-j}$) are instrumented with the past levels of $g_{i,t}$. This approach is called 'difference GMM approach'. When finding suitable instrumental variables, it is very

[93] We also estimate the equation (*5.1*) using the two-stage least-squares first-differenced estimator (FD2SLS) considering that Anderson and Hsiao (1981) used a version of FD2SLS to fit a panel-data model with lagged dependent variables. The results are similar to those of the dynamic panel GMM (See Appendix 5.6).

important for the instruments to be highly correlated with the lagged dependent variables but uncorrelated with the differenced error term, Δv_{it}.

However, the application of the difference GMM estimators has tended to produce very unsatisfactory results if there are weak correlations between differenced lagged dependent variables and their instrumental variables (Mairesse and Hall, 1996). To reduce this problem, Arellano and Bover (1995) and Blundell and Bond (1998) suggest including the lagged first-differences as instruments for equations in levels, in addition to the usual lagged levels as instruments for equations in first-differences. This is commonly called as 'system GMM approach'. In this chapter, we use both difference GMM approach and system GMM approach to strengthen the robustness of the analysis.

5.3.2.1.2 Extension Model Specification

In the baseline model above equation (*5.1*), the coefficient of $ABFC_{i,t}$ is assumed to be β regardless of country i, even if this assumption can be criticized because it may be too strong a restriction considering the different conditions of each country. The effects of fiscal consolidation on the economy could be different depending on the situation of each country. This criticism can be addressed to some degree by subdividing the *ABFC* into two variables considering the special factors influencing the effects of fiscal consolidation on the economy.

First, to investigate the role of the debt-to-GDP ratio, the sample is divided into two sub-samples according to the level of the debt-to-GDP ratio. Reinhart and Rogoff (2010) found that a country's output falls substantially as soon as its total public debt passes 90 per cent of GDP. Using 20 advanced economies since 1945, they found that GDP growth had

been between 3 and 4 per cent when public debt had been below 90 per cent of GDP, but that GDP growth had collapsed to an average of -0.1 per cent when public debt had risen above 90 per cent of GDP. They argued that the relationship between public debt and real GDP growth gains strength for debt-to-GDP ratios above a threshold of 90 per cent of GDP. According to their analysis, real GDP growth rates fall over one per cent in the case of debt-to-GDP ratios above 90 per cent. Following their argument, the two sub-samples are grouped by the threshold of 90 per cent debt-to-GDP ratios[94]. So, the two sub-samples are as follows: fiscal consolidations occurring with public debt-to-GDP ratios above 90 per cent of GDP; and those occurring with public debt-to-GDP ratios below 90 per cent of GDP.

$$(5.3)\quad g_{it} = \sum_{j=1}^{2} \alpha_j g_{i,t-j} + \sum_{s=0}^{2} \beta_{1,s}\, ABFC_{i,t-s}^{HD} + \sum_{s=0}^{2} \beta_{2,s} ABFC_{i,t-s}^{LD} + \gamma_i + \mu_t + v_{it}$$

Second, the role of the composition of fiscal consolidation in terms of government spending and taxes can be investigated. So, the fiscal consolidation of the baseline model can be divided into two types: spending-based fiscal consolidation and tax-based fiscal consolidation[95].

$$(5.4)\quad g_{it} = \sum_{j=1}^{2} \alpha_j g_{i,t-j} + \sum_{s=0}^{2} \beta_{1,s}\, ABFC_{i,t-s}^{S} + \sum_{s=0}^{2} \beta_{2,s} ABFC_{i,t-s}^{T} + \gamma_i + \mu_t + v_{it}$$

[94] Sensitivity analysis using alternative criteria for debt-to-GDP ratios can be seen in Appendix 5.3.

[95] 'Tax-based type' is defined as a fiscal consolidation in which the contribution of tax rises to the consolidation is greater than that of government spending cuts, and 'spending-based type' is defined as a fiscal consolidation in which the contribution of government spending cuts is greater than that of tax rises (IMF, 2010, p98).

5.3.2.2 Test for the Determinants of Successful Fiscal Consolidation

5.3.2.2.1 Random Effects Panel Probit Models

It is important to know how to ensure successful fiscal tightening when fiscal consolidation is executed. As mentioned in the literature review, successful fiscal consolidation means a sufficiently large and persistent reduction in the debt-to-GDP ratio or the primary budget balance. To find out the main factors of successful fiscal consolidation, a panel probit regression model is used. The panel probit model puts a dummy variable identifying successful fiscal consolidation on the left-hand side as a dependent variable, and puts a set of candidate determinants on the right-hand side as independent variables. The panel probit model estimates the likelihood of fiscal consolidation being successful depending on the realizations of the explanatory variables in a given period.

Therefore, following Alesina and Ardagna (1998), Ardagna (2004), and Giudice *et al*. (2007), a panel probit regression model is used to estimate the main determinants of successful fiscal consolidation[96]. After determining the nature of the fiscal consolidation episodes as either successful or not, the possible determinants of the successful fiscal consolidation are assessed using the panel probit regression model. To construct a successful fiscal consolidation dummy, the degree of debt reduction achieved over the following three years is focused on. The dependent variable is a binary variable with a value equal to one or zero. Following Alesina and Ardagna (2010), a fiscal consolidation is considered to be successful and defined as being 'one' if the debt-to-GDP ratio for the three years after the

[96] Afonso (2006), Afonso and Jalles (2012) use logit models to measure the success of fiscal consolidations.

fiscal consolidation is at least 4.5 per cent points below the level observed immediately prior to the fiscal consolidation. If the degree of debt reduction achieved is less than 4.5 per cent points, the fiscal consolidation is considered to be unsuccessful and is defined to be zero[97].

Using the 'general-to-specific' approach, insignificant variables are excluded so as to keep the most parsimonious equation with the relevant variables remaining for each dimension (Guichard *et al*., 2007, p. 29). The panel probit model is constructed as follows.

$$(5.5)\quad s_{it}^{*} = \alpha + \beta X_{it} + \mu_i + \varepsilon_{it}, \quad i= 1,\ldots,N,\ t=1,\ldots,T$$

where s_{it}^{*} is an unobserved latent variable, α is a constant, $X_{it} \equiv (g_t, \Delta CAPB_t, EXP_t, OUTGAP_t, \Delta EXCH_t, \Delta INF_t, \Delta UNR_t, \Delta IRL_t, \Delta IIR_t)'$ is a vector of the independent variables, β is a vector of the associated parameters, and ε_{it} is error terms with $\varepsilon_{it} \sim N(0, \sigma^2)$.

While s_{it}^{*} is not observed, the action based fiscal consolidation (s_{it}) is observed and can be taken as a surrogate of s_{it}^{*}. s_{it} is assigned the value of one if a fiscal consolidation is successful and zero otherwise. The equation (*5.5*) can be rewritten as follows:

$$(5.6)\quad s_{it} = \alpha + \beta X_{it} + \mu_i + \varepsilon_{it}, \quad i= 1,\ldots,N,\ t=1,\ldots,T$$

$s_{it} = \begin{cases} 1, & if\ s_{it}^{*} > 0 \\ 0, & otherwise \end{cases}$, where s_{it} is the observed fiscal consolidation.

There is an issue of which model to use, with a choice between a random effects model and a fixed effects model, in estimating equation (*5.6*) with a panel probit model. Of course, there is no method to evaluate which of the non-linear models is better: a fixed effects

[97] Alternative values other than 4.5 per cent points cut-off have been considered in Appendix 5.5.

model or a random effects model (Greene, 2003). Following the suggestion made by Maddala (1987, pp 315-324)[98], a random effects model is used.

5.3.2.2.2 Marginal Effects

A marginal effect is the effect of a unit change in an independent variable on the change in the probability of a dependent variable. Interpretation of the coefficients for panel probit models needs a degree of care. Unlike the coefficients of linear regression, the marginal effects of probit models cannot be measured directly.

If an independent variable is a continuous variable, we can calculate the marginal effect as follows.

$$(5.7) \quad \frac{\partial \Pr[s_{it}=1 \mid X]}{\partial X_{it}} = \frac{\partial F[\alpha + \beta X_{it} + \mu_i]}{\partial X_{it}} = \beta f[\alpha + \beta X_{it} + \mu_i]$$

where $f[\alpha + \beta X_{it} + \mu_i]$ is the standard normal probability density function evaluated at $\alpha + \beta X_{it} + \mu_i$.

In the equation (*5.7*), $f[\alpha + \beta X_{it} + \mu_i]$ hinges on the value *X*. Usually, the means of the explanatory variables *X* are used to calculate function f.

Meanwhile, if an independent variable is the dummy variable, the marginal effect means the effect of a change of state from 0 to 1, as follows.

$$(5.8) \quad \frac{\partial \Pr[s_{it}=1]}{\partial X_{it}} = \Pr[s_{it} = 1 \mid X] - \Pr[s_{it} = 0 \mid X]$$

[98] The fixed effects probit model does not give consistent estimates of the coefficients in the case when the dependent variable is observed only as a qualitative variable and there are only a few time-series observations.

5.4 Data Description

5.4.1 Data for the Existence of Expansionary Fiscal Consolidation Test

Data on 18 OECD countries from 1978 to 2011 are used. The countries included in the sample are Australia, Austria, Belgium, Canada, Denmark, France, Finland, Germany, Italy, Ireland, Japan, the Netherlands, Portugal, Korea, Spain, Sweden, the United Kingdom, and the United States. All fiscal and macroeconomic data are from the OECD Economic Outlook Database No. 92. In the 18 OECD countries, fiscal consolidation episodes are selected according to the criterion of a policy action-based approach as described above. The sample size is relatively small both in terms of time series and of the cross-sectional data. The budgetary effects of the fiscal consolidation are scaled by GDP.

The data for general government are used, rather than those for central government. This has one advantage and one disadvantage. The advantage is that the definition of general government is more comparable across countries. In fact, according to the OECD, general government includes ‘all departments, offices, organisations and other bodies which are agencies or instruments of the central, state or local public authorities', including 'all social security arrangements for large sections of the population imposed, controlled or financed by a government', and 'government enterprises which mainly produce goods and services for government itself or primarily sell goods and services to the public on a small scale'. Using general government data therefore avoids the problem of allocating expenditures to, say, state rather than local governments, or to the central administration rather than to social security funds, which can sometimes be difficult and unreliable in a cross-country comparison. The disadvantage of using general government data is that discretionary fiscal policies are usually

undertaken through the central government budget. However, fluctuations in the general government balance may reflect effects comming from local governments, which may be not a matter of interest (Alesina and Perotti, 1995).

5.4.2 Data for the Determinants of Successful Fiscal Consolidation Test

The definition and measurement of the variables used in the panel probit model are shown in Table 5.4. The dependent variable, *s*, represents a successful fiscal consolidation, which is a dummy variable being assigned the value of '1' if the debt-to-GDP ratio for three years after the fiscal consolidation is at least 4.5 per cent points below the level observed immediately prior to the fiscal consolidation, and '0' if not.

There are nine independent variables in this probit model. Among them, spending-based fiscal consolidation (*EXP*) is a dummy variable, which is assigned the value of '1' if the change in the value for total government expenditure is bigger than that of the value for total revenue, and '0' otherwise. The other eight variables have continuous values. As regards change in the CAPB ($\Delta CAPB$), the average change over a three-year period is used to capture the strong fiscal adjustments that are spread over several years. The output gap (*OUTGAP*) represents the cyclical conditions immediately preceding the fiscal consolidation; so it is constructed by averaging the output gap of years *t*-1 and *t*. Meanwhile, the exchange rate ($\Delta EXCH$), interest rate (ΔIRL), unemployment rate (ΔUNR), inflation rate (ΔINF), and the sovereign default risk (ΔIIR) variables are all instead aimed at capturing developments both immediately preceding and following the fiscal consolidation. Therefore these variables are defined as the average per cent change between *t*-1 and *t*+1 (Giudice *et al*., 2007).

Table 5.4 The Definition and Measurement of the Variables in the Probit Model

Variables	Definition	Measurement
Dependent variable s	Successful fiscal consolidation	1 if the debt-to-GDP ratio for the three years after the fiscal consolidation is at least 4.5 per cent points below the level observed immediately prior to fiscal consolidation. ($d_{i,t-1} - d_{i,t+2} \geq 4.5\ \%p$)
Independent variables g	Yearly GDP growth rate	Continuous
$\Delta CAPB$	Average change between t-1 and t+1 in the cyclically adjusted primary balance (% of potential GDP)	Continuous
EXP	Spending-based fiscal consolidation	1 if the change in the value of total government expenditure is bigger than that in the value of total revenue, 0 otherwise
$OUTGAP$	Average in the output gap (% of potential GDP) between t-1 and t	Continuous
$\Delta EXCH$	Average change in exchange rate between t-1 and t+1	Continuous
ΔIRL	Average change in real long-run interest rate between t-1 and t+1	Continuous
ΔUNR	Average change in unemployment rate between t-1 and t+1	Continuous
ΔINF	Average change in inflation rate between t-1 and t+1	Continuous
ΔIIR	Average change in sovereign default risk index between t-1 and t+1	Continuous

5.5 Empirical Results

5.5.1 Test for the Existence of Expansionary Fiscal Consolidation

5.5.1.1 Baseline Model Analysis

5.5.1.1.1 Arellano-Bond Difference GMM Estimation

A. The Results of Estimation

Arellano and Bond (1991) first used the Arellano-Bond estimator by constructing instrumental variables in a GMM context with a dynamic panel data model. Later, Roodman (2006) devised more efficient Arellano-Bond estimator.

By taking the first differences of the original model, the country-fixed effects (including the constant term) can be removed. It should be noted that time variables μ_t are not transformed by taking first differences.

(*5.11*) $g_{it} = \sum_{j=1}^{2} \alpha_j g_{i,t-j} + \sum_{s=0}^{2} \beta_s ABFC_{i,t-s} + \gamma_i + \mu_t + v_{it}$,

When the above equation is first differenced, it is changed as below.

(*5.12*) $\Delta g_{it} = \sum_{j=1}^{2} \alpha_j \Delta g_{i,t-j} + \sum_{s=0}^{2} \beta_s \Delta ABFC_{i,t-s} + \lambda_t + \Delta v_{it}$,

In estimation, the maximum lag of an instrument is limited to four in order to prevent the number of instruments from becoming too large and to address a possible loss of efficiency (Baum, 2006, p234). Only lags of two to five years are to be used as GMM instruments in this model. The results of the estimation of the growth rate function are shown in Table 5.6.

Table 5.5 The Results of the Arellano-Bond Dynamic Panel Data Difference GMM

Dependent variable : g		
Independent variables	Arellano-Bond's Coefficient	Roodman's Coefficient
g_{t-1}	0.3209*** (0.000)	0.1969*** (0.001)
g_{t-2}	-0.1182* (0.061)	-0.0793 (0.119)
$abfc_t$	-0.2210* (0.098)	-0.3377*** (0.007)
$abfc_{t-1}$	-0.2520** (0.045)	-0.3424*** (0.003)
$abfc_{t-2}$	0.2560 (0.101)	0.1608 (0.189)
No. of observations	543	543
Instruments for first differences equation	Standard: *D.*(*abfc, labfc, l2abfc*) GMM-type : *L*(2/5).*g*	Standard: *D.*(*abfc, labfc, l2abfc*) GMM-type : *L*(2/5).(*L.g L2.g*)
Wald test : χ^2(k)	628.21 (5) (0.000)	603.38 (5) (0.000)

Notes: 1. The time dummies are included in all equations but are not shown here to save space.

2. ***, ** and * denote the rejection of the null hypothesis at the 1%, 5% and 10% significance levels, respectively.

3. *p*-values are in parentheses.

4. The Wald statistic is a test of the joint significance of the independent variables asymptotically distributed as χ^2_k under the null of no relationship, where *k* is the number of coefficients estimated (excluding time dummies).

The main result of estimation is that fiscal consolidation is not expansionary but contractionary. GDP growth responds negatively to contemporaneous and lagged changes in action-based fiscal consolidation, meaning that fiscal consolidation typically reduces GDP growth. The results are statistically significant at the 10 per cent significance level at the least. Based on the above results, we can say that the idea of non-Keynesian effects that fiscal consolidation stimulates economic activity even in the short run cannot be supported empirically. The results are in line with those of Leigh *et al*. (2011) who use a policy action-based approach.

B. Tests for the Validity of Over-Identifying Restrictions

The Sargan-Hansen test for over-identifying restrictions should be performed in any over-identified model estimated with instrumental variables techniques. If there is a strong rejection of the null hypothesis of the Sargan-Hansen test, we have to cast doubt on the validity of the dynamic panel data GMM estimates (Baum, 2013).

The Sargan test has a null hypothesis that 'the instruments as a group are exogenous'. In other words, the null hypothesis of the Sargan test is that over-identifying restrictions are valid. The Sargan test sets basis on the idea that the residuals should be uncorrelated with the exogenous variables if the instruments are exogenous. Consequently, a high *p*-value of the Sargan statistic means that the instruments are not useful. In our estimation, the null hypothesis that over-identifying restrictions are valid is rejected. However, this result cannot be fully credible because the Sargan test is not so powerful when there are many instrumental variables and there is heteroscedasticity in the error term (Arellano and Bond, 1991; Roodman, 2006).

Table 5.6 The Results of the Test for the Validity of Over-Identifying Restrictions

Order	Arellano-Bond's Coefficient	Roodman's Coefficient
Sargan test of overid. restrictions	χ^2 (119) = 348.07 *p*-value = 0.000	χ^2 (112) = 217.02 *p*-value = 0.000
Difference in Sargan tests of exogeneity of instrument subsets		
Sargan test excluding group:		χ^2 (109) = 210.40 *p*-value = 0.000
Difference (null H = exogenous):		χ^2 (3) = 6.62 *p*-value = 0.085

C. Autocorrelation Test for the Differenced Error Term

The Arellano-Bond autocorrelation test is an important diagnostic test of the residuals in the dynamic panel data estimation. Having a null hypothesis of no autocorrelation, it estimates the first and second-order autocorrelation in the first-differenced residuals. By construction, the residuals of the equation (5.12), Δv_{it}, should be serially correlated. But if we assume serial independence in the original errors, the differenced residuals should not follow significant AR(2) process. If there is a significant AR(2) statistic, the second lags of endogenous variables cannot be proper instruments for current values (Baum, 2012).

Table 5.8 shows the results of autocorrelation test. The test for first-order serial correlation AR(1) process rejects the null hypothesis of no autocorrelation at the 1 per cent significance level. But, the test for the AR(2) process cannot reject the null hypothesis that there is no second-order serial correlation at the 5 per cent significance level. Consequently, we can conclude that the instruments that we use are appropriate. This is what one expects in a first-differenced equation with the original untransformed error terms assumed not to be serially correlated (Baltagi, 2008, p158).

Table 5.7 Arellano-Bond Tests for Zero Autocorrelation in First-Differenced Errors

Order	Arellano-Bond's estimator	Roodman's estimator
Arellano-Bond test for AR(1) in first differences	z = -16.674*** (0.000)	z = -7.94*** (0.000)
Arellano-Bond test for AR(2) in first differences	z = -1.418 (0.156)	z = -1.65* (0.099)

Notes: 1. ***, ** and * denote the rejection of the null hypothesis at the 1%, 5% and 10% significance levels, respectively.
2. *p*-values are in parentheses.

5.5.1.1.2 System GMM Estimation

A. The Results of Estimation

The application of GMM estimators which take first differences to eliminate unobserved country-fixed effects and use lagged instruments to correct for simultaneity in the first-differenced equations has tended to produce very unsatisfactory results (Mairesse and Hall, 1996). These problems are related to the weak correlations between endogenous explanatory variables and their instrumental variables in the first-differenced GMM estimators.

Arellano and Bover (1995) and Blundell and Bond (1998) point out that the lagged level variables are poor instruments for identifying first-differenced variables, especially if the level variables are following random walk processes. To reduce this problem, they suggest including lagged first differences as instruments for equation in levels (e.g., equation (*5.11*)), in addition to the usual lagged levels as instruments for equation in first-differences (e.g., equation (*5.12*)). This expanded approach is commonly termed system GMM estimation.

The results of estimation using the system-GMM estimator are shown in Table 5.9. The results are the same as those of the difference GMM estimator. It should be noted that the system-GMM estimator produces a higher estimate of the coefficient on lagged growth rates because of using additional instrumental variables. This result agrees with that of Blundell and Bond (1998), who show that the system GMM estimator does not have the downward bias that Arellano-Bond's difference GMM estimator has when the true value is high.

Table 5.8 The Results of the Blundell-Bond Dynamic Panel Data System GMM

Dependent variable: g				
Independent variables	Coefficient	S.E	*z*	*P*>|*z*|
g_{t-1}	0.3273***	0.0621	5.27	0.000
g_{t-2}	-0.0943	0.0963	-0.98	0.219
$abfc_t$	-0.1442*	0.0914	-1.25	0.071
$abfc_{t-1}$	-0.2490**	0.0788	-3.16	0.013
$abfc_{t-2}$	0.2134	0.1967	1.08	0.127
No. of observations	561			
Instruments for first differences equation	GMM-type: *L*(*2/5*). *g* Standard: *D.*(*abfc*, *labfc*, *l2abfc*)			
Instruments for level equation	GMM-type: *LD. g* Standard: *_cons*			
Wald test : χ^2(k)	1059.51 (5) (0.000)			

Notes: 1. The time dummies are included in all equations but are not shown here to save space.
2. ***, ** and * denote the rejection of the null hypothesis at the 1%, 5% and 10% significance levels, respectively.
3. *P* denotes *p*-value.
4. The Wald statistic is a test of the joint significance of the independent variables asymptotically distributed as χ_k^2 under the null of no relationship, where *k* is the number of coefficients estimated (excluding time dummies).

B. Tests for the Validity of Over-Identifying Restrictions

According to the Sargan test, the chi-square statistic is 311.71 and its *p*-value is almost zero. The null hypothesis that over-identifying restrictions are valid is rejected. However, as mentioned in the previous section 5.5.2.1.1, this result cannot be totally reliable because the Sargan test is not very powerful when there are many instrumental variables and heteroscedasticity in the error term (Arellano and Bond, 1991; Roodman, 2006).

C. Autocorrelation Test for the Differenced Error Term

The test for the AR(1) process in the first differences rejects the null hypothesis of no autocorrelation at the 1 per cent significance level. The test for the AR(2) process cannot reject the null hypothesis that there is no second-order serial correlation at the 10 per cent significance level. Hence, we can conclude that the instruments that we use are appropriate.

Table 5.9 Arellano-Bond Tests for Autocorrelation

Order	z	*p*-value
Arellano-Bond test for AR(1) in first differences	z = -2.888***	P=0.003
Arellano-Bond test for AR(2) in first differences	z = -1.2456	P=0.213

Note: 1. ***, ** and * denote the rejection of the null hypothesis at the 1%, 5% and 10% significance levels, respectively.

5.5.1.2 Extension to the Analysis

In this section, the effects of sub-divided fiscal consolidation on GDP growth are estimated using extended models. By doing this, the strength of the factors' influence on economic activity – especially, GDP growth rates - can be measured.

First, to investigate the role of the debt-to-GDP ratio, the variable *ABFC* is divided according to the level of the debt-to-GDP ratio. An *ABFC* can be classified into two sub-groups: fiscal consolidations occurring with public debt-to-GDP ratios above 90 per cent of GDP ($ABFC_{i,t}^{HD}$); and those occurring with public debt-to-GDP ratios below 90 per cent of GDP ($ABFC_{i,t}^{LD}$). The baseline model may be changed into the following equation.

$$(5.13) \quad g_{it} = \sum_{j=1}^{2} \alpha_j g_{i,t-j} + \sum_{p=0}^{2} \beta_{1,p} ABFC_{i,t-p}^{HD} + \sum_{p=0}^{2} \beta_{2,p} ABFC_{i,t-p}^{LD} + \gamma_i + \mu_t + v_{it}$$

The results of the estimation are shown in Table 5.11. The results suggest that the effects of fiscal consolidation on GDP growth are all contractionary, regardless of the level of debt-to-GDP ratios. However, there are some differences in the degree of effects of fiscal consolidation depending on the public debt level. That is, the fiscal consolidation in low debt-to-GDP ratios may have significant negative effects on GDP growth, while those in time period of high debt-to-GDP ratios have insignificant negative effects on GDP growth at the 5 per cent significance level. Basically, the empirical results are not consistent with the non-Keynesian effects hypothesis that fiscal consolidation can expand economic activity by executing fiscal austerity measures in an economic crisis. However, the results also imply that if fiscal consolidation is unavoidable, fiscal consolidation in the situation of high debt-to-GDP ratios may be less harmful to economic activity. This is partially in line with the idea of Reinhart and Rogoff who support government's austerity measure in time of high public debt.

Table 5.10 The Results of GMM Estimation Considering Difference in Debt-to-GDP Ratios

Dependent variable : g				
Independent variables	Coefficient	S.E	z	$P>\|z\|$
g_{t-1}	0.1874***	0.0629	2.98	0.003
g_{t-2}	-0.0836	0.0523	-1.60	0.110
$abfc\_hd_t$	-0.0457	0.2618	-0.18	0.861
$abfc\_hd_{t-1}$	-0.4111*	0.2219	-1.85	0.064
$abfc\_hd_{t-2}$	-0.3332	0.2549	-1.31	0.191
$abfc\_ld_t$	-0.3856***	0.1481	-2.60	0.009
$abfc\_ld_{t-1}$	-0.3568***	0.1376	-2.59	0.009
$abfc\_ld_{t-2}$	0.2828*	0.1461	1.94	0.053
No. of observations	544			
Instruments for first differences equation	Standard: *D.*(*abfc_hd, labfc_hd, l2abfc_hd abfc_ld, labfc_ld, l2abfc_ld*) GMM-type : *L*(2/5).(*L. g L2. g*)			
Wald test : χ^2(k)	668.29 (8) (0.000)			
Arellano-Bond test for AR(1) in first differences	Z=-7.46 (*p*-value =0.000)			
Arellano-Bond test for AR(2) in first differences	Z=-1.26 (*p*-value =0.207)			

Notes: 1. The time dummies are included in all equations but are not shown here to save space.
2. ***, ** and * denote the rejection of the null hypothesis at the 1%, 5% and 10% significance levels, respectively.
3. *P* denotes *p*-value.
4. The Wald statistic is a test of the joint significance of the independent variables asymptotically distributed as χ_k^2 under the null of no relationship, where *k* is the number of coefficients estimated (excluding time dummies).

Second, the role of the composition of fiscal consolidation in terms of government spending and taxes is investigated. The *ABFC* is divided into two types in a baseline model: spending-based fiscal consolidation ($ABFC_{i,t}^S$); and tax-based fiscal consolidation ($ABFC_{i,t}^T$) [99].

$$(5.14)\quad g_{it} = \sum_{j=1}^{2} \alpha_j g_{i,t-j} + \sum_{p=0}^{2} \beta_{1,p}\, ABFC_{i,t-p}^S + \sum_{p=0}^{2} \beta_{2,p} ABFC_{i,t-p}^T + \gamma_i + \mu_t + v_{it}$$

where the coefficient on $ABFC_{i,t-p}^S$, $\beta_{1,p}$, is the effects of a spending-based fiscal consolidation and the coefficient on $ABFC_{i,t-p}^T$, $\beta_{2,p}$, is the effects of a tax-based one.

[99] 'Tax-based type' is defined as a fiscal consolidation in which the contribution of tax rises to the consolidation is greater than that of spending cuts; and 'spending-based type' is defined as a fiscal consolidation in which the contribution of spending cuts is greater than that of tax rises.

The results of the effects of the two types of fiscal consolidation are shown in Table 5.12, which indicates that the effects of the two types of fiscal consolidation on GDP growth are both negative. In particular, spending-based fiscal consolidation is less contractionary for GDP growth than tax-based fiscal consolidation. Based on the results, we can say that there is no evidence of any expansionary effects of fiscal consolidation regardless of its composition. We can also suggest that if fiscal consolidation is inevitable, spending-based fiscal consolidation may be less harmful to the economy.

Table 5.11 The Results of GMM Estimation Considering the Composition of Fiscal Consolidation

Dependent variable : g				
Independent variables	Coefficient	S.E	z	$P>\|z\|$
g_{t-1}	0.1941***	0.0633	3.07	0.002
g_{t-2}	-0.0793	0.0524	-1.51	0.131
$abfc\_s_t$	-0.2647*	0.1495	-1.77	0.077
$abfc\_s_{t-1}$	-0.2945**	0.1390	-2.12	0.034
$abfc\_s_{t-2}$	0.2285	0.1489	1.54	0.125
$abfc\_t_t$	-0.4962**	0.2005	-2.48	0.013
$abfc\_t_{t-1}$	-0.6373***	0.1891	-3.36	0.001
$abfc\_t_{t-2}$	-0.0177	0.1991	-0.09	0.929
No. of observations	544			
Instruments for first differences equation	Standard: *D.*(*abfc_hd, labfc_hd, l2abfc_hd abfc_ld, labfc_ld, l2abfc_ld*) GMM-type : *L*(2/5).(*L.g L2.g*)			
Wald test : χ^2(k)	668.17 (8) (0.000)			
Arellano-Bond test for AR(1) in first differences	*Z*=-7.53 (*p*-value =0.000)			
Arellano-Bond test for AR(2) in first differences	*Z*=-1.10 (*p*-value =0.272)			

Notes: 1. The time dummies are included in all equations but are not shown here to save space.
2. ***, ** and * denote the rejection of the null hypothesis at the 1%, 5% and 10% significance levels, respectively.
3. *P* denotes *p*-value.

The estimation results are the same when the effects of fiscal consolidation are investigated after dividing the variables by the level of perceived sovereign risk (The results can be seen in Appendix 5.4).

5.5.2 Tests for the Determinants of Successful Fiscal Consolidation

The success of fiscal consolidation can be judged by the degree of stabilization of the debt-to-GDP ratio they achieve, despite the disadvantage of this measure[100]. The panel probit model is used to find the crucial determinants of successful fiscal consolidation. A random effects probit model is better than a pooled probit model for our analysis. This is easily proved by a likelihood ratio (*LR*) test, where the null hypothesis that there is no presence of random effects (i.e., $H_0 = \sigma_\mu^2/(\sigma_\mu^2 + 1) = 0$) is rejected. This indicates that the panel-level variance components (random effects) are relatively important.

By performing a random effects panel probit regression model analysis, it is possible to investigate the role of the characteristics of fiscal consolidation in determining the probability of the consolidations' success.

The results of estimations from a pooled probit model and a random effects panel probit model are shown in Table 5.13. The results show that GDP growth rate (g) is a crucial determinant of the success of fiscal consolidation, which is in line with the empirical estimates of Afonso and Jalles (2012) and Hernandez and Moral-Benito (2011). The marginal effect of the GDP growth rate amounts to approximately 120 per cent points. As for the size of fiscal consolidation, the results do not support the idea that size ($\Delta CAPB$) is an important factor in the success of fiscal consolidation. This is in line with the empirical estimates of Alesina and Perotti (1995), who suggest that the size of fiscal consolidation is not strongly related to the success of fiscal consolidation policy. Meanwhile, the results support the view that fiscal consolidation is more likely to be successful in periods of consolidation based on

[100] The debt-to-GDP ratio may include stock-flow adjustments that affect the level of debt which is unrelated to discretionary consolidations and may even reflect fiscal tricks designed to reduce debt levels in the short-term without improving the underlying government balance sheet.

government spending cuts than in periods based on tax rises. That is, the composition variable (EXP) has a positive effect on the successful fiscal consolidation and the coefficient of EXP is significant at the 10 per cent significance level. These results are consistent with the empirical studies of Alesina and Perotti (1995) and McDermott and Wescott (1996), who insist that fiscal consolidation with government spending cuts can be more successful at reducing debt-to-GDP ratios than tax-based fiscal consolidation. Its marginal effect amounts to 3.5 per cent points. Fiscal consolidation is more likely to be successful in periods with a positive output gap (i.e., actual GDP is bigger than potential GDP). This means such a policy is to be more successful when the domestic economy is doing well. Consequently, we can say that a recessionary economic situation, indicated by a negative output gap, lowers the likelihood of a successful fiscal consolidation. But this estimate is not significant statistically.

The exchange rate ($\Delta EXCH$), inflation rate (ΔINF) and unemployment rate (ΔUNR) have positive but statistically insignificant effects on the success of a fiscal consolidation. On the other hand, the long-term interest rate (ΔIRL) and sovereign default risk (ΔIIR)[101] are significant determinants of the success of fiscal consolidation. To be more precise, an increase in the long-term interest rate has a negative effect on the success of fiscal consolidation. Judging by the marginal effects, we can infer that, on average, an increase in the long-term interest rate lowers the probability of fiscal consolidation being successful by about 4 per cent points. This result is in contrast with the empirical estimates of Alesina and Ardagna (2010, 2012) who suggest an insignificant role for the interest rate in the success of

[101] Institutional Investor Ratings (*IIR*) are based on assessments of sovereign risk by private sector analysts. They rate each country on a scale of 0 to 100, with a rating of 100 assigned to the lowest perceived sovereign default risk probability.

fiscal consolidation. Lastly, a decrease in sovereign default risk has a positive effect on the success of fiscal consolidation, which is significant at the 1 per cent level. Its marginal effect amounts to 3.6 per cent points. This result makes sense in that the possibility of decreasing the debt-to-GDP ratio by fiscal consolidation is likely to get higher when the sovereign default risk becomes lower and improves the borrowing conditions of one's country (Corsetti and Muller, 2012).

Table 5.12 A Pooled Probit Model and a Random Effects Probit Model

Dependent variable: s	A pooled probit model			A random effects probit model		
Independent variables	Coefficient	Standard errors	Marginal effects	Coefficient	Standard errors	Marginal effects
g	24.678*	12.691	2.5111	24.628*	15.187	1.2056
$\Delta CAPB$	0.049	0.198	0.0050	0.223	0.300	0.0109
EXP	0.699**	0.349	0.0655	0.765*	0.418	0.0345
$OUTGAP$	0.083	0.094	0.0084	0.130	0.122	0.0064
$\Delta EXCH$	0.030	0.041	0.0031	0.042	0.053	0.0020
ΔINF	0.280	0.238	0.0285	0.254	0.269	0.0124
ΔUNR	0.126	0.323	0.0128	0.207	0.378	0.0102
ΔIRL	-0.764**	0.319	-0.0777	-0.846**	0.391	-0.0415
ΔIIR	0.591***	0.205	0.0601	0.735***	0.278	0.0360
constant	-2.609***	0.478		-3.086***	0.779	
σ_μ				0.759	0.501	
ρ				0.366	0.306	
Log likelihood	-46.063165			-45.147781		
Wald test for all regressors	χ^2 (9) =53.49*** p-value 0.000			χ^2 (9) =19.53** p-value 0.021		
LR test for $\rho = 0$				χ^2 (1) = 1.83*, p-value 0.088		
Pseudo R^2	0.3673					
Observations	161			161		

Notes: 1. The marginal effects are calculated under the assumption of $\mu_i = 0$.
2. A rise in the average change of exchange rate ($\Delta EXCH$) indicates an appreciation of the Korean won.
3. ***, ** and * denote the rejection of the null hypothesis at the 1%, 5% and 10% significance levels, respectively.

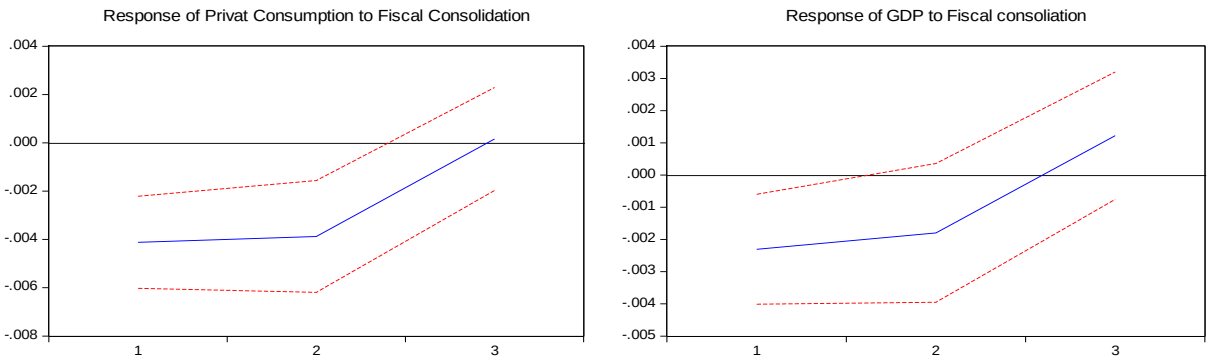
5.6 Robustness Checks

5.6.1 Test for the Existence of Expansionary Fiscal Consolidation

The robustness of the results discussed above depends on how independent variables have been controlled for during estimation (Briotti, 2005). In this section, by performing several different tests, we recheck whether fiscal consolidation has either non-Keynesian effects or contractionary effects on economic activity.

First, the two variable VAR models of GDP growth rate (g) and the size of action-based fiscal consolidation are estimated, allowing for the effects of a lagged growth rate and past action-based fiscal consolidation on current fiscal consolidation. The action-based fiscal consolidation variable is ordered first, followed by the GDP growth rate variable. Figure 5.2 shows that private consumption and GDP growth respond negatively to fiscal consolidation. The results of the VAR model also support the view that fiscal consolidation has contractionary effects on economic activity: the estimated effects of 1 per cent fiscal consolidation of GDP on private consumption and GDP in the first two years are -0.004 per cent (t-statistic = -3.34) and -0.002 per cent (t-statistic = -6.29), respectively.

Figure 5.2 The Responses to Cholesky One S.D. Innovations ± 2S.E.



Second, the effects of fiscal consolidation on the labour market can be measured by using a dynamic panel data GMM model. In the case of the difference GMM estimator, the coefficients of contemporaneous fiscal consolidation ($ABFC_t$) on the unemployment rate (*UNR*) are positive and significant at the 1 per cent significance level. The results of the system GMM estimator are similar to those of the difference GMM estimator. So, the results illustrate that fiscal consolidation raises the unemployment rate significantly. Moreover, the results support our empirical finding that fiscal consolidation has negative effects on economic activity.

Table 5.13 The Results of the Dynamic Panel Data GMM

Dependent variable : *UNR*	Difference GMM		System GMM
Independent variables	Arellano-Bond's Coefficient	Roodman's Coefficient	
UNR_{t-1}	1.2307*** (0.000)	1.2526*** (0.000)	1.4467*** (0.000)
UNR_{t-2}	-0.5863*** (0.000)	-0.5942 (0.000)	-0.5707 (0.000)
$abfc_t$	0.3021*** (0.000)	0.2919*** (0.000)	0.1237** (0.025)
$abfc_{t-1}$	0.1047* (0.061)	0.0907 (0.101)	0.0020 (0.270)
$abfc_{t-2}$	0.0790 (0.187)	0.0602 (0.311)	0.0770 (0.162)
No. of observations	543	543	561
Instruments for first differences equation	Standard: *D.*(*abfc, labfc, l2abfc*) GMM-type : *L*(*2/5*).*UNR*	Standard: *D.*(*abfc, labfc, l2abfc*) GMM-type : *L*(*2/5*).(*L.UNR L2.UNR*)	Standard: *D.*(*abfc, labfc, l2abfc*) GMM-type : *L*(*2/5*).*UNR*
Instruments for level equation			Standard: *_cons* GMM-type:*LD.UNR*
Wald test : χ^2(k)	1637.22 (5) (0.000)	1672.80 (5) (0.000)	5793.04 (5) (0.000)

Notes: 1. The time dummies are included in all equations but are not shown here to save space.

2. ***, ** and * denote the rejection of the null hypothesis at the 1%, 5% and 10% significance levels, respectively.

3. *p*-values are in parentheses.

4. The Wald statistic is a test of the joint significance of the independent variables asymptotically distributed as χ_k^2 under the null of no relationship, where *k* is the number of coefficients estimated (excluding time dummies).

Third, several control variables are added to address the possibility that the baseline equation omits variables affecting economic activity, which are correlated with fiscal consolidation. The omitted variables can be a number of additional non-policy factors, such as long-term interest rates (*IRL*), nominal effective exchange rates (*EXCHEB*) [102], unemployment rates (*UNR*), and perceived sovereign default risk. As for the sovereign default risk, the Institutional Investor Ratings (*IIR*) index[103] is used as a proxy measure of the perceived sovereign default risk, following Reinhart, Rogoff, and Savastano (2003) and Eichengreen and Mody (2004). The results are also similar to those of baseline equation[104]. It should be noted that the changes in interest rates, exchange rates, and unemployment rates help cushion or mitigate the negative impact on economic growth of fiscal consolidation.

Table 5.14 The Results of the Arellano-Bond Difference GMM with Control Variables

Alternatives / Independent variables	Coefficient				
	(1)	(2)	(3)	(4)	(5)
g_{t-1}	0.1969*** (0.001)	0.2024*** (0.001)	0.2051*** (0.001)	0.1420** (0.022)	0.2934*** (0.000)
g_{t-2}	-0.0793 (0.119)	-0.1049* (0.054)	-0.0885* (0.085)	-0.1108** (0.030)	-0.1522** (0.027)
$abfc_t$	-0.3377*** (0.007)	-0.3344*** (0.007)	-0.3323*** (0.008)	-0.2724** (0.026)	-0.3437*** (0.003)
$abfc_{t-1}$	-0.3424*** (0.003)	-0.3408*** (0.003)	-0.3270** (0.005)	-0.2752** (0.016)	-0.1845 (0.116)
$abfc_{t-2}$	0.1608 (0.189)	0.1454 (0.235)	0.1643 (0.181)	0.1856 (0.118)	0.1587 (0.191)
IRL	-	-0.0018** (0.015)	-	-	-
EXCHEB	-	-	-0.0001** (0.024)	-	-
UNR				-0.0020*** (0.007)	
IIR	-	-	-		0.0004 (0.295)
No. of observations	543	541	543	543	479
Wald test : χ^2(k)	603.38 (5)	693.17 (6)	684.51 (6)	736.20 (6)	853.53 (6)

[102] A rise of nominal effective exchange rates indicates an appreciation of the Korean won.

[103] The ratings are based on assessments of sovereign risk by private sector analysts. They rate each country on a scale of 0 to 100, with a rating of 100 assigned to the lowest perceived sovereign default risk probability.

[104] The results are the same when two lags of the additional control variable are implemented in the equation.

Note: 1. The time dummies are included in all equations but are not shown here to save space.
2. ***, ** and * denote the rejection of the null hypothesis at the 1%, 5% and 10% significance levels, respectively.
3. *p*-values are in parentheses.
4. The Wald statistic is a test of the joint significance of the independent variables asymptotically distributed as χ_k^2 under the null of no relationship, where *k* is the number of coefficients estimated (excluding time dummies).

Fourth, the equation is also estimated after excluding lags of growth from the baseline equation. The conclusions are the same as those of the baseline model, as expected. And the different lag length of growth has little effect on the results.

5.6.2 Test for the Determinants of Successful Fiscal Consolidation

As for the estimation of the determinants of successful fiscal consolidation using a random effects panel probit model, different definitions of successful fiscal consolidation episodes do not change the results shown above.

First, a successful fiscal consolidation is re-defined as an episode in which the CAPB improves and, three years after, the debt-to-GDP ratio is 3 per cent points lower than in the previous year of fiscal consolidation. Second, successful fiscal consolidation is re-defined as an episode in which the CAPB improves and, two years after, the debt-to-GDP ratio is at least 1.5 per cent points lower than in the previous year of the beginning of fiscal consolidation. Finally, the shorter horizon is considered to obtain more observations of successful fiscal consolidation. A successful fiscal consolidation is re-defined as an episode in which the debt-to-GDP ratio declines by at least 1 per cent point a year after the fiscal consolidation. The robustness checks support the conclusions obtained using the baseline model (See Appendix 5.5 for details).

5.7 Conclusion

This chapter has tried to investigate two issues related to fiscal consolidation: whether or not there exist expansionary fiscal consolidation; and what are the determinants of successful fiscal consolidation that significantly reduce debt-to-GDP ratios. The former issue has been investigated by using dynamic panel data analysis with GMM estimation; while the latter has been estimated by analysis using a random effects probit model.

Although the existence of non-Keynesian effects of fiscal consolidation is theoretically reasonable and attractive, it is very difficult to get empirical evidence because of the difficulty of gaining credibility for the policy (Prammer, 2004). As Cottarelli (2012) points out, a reform process on the basis of fiscal consolidation alone, in the middle of an economic crisis, can be exposed to the risk of becoming self-defeating. That is, fiscal consolidation in an economic recession may lead domestic demand to fall into line with consumers' raising concerns about job security and disposable incomes, thus reducing national tax revenues.

According to the estimates of dynamic panel data analysis with GMM estimation, fiscal consolidation is not expansionary in terms of GDP growth, but instead it is contractionary. Unlike the ideas put forward about non-Keynesian effects, our empirical estimates show that fiscal consolidation reduces the GDP growth rate significantly. That is, the view that fiscal consolidation may stimulate the economy in the short run cannot be supported. Both the Arellano-Bond difference GMM estimation and the Blundell-Bond system GMM estimation show that fiscal consolidation has significant negative effects on economic growth. The results are similar when the baseline model is extended by taking several factors into consideration. As for the results produced by extension models, it should

be noted that fiscal consolidation in the period of high debt-to-GDP ratios, the spending-base, or high sovereign risk has less negative effects on economic growth than that in the period of low debt-to-GDP ratios, the tax-base, or low sovereign risk.

Using a random effects panel probit model, several important points have been established, as follows. First, the economic growth rate (g) has a significant effect in reducing the debt-to-GDP ratio with fiscal consolidation policy. Second, fiscal consolidation is more likely to succeed in reducing debt-to-GDP ratio when based on government spending cuts (*EXP*) rather than on tax increases. On the other hand, the size of fiscal consolidation ($\Delta CAPB$) is not strongly related to the success of the policy, a result consistent with the empirical study of Alesina and Perotti (1995). Third, like Afonso and Jalles (2012), fiscal consolidation is more likely to be successful in periods with a positive output gap (i.e., actual GDP is bigger than potential GDP). The significance of the result is not that strong. Fourth, the exchange rate ($\Delta EXCH$), inflation rate (ΔINF) and unemployment rate (ΔUNR) have positive but statistically insignificant effects on the success of fiscal consolidation, while the long-term interest rate (ΔIRL) and sovereign default risk (ΔIIR) have significant effects on successful fiscal consolidation.

On the grounds of the findings made using a panel probit model, some meaningful implications can be drawn. The composition of fiscal consolidation is a more important factor of successful fiscal consolidation than their size. Moreover, economic conditions, such as the GDP growth rate, long-term interest rate and sovereign default risk, do matter for successful fiscal consolidation. That is, economic conditions may help to enhance the likelihood of successful fiscal consolidation.

CHAPTER 6

CONCLUSIONS

Chapter 6. Conclusions

This thesis has tried to analyse both the macroeconomic effects of fiscal policy and the sustainability of public debt. To do this, three empirical studies in Chapters 3, 4 and 5 have been performed using different, cutting-edge econometric methodologies. The first estimation is related to the effects of fiscal policy shocks on the macro economy. The other two estimations narrow the focus down to the sustainability of government debt and the effects of fiscal consolidation. The following section summarises the findings of this thesis, its policy implications, its limitations and the direction that further research might take.

6.1 Summary of Main Findings

First, while aggregated government spending has positive effects on output and the labour market, disaggregated government spending shows different effects. For instance, current government spending has a negative effect on private consumption, while government capital spending has a positive effect. As concerns the labour market, each type of government spending has positive effects on this. However, capital government spending is likely to boost the labour market more effectively than current government spending. A net tax rise causes a significant fall in output but shows ambiguous effects on the labour market.

Second, according to the results of Johansen's tests and ARDL bounds tests, there is a cointegrating relationship between the variables in Korea and in the US, but not in the UK. This means that fiscal policies in Korea and the US are sustainable, while fiscal policies in UK are not. It is notable that the long-run relationship between variables in the US is not strong compared to that in Korea. Modified Bohn's tests with DOLS, which estimate the response of the primary surplus to government debt, also support the above conclusion.

Third, as concerns the existence of expansionary fiscal consolidation, the estimates of dynamic panel data GMM analysis show that fiscal consolidation is not likely to be expansionary for GDP growth. Both Arellano-Bond difference GMM estimation and Blundell-Bond system GMM estimation suggest that fiscal consolidation has negative effects on economic growth. The results do not support the expansionary fiscal consolidation hypothesis. In particular, our analyses also find that fiscal consolidation in time of high debt-to-GDP ratios, the spending-base, or high sovereign risk has less negative effects on economic growth than those in time of low debt-to-GDP ratios, the tax-base, or low sovereign risk. As concerns the main determinants of successful fiscal consolidation, a random effects panel probit model indicates that the economic growth rate, government spending-based fiscal consolidation, low long-term interest rates, and higher sovereign risk have significant effects on reducing debt-to-GDP ratio. On the other hand, the panel probit model suggests that the size of fiscal consolidation, exchange rates, and unemployment rate have positive, but statistically insignificant effects, on successful fiscal consolidation.

In conclusion, the empirical results show that the new Keynesian approach describes reality more accurately than the neoclassical approach regardless of the methods used in both fiscal expansion and consolidation. The empirical results indicate that government spending shocks are likely to boost economic activity, private consumption, and the labour market, fiscal consolidation shocks tend to contract economic activity, which is the opposite of the non-Keynesian expansionary effects hypothesis. The empirical results also suggest that public debt can be sustainable in the case where a government reacts positively to a public debt rise by increasing the primary surplus.

6.2 Policy Implications

The role of fiscal policy becomes more important in the absence of an independent monetary policy or exchange rate policy. The policy implications of this thesis are as follows.

First, the new Keynesian view that active fiscal policy plays a crucial role in boosting a recessionary economy has proved to be accurate in economic crises. In particular, capital government spending has more positive and long-lasting effects on the economy than current government spending. From this, it can be suggested that a government should allocate its resources to government investment, such as infrastructure investment or research spending, rather than to government consumption, if it wants to increase future benefits by expansionary government spending.

Second, it is necessary to tighten up a government's budget deficit if sustainable fiscal policy is eventually to be achieved. According to our analysis in Chapter 5, it is legitimate and credible to implement fiscal consolidation measures when a government is suffering from high government debt. In the case of high debt-to-GDP ratios, fiscal consolidation seems to be less harmful to economic activity. Instead, the government can gain the credibility of its fiscal policy from people, even offsetting the negative effects of fiscal austerity measures. However, timing is vital. If a government only focuses on tightening up the budget deficit by cutting government spending or raising taxes in serious periods of economic recession, this might cause a much worse recession by reducing aggregate demand. A government should be more careful at a time of economic crisis when implementing fiscal consolidation, because austerity measures can lead to a domestic demand

reduction, consumers' raising concerns about job security, and finally to a decrease in national tax revenue.

Third, if a government has to use fiscal consolidation, it may be a better strategy to mix these with other measures, such as monetary policy and fiscal reform. The proper policy mix can mitigate the negative impact on the macro economy of a fiscal consolidation policy. Fiscal consolidation for the purpose of reducing public debt should be carried out based on government spending cuts rather than on tax rises, because the former is more likely to succeed.

6.3 Limitations of the Study and Further Research

This thesis has a number of limitations. The first one is a lack of data availability. Most relationships in this thesis are estimated using annual data and the sample period is relatively short. For instance, our study uses annual data over sample periods from 1972 to 2010. This was an inevitable choice, because higher frequency data and longer sample spans are difficult to obtain. The use of low frequency data and small samples is unavoidable for this kind of study; but bias caused by having small samples in the tests can weaken the strength of the findings in the research. The second limitation is the use of an incomplete model set-up. In Chapter 5, the baseline model is constructed under a particular assumption that the effects of fiscal consolidation on economic growth are the same regardless of country (i.e., coefficient β_i of $ABFC_{i,t}$ equals to β). This assumption is too strong, because the effects of fiscal consolidation on economic activity could be quite different depending on the economic conditions of each country. Even though we try to address this shortcoming by

dividing the independent variable by considering some special factors, this extended model still cannot fully cover the weakness of the baseline model's assumption. The third limitation is the possibility of omitted variables. Even though a great effort has been made to include the various control variables that were identified in the previous literature, it is always possible that other factors have not been controlled for.

Further research can be done to develop the findings and overcome the limitations of this thesis. These findings and limitations may illuminate several avenues to explore in future work. First, considering that Chapter 3 shows only the effects of aggregated net tax shocks on the economy, it would be better to estimate the effects of disaggregated net tax variables on economic activity. For instance, aggregated net taxes can be divided into main five sub-components: corporate tax, income tax, property tax, indirect tax, and social security contributions. Second, Chapter 3 has looked only at the transmission mechanism for fiscal policy shocks in Korea. To establish the stylized facts about the effects of fiscal policy shocks, the same form of estimation could be extended to other developing countries and the results compared. Third, in Chapter 4, we estimate the sustainability of public debt without including qualitative variables such as changes in the political systems or the decision-making processes. It would be a more convincing estimation of sustainability if we were to include such qualitative variables in the model. Lastly, the work described in Chapter 5 could be further developed by adding more control variables related to the labour market and political issues to the dynamic panel data analysis. This would refine the precision of our estimation and finally produce more credible and generally applicable results on the effects of fiscal consolidation.

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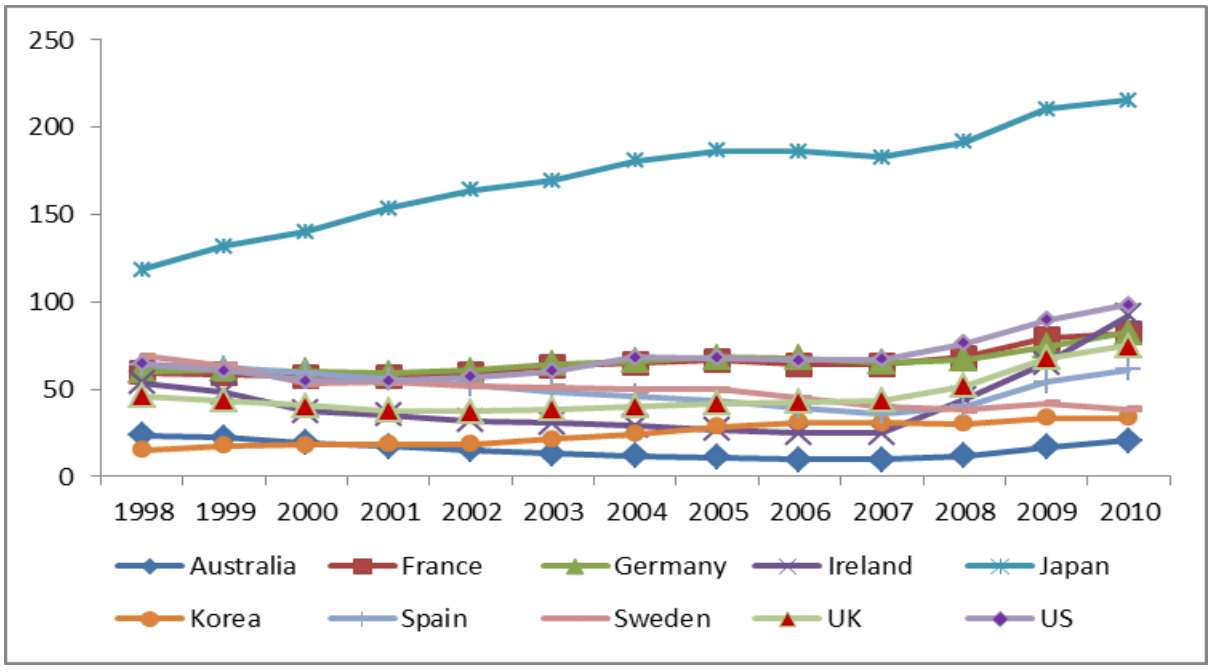
Appendices

Appendix 2.1

Government Debt-to-GDP ratio of Main Countries

(% of GDP)

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Australia	23.8	22.5	19.5	17.1	15.1	13.2	12.0	10.9	10.0	9.7	11.8	16.9	20.5
France	59.5	58.9	57.4	56.9	59.0	63.2	65.0	66.7	64.1	64.2	68.2	79.2	82.3
Germany	60.5	61.3	60.2	59.1	60.7	64.4	66.2	68.5	67.9	65.4	66.9	74.7	82.4
Ireland	53.5	48.4	37.5	35.3	32.0	30.8	29.2	27.1	24.8	25.0	44.5	64.9	92.2
Japan	118.3	131.9	140.1	153.6	164.0	169.6	180.7	186.4	186.0	183.0	191.8	210.2	215.3
Korea	15.4	17.6	18.0	18.7	18.6	21.6	24.6	28.7	31.1	30.7	30.1	33.8	33.4
Spain	64.2	62.4	59.4	55.6	52.6	48.8	46.3	43.2	39.7	36.3	40.2	53.9	61.3
Sweden	69.1	63.6	53.3	54.1	51.8	51.0	49.9	50.0	44.8	39.7	38.4	42.0	38.8
UK	46.1	43.6	40.9	37.8	37.5	38.7	40.3	41.8	43.0	43.7	52.2	68.0	75.0
US	64.6	60.8	54.8	54.7	57.1	60.4	68.3	67.9	66.6	67.2	76.1	89.7	98.6

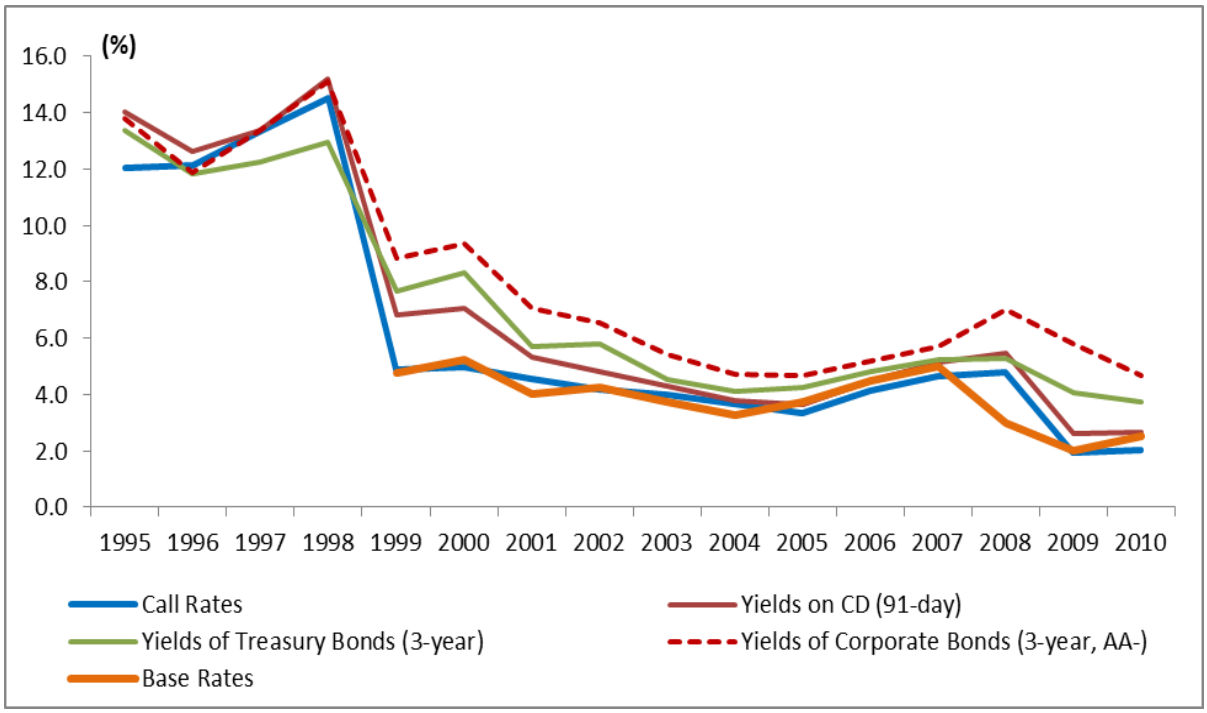


Source: IMF's World Economic Outlook 2012

Appendix 2.2

The Trends in Interest Rates in Korea

Interest rates belong to two categories: market interest rates and the base rate. Market interest rates consist of call rates, yields on CD, yields of treasury bonds and yields of corporate bonds. The Korean government used the call rate as the policy rate from May 1999 to February 2008. Since then, the base rate of the Bank of Korea has been used as the policy rate. Since the mid-1990s, there have been two big economic crises and one monetary policy regime change in Korea: the Asian Financial Crisis in 1997, the Global Financial Crisis in 2008, and a monetary policy regime change from money targeting to inflation targeting in April 1998. During the two economic crises, the Korean government actively implemented monetary policy in order to overcome the crises. According to the Figure, interest rates do not show big fluctuations between 1999 and 2008.



Appendix 3.1

Shock Identification Strategies for Measuring the Effectiveness of Fiscal Policy

Researchers	Shock identification strategy
Ramey and Shapiro (1998) and Edelberg, Eichenbaum, and Fisher (1999)	VAR models with dummy variables specifying certain episodes (such as wars and drastic changes in fiscal stance)
Mountford and Uhlig (2002, 2009)	VAR with sign restrictions on the impulse response functions
Fatás and Mihov (2000), Favero (2002), and De Castro (2004)	SVAR (Cholesky decomposition)
Blanchard and Perotti (2002), Perotti (1999), and Höppner (2002)	SVAR using institutional information and quarter dependence.

The Effectiveness of Fiscal Policy Measured by VAR Approach in Korea

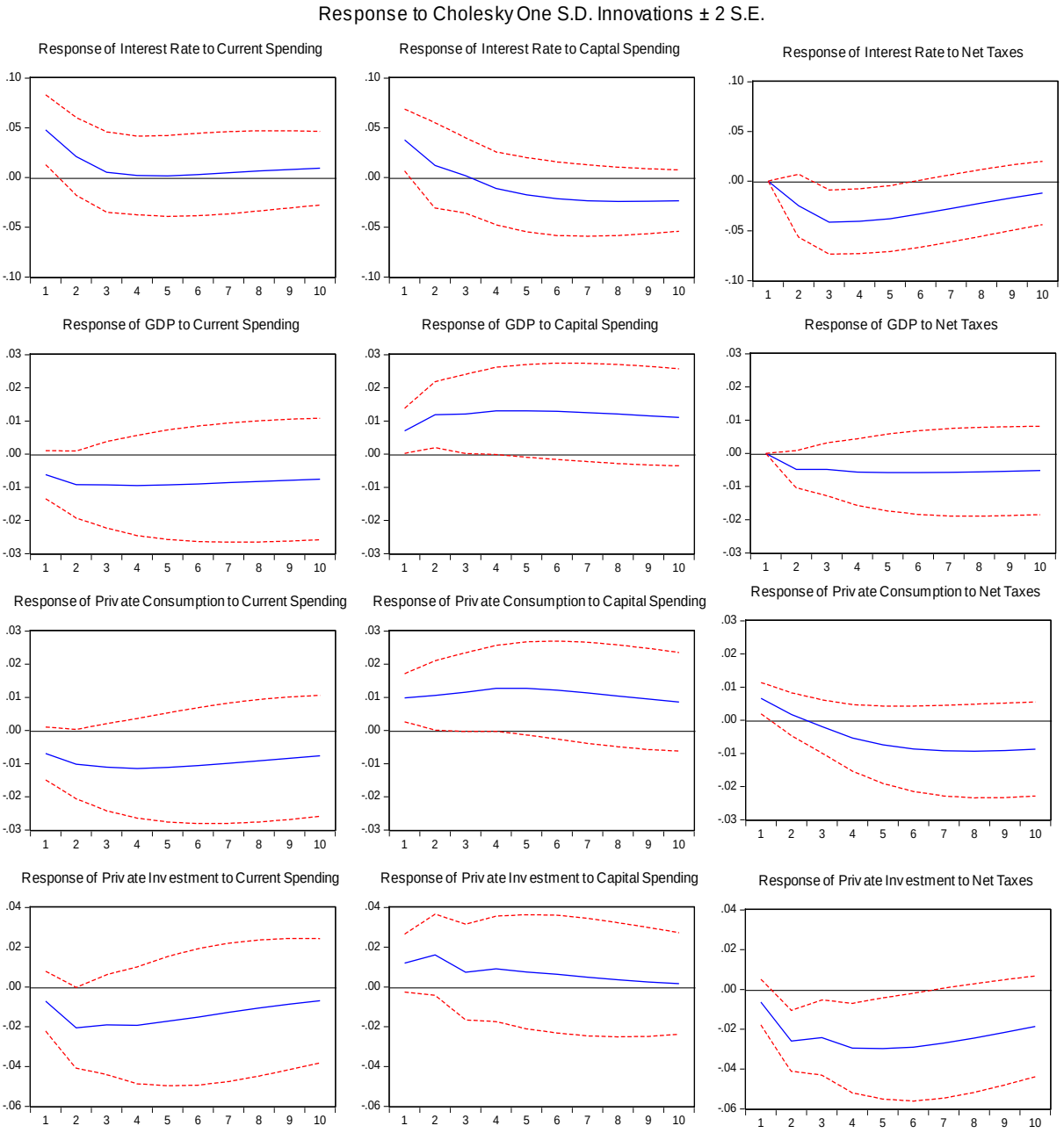
Researchers	Methodology	Results
Park, J. (1995)	Single equation approaches (Feldstein 1982 and Kormendi 1983). VAR (Cholesky decomposition).	Ricardian equivalence hypothesis is not sustained by either of the single equation approaches. An impulse response of private consumption to government expenditure reveals a positive effect over a long time span
Kim, S.(1997)	VAR (Cholesky decomposition). Government expenditure is classified into six sub-groups, and their impacts on consumption, investment, and income are separately estimated.	The impact of government expenditures differs significantly item-by-item. Government investment tends to boost private economic activities, whereas government consumption is likely to crowd them out.

Researchers	Methodology	Results
Park, H., and J. Choi(1997)	VAR with seven variables (Cholesky decomposition). The seven variables are government expenditure, bonds, money stock, interest rate, exchange rate, consumption, and current account balance.	Not able to reject Ricardian equivalence theorem. Insignificant impact of government debt, and spending increase on consumption, interest rate, exchange rate, and current account balance.
Choi, J.(2002)	Estimation of asset demand functions with inclusion of government bonds. Causality analysis of a VAR system.	The government debt doesn't seem to be perceived as net wealth by consumers. Insignificant impact of government debt and the money stock (not high-powered money) on real GDP, nominal GDP, and GDP deflator.
Kim, S.(2003)	SVAR of all the components of national income identity (private consumption, investment, net export, and the remaining sectors) with dummy variable identifying a structural break (Cholesky decomposition). Fiscal variables, such as government consumption, investment, and tax revenues, are given exogenously in the VAR system.	After a currency crisis, the impact of government expenditure on GDP changed signs from (-) to (+) During the same period, the impact of government investment on private investment as well as government consumption on private consumption changed signs from (-) to (+).
Kim, S.(2005)	SVAR of GDP, price (P) and money stock (M) with dummy variables considering a structural break (before and after the currency crisis). Fiscal variables, such as government consumption, investment, and tax revenues, are given exogenously in the VAR system.	Before the currency crisis, an exogenous shock from government expenditure had a negative influence on price and the money stock while it had a positive influence on GDP. After the currency crisis the exogenous government expenditure shock had a negative influence on price and GDP, while it has positive influence on the money stock.
Hur, S.(2007)	SVAR of real GDP, government expenditure, and tax revenue (Cholesky decomposition, institutional information, expenditure within revenue).	The effectiveness of fiscal policy is not significantly identified in Korea, regardless of policy measures such as tax reduction and spending increases, or of methods of identifying shocks. The results are exactly opposite to the generally accepted Keynesian theory.

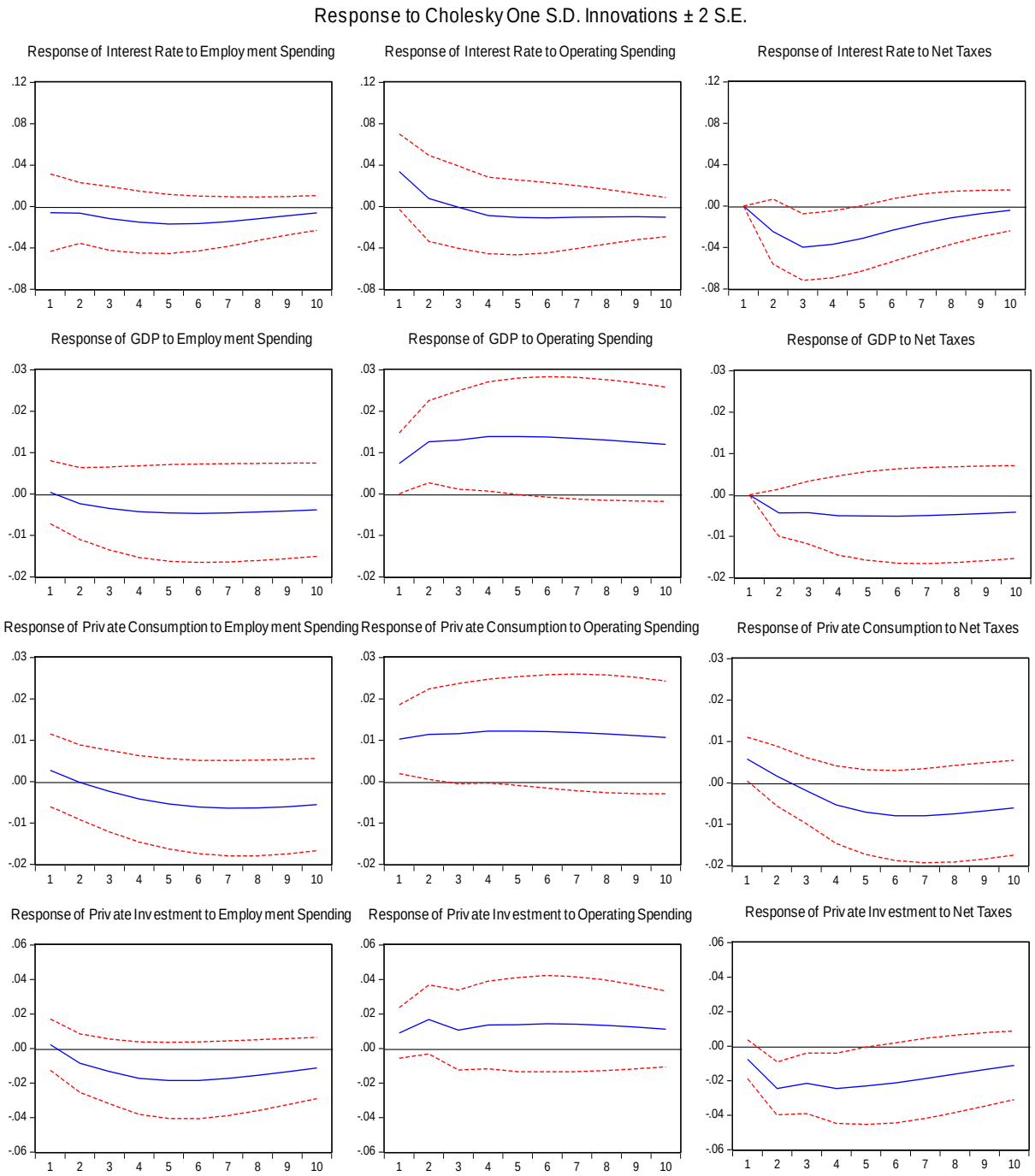
Appendix 3.2

Response of Macroeconomic Variables to Fiscal Policy Shocks

A. The seven-variable VAR model 1: Current government spending, Capital government spending, Net taxes, Interest rate, GDP, Private consumption, Private investment



B. The seven-variable VAR model 2: Government employment spending, Government operating spending, Net taxes, Interest rate, GDP, Private consumption, Private investment



Appendix 5.1

The Various Ways of Measuring the Cyclically Adjusted Primary Balance (CAPB)

The CAPB is calculated by taking the actual primary balance (non-interest government revenue minus non-interest government spending) and subtracting the estimated effect of business cycle fluctuations on fiscal accounts (IMF, 2010). There are three approaches to cyclical adjustment of fiscal variables.

Hodrick–Prescott filter (Hodrick & Prescott, 1980; Kydland & Prescott, 1990). This smoothing approach computes the cyclically adjusted measure (y_t^*) of a variable (y_t) by the following expression:

$$\text{Min}\sum_{t=1}^{T}(y_t - y_t^*)^2 + \lambda \sum_{t=2}^{T-1}((y_{t+1}^* - y_t^*) - (y_t^* - y_{t-1}^*))^2$$

The crucial point in the application of the HP filter is the choice of the weighting factor λ, determining the degree of smoothness. In the case of annual data, λ is set to 100.

Elasticity approach. Cyclically adjusted series are computed on the basis of the elasticity of each budgetary category with regard to the potential or trend output. The approach has been used by the OECD, the IMF and the EC (Giorno *et al*., 1995; Alesina *et al*., 2002). The main criticism of this approach is that the elasticities are assumed to be constant over time. Also, the results depend on the estimates of the potential output, specifically the natural rate of unemployment and the capital stock.

$$\text{Fiscal Impulse} = [(G_t - T_t) - \left(G_{t-1}(1+\hat{y}_t) - -\left(T_{t-1}(1+y_t)\right)\right] / Y_{t-1},$$

where G_t is the total current expenditure plus gross capital accumulation less interest payments, T_t is total revenues, Y_t is the nominal GDP, $\hat{y}_t$ is the growth rate of nominal potential GDP, $y_t$is growth rate of nominal GDP.

Blanchard Fiscal Impulse (BFI). Blanchard (1993) proposes that the discretionary shock should be estimated as the difference between the actual policy and the policy that would prevail under the previous year's growth rate.

$$\text{Fiscal Impulse} = (g_t(U_{t-1}) - t_t) - (g_{t-1} - t_{t-1}),$$

where g_t and t_t represent the GDP ratio of G_t and T_t, respectively; U_t is the unemployment rate.

Alesina & Perotti (1995) employ the methodology and calculate what the tax revenues and transfer payments would have been if the unemployment rate had remained the same as in the previous year, suggesting that the other spending categories move independently of the business cycle. The fiscal impulse is then constructed as the difference between this unemployment-adjusted primary deficit in period *t* and the previous period's structural budget balance. Following the method's principle, only the fiscal impulse for government spending could be calculated. The BFI would be a poor measure if discretionary policy changes were correlated with the unemployment rate and looked as though they were induced by cyclical fluctuations. Additionally, the BFI is not entirely suitable for international comparisons because the unemployment rate is not measured in the same way in different countries (Neicheva, 2006).

Appendix 5.2

Definitions of the Data of Previous Literature

Variable	Adagna (2004)	Alesina and Adagna (2010)	Giudice *et al*. (2007)
Debt	Government gross debt as a share of GDP	Government gross debt as a share of GDP	Government gross debt (% of GDP)
Primary expense	Transfers + government consumption + public investment + subsidies	Cyclically adjusted primary expenditure as a share of GDP = Transfers + ((Government wage expenditure + Government non-wage expenditure + Subsidies + Government investment)/GDP)	
Δprimary expense			Change in primary expense between *t* and *t*-1(% of GDP)
Total deficit		Cyclically adjusted total deficit as a share of GDP = primary deficit + (interest expenses on government debt/GDP)	
Primary deficit or CAPB	Cyclically adjusted primary deficit as a share of GDP = Primary expense-Total revenue	Cyclically adjusted primary deficit as a share of GDP = Primary expense-Total revenue	
ΔCAPB			Average change between *t*+1 and *t*-1 in the cyclically adjusted primary balance (% of GDP)
Primary expense		Cyclically adjusted primary expenditure as a share of GDP	
Total revenue		Cyclically adjusted total revenue as a share of GDP	

Variable	Adagna (2004)	Alesina and Adagna (2010)	Giudice *et al.* (2007)
Curr. G		Cyclically adjusted current expenditure as a share of GDP = Transfers + ((Government wage expenditure + Government non-wage expenditure + Subsidies)/GDP)	
Transfers	Cyclically adjusted transfer as a share of GDP	Cyclically adjusted transfer as a share of GDP	
Government wage expenditure	Government wage consumption	Government wage bill expenditure	
Government non-wage expenditure		Government non-wage bill expenditure	
Subsidies		Subsidies to firms	
Government investment		Gross government consumption on fixed capital	
GDP Growth	Growth rate of real capita GDP	Growth rate of real capita GDP	
OUTGAP			Output gap (% of GDP), simple average at *t* and *t*-1
Trade Balance		Trade balance as a share of GDP = (Exports of goods and services – Imports of goods and services)/GDP	
ΔInterest rate	Short-term interest rate (*t*) – Short-term interest rate (*t*-1)		Average change in the short-run interest rates between *t*+1 and *t*-1
ΔExchange rate	Rate of change of the nominal effective exchange rate		Average percentage change in the exchange rates between *t*+1 and *t*-1
Composition			
Sovereign risk			

Data Sources

Variable	Source
CAPB/GDP	The OECD Economic Outlook Database (NLGXQA)
Real GDP (*GDPVD*)	World Band World Development Indicators (WDI) Database, World Economic Outlook (WEO) Database The OECD Economic Outlook Database
Real Private Consumption (*CPV*)	WDI Database, WEO Database The OECD Economic Outlook Database
Real Private Investment (*IPV*)	WDI Database, WEO Database The OECD Economic Outlook Database
Nominal Effective Exchange Rate (*EXCHEB*)	The OECD Economic Outlook Database
Output Gap (*GAP*)	The OECD Economic Outlook Database
Unemployment Rate (*UNR*)	WDI Database, WEO Database The OECD Economic Outlook Database
Real Effective Exchange Rate	International Financial Statistics (IFS) Database
Long -Term Interest Rate on government bonds (*IRL*)	The OECD Economic Outlook Database
Short-Term Interest Rate (*IRS*)	The OECD Economic Outlook Database
Policy interest rates and 10-year government bond yields	Bloomberg Financial Markets, Thomson Data stream
Institutional Investor Ratings (*IIR*)	Institutional Investor
Government debt-to-GDP ratio	IMF's World Economic Outlook Database

Fiscal Consolidation Episodes (FCE), Based Both on the Change in the CAPB and on the Policy Action-Based Approach of the IMF

Country	IMF(2010)	IMF(2011)	FCE1	FCE2	FCE3
Australia	1980, 1985-88, 1994-99	1985-88, 1994-99	1987-88	1987-88	1987-88
Austria		1980-81, 1984, 1996-97, 2001-02	1997	1984, 1997, 2001, 2005	1984, 1997, 2001, 2005
Belgium	1982-84, 1987, 1990, 1992-99	1982-85, 1987, 1990, 199294, 1996-97	1982-87	1982-85, 1993, 2006	1982-85

Country	IMF(2010)	IMF(2011)	FCE1	FCE2	FCE3
Canada	1980-1999	1984-97	1987, 1996-98	1981, 1986-87, 1996-97	1987, 1996-97
Denmark	1983-86, 1995	1983-86, 1995	1983-87	1983-86	1983-86
Finland	1984, 1988, 1992-2000, 2006-07	1992-97	1976-77, 1997-98, 2000-01	1976-77, 1981, 1984, 1988, 1996-97, 2000-01	1976-77, 1996-97, 2000-01
France	1984, 1986-89, 1991, 1995-98, 2000, 2006-07	1979, 1987, 1989, 1991-92, 1995-97, 1999-2000		-	
Germany	1982-89, 1992-2000, 2003-07	1982-84, 1991-95, 1997-2000, 2003-04, 2006-07		-	
Greece			1991-92, 1994, 1996-99, 2006, 2010	1982, 1986, 1991-92, 1996-98, 2005-06, 2010	1991, 1994, 1996-97, 2006, 2010
Ireland	1982-88, 2009	1982-88, 2009	1976-77, 1983-86, 1988-89, 2010	1976-77, 1983-84, 1988, 2010	1976-77, 1983-84, 1988, 2010
Italy	1992-98, 2004-07	1991-98, 2004-07	1977, 1982-83, 1992-94	1977, 1982-83, 1992-93	1977, 1982-83, 1992-93
Japan	1997, 2003-07	1979-83, 1997-98, 2003-07	1998-2000, 2005-07	1998-99, 2005-06	1999-00, 2006-07
Netherlands		1981-88, 1991-93, 2004-05	1991, 1993	1991, 1993	1991
Portugal	1983, 2000-03, 2005-07	1983, 2000, 2002-03, 2005-07	1977, 1983-84, 1986	1977, 1983-84, 1986, 1988, 1992, 1995, 2006	1977, 1983-84, 1986, 1988, 1992
Spain	1983-89, 1992-98	1983-84, 1989-90, 1992-97	1987	1986, 1987, 2010	1987
Sweden	1983-84, 1986, 1992-97, 2007	1984, 1993-98	1984, 1987, 1996-99	1976, 1983-84, 1987, 1996-97	1984, 1987, 1996-97
UK	1981-82, 1994-99	1979-82, 1994-99	1981-82, 1997-2000	1981, 1997-98, 2000	1981, 1997-98
US	1980-81, 1985-86, 1988, 1990-91, 1993-94, 2000	1978, 1980-81, 1985-86, 1988, 1990-98	-	-	-
Korea	-	-	-	-	-

Notes: based on Afonso and Jalles (2012)

IMF (2010) - measure computed by Leigh *et al*. (2010): so-called policy action-based approach in order to account for consolidation episodes.

IMF (2011) – measure computed by Leigh *et al*. (2011).

FCE1 - measure based on Giavazzi and Pagano (1996): the cumulative change in the cyclically adjusted primary budget balance is at least 5,4, 3 percentage points of GDP in 4, 3,or 2 successive years respectively, or 3 percentage points in one year.

FCE2 - measure based on Alesina and Ardagna (1998): the change in the cyclically adjusted primary budget balance is at least 2 percentage points of GDP in one year or at least 1.5 percentage points on average in the last two years.

FCE3 - measure based on Afonso (2010): A fiscal episode occurs when either the change in the cyclically adjusted primary budget balance is at least one standard deviation on average in the last two years.

Summary of Fiscal Consolidation Episodes (following policy action-based approach of the IMF)

Country	Year	$\Delta ABFC/GDP$	Tax Rise	Spending Cut
AUSTRALIA	1985	0.45	0.00	0.45
AUSTRALIA	1986	1.02	0.17	0.85
AUSTRALIA	1987	0.90	0.19	0.71
AUSTRALIA	1988	0.10	-0.27	0.37
AUSTRALIA	1994	0.25	0.25	0.00
AUSTRALIA	1995	0.50	0.50	0.00
AUSTRALIA	1996	0.62	0.34	0.28
AUSTRALIA	1997	0.70	0.18	0.53
AUSTRALIA	1998	0.37	0.05	0.32
AUSTRALIA	1999	0.04	-0.04	0.07
AUSTRIA	1980	0.80	0.11	0.69
AUSTRIA	1981	1.56	0.50	1.06
AUSTRIA	1984	2.04	1.30	0.74
AUSTRIA	1996	2.41	0.88	1.53
AUSTRIA	1997	1.56	0.44	1.12
AUSTRIA	2001	1.02	0.90	0.12
AUSTRIA	2002	0.55	0.00	0.55
BELGIUM	1982	1.66	0.00	1.66
BELGIUM	1983	1.79	0.69	1.10
BELGIUM	1984	0.69	0.28	0.41
BELGIUM	1985	1.61	0.73	0.88
BELGIUM	1987	2.80	0.00	2.80
BELGIUM	1990	0.60	0.40	0.20
BELGIUM	1992	1.79	0.99	0.80
BELGIUM	1993	0.92	0.43	0.49
BELGIUM	1994	1.15	0.55	0.60
BELGIUM	1996	1.00	0.50	0.50
BELGIUM	1997	0.91	0.41	0.50
CANADA	1984	0.27	0.27	0.00
CANADA	1985	1.03	0.53	0.50
CANADA	1986	0.99	0.84	0.15
CANADA	1987	0.28	0.14	0.14
CANADA	1988	0.30	0.33	-0.03
CANADA	1989	0.31	0.24	0.08

Country	Year	$\Delta ABFC/GDP$	Tax Rise	Spending Cut
CANADA	1990	0.86	0.57	0.29
CANADA	1991	0.40	0.13	0.27
CANADA	1992	0.21	-0.01	0.22
CANADA	1993	0.35	-0.01	0.36
CANADA	1994	0.49	0.04	0.45
CANADA	1995	0.99	0.18	0.81
CANADA	1996	0.97	0.09	0.88
CANADA	1997	0.47	0.01	0.47
DENMARK	1983	2.77	0.92	1.85
DENMARK	1984	2.38	0.67	1.71
DENMARK	1985	1.54	0.77	0.77
DENMARK	1995	0.30	0.30	0.00
FINLAND	1992	0.91	0.00	0.91
FINLAND	1993	3.71	0.00	3.71
FINLAND	1994	3.46	0.69	2.77
FINLAND	1995	1.65	-0.63	2.28
FINLAND	1996	1.47	0.00	1.47
FINLAND	1997	0.23	-0.70	0.93
FRANCE	1979	0.85	0.85	0.00
FRANCE	1987	0.26	-0.50	0.76
FRANCE	1991	0.25	0.00	0.25
FRANCE	1995	0.28	0.43	-0.15
FRANCE	1996	1.33	0.86	0.47
FRANCE	1997	0.50	0.41	0.09
FRANCE	2010	0.94	0.00	0.94
FRANCE	2011	1.34	0.00	1.34
GERMANY	1982	1.18	0.56	0.62
GERMANY	1983	0.87	0.30	0.57
GERMANY	1984	0.18	-0.41	0.59
GERMANY	1991	1.11	1.08	0.03
GERMANY	1992	0.46	0.27	0.19
GERMANY	1993	0.11	-0.07	0.18
GERMANY	1994	0.91	0.08	0.83
GERMANY	1995	1.08	0.84	0.24

Country	Year	$\Delta ABFC/GDP$	Tax Rise	Spending Cut
GERMANY	1997	1.60	0.50	1.10
GERMANY	1999	0.30	0.30	0.00
GERMANY	2000	0.70	-0.05	0.75
GERMANY	2003	0.74	0.74	0.00
GERMANY	2004	0.40	-0.70	1.10
GERMANY	2006	0.50	0.00	0.50
GERMANY	2007	0.90	0.50	0.40
IRELAND	1982	2.80	2.54	0.26
IRELAND	1983	2.50	2.44	0.06
IRELAND	1984	0.29	0.29	0.00
IRELAND	1985	0.12	0.12	0.00
IRELAND	1986	0.74	0.74	0.00
IRELAND	1987	1.65	0.53	1.12
IRELAND	1988	1.95	0.00	1.95
IRELAND	2009	4.74	2.35	2.39
IRELAND	2010	2.50	0.00	2.50
IRELAND	2011	2.20	0.00	2.20
ITALY	1991	2.77	1.69	1.08
ITALY	1992	3.50	1.60	1.90
ITALY	1993	4.49	2.00	2.49
ITALY	1994	1.43	-0.27	1.70
ITALY	1995	4.20	2.41	1.79
ITALY	1996	0.34	-0.74	1.08
ITALY	1997	1.82	0.89	0.93
ITALY	1998	0.68	0.01	0.67
ITALY	2004	1.30	0.67	0.63
ITALY	2005	1.00	0.40	0.60
ITALY	2006	1.39	0.50	0.89
ITALY	2007	1.03	1.32	-0.29
ITALY	2010	0.80	0.00	0.80
ITALY	2011	0.81	0.00	0.81
JAPAN	1979	0.12	0.12	0.00
JAPAN	1980	0.21	0.21	0.00
JAPAN	1981	0.43	0.43	0.00
JAPAN	1982	0.71	0.31	0.40
JAPAN	1983	0.42	0.06	0.37
JAPAN	1997	1.43	0.98	0.45
JAPAN	1998	0.48	0.33	0.15
JAPAN	2003	0.48	0.00	0.48

Country	Year	$\Delta ABFC/GDP$	Tax Rise	Spending Cut
JAPAN	2004	0.64	0.19	0.45
JAPAN	2005	0.28	0.06	0.22
JAPAN	2006	0.72	0.45	0.27
JAPAN	2007	0.15	0.15	0.00
KOREA	1981	0.43	0.00	0.43
KOREA	1982	0.04	0.00	0.04
KOREA	1983	1.56	1.56	0.00
KOREA	1986	0.35	0.35	0.00
KOREA	1987	0.27	0.27	0.00
KOREA	1990	2.58	0.00	2.58
KOREA	1992	1.09	0.00	1.09
KOREA	1995	0.30	0.00	0.30
KOREA	1996	0.19	0.00	0.19
KOREA	2000	2.98	2.98	0.00
KOREA	2001	0.36	0.00	0.36
KOREA	2002	0.50	0.50	0.00
KOREA	2003	0.10	0.10	0.00
KOREA	2004	0.70	0.00	0.70
NETHERLANDS	1981	1.75	0.53	1.22
NETHERLANDS	1982	1.71	0.00	1.71
NETHERLANDS	1983	3.24	0.49	2.75
NETHERLANDS	1984	1.76	0.00	1.76
NETHERLANDS	1985	1.24	0.00	1.24
NETHERLANDS	1986	1.74	0.00	1.74
NETHERLANDS	1987	1.48	1.48	0.00
NETHERLANDS	1988	0.06	-0.69	0.75
NETHERLANDS	1991	0.87	0.87	0.00
NETHERLANDS	1992	0.74	-0.58	1.32
NETHERLANDS	1993	0.12	-0.16	0.28
NETHERLANDS	2004	1.70	0.40	1.30
NETHERLANDS	2005	0.50	0.20	0.30
NETHERLANDS	2010	1.39	0.00	1.39
PORTUGAL	1983	2.30	1.35	0.95
PORTUGAL	2000	0.50	0.00	0.50
PORTUGAL	2002	1.60	1.20	0.40
PORTUGAL	2005	0.60	0.52	0.08
PORTUGAL	2006	1.65	1.10	0.55
PORTUGAL	2007	1.40	0.50	0.90
PORTUGAL	2011	2.50	0.00	2.50

Country	Year	$\Delta ABFC/GDP$	Tax Rise	Spending Cut
SPAIN	1983	1.90	1.90	0.00
SPAIN	1984	1.12	0.37	0.75
SPAIN	1989	1.22	0.98	0.24
SPAIN	1992	0.70	0.30	0.40
SPAIN	1993	1.10	0.80	0.30
SPAIN	1994	1.60	0.00	1.60
SPAIN	1995	0.74	0.00	0.74
SPAIN	1996	1.30	0.20	1.10
SPAIN	1997	1.20	0.10	1.10
SPAIN	2011	3.40	0.00	3.40
SWEDEN	1984	0.90	0.21	0.69
SWEDEN	1993	1.81	0.42	1.39
SWEDEN	1994	0.78	0.19	0.59
SWEDEN	1995	3.50	1.40	2.10
SWEDEN	1996	2.00	0.80	1.20
SWEDEN	1997	1.50	0.60	0.90
SWEDEN	1998	1.00	0.40	0.60
United Kingdom	1979	0.27	-0.45	0.72
United Kingdom	1980	0.08	-0.13	0.21
United Kingdom	1981	1.58	1.43	0.16
United Kingdom	1982	0.53	0.48	0.05
United Kingdom	1994	0.83	0.68	0.15
United Kingdom	1995	0.28	0.23	0.05
United Kingdom	1996	0.30	0.00	0.30
United Kingdom	1997	0.69	0.53	0.16
United Kingdom	1998	0.31	0.30	0.01
United Kingdom	1999	0.21	0.21	0.01
United Kingdom	2010	0.21	0.00	0.21
United Kingdom	2011	0.31	0.00	0.31
United States	1978	0.14	0.14	0.00
United States	1980	0.06	0.06	0.00
United States	1981	0.23	0.23	0.00
United States	1985	0.21	0.21	0.00
United States	1986	0.10	0.10	0.00
United States	1988	0.85	0.39	0.46
United States	1990	0.33	0.26	0.07
United States	1991	0.58	0.29	0.29
United States	1992	0.52	0.24	0.28
United States	1993	0.32	0.08	0.23
United States	1994	0.90	0.40	0.50
United States	1995	0.53	0.20	0.33
United States	1996	0.29	0.08	0.22
United States	1997	0.30	0.06	0.24
United States	1998	0.15	0.00	0.15

Note: All the data are in the form of per cent of GDP

(-) sign means spending increases or tax cuts.

$\Delta ABFC/GDP$ indicates the budgetary effect of fiscal consolidation measured by policy records.

Appendix 5.3

Sensitivity Analysis with Alternative Debt-to-GDP Criteria

In Section 5.3.2, we extend the baseline model by dividing the fiscal consolidation sample into two sub-samples, according to the level of the debt-to-GDP ratio: 90 per cent. However, this threshold, 90 per cent of GDP, is arbitrary to some degree. So, it is necessary to see whether the results are sensitive to changes in the threshold. We change our thresholds variously from 60 per cent to 90 per cent. Table A-1 shows that the results are sensitive to the alternative criteria for the debt-to-GDP ratio. As the threshold gets lower, the negative effects of fiscal consolidation on GDP growth become similar, regardless of sub-samples.

Table A-1 The Effects of Alternative Criteria on GDP Growth

Alternatives / Independent variables	Criteria for the debt-to-GDP ratio			
	Threshold 90 per cent	Threshold 80 per cent	Threshold 70 per cent	Threshold 60 per cent
g_{t-1}	0.1874***	0.1870***	0.1935***	0.1920***
	(0.0629)	(0.0625)	(0.0628)	(0.0630)
g_{t-2}	-0.0836	-0.0870*	-0.0821	-0.0799
	(0.0523)	(0.0526)	(0.0528)	(0.0535)
$abfc\_hd_t$	-0.0457	-0.0619	-0.3532	-0.3204*
	(0.2618)	(0.2548)	(0.2186)	(0.1921)
$abfc\_hd_{t-1}$	-0.4111*	-0.3794*	-0.4257**	-0.4062**
	(0.2219)	(0.2220)	(0.1955)	(0.1773)
$abfc\_hd_{t-2}$	-0.3332	-0.2991	-0.1985	0.0011
	(0.2549)	(0.2516)	(0.2145)	(0.1896)
$abfc\_ld_t$	-0.3856***	-0.4397***	-0.3156**	-0.3690**
	(0.1481)	(0.1499)	(0.1554)	(0.1729)
$abfc\_ld_{t-1}$	-0.3568***	-0.3509**	-0.3467**	-0.3234**
	(0.1376)	(0.1385)	(0.1431)	(0.1571)
$abfc\_ld_{t-2}$	0.2828*	0.2652*	0.3320**	0.2603
	(0.1461)	(0.1472)	(0.1532)	(0.1677)
No. of observations	544			
Instruments for first differences equation	Standard: *D.*(*abfc_hd, labfc_hd, l2abfc_hd abfc_ld, labfc_ld, l2abfc_ld*) GMM-type : *L*(*2/5*).(*L.g L2.g*)			

Notes: 1. The time dummies are included in all equations but are not shown here to save space.
2. ***, ** and * denote the rejection of the null hypothesis at the 1%, 5% and 10% significance levels, respectively.
3. Standard errors in parentheses.

Appendix 5.4

The Role of Perceived Sovereign Risk in Fiscal Consolidation

The role of the perceived sovereign risk in fiscal consolidation can be estimated using GMM estimation. To do this, fiscal consolidations in the baseline model are divided into two types: fiscal consolidations with high (below-median) perceived sovereign risk in the year before fiscal consolidation; and fiscal consolidations with low (above-median) perceived sovereign risk. The following equation is estimated using the GMM method.

$$g_{it} = \sum_{j=1}^{2} \alpha_j g_{i,t-j} + \sum_{p=0}^{2} \beta_{1,p}\, ABFC_{i,t-p}^{HR} + \sum_{p=0}^{2} \beta_{2,p} ABFC_{i,t-p}^{LR} + \gamma_i + \mu_t + v_{it}$$

Based on the results of estimation, we can infer that the fiscal consolidations in time of low sovereign risk periods have significant negative effects on GDP growth, while those in time of high sovereign risk periods have insignificant negative effects on economic activity.

Table A-2 The Results of GMM Estimation Considering Perceived Sovereign Risk

Dependent variable : g				
Independent variables	Coefficient	S.E	z	P>|z|
g_{t-1}	0.1969***	0.0632	3.12	0.002
g_{t-2}	-0.0782	0.0525	-1.49	0.137
$abfc\_hr_t$	-0.2935*	0.1534	-1.91	0.056
$abfc\_hr_{t-1}$	-0.2264	0.1422	-1.59	0.111
$abfc\_hr_{t-2}$	0.1076	0.1493	0.72	0.471
$abfc\_lr_t$	-0.5202**	0.2406	-2.16	0.031
$abfc\_lr_{t-1}$	-0.7017***	0.2179	-3.22	0.001
$abfc\_lr_{t-2}$	0.1168	0.2429	0.69	0.492
No. of observations	544			
Instruments for first differences equation	Standard: *D.*(*abfc_hr, labfc_hr, l2abfc_hr abfc_lr, labfc_lr, l2abfc_lr*) GMM-type: *L*(*2/5*).(*L. g L2. g*)			
Wald test : χ^2(k)	662.91 (8) (*p*-value =0.000)			
Arellano-Bond test for AR(1) in first differences	Z = -7.57 (*p*-value = 0.000)			
Arellano-Bond test for AR(2) in first differences	Z = -1.27 (*p*-value = 0.204)			

Notes: 1. The time dummies are included in all equations but are not shown here to save space.

2. ***, ** and * denote the rejection of the null hypothesis at the 1%, 5% and 10% significance levels, respectively.

Appendix 5.5

Robustness Checks for the Determinants of Successful Fiscal Consolidation

In Section 5.5.3, a fiscal consolidation is defined to be successful if the debt-to-GDP ratio for the three years after the fiscal consolidation is at least 4.5 per cent points below the level observed immediately prior to the fiscal consolidation. This definition is arbitrary. We check whether the alternative definition of a successful fiscal consolidation would change the baseline results. Table A-3 shows that most estimates are similar to the baseline results.

Table A-3 Probit Model with Alternative Definition of Successful Fiscal Consolidation

Dependent variable: *s*	Coefficients of Probit Model			
Independent variables	Baseline (3years after, Debt/GDP is at least 4.5%p lower)	Alternative 1 (3years after, Debt/GDP is at least 3%p lower)	Alternative 2 (2years after, Debt/GDP is at least 1.5%p lower)	Alternative 3 (1year after, Debt/GDP is at least 1%p lower)
g	24.628*	27.316*	12.324	20.277*
$\Delta CAPB$	0.223	0.346	0.102	0.007
EXP	0.765*	0.707*	0.741**	0.462
$OUTGAP$	0.130	0.039	0.076	0.211
$\Delta EXCH$	0.042	0.069	0.033	0.068
ΔINF	0.254	0.224	0.082	0.024
ΔUNR	0.207	0.228	0.243	0.732*
ΔIRL	-0.846**	-0.708**	-0.412*	-0.315
ΔIIR	0.735***	0.679***	0.842***	1.049***
constant	-3.086***	-2.829***	-2.111***	-2.229***
σ_μ	0.759	0.861	0.512	0.375
ρ	0.366	0.426	0.208	0.123
Log likelihood	-45.15	-51.96	-56.91	-50.54
Wald test for all regressors(χ^2 (9))	19.53**	20.20**	26.20***	23.74***
LR test for $\rho = 0$ (χ^2 (1))	1.83*	2.44*	2.12*	0.96
Observations	161	161	161	161

Notes: 1. A rise in the average change of exchange rate ($\Delta EXCH$) indicates an appreciation of the Korean won.
2. ***, ** and * denote the rejection of the null hypothesis at the 1%, 5% and 10% significance levels, respectively.

Appendix 5.6

The Results of the two-stage least-squares first-differenced estimator (FD2SLS)

The results of 2SLS model are quite similar to those of dynamic panel data difference GMM.

Table A-4 The Results of the FD2SLS and Dynamic Panel Data Difference GMM

Dependent variable : g	FD2SLS	Dynamic Panel Data Difference GMM	
Independent variables	Anderson-Hsiao's Coefficient	Arellano-Bond's Coefficient	Roodman's Coefficient
g_{t-1}	0.3069** (0.040)	0.3209*** (0.000)	0.1969*** (0.001)
g_{t-2}	-0.1665*** (0.011)	-0.1182* (0.061)	-0.0793 (0.119)
$abfc_t$	-0.3608** (0.020)	-0.2210* (0.098)	-0.3377*** (0.007)
$abfc_{t-1}$	-0.2609* (0.095)	-0.2520** (0.045)	-0.3424*** (0.003)
$abfc_{t-2}$	0.2191 (0.140)	0.2560 (0.101)	0.1608 (0.189)
No. of observations	490	543	543
Instruments for first differences equation	*abfc, labfc, l2abfc, L(2/5). g*	Standard: *D.*(*abfc, labfc, l2abfc*) GMM-type : *L*(2/5).*g*	Standard: *D.*(*abfc, labfc, l2abfc*) GMM-type : *L*(2/5).(*L.g L2.g*)
Wald test : χ^2(k)	407.44 (5) (0.000)	628.21 (5) (0.000)	603.38 (5) (0.000)

Notes: 1. The time dummies are included in all equations but are not shown here to save space.

2. ***, ** and * denote the rejection of the null hypothesis at the 1%, 5% and 10% significance levels, respectively.

3. *p*-values are in parentheses.

4. The Wald statistic is a test of the joint significance of the independent variables asymptotically distributed as χ_k^2 under the null of no relationship, where *k* is the number of coefficients estimated (excluding time dummies).