Investigating the Impacts of Macroeconomic Shocks on the Economy: A Sign-Restriction Approach

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To My Wonderful Mom and Dad

Abstract

We investigate the effects of different sets of shocks on different economies in this thesis. First we study "contractionary" monetary shocks by imposing sign restrictions on the impulse responses of macroeconomic variables for 6 different economies namely Japan, UK and the US as well as Malaysia, Mexico and South Korea. We show that i) the effect of an adverse monetary policy shock on industrial production is ambiguous; ii) there is price puzzle for Japan and UK which we conjecture as an outcome of excessive bank lending and poor regulation but not of passive monetary policy; iii) there is delayed overshooting puzzle for Japan and the exchange rate puzzle for the UK and the US. For the case of developing countries, we find evidence of delayed overshooting of the exchange rate and evidence of price puzzle for Mexico. This thesis also compares the dynamic effect of fiscal policy on macroeconomic variables implied by a substantial class of DSGE models with the empirical results from imposing sign restriction for Italy and the UK. We observe that private consumption and output increase after an "expansionary" spending shock. This is in a sharp contrast with neoclassical theories such as real business cycle (RBC) model that presumes consumers behave in Ricardian manner. A "contractionary" fiscal policy, whether it is revenue or an expenditure shock, induce a recessionary impact on the economy. Therefore while we find support for the conventional Keynesian models, RBC and some variants of this model are naive to explain the behavior of private consumption and wages after a fiscal policy shock. Finally in this thesis we attempt to shed new light on the dynamic impacts of government spending and technology shocks on the real exchange rate for the Euro area. The main idea under this identification scheme is to let the data speak about the behaviour of the interested variables. Moreover, this thesis investigates the impacts of fiscal policy and technology shock jointly in contrast to most of the literature which just focuses on one shock only. Our investigation suggest that the real exchange rate appreciates (falls) following an expansionary fiscal shock. It appreciates in response to a positive technology shock as well however after an on impact depreciation (increase) which lasts for 8 quarters.

Key words: Exchange rate puzzles, Government spending shocks, Technology shocks, DSGE model, Sign restrictions, Monetary shocks, Business cycles, Vector auto-regression, Fiscal Shocks

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Introduction

Modern economies experience considerable short-run fluctuations in their main economic indicators. Recognizing the sources of these extensive fluctuations is the main goal of the macroeconomic research agenda. There is a large body of literature, indeed, dedicated to introducing a theory that is able to interpret these fluctuations. This thesis, likewise, is devoted to shedding some light on the facts behind macroeconomic dynamics by investigating the behavior of the economy following different shocks.

Moreover, economics is referred to as a "science" and is based on objective analysis. Milton Friedman (1953) argues that (positive) economics in essence should be independent of any ethical positions and normative judgments. To study any science, including economics, there are two methods to employ: first, the researcher might choose to go from theory to data (i.e. deductive approach), and second s/he can let the data speak and afterwards determine theories that could reflect this data, (i.e. inductive approach). This thesis scrutinizes the data to find the benchmark theory that is able to interpret the macroeconomic movements more concretely. In the first two chapters, no specific theory is applied per se to generate the sign-restrictions. In the third chapter, however, the implications of the RBC model are utilized to obtain the sign-restrictions for technology shock.

In monetary policy literature for instance, to understand the impacts of contractionary monetary shock, researchers often examine all the past data, since it affects the current monetary policy choices (Leeper, Sims and Zha 1996). They also consider contemporaneous data since central banks might use that in making decisions about monetary policy. If central banks therefore increase the interest rate unexpectedly, the data usually demonstrates that inflation as well as reserves will decline respectively. Empirically speaking, if one just chooses these reactions, as the only identifying restrictions, real GDP shows an ambiguous reaction to a contractionary shock. However, most central banks believe that a contractionary monetary policy will reduce real output. Yet, the controversy is, what is the process by which central banks have achieved these further assumptions in identifying a contractionary monetary shock? This fits a certain truth that economists want their results to fit with their prior theorizing. Therefore, there is a danger that economists get stuck in obtaining the same results as a result of imposing restrictive priors on their models. The objective of this thesis, therefore, is to impose as few restrictions as possible in identifying the shocks.

This thesis initially studies monetary policy in developed and developing countries, since in the majority of the countries today, short-term stabilization is mainly done by monetary policy. The theories explaining monetary policy assume that the central bank has the power to set the interest rate according to the Taylor rule. The only exception is if the rule imposes a negative nominal interest rate, because the nominal rate cannot fall below zero[1]. Central bankers were largely credible in the past and they were in charge of financial and monetary stability. However, after the current financial crisis in 2008 with the massive quantitative easing and expansionary monetary policies, central banks experience a circumstance that no central bank has experienced before. According to Goodhart et al. (2012), from a traditional point of view, the central banks today are indeed increasing uncertainty by running quantitative easing packages. He therefore argues that it is very important to review the implementation of the monetary policy and its role in the economy over time.

The short-term nominal interest rate in some countries such as United States was however, close to zero during the 1930s. Japan also experienced a virtually near zero percent interest rate on short-term government bonds during the 1990s. Furthermore, the Federal Reserve more recently lowered the short-term nominal interest rate not really much higher than zero. The question here is that how monetary policy, if at all, can affect the economy when nominal interest rate is very close to zero. One possible solution is to use fiscal policy instead of monetary policy when short-term interest rate is in its zero lower bound. A second possibility is to conduct "open market operation". Even though it cannot lower the nominal rate when it is already zero, they may be able to decrease the real interest rate. C.Romer (1992) argues that the rapid growth in money stock in United States in the middle of the 1930s increased inflationary expectations, simulated interest-sensitive sectors of the economy, and caused the economy to bounce back from the great depression. The issue of whether or not expansionary monetary policy with a zero nominal rate increases expected inflation is complicated. When nominal interest rate is nearly zero percent, the economic agents are reluctant to use the liquidity services that are provided by money. Therefore, when the central bank increases stock of money by open market operation, economic agents can merely hold the additional money in place of the bonds. It is not really obvious why inflationary expectations of the individuals have to rise[2].

The second chapter of this thesis studies the effectiveness of the different kinds of fiscal policy shocks. The third chapter focuses on the the effects of the technology shock

[1]This implies that if high-powered money obtains a nominal return of zero, there would be no reason for any economic agent to purchase an asset that offers a negative real interest rate.

[2]Goodhart et al. (2012b) criticize the massive recent quantitative easing packages that has happened in the UK, EU and the US. They argue that:" reducing the official long-run risk-free interest rates on treasury bonds by few further bases points is of second order importance since we are already at historically low level". They add that: " what really matters is not the yield curve of the official risk-less rate but rather the high credit risk premium in weaker banks, both in stronger and weaker countries".

as well as fiscal policy shocks simultaneously. Regarding to the impacts of fiscal policy on economic activities, studies show that the US government has faced large budget deficits since the very early 1980s. Moreover, as a result of aging issues in the US, it seems like there are going to be more retiree than people who are willing to work in coming decades. If there is not any change in the policy related to governing these issues, the resulting boost in health care and security expenses are going to push the deficit even higher over the coming years. This concern is being discussed recently in the US in the name of “fiscal cliff”. Many other industrialized countries, as well, run considerably large budget deficit and face long-run budgetary problems. That is the reason why it is important to study the impact of fiscal policies. It is always assumed that long and consistent budget deficit reduce growth, and that they lead to some type of crisis in the economy. The other important issue in studying of fiscal policy is to understand the impacts of government's choice between taxes and bonds. The *Ricardian equivalence model* that is the benchmark model in this regard, assumes that the household budget constraints can be expressed in terms of the present value of government purchases without any need to distinguish if they are financed through taxes or bonds. Additionally, it is reasonable to presume that taxes do not affect households preferences directly. Furthermore, since the path of taxes does affect either households utilities nor preferences, it does not have any impact on their consumption. Similarly, it is not taxes but government purchases that affect the accumulation of investment at each point of time. The key result here therefore is that it is merely the value of government purchases and not the way they have been financed that has an impact on the economy[3]. This irrelevance of the way government choose to finance their expenditures is called “Ricardian equivalence between debt and taxes”.

The performance of Ricardian equivalence is closely related to the issue of whether the permanent-income hypothesis is robust enough to explain the consumption behaviour of individuals. In the permanent-income model, we assume that merely an economic agents lifetime budget constraint has an impact on its behaviour. This means that the time path of individuals after-tax income does not matter. For example, a bond which is issued today and will be repaid by future taxes result in changes in the path of after-tax income without having any impact on the lifetime budget constraint. In this condition, if the permanent-income hypothesis is the good approximation of the consumption behaviour of economic individuals, Ricardian equivalence hypothesis can also describe the economic soundly. The assumptions that lead to Ricardian equivalence also imply that a tax cut increases expectations of the present value of future tax expenditures by precisely the amount of the cut. Therefore the households consumption remains unaffected since their lifetime resources does not change. In this situation, when there is an endogenous government

[3] Government purchases can be financed through either bonds or taxes.

expenditure, a tax cut increases expectations of the future tax imbursements by less than the value of the tax cut, and therefore consumption increases. The role of expectations increases the likelihood that there are occasions in which, an increase in the rate of taxes or a decrease in government expenditure increases the overall demand of good and services in the economy[4].

Regarding to the importance of the technology shock, RBC model basically provides an example of an economy where real shocks drive output fluctuations. Assuming that the economy is Walrasian, the responses to the shocks are optimal. Therefore, here fluctuations in the economy are not the byproduct of market failure, and government interventions to tackle them merely reduce welfare. This model also predicts that the fluctuations of output are largely determined by the persistence of the technology shocks[5]. The Real-business-cycle model, indeed, recognizes disturbances in technology as the main source of macroeconomic fluctuations. By assumption, the impacts on the level of technology eliminates gradually. The net outcome of the improvements in the level of technology is that output rises in the period of the shock and then slowly goes back to normal. Consumption responds less significantly and also more sluggishly than output; therefore investment is more volatile than consumption after a technology shock.

As the remaining of this introduction, we discuss the questions and the findings of each chapter about the sources of these fluctuations. The first chapter of this thesis considers monetary policy in developed and developing countries, and the following chapters study fiscal policy and technology shocks.

1.1 Monetary Policy and Macroeconomics

Monetary economists scrutinize the behaviour of prices, monetary aggregates, interest rates and output while the fundamental theoretical and empirical issue centers on understanding whether money and monetary policy have any impact on real economic activity. In their analysis, empirical monetary economists often resort to using a vector autoregressive (VAR) framework, developed by Sims (1980), as a toolkit both to describe and understand the behavior of the data as well as to conduct policy experiments while they scrutinize the impact of monetary policy on real economic activity. To that end empirical researchers have been particularly interested in investigating the validity of the benchmark theories focusing on the impact of monetary policy shocks that lead to economic

[4]These possibilities has been confirmed by Giavazzi and Pagano (1990) in their study of Denmark and Ireland during 1980s.

[5]One of the shortcomings of this model is that the saving rate is assumed to be constant and not time-varying. Therefore, investment and consumption are equally volatile and labour supply does not change. In practice, however, investment in most cases changes more than consumption, and employment, real wages and hours is significantly pro-cyclical. This means that the latter variables vary in the same direction as aggregate output.

fluctuations.

The fashionableness of VAR models is probability as a result of the possibility to use these models to validate DSGE models imposing sign restrictions. Therefore, extracting meaningful results from a reduced form VAR is a difficult task and requires cross-equation restrictions which should be credible and uncontroversial. In this thesis, taking into account the developments in the field, we investigate the impact of monetary shocks for several (developed and developing) countries considering a Bayesian structural VAR model as suggested by Uhlig (2005) and Mountford and Uhlig (2009). This methodology identifies structural monetary shocks by imposing a small number of sign restrictions for a few periods on the impulse responses to a monetary policy innovation to avoid some of the identification problems that arise in the traditional structural VAR models. In particular, we impose no restrictions on the responses of the key variables of interest, industrial production and exchange rate, to monetary policy shocks to let the data speak as we concentrate on data for six countries; three of which are developed economies namely UK, US, Japan and the other three are emerging countries including Mexico, Malaysia and South Korea

It is worth stressing at this point that although most of the results in the VAR literature are consistent with the economic theory, Sims (1992) using a recursive identification approach observed a positive relationship between prices and interest rate. Eichengreen (1992) named this anomaly as a price puzzle. Sims (1992) argues that the price puzzle is possibly an artifact of the omitted variables problem. In other words, because the central bank has more information concerning expected inflation than a researcher can incorporate in a VAR model, the finding that the interest rate rises in response to expected high inflation can only be explained due to the omission of a fundamental variable from the model. Recently, Castelnuovo and Surico (2009) show that the price puzzle is the by-product of a passive monetary policy with respect to inflation. More concretely, if a central bank accommodates instead of fighting inflation, such a passive policy will generate indeterminate multiple equilibria and expectations become self-fulfilling. Thus, high inflationary expectation will be fulfilled by a passive monetary policy leading to expectation for even higher inflation. This implies that the argument of Sims (1992) is correct only when monetary policy is passive. However, the price puzzle could as well be an artifact of poor identification problem of the VAR structure or structural breaks in the data.

Our empirical findings can be summarized as follows. Following a “contractionary” monetary policy shock, the real industrial production increases slightly in the US and in the UK. In contrast, in Japan, the response of real GDP to the shock is negative; however, this response is small and negligible. When we turn to developing countries, we find that the size of the response of real GDP to the shock is not different from that in developed countries and it is small. These findings are similar to that in Uhlig (2005) who find that contractionary monetary policy shocks do not necessarily lead to a fall on real GDP. Although the response of prices is tainted due to the sign restriction, it is interesting to note that we do not observe the price puzzle for the set of countries we carry this investigation. Exception to this observation is Mexico where there is evidence of a price puzzle which we later show that this anomaly is an outcome of the 1994 crises.

1.2 Macroeconomy After Different Kinds of Fiscal Polies

One shortcoming of the literature is that compared to a large body of research which study monetary policy shock, fiscal policy has not attracted enough attention in the literature. On that ground, it is inconsistent with lengthy public debates on the impacts of fiscal policy which strengthen the arguments about the importance of government spending and taxation. All the discussion about the Balanced Budget Amendment in the US or having independent organizations to implement fiscal policy in EU emphasize that fiscal policy is an effective way in smoothing out the business cycles variations. Furthermore, there is not a single economic theory which is universally applied to explain the impacts of fiscal policy on key economic variables. For that purpose, researchers have been particularly eager to systematically observe the validity of the benchmark theories focusing on the effect of various sorts of fiscal policy shocks on the macroeconomy. We believe that this is a very important deficiency in the literature. Therefore, one of the objectives of this thesis is to examine which theory explains the economy.

We focus on the behavior of private consumption and wages in this thesis. The reason is that different theories predict very dissimilar reaction of these two variables after a fiscal policy shock. Put it differently, even though most theories suggest that an expansionary government expenditure increases output, the behaviors of wages and private consumption are obscure. For instance, the classical IS-LM model predicts that after an increase in government expenditure, private consumption grows as a result. Real business cycle (RBC) model, on the other hand, shows consumption falls as a consequence of negative wealth effect after the similar shock. While it is mostly agreed that an expansionary government expenditure increases output, different theories suggest a different response of wages and consumer prices. The classic IS-LM model predicts that after an increase in government expenditure, there will be an expansion in private consumption. RBC model, on the other hand, shows that consumption will fall as a result of negative wealth effect. As private consumption is the main determinant of the aggregate demand, we put it as the center of attention. The impact of fiscal policy on wages, as well, is a controversial issue in the literature. The purpose in this thesis$_{\text{paper}}$, therefore, is to investigate the comparability of these two benchmark theories.

We apply the new identification scheme for vector autoregressive (VAR) approach for two chief European countries namely UK and Italy. Studying the effects of fiscal policy on European economies seems to become a hot topic recently since a large body of literature about fiscal policy is focused on the US. Furthermore, after the recent financial crisis, UK and Italy apply large cuts in different sectors of the economy which lead to different demonstrations and protests from people who are going to be affected by these tight fiscal policies. Therefore, we find it worthwhile to see what will be the impact of these changes for 6 coming years after such shocks happens.

To summarize our results, we find that an expansionary government spending shock will cause a remarkable increase in private consumption and wages. Thus, our empirical results seems to be in line with the conclusions of the models in which consumers behave in a non-Ricardian manner and are hard to reconcile with those of the neoclassical theories such as RBC model.

1.3 Fiscal Policy and Technology Shock

The reaction of the real exchange rate after government spending and technology shocks across OECD countries show significant and systematic inconsistencies from standard theories. On the other hand, it is important to have a comprehensive idea of the behaviour of the exchange rate to understand the mechanism behind exchange rate fluctuations. In general, it seems like current studies cannot support the predictions of both Mundell-Fleming type and intertemporal business cycle models under standard assumptions. Theoretically speaking, inflation increases after an expansionary government spending shock since these shocks result in higher total demand for domestic goods. Technology shock, however, decrease relative prices as a result of an increase in supply of domestic goods.

Recent literature delivers numerical evaluations of the impacts of an expansionary government spending on exchange rate mostly for the Unites States. These findings help to understand the proper size and timing of countercyclical fiscal policy measures and are important for policy making. Having said that, the observed results on this fundamental question tend to bring contradictory answers up to this time. Besides, most findings concerning the effect of fiscal policy in addition to technology shock on exchange rate are done for the U.S. and Euro Area appears not to attract enough attention in this regard.

An expansionary fiscal policy in theory would deteriorate current account and as a result appreciates the real exchange rate. After technology shocks the direction and the size of the reactions of key economic indicators for example hours worked, employment and exchange rate are controversial.

These disagreements appear to stem from the Real Business Cycle (RBC) model. The focal assumptions of the DSGE models that are founded in RBC theory are that prices are flexible and firms are optimizing agents. In the textbook collaboration of the RBC model, productivity gains shocks amends demand for labour and increase together per capita hours worked and output. As a result, it decreases the relative price of domestic goods. These predictions have little support empirically, however.

The aim of this chapter is to re-examine the dynamic reaction of exchange rate employing a new identification scheme putting forward by Enders et al.(2011) to identify fiscal shocks and productivity gains at the same time within an estimated VAR model. Essentially, they engage DSGE model in order to determine the sign and also the time horizons of the identification restrictions. The credibility of these identification collaborations chiefly depends on the theoretical framework that has been chosen. This model is fully identified and endures robust predictions of the reaction of several key variables, it leaves exchange rate behavior unrestricted following an expansionary government expenditure and productivity gain. Furthermore, we re-examine this issue for the Euro Area since the impacts of these two shocks is less empirically investigated in the EU compared to the U.S.

The VAR model we employ for this chapter uses data on quarterly frequencies for the Euro Area relative to the US for post-Bretton-Woods period but before the current financial crisis. The integrated variables in this model are namely consumption, output, investment, government spending, government budget balance, inflation, the short term interest rate and exchange rate. The findings here illustrate that exchange rate appreciates (falls) following an expansionary fiscal policy in the EU. On the other hand, after a positive technology shock, exchange rate appreciates for the whole period after an on impact depreciation (increase). In general, although we employ an identification scheme that is not often used in the study of fiscal policy, the empirical estimations are effectively in line with the existing literature concerning these issues. One therefore, can conclude that the facts behind the exchange rate dynamics that are widely used across different identification schemes are in particular appropriate to examine theories of the international transmission mechanism.

Theoretical Framework

Solution of DSGE Model

This section summarizes the theories of the business cycle, which are the theoretical background of our empirical analysis. It also briefly explains how these models contradict each other.

1.1 Real Business Cycle Model

RBC model delivers the benchmark framework for the analysis of the macroeconomic fluctuations following the seminal works by Kydland and Prescott (1982) and Prescott (1986). Its specifications are also broadly used in the dynamic stochastic general equilibrium (DSGE) framework. Moreover, rational expectation hypothesis (REH) has been developed within the RBC framework, based on the assumptions about rationality and human behavior. The most important aspects of the RBC theory are grounded in three basic factors: the efficiency of the business cycle, the significance of technology shocks as the main foundation of economic fluctuations and the narrow role of monetary factors.

RBC theory is very popular among macroeconomists even though it is not as attractive for policy makers. Central bankers prefer to employ other macroeconomic models, although their effectiveness has been critically questioned by macroeconomists such as Lucas (1976). Cooley and Hansen (1989) try to integrate the monetary sector in a conventional RBC model with the assumptions of fully competitive and frictionless markets. This model is called the "classical monetary model" and implies the neutrality of monetary policy. These results are not desirable for most central bankers who think that their policies have an impact on the real sectors of the economy, at least for a short period of time. These models' policy implication is that monetary authorities have to maintain the short term nominal rates at a constant and equal to zero[6]. The monetary authorities in the real world, however, change interest rates to soothe the deviations of the inflation and other main indicators from their target value. This gap between theory and the practice of monetary policy implies that there should be some missing aspects within the current economic models. These shortcomings are indeed the main motivation behind some of the post-Keynesian assumptions[7].

The RBC model, similar to any macroeconomic theory, is concerned with the sources and the nature of macroeconomic fluctuations. The assumptions in this model are comparable to most similar models[8]. The economy contains a large number of similar, price-

[6] This is known as the "Friedman Rule".

[7] New Keynesian models keep the RBC as one of the underlying structures while adding some new assumptions.

[8] The model is a discrete-time variation of the Ramsey growth model.

taking firms as well as households. Households exists for an indefinite period. There are three different kinds of input for production by firms: labor, capital and technology. The components of output are consumption, investment and government spending. Government spending is financed by lump-sum taxes[9]. The last assumption is about the two driving forces in the model namely technology and government spending. The model, furthermore, assumes that in the absence of other kinds of shocks, GDP growth rate directly depends on the rate of technological progress. Technology, after all, is determined by random disturbances. Similar assumptions hold for government spending: the growth rate of government spending follows the growth rate of technology shock. Two main contributions to this model are the inclusion of leisure and the introduction of randomness in technology and government spending. Furthermore, RBC solves the household's optimization problem by assuming that consumers are uncertain about rate of returns and future wages. Uncertainty, furthermore, leads households not to follow a predictable pattern in their consumption behavior. Instead, their behavior largely depends on the shocks in technology and government spending that has occurred up to that date.

In order to solve the problem of the RBC model, the model was changed in two respects: first, the role of government is excluded and second, 100 percent depreciation of capital is assumed in each period. We justify the exclusion of government in order to isolate the impacts of shocks in technology. The model shows that an increase in technological progress increases the current wage relative to the expected future wage, and results in increased supply of labor. However, increase in saving reduces the expected future interest rates that will reduce labor supply in return. This model basically provides an example of an economy where real shocks derive from output fluctuations. Assuming that the economy is Walrasian, its response to the shocks is optimal. Therefore, fluctuations in the economy are not the byproduct of market failure, and government interventions merely reduce welfare. The real-business-cycle theory implies that the dynamics in aggregate output show the time-varying Pareto optimum. This model also predicts that the fluctuations of output are considerably determined by the persistence of technology shocks. Transitory technology shock in the RBC framework, however, cannot count for significant long-lasting output movements. One of the shortcomings of this model is that the saving rate is assumed to be constant and not time-varying. Therefore, investment and consumption are equally volatile and the labor supply does not change. In practice, however, investment is most of the time, more volatile than consumption. Employment, real wage and hours also are significantly pro-cyclical (See Kollmann et al, (2010)). This implies that the latter variables fluctuate in the same direction as aggregate output.

[9] As in the Ramsey model, there is no difference between the impact of debt or tax finance on the outcome of the model.

The Real-business-cycle model, therefore, recognizes disturbances in the technology as the main source of macroeconomic fluctuations. It s assumed that improvements in the level of technology eliminates gradually. Therefore, output rises in the period of the shock and then slowly goes back to its baseline level. The RBC model implies that the majority of the fluctuations in the industrialized countries are indeed the optimum reaction of the economy to the exogenous fluctuations in the real forces (most significantly changes in technology). It also assumes that we have perfect competition and a frictionless market in the economy. Accordingly, cyclical variations do not necessarily mean the inefficient allocation of resources and hence, stabilization policies may not be needed at all. Therefore, fluctuations in total factor productivity are supposed to be the only driving force behind the business cycle. This is, however, in contrast to the traditional theories of technology shock. These models assume that technology shock is the source of the long-run economic growth and is uncorrelated with the business cycle. More significantly, RBC theory leaves out the monetary factors in its analysis of the economy. After a government expenditure shock, this model assumes that consumption falls and labor input increases as a result of its negative "wealth effect"[10].

However, there are several criticisms to the basic real-business-cycle model predictions. The first critique concerns technology shocks. There is significant evidence that short-term changes in the Solow residual echoes more than variations in the speed of technological progress[11]. Hall (1988) demonstrates that the dynamics in the Solow residual are closely related to external factors such as the political party of the president, variations in military expenditures, and changes in oil prices. However, none of these variables appear to influence technology considerably in the short-term. These findings show that changes in the Solow residual may not be a good measure of technology innovations. Different factors, therefore, determine output growth and it seems that output growth is not necessarily reproduced from a positive technology shock. The second critique of the model concerns the exclusion of monetary disturbances. A key aspect of this model is that it associates the fluctuations in output just with real shocks rather than monetary shocks. However, there is a strong set of evidence that monetary shocks can affect the economy considerably. It is indeed argued that monetary policy can have *real* impacts on the economy as a result of sluggish prices and wages.

1.2 Basic Keynesian Model

The second important theory of macroeconomic fluctuations is called Traditional-Keynesian theory. This model is based on the assumption that there are some barriers to the on-

[10] Since these changes in government purchases are not permanent, agents react by reducing their capital possessions.

[11] See for instance Bernanke and Parkinson (1991)

impact adjustment of nominal prices and wages. These sluggish nominal adjustments lead to aggregate demand fluctuation at the given price level. Thus, it causes monetary disturbances, that merely affect the demand side of the economy, to affect employment and output. Moreover, in most empirical studies, the exchange rate and international trade have a significant role in short-run fluctuations[12]. An increase in the exchange rate implies that foreign currency becomes more expensive and domestic currency depreciates. The basic assumptions about capital flows are that there are no restrictions on "capital mobility" and that investors are risk-neutral[13]. The assumption about the exchange rate expectation is that investors do not expect the "real" exchange rate to change. If we assume that the exchange rate is floating and then add robust restrictions on the behavior of the price level and output, it turns out that there are variations in the exchange rate that are fairly predictable. When expectations about the real exchange dynamics are not static, perfect capital mobility no longer implies that domestic and foreign interest rates are identical. Indeed, traditional Keynesian theories state that under perfect capital mobility, interest rate disparities have to be offset by expectations of exchange rate dynamics. This means that the domestic real interest rate can be higher than the foreign real interest rate only if the domestic currency depreciates by this difference in interest rates. This is called "uncovered interest rate parity".

This correlation between expected exchange rate dynamics and interest rate disparities leads to the "exchange rate over-shooting" that is put forward by Dornbusch (1976). Overshooting basically means that on-impact reaction of a variable to a shock is larger than its long-run response. The interest rate disparity assumption suggests that the nominal exchange rate is prone to overshoot in response to a monetary shock. For instance, suppose that initially domestic and foreign real interest rates are equal and therefore nominal exchange rate is not expected to change. Then the central bank employs a more expansionary monetary policy by targeting a lower interest rate for a given level of output and inflation. We know that this means an increase in the supply of money. Keynesian models in general argue that monetary interventions do not have any real impact in the long-term. Therefore, the long-term outcome of an expansionary monetary policy is an increase in both price level and the exchange rate.

In the short-run, an expansionary monetary policy is assumed to reduce the domestic nominal interest rate. Investors, therefore, only hold more domestic assets if they expect that domestic currency is going to appreciate. However, this implies that the domestic currency is now cheaper than its long-term value and hence it has to appreciate so much

[12] The nominal exchange rate here is defined as the price of a unit of foreign currency in terms of domestic currency.

[13] This is called "perfect capital mobility".

on impact that it overshoots its expected long-term value.

1.3 The New-Keynesian Model

During the late 1970s economists did not follow the Keynesian model anymore and classical theories were dominant in the literature. Fischer (1977) and Phelps and Taylor (1977), however, form a new strand of thinking within the Keynesian framework by taking into account the microeconomic foundations of wage and price rigidities. This new theory is called the "new-Keynesian" model. The new-Keynesian model's goal is to explain why the dynamics in price level are inconsistent with nominal output fluctuations. This is referred to as "price stickiness" and suggests that real output cannot be chosen by individual households and firms but rather is part of the residual. New-Keynesian economics concerns the decisions of monopolistic competitive firms that determine their individual prices. The firms are also constrained by their sales level. This is in contrast to the new-classical models in which competitive price-taking firms determine the level of output. According to the new-Keynesian model, however, price and wage rigidities are the consequence of the microeconomic factors such as the level of technology, imperfect information, imperfect capital market and etc. These factors take away any motivation for each individual firm to concentrate on the nominal demand in setting their own prices. This therefore supports the traditional Keynesian prediction that macroeconomic externalities lead to the failure of the free-market economy. Different economists, however, disagree on the extent of the price stickiness.

This model consists of households that supply labour, consume goods and hold money and bonds. Firms, on the other hand, hire labour and produce and sell products in monopolist competitive markets. Households and firms behave optimally. Households maximize the expected present value of utility, and firms maximize profits. There is also a central bank that controls the interest rates. The main aspect of the new-Keynesian economics is the lack of a market clearing mechanism. Therefore, a new-Keynesian model is a model in which prices cannot adjust fast enough to clear markets within a short period of time. A well-documented prediction of the new-Keynesian framework is that after a fall in nominal demand, the aggregate price level decreases less than proportionately over a relatively long period of time. During this period, the real price level exceeds the equilibrium price level. This implies that the sub-equilibrium level of output is not chosen willingly by firms and labours but imposed on them as a constraint. Every agent experiences a constraint that is implicitly a product of its own failure to adequately decrease its price level. This leads to the coordination failure that is a key feature in explaining price stickiness. The growth of new-Keynesian economics in the previous decade is mainly associated with the search for a realistic model to explain the wage and price rigidities using rational expectations.

Most new-Keynesian models relate rational expectations to the maximizing behavior of the economic agents.

Moreover, similar to the RBC model, the equilibrium is in the form of a stochastic process for all the endogenous variables in the economy. Economic agents intertemporal optimization decisions are also subject to their goals and constraints given the market's clearing mechanism (Gali, J. (2009)). Furthermore, in spite of the contrasts between the RBC and the new-Keynesian model, they have some very strong similarities with each other. The new-Keynesian model does indeed have roots in some of the implications of the RBC model. It is based on the assumption of the infinitely-lived representative household which maximizes its utility by consumption and leisure, subject to the intertemporal budget constraint. The second assumption, that reflects this similarity, is the large number of firms that have access to the same level of technology, subject to exogenous random shifts. Even though capital accumulation, which is the key feature of the RBC model, has been dismissed in the new-Keynesian model, it can be integrated simply and is indeed a common aspect of the medium-scale versions. The new-Keynesian model combines the DSGE features of the RBC model with the assumptions that differentiate it from the "classical monetary models". For instance, some of the main elements of the new-Keynesian model are monopolistic competition, nominal rigidities and short-run non-neutrality of monetary policy. Therefore, the new-Keynesian model assumes that the prices in the good market are determined by private firms maximizing their profits and not by the Walrasion "auctioneer" trying to clear all the markets simultaneously. This would lead to some friction in the market since adjusting prices of goods is costly for firms. Nominal rigidities in the market cause changes in nominal interest rate not matched one-by-one by the changes in inflation expectations. This changes real interest rates and leads to fluctuation in private consumption and investment. It also changes output and employment since firms optimally adjust their level of production to the new level of demand. In the long run, however, all the prices and wages return to their baseline level and the economy bounces back to its natural equilibrium level.

The standard new-Keynesian model assumes that monetary policy affects a household's intertemporal consumption through the interest rate. The literature, however, has not found enough support for purely forward-looking consumers. Fuhrer (2000), Christiano, Eichenbaum, and Evans (2005), and Leith and Malley (2005) modify the new-Keynesian models by introducing different habits that affect the consumers' behavior. This consumption habit can be internal or external[14]. Amato and Laubach (2004) study optimal monetary policy in a sticky-price new-Keynesian model using internal habits[15]. They ar-

[14]When households are not successful to internalize the externalities that their consumption creates for other households, their habit is called External.

[15]Internal habit means households increase their consumption relative to their own past consumption

gue that since habits are internal, the equilibrium price level near the original steady-state price level is still efficient. This implies that there is no trade-off between the output gap and inflation. Hence the observed trade-off in the data is the result of other kinds of inefficiencies such as mark-up shocks. It might also be the byproduct of the "zero lower bound nominal interest rates" that some countries face during recessionary periods.

The focus of the new-Keynesian model is to provide microfoundations to explain price stickiness and also the non-neutrality of money. It also emphasizes the role of contracts on the persistence of price stickiness and the resulting effectiveness of monetary policy. New generations of monetary models include these aspects in a fully specified DSGE model and apply the formal modeling strategy that has been the feature of a RBC model. The new-Keynesian model is developed as a tool to understand monetary policy and its effects on inflation, economic growth and welfare. It is also the backbone of new intermediate-term models that are currently being developed in the IMF, The Federal Reserve Board and some other central banks. It also delivers a theoretical justification of the inflation-targeting policies being implemented by most of the central banks in the industrialized world. It is, however, worth mentioning that the new-Keynesian model is based on the basic Keynesian model that assumes monopolistic competition and price stickiness along with the perfectly competitive labor market.

1.4 New Consensus Macroeconomics

The new Consensus Macroeconomics (NCM) has been extensively used recently to interpret the impacts of monetary policy[16]. This model of macroeconomy is based on the new-Keynesian framework and pushes it further by encompassing developments in this area such as rational expectation hypothesis. The NCM model underlines the effectiveness of monetary policy while reducing the importance of fiscal policy. It also shows that price stability is achievable through monetary policy since inflation is a "monetary phenomenon" and can only be controlled through changes in interest rate (See Woodford (2009)).

Arestis (2011b) studies the NCM model in an open economy through the following 6 equations:

$$Y_t^g = a_0 + a_1 Y_{t-1}^g + a_2 E_t(Y_{t+1}^g) + a_3[R_t - E_t(P_{t+1})] + a_t(rer)_t + s_t \tag{1.4.1}$$

$$P_t = b_1 Y_t^g + b_2 P_{t-1} + b_3 E_t(P_{t+1}) + b_4[E_t(P_{wt+1}) - E_t \Delta(er)_t] + s_2 \tag{1.4.2}$$

and do not take into account the level of other households' consumption.

[16]This model is comprehensively discussed in Arestis, (2007a), (2007b), (2009), (2011); Arestis and Sawyer, (2008b)

$$R_t = (1 - c_3)[RR' + E_t(P_{t+1}) + c_1 Y^g_{t-1} + c_2(P_{t-1} - P^T)] + c_3 R_{t-1} + s_3 \tag{1.4.3}$$

$$(rer_t) = d_0 + d_1[[R_t - E_t(P_{t-1})] - [(R_{wt}) - E(P_{wt+1})]] + d_2(CA)_t + d_3 E(rer)_{t+1} + s_4 \tag{1.4.4}$$

$$(CA)_t = e_o + e_1(rer)_t + e_2 Y^g_t + e_3 Y^g_{wt} + s_5 \tag{1.4.5}$$

$$er_t = rer_t + P_{wt} - P_t \tag{1.4.6}$$

a_t is a constant that can reproduce fiscal policy. Y_g is the output gap of the domestic country while Y^g_w is the world output gap. R is nominal interest rate and R_w is the world nominal interest rate. P represents the inflation rate while P_w shows the world inflation rate and P^T is the inflation target. RR' is called the equilibrium real interest rate. Equilibrium interest rate is a rate in which the output gap is zero. According to the second equation above, this means that the rate of inflation is constant. rer represents real exchange rate in these equations and er shows the nominal exchange rate. The nominal exchange rate is defined in the last equation and is expressed as foreign currency units per domestic currency unit. P_w and P are world and domestic price level correspondingly. CA is the current account of the balance of payments. s characterizes stochastic innovations. E represents the expectations at time t. The nominal exchange rate can be calculated from the last equation: $\Delta(er)_t = \Delta(rer)_t + P_{wt} - P_t$.

The first equation represents aggregate demand where the current output gap is generated by past as well as expected future output gaps, real interest rates and the real exchange rate. It is assumed here that monetary policy has an impact on the economy through output gap, which is the difference between actual output and trend output[17]. This equation actually exhibits intertemporal optimization of expected lifetime preferences of the representative agent. The controversial feature of the representative agent is that it never defaults under the standard collaboration of the model. The intertemporal optimization is rooted in the assumption that all debts are being paid fully at the end of the period. This being the case, there is no credit risk or default risk in this model as a result of the "transversality" condition. This implies that every economic agent that has rational expectations is completely creditworthy. All the IOUs in the economy could be accepted in exchange (See Arestis 2011). Consequently, there will be no need for any kind of monetary asset, and hence any fixed-interest financial assets are similar to each other[18]. The interest rate would vary over time as saving and borrowing propensity changes. Nonetheless, neither individuals nor firms are financially constrained, and consequently there is no requirement for financial intermediaries or even money[19].

[17] Trend output is the output that occurs when prices are completely flexible.

[18] Arestis (2011) argue that by grounding the NCM framework on the transversality assumption, the advocates have revolved the model into an effectively non-monetary framework.

[19] See Arestis (2011), Goodhart (2007), (2009) and Buiter (2008).

The second equation is a Phillips curve, which originates from the intertemporally-optimising representative firm, assuming that prices are sticky. Inflation is generated by the current output gap, the inflation rates in previous periods, inflation rates in the future and also the expected changes in nominal exchange rates. It is also based on the expected world prices. This model assumes that prices are sticky and flexible in the short-term and long-term respectively. The Philips curve in this model is also assumed to be vertical given that $b_2+b_3+b_4=1$. $E_t(p_{1+t})$ encapsulates the forward-looking property of inflation. This equation also indicates that central bank's success in defeating inflation depends on its present policy stance, as well as market participants expectation about the future stance of these policies[20]. This also suggests that economic individuals and agents have a clear understanding of how central banks would respond to a macroeconomic innovation that will have an impact on their current decisions. Hence, one could describe modern central banking as the management of private expectations, and $E_t(P_{t+1})$ can represent the credibility of the monetary authorities. Monetary authorities' ability to realize and keep inflation low will therefore decrease inflation expectations.

The third equation depicts a monetary policy stance. It can be generated from optimization of central bank's loss function, conditional on the economy's structural constraints. This model determines the nominal interest rate that is produced by the rate of expected inflation, the output gap, the inflation gap, as well as the equilibrium rate of the real interest rate[21]. Monetary policy rule, in this model, is captured by the behavior of the central bank and the short-run interbank interest rate. As discussed in Arestis (2011), the lagged interest rate shows "interest rate smoothing" that is often disregarded in the literature and is carried out by the central banks[22]. This equation suggests that policy adjusts itself to the systematic innovations and changes in the economy in a predictable way.

The fourth equation above, sets the exchange rate as determined by the differences in the real interest rates, the condition of the current account, as well as the expectations about future exchange rate. Equation five shows that the current account is generated from the real exchange rate, and the differences between domestic and the world's actual and potential output. Finally, the last equation determines the nominal exchange rate using the real exchange rate[23]. It is important to emphasize that, having a "representative agent" in the NCM model, leads to the controversy that banks and credits are absent in

[20]The important assumption in this regard is rational expectation hypothesis. By rational expectation, we mean that agents have a full understanding of how the economy performs and they comprehend the consequences of their present decisions on the future.

[21]Inflation gap is defined as the deviation of inflation from its target value.

[22]See also Goodhart (2009).

[23]Angeriz and Arestis (2007), furthermore, criticize NCM model on the ground that exchange rate has no role in the setting of interest rate by monetary authorities.

this framework. This criticism has proved to be even more important after the existing economical models failed to predict the onset of the current financial crisis, which is indeed a credit crisis in nature.

Justification of the Methodology

Structural vector auto-regression is used to examine the impacts of different shocks on business cycles in this thesis. SVAR is a popular tool in macroeconomics to derive information about the impacts of macroeconomic shocks. The VAR approach in macroeconomic research is applied to measure the response of state variables to the structural policy shocks. SVAR is considered as a proxy of the underlying DSGE model. More formally, Ireland (2004) shows that taking the first-order condition of the RBC model leads to a system of non-linear, stochastic difference equation. The log-linearization of the first order condition around the steady state of each state variable, leads to a system of rational expectations model. Solving rational expectations leads to a first order VAR.

1.1 Vector Auto-regression: Sign Restriction Approach

Vector auto-regression has been used broadly in macroeconomics partly because macroeconomists are unable to agree on a comprehensive structural model of the economy. In other words, VAR can determine the important dynamics of the economy without imposing restrictions from a particular structural model. The VAR method characterizes the dynamic structure of the model, utilizing impulse responses and variance decomposition simulations. Sims (1980), however, argues that the initial techniques to decompose VAR residuals into meaningful economic shocks are not able to give structural interpretation to the orthogonal shocks. This critique of the VAR has led to the construction of the SVAR (structural VAR) by Blanchard (1989), Blanchard and Watson (1986), Bernanke (1986) and Sims (1986) among others. In the SVAR framework, the researcher has the opportunity to impose minimum restrictions while identifying the contemporaneous structural relationship in the economy. This method produces shocks that can be interpreted economically. One of the strengths of the VAR model is that it can be directly employed to the data. In addition, it is easy to estimate. VAR specification needs little reference to economic theories. Therefore, it is considered to be flexible enough to accommodate a wide range of issues relating to the nature and the sources of the business cycle dynamics. This feature of the VAR, however, has been criticized. Some researchers argue that these models may show instability across the periods when monetary and fiscal policy rules change, given that VAR is loosely based on macroeconomic theories.

What's more, following the work of Kydland and Prescott (1982), macroeconomists try to understand the economic indicators' dynamics by employing dynamic, stochastic, general equilibrium (DSGE) models[24]. DSGE models are utilized to understand the sources

[24]The phrase DSGE model is stereotypically employed to suggest a broad class of dynamic macroe-

of the business-cycle dynamics and the transmission of shocks into the macroeconomy. It has been also used in interpreting the welfare impacts of economic decision making, considering together parameters and model uncertainty. DSGE models are, in fact, firmly rooted in economic theories[25]. Hence, the structural parameters in DSGE models remain persistent in different policy regimes. DSGE models, nonetheless, are difficult to apply directly to the data since they depend considerably on economic theories. They are also considered to be too stylized to be suitable for this purpose[26].

Ireland (2004) suggests combining the power of the DSGE framework with the flexibility of the VAR time-series models. He argues that this "hybrid" will bring the desirable features of both approaches to the macroeconomic research. He emphasizes that these two different methods of macroeconomic analysis can continue providing insights today if they are combined with each other. This model uses, for the starting point, a fully-specified DSGE model. However, he acknowledges that even though this model is a powerful tool to investigate the economy, it is nevertheless too stylized to capture all the observed dynamics of the data. To make estimation feasible, he developed the "hybrid" framework so that DSGE model residuals are explained by a VAR method. Residuals in the DSGE model are basically the dynamics in the data that theory is not able to explain. Similarly, in the structural VAR models, following Bernanke (1986), Blanchard and Watson (1986), and Sims (1986), researchers try to rely on the power of the economic theories while keeping the flexibility of the more conventional VAR models. Macroeconomists' objectives are, therefore, to construct the macroeconomic models that are capable of explaining the data while remaining rooted in the theoretical background. Structural VAR models normally depend on the economic theories, only to the extent that it is mandatory for identification, while the hybrid model is based on a fully-specified DSGE model. Which method one uses depends on how confident the researcher is about the implications of the fundamental theories. Significantly, the solution of the DSGE model can be shown to be a first order VAR[27]: the new-Keynesian model below consists of households, firms and monetary policy authorities. Households maximize utility subject to budget constraints. Firms maximize

conomic models that extends the benchmark neoclassical growth model discussed in King, Plosser, and Rebelo (1988) in addition to the monetary model with numerous real and nominal frictions established by Christiano, Eichenbaum, and Evans (2005).

[25] According to DSGE models, a firm's decision-making depends on their preferences as well as the state of technology. This property can be achieved from solving the firm's intertemporal optimization problem. Furthermore, DSGE models assume that agents possibly face uncertainty regarding the total factor productivity, for example, or the nominal interest rate determined by a central bank. This uncertainty comes from exogenous stochastic processes such as change in technology or unpredicted changes in central bank's interest-rate feedback rule.

[26] Depending on distributional postulations for the exogenous shocks, the DSGE model produce a joint probability distribution for the endogenous system variables such as GDP, private consumption, investment, and price level. In a Bayesian background, this likelihood function might be employed to convert a prior distribution for the structural parameters of the DSGE system into a posterior distribution. This posterior is the source for substantive information for decision making.

[27] This is indeed one of the significant advantages of using the VAR framework to study macroeconomics.

their profit subject to the demand curve and to a production function. Finally, monetary authorities choose an optimized policy value to minimize its loss function.

Households: The preferences of households defined over consumption goods, real money balances (M_t/P_t), and leisure $1 - N_t$, where t_i is the time devoted to market employment. Households maximize the expected discounted present value of the utility:

$$E_{t_i=0}^{\infty}[\frac{C_{t+i}^{1-\sigma}}{1-\sigma} + \frac{\gamma}{1-b}(\frac{M_{t+i}}{P_{t+i}})^{1-b} - \chi\frac{N_t^{1+\eta}}{1+\eta}] \tag{1.1.1}$$

subject to a budget constrain given by

$$C_t + \frac{M_t}{P_t} + \frac{B_t}{P_t} = \frac{W_t}{P_t}N_t + \frac{(1+i_{t-1})B_{t-1}}{P_t} + \frac{M_{t-1}}{P_t} + \Pi_t \tag{1.1.2}$$

where M_t (B_t) is the household's nominal holdings of money (one-period bonds). Bonds pay a nominal interest rate i_t. Π_t denotes real profits received from firms. This leads to the followings first-order conditions:

$$C_t^{-\sigma} = \beta(1+i_t)E_t\left(\frac{P_t}{P_{t+1}}\right)C_{t+1}^{-\sigma} \tag{1.1.3}$$

$$\frac{\gamma\left(\frac{M_{t+i}}{P_{t+i}}\right)^b}{C_t^{-\sigma}} = \frac{i}{1+i} \tag{1.1.4}$$

$$\chi\frac{N_t^{\eta}}{C_t^{-\sigma}} = \frac{W_t}{P_t} \tag{1.1.5}$$

These conditions represent an Euler condition for optimal allocation of consumption, the intratemporal optimal condition setting the marginal rate of substitution between money and consumption equal to the opportunity cost of holding money and the intratemporal optimality condition of setting the marginal rate of substitution between leisure and consumption equal to real wage.

Firms: Firms maximize profits by facing three constraints. The first is the production function summarizing the available technology. Second, is the demand each firm faces. The third constraint is that in each period only a fraction $1-\omega$ of firms are able to adjust prices. The firm's pricing decision problem is the choice of price p_{jt} to maximize expected profits. After a long algebra the optimal level of price inflation is given by

$$\pi_t = \beta E_t\pi_{t+1} + \lambda x_t + u_t \tag{1.1.6}$$

This equation is known as a New-Keynensian Philips curve.

Log-linearization of the equation that represents the optimal allocation of consumption leads to the new-Keynesian IS curve:

$$y_t = E_t y_{t+1} - \left(\frac{1}{\sigma}\right)(i_t - E_t\pi_{t+1})$$

expressing the resulting equation in terms of output gap $x_t = y_t - \overline{y}$, where $\overline{y}$ is the potential out, we obtain:

$$x_t = E_t x_{t+1} - \left(\frac{1}{\sigma}\right)(i_t - E_t \pi_{t+1}) + g_t \tag{1.1.7}$$

The last two equations above includes output, inflation and nominal interest rate. The model can be closed by assuming that the central bank implements monetary policy by controlling nominal interest rate. We assume that the central bank follows a policy rule given by

$$i_t = \rho i_{t-1} + v_t \tag{1.1.8}$$

Combining the last three equations, the resulting system of equations can be written as

$$\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & \sigma^{-1} \\ 0 & 0 & \beta \end{bmatrix} \begin{bmatrix} i_t \\ E_t x_{t+1} \\ E_t \pi_{t+1} \end{bmatrix} = \begin{bmatrix} \rho & 0 & 0 \\ \sigma^{-1} & 1 & \sigma^{-1} \\ 0 & -\kappa & 1 \end{bmatrix} \begin{bmatrix} i_{t-1} \\ x_t \\ \pi_t \end{bmatrix} + \begin{bmatrix} v_t \\ -g_t \\ -u_t \end{bmatrix}$$

or in compact form:

$$A_0 E_t X_{t+1} = A_1 X_t + B_0 f_t \tag{1.1.10}$$

Note that f_t is regarded as exogenous structural shocks. If we note $\eta_t = X_t - E_{t-1}X_t$ as the forecast error, then we can write the above equation as $\zeta_{t-1} = A\zeta_t + B\zeta_t + \pi\eta_t$ where $\zeta_t = E_{t-1}X_t$. Solution of the last equation will lead to a first-order VAR as follows:

$$X_{t+1} = AX_t + Bf_t \tag{1.1.11}$$

where $A = A_0^{-1}A_1$ and $B = A_0^{-1}B_0$.

The plausibility of the uncorrelated shocks depends on whether the SVAR can adequately capture the fluctuations in macroeconomy. This requires both a sufficient number of variables to be included in the VAR and sufficient lag length in order to effectively illustrate the dynamics. In practice, we increase the number of lags to understand the developments in state variables dynamics.

1.2 Different Identification Approaches for the SVAR

The aim of the SVAR is therefore to identify structural shocks. One approach is to impose short-run restrictions (on the structural contemporaneous matrix). In this set-up, you impose restrictions on the variance/covariance matrix (VCM) and compute the empirical impulse response functions (IRF). If the empirical impulse response functions are consistent with the expected theoretical impulse response functions, then the model is identified. Providing information about the reduced form dynamics will not add any information to our structural analysis. VAR is a reduced form model and therefore is unable to robustly interpret the impacts of different structural shocks on key economics variables. The first step in obtaining meaningful results is to construct shocks that are serially and contemporaneously uncorrelated. The second step is to identify the model by imposing restrictions on it. This identification is required to estimate the structural equation parameters (shocks)[28].

There are three main ways to identify the VAR system: first, Sims (1980) proposed to obtain identification by making the structural system "recursive", and then put no restrictions on the dynamics of the model. Recursivity fundamentally contains two different assumptions: first, it assumes that the shocks in the structural equations are not correlated with each other, and next, endogenous variables should be ordered in a way that each variable simultaneously builds on further variables down the structural system while not depending on those above. In other words, the system is constructed to show a triangular structure. The latter assumption is supported by "institutional knowledge". Whether the shocks are uncorrelated to each other primarily depends on how effectively the structural VAR reflects the macroeconomic system. Therefore, the first assumption needs an adequate number of variables to be integrated in the model. It also requires a lag length of high enough order to effectively capture the dynamics.

The second way of identification features imposing long-run restrictions on variables. Fry and Pagan (2011) argue that: "Recognizing that some macro-economic variables are best thought of as being stochastically non-stationary brings in the fact that there may be shocks with permanent effects upon those variables. *Long-run restrictions* exploit this fact"[29]. The *jth* horizon impulse responses of the variables to the structural shocks as C_j and the long-run impacts of the shocks can be symbolized as C_∞. One can then differentiate the permanent from the transitory effects of *ith* shock on the *kth* variable by the existence of a non-zero factor in the *kth* row and *ith* column of C_∞. These can be interpreted into linear restrictions on the structural coefficients of an SVAR[30]. These kinds of restrictions decrease the number of parameters that can be estimated and release instruments.

However, researchers stress that the identification of shocks based on either of the above methods presents various shortcomings. Cooley and Leroy (1985) argue that identification based on the Cholesky decomposition is unsatisfactory because this approach is not consistent with the DSGE models. Canova and Pina (1999) show that DSGE models do not imply the recursive structure imposed by the Cholesky decomposition. Cooley and

[28]These restrictions decrease the number of "free" parameters in the structural equations to the number that can be recovered from the information in the reduced form.

[29]See Fry, R., and Pagan, A. (2011). "Sign restrictions in structural vector autoregressions: a critical review". Journal of Economic Literature, 49(4), 938-960.

[30]For more details, see Shapiro and Watson (1988), Pagan and Robertson (1998).

Dwyer (1998) show that the long-run restrictions used by Blanchard and Quah (1980) rely on weak instruments and makes the differentiation of the permanent shocks from transitory shocks unreliable. Further researchers (see, for instance, Giordani (2004) and Benati and Surico (2009)) point out that for a certain class of DSGE models, VARs are unable to trace out both the true dynamics of the state variables and the true shocks even if the appropriate identification restrictions were used. The is because the log-linearization of the DSGE models around the steady state, leads to a VARMA data generating process (DGP)[31]. If one of the roots of the MA component is large, then a finite order VAR would not necessarily capture the true DGP.

Given the criticism regarding the use of zero-restrictions in identifying parameters of a VAR structure and the fact that DSGE models do not exhibit zero-restrictions, researchers began to use sign restriction to validate DSGE models. To that end, Canova (2007) argues that a log-linearized DSGE model rarely delivers zero restrictions, but often embodies sign restrictions which could be used to identify the model. This thesis utilizes theoretically-based sign restrictions on the dynamic responses of the vector of variables to scrutinize whether orthogonal disturbances have any stimulating economic interpretation. Sign-restriction approach clearly isolates the statistical problem of orthogonalizing the covariance matrix of reduced form innovations from problems concerning identification of structural disturbances (Canova and De Nicolo (2002)).

1.3 Summarizing the Data and Structural Demonstrations

Reduced-form VARs put in a nutshell the auto-covariance properties of the data. It also provides a practical estimation tool although they cannot be interpreted economically. To add economic content to the VAR system, researchers exploit the close relationship between VARs and the modern dynamic stochastic general equilibrium models. In the setting of a DSGE model, a monetary policy rule might be well defined, however, the concept of an aggregate demand or supply function is ambiguous. We will explain later that these models are identified in terms of preferences of the economic agents and production technologies. The optimal solution of the agents' decision problems together with the equilibrium condition causes an autoregressive law of motion for the endogenous variables. Economic fluctuations are reproduced by unexpected changes in technology, preferences, monetary policy and fiscal policy. Some economists, furthermore, argue that the captured co-movements between the macroeconomic variables in the DSGE models can be gener-

[31] Benati and Surico (2009), using a new-Keynesian model, show that if there is a structural change in the policy rule (i.e., from passive to active) then a VAR analysis will detect this as the variance of the shocks has changed. However, their approach can be criticized on the grounds of the omitted variables problem which induces biased coefficient and overestimated variance of shocks. To that end, Canova (2006) states that an augmented VAR model including a proxy for the omitted variables (i.e. expected inflation), may uncover the true DGP. Along the same lines also see Canova and Gambetti (2010).

ated through well-specified economic transmission mechanisms rather than from correlated exogenous shocks. Subsequently, these shocks are generally assumed to be orthogonal to each other. These kinds of dynamic macroeconomic theories in essence imply that the one-step-ahead forecast errors, u_t, are the function of the orthogonal structural shocks in technology, preferences and policies.

1.3.1 Reduced-Form VARs and Structural Shocks

Assume that the data is represented by a first order VAR:

$$z_t = A_1 z_{t-1} + e_t \tag{1.3.1}$$

where z_t is an $M \times 1$ vector of variables, A_j is an $M \times M$ matrix of coefficients and e_t is a i.i.d. $N(0, \Sigma)$[32].

The VAR can be displayed in matrix form in various ways. Some of the studies convey results using the multivariate Normal distribution and others by employing the matric-variate Normal distribution[33]. Researchers use the multivariate Normal distribution if they employ a $MT \times 1$ vector Z which contains all T observations on the first dependent variable, and then afterwards each of the T observations on the second dependent variable, etc. The matric-variate Normal distribution is used if researchers describe Z to be a $T \times M$ matrix that contains the T observations on every dependent variable in columns after one another. Express $x_t = \begin{pmatrix} 1 & z'_{t-1} & \cdots & z'_{t-p} \end{pmatrix}$ and

$$X = \begin{bmatrix} x_1 \\ x_2 \\ \cdots \\ x_T \end{bmatrix}. \tag{1.3.2}$$

Lastly, if $A = \begin{pmatrix} A_1 & A_2 & \ldots & A_p \end{pmatrix}'$ we define $\vartheta = vec(A)$ which is a $M \times 1$ vector which holds all the VAR coefficients into a vector. Therefore we can write the VAR either as:

$$Z = XA + E \tag{1.3.3}$$

or

$$z = (I_M \otimes X)\vartheta + e \tag{1.3.4}$$

where $e \sim N(0, \Sigma \otimes I_T)$ and Z is a $T \times M$ matrix.

[32]Exogenous variables or more deterministic terms such as trends might simply be integrated to the VAR system and incorporated in all the derivations. We do not do so, however, to make the notation as simple as possible.

[33]See, e.g., Canova, (2007); Kadiyala and Karlsson, (1997).

The likelihood function is obtained from the sampling density, $p(z|\vartheta, \Sigma)$. If it is regarded as a function of the parameters, it may be displayed in two parts. The first part is a distribution for ϑ given Σ. The second part is when Σ' has a Wishart distribution.

Define $\theta = (\vartheta, \Sigma)$ and note that $P(\theta)$ and $P(\theta|Z, X)$ denotes the prior and posterior distribution of θ. To estimate θ, we use a normal-Wishart prior both for ϑ and σ. The posterior distribution of θ is given by the following equations:

$$\vartheta|\Sigma, z \sim N(\hat{\vartheta}, \Sigma \otimes (X'X)^{-1}) \tag{1.3.5}$$

and

$$\Sigma^{-1}|z \sim W(S^{-1}, T - K - M - 1) \tag{1.3.6}$$

where W denotes the Wishart distribution, K is the number of coefficients in each equation of the VAR and T is the number of observations. $\hat{A} = (X'X)^{-1}X'Z$ is the OLS estimation of A and

$$S = (Z - X\hat{A})'(Z - X\hat{A}) \tag{1.3.7}$$

Let ε_t be the vector of structural shocks with the variance-covariance matrix Σ_ε. The problem of identification arises because S is the linear computation of Σ_ε and the matrix of contemporaneous interaction among the elements of Z.

1.3.2 Structural VAR

This section produces a brief description of the SVAR analysis. A description of the data in the SVAR is described as follows:

$$B_0 z_T = B_1 z_{t-1} + \varepsilon_t \tag{1.3.8}$$

This implies that $B_0 e_t = \varepsilon_t$ and literally means that the structural shocks we want to quantify are linear combinations of the VAR errors ε_t. The latter is computed by the VAR residuals $\hat{e}_t$. Estimating the structural (economic) innovations, ε_t, requires that one create a fitting set of weights ($\hat{B}_0$) on $\hat{e}_t$.

To construct impulse response functions, we write the previous equation in MA form.

$$Z_t = D(L)e \tag{1.3.9}$$

or

$$z_t = D_0 e_t + D_1 e_{t-1} + D_2 e_{t-2} + ... \tag{1.3.10}$$

D_j is the jth period impulse response of z_{t+j} to a unit modification in e_t ($D_0 = I_n$).

Therefore the MA form for the SVAR is:

$$z_t = C_0\varepsilon_t + C_1\varepsilon_{t-1}.... \tag{1.3.11}$$

where

$$C_j = D_j B_0^{-1} = D_j C_0. \tag{1.3.12}$$

The VAR can be easily computed by OLS regardless of the nature of the structural VAR (SVAR). Therefore, D_j can always be quantified after the lag length of VAR is specified since $\hat{C}_j = \hat{D}_j\hat{C}_0$ and $\hat{D}_j$ is set by the data autonomously of any structural model. Every restriction that is put on the C_j is essentially the only restrictions on combinations of the columns of C_0, with the weights employed in creating such combinations being the rows of the D_j. To identify many issues concerning sign restriction, it is vital to understand that researchers are most of the time restricting the factors of C_0. These restrictions may be put on C_0 or on C_j for $j \geq 1$. However, some argue that imposing sign restrictions on impulse responses for longer time periods, $C_{i,j} > 0$, is not desirable since it can be excessively constraining.

In combining theory-inspired models (such as DSGE models) with a summative model, we often face the problem that there are variables in theories that cannot be observed in the data. Hence, the model is fitted with a smaller number of variables. Suppose that the observable variables in the dataset is represented as z_t while the larger set in the theory is depicted as z°. Therefore, it is argued that a VAR in z° is equal to the VARMA in z_t[34]. Yet, the VAR cannot successfully represent the data if it is obtained from a theoretical model with unobserved (latent) variables. Similarly, Kapetanios et al (2006) argue that since the number of unobserved (latent) variables can be considerable for some structural models, one needs to be careful when employing information from theory-consistent models to identify innovations in the structural VARs. However, the literature attempts to solve this issue by setting the orders of the observed variables relatively high. Nevertheless, imposing restrictions on the signs of the impulse responses can solve this problem to some degree, especially compared with the kind of approaches that impose restrictions on the magnitude of shocks.

1.4 How Informative are SVAR Methodologies Using Sign Restrictions in Generating Candidate Shocks?

1.4.1 Multiple Shocks

The chosen summative model, in all circumstances, will provide a set of n quantified shocks, $\tilde{e}_t$. Uncorrelated candidate structural shocks, $\hat{\varepsilon}_t$, can be generated by combining

[34]See for example Wallis (1977) and Zellner and Palm (1974).

them in a proper way. There will in fact be many such combinations. Some of them generate impulse responses that possess the correct signs whereas others will not. The first thing to conform in empirical research is hence to choose an algorithm, that provides a set of weights. The criteria for choosing a "successful" algorithm is literally to check whether impulse responses functions, $\hat{C}_j$, for the related structural innovations are in line with the nominated sign restrictions. We then discard the impulse responses if they do not satisfy the sign restrictions and "draw" additional set of weights.

The next step is to check whether the generated weights affirm the orthogonality condition of the constructed structural innovations, $\hat{\varepsilon}_t$. Assuming that, we start by initially calculating a recursive VAR. Afterwards, we would have $\hat{e}_t = \hat{B}_0^{-1}\hat{\varepsilon}_t$, where $\hat{B}_0$ is triangular. Even though these structural shocks, $\hat{\varepsilon}_t$, are uncorrelated by construction, still we ought to use the shocks that have unit variance. This can be obtained by dividing each of the $\hat{\varepsilon}_{kt}$ by its standard deviations. Therefore, we assume that $\hat{S}$ is the matrix that has the computed standard deviation of the $\hat{\varepsilon}_t$ on its diagonal and zeros elsewhere. Therefore $\hat{e}_t = \hat{B}_0^{-1}\hat{S}\hat{S^{-1}}\hat{\varepsilon}_t = \hat{T}\hat{\eta_t}$, where $\hat{\eta_t} = \hat{S^{-1}}\hat{\varepsilon}_t$ become new structural innovations with unit variances. $\hat{\eta_t}$ are called *base set*. It is easier to compute $\hat{\eta_t}$ by quantifying the covariance matrix of the residuals $\hat{e}_t$, $\hat{\Omega}$, and then applying a Cholesky decomposition $\hat{T^{-1}}\hat{\Omega}\hat{T}' = I_n$ to get $\hat{T}$. Hence, $\hat{\eta_t} = \hat{T^{-1}}\hat{e}_t$. This is a convenient approach since all that is required for creating impulse responses is the estimated covariance matrix of the errors in the summative model equation.

We can now proceed to compute combinations of $\hat{\eta_t}$ employing a matrix Q where $\hat{\eta_t}'' = Q\hat{\eta_t}$. The $\hat{\eta_t}''$ are potential normal structural shocks and therefore need to be orthogonal and Q must be restricted. The adequate restriction is that Q is a square matrix and $Q'Q = QQ' = I_n$. The means:

$$\hat{e}_t = \hat{T}Q'Q\hat{\eta_t} = \hat{T}''\hat{\eta_{t''}} \tag{1.4.1}$$

where $Cov(\eta_t''\eta_t''') = QCov(\hat{\eta_t}\hat{\eta_t}')Q' = I_n$. Accordingly, we have discovered a new set of structural shocks, η_t''', that possess the same covariance matrix as $\hat{\eta_t}$ and will give us $Var(z_t)$. However, it has different effects ($\hat{T''}$) on e_t and will therefore produce different impulse responses. Sign restriction approach is grounded in this ability to generate a considerably large number of candidate shocks, draws, by changing impulse responses. After we construct a Q so that $QQ' = Q'Q = I_n$, it is convenient to compute all these shocks by using programs that are able to compute matrix operations[35]. There are many such Q_s' and we call each a "draw". There are different ways to calculate the Q, and two of the most popular approaches are through "Givens" and "Householder transformations"[36].

[35] In this thesis we have used MATLAB and RATS softwares for this purpose.

[36] The calculation of Givens and Householder transformation are explained in the appendix of this thesis.

1.4.2 A Single Shock

So far we have identified n shocks. Sometimes, however, we are just interested to identify one single structural shock. In doing so, we might still employ the $M \times M$ Q- matrices described above. Therefore, we need to compute M orthogonal structural shocks but just focus on one of them. Scholl and Uhlig (2008), for instance, argue that the important issue in identifying a single shock is the weights that we choose. These weights are required to generate the structural shocks that are $M \times 1$ vector q and has a unit length. If q is not chosen from Q, then the subsequent shock does not have to be orthogonal with the rest of the (unidentified) $M-1$ shocks. This property can also be problematic, if for instance, one is interested to perform a variance decomposition. This is because most empirical papers employing sign restrictions does not necessarily choose q in a way to ensure orthogonality.

Furthermore, let's assume that there are two variables and we presume that one shock has a strong positive effect on the first variable but we cannot predict its impact on the second variable. This implies the sign for C_0 is $\begin{bmatrix} + & ? \\ ? & ? \end{bmatrix}$ in this example[37]. This information is not adequate to achieve identification. A problem thus, occurs if we fail to integrate sufficient information in order to distinguish between shocks. It is called the *multiple shocks problem*[38].

1.5 Shock Identification

How do sign restrictions tackle the structural identification issue in the macroeconomics model? To discuss this question, it is useful to find some primary orthogonal shocks by presuming that the system is recursive. Recursivity implies that the moment conditions to acquire the fundamental estimates of the structural parameters would be $E(q_t \varepsilon_{St}) = 0$ as well as $E(\varepsilon_{St}\varepsilon_{Dt}) = 0$. This recursive VAR system is assumed to have the following form:

$$p_t = \eta_{1t} \tag{1.5.1}$$

$$q_t - \gamma p_t = \eta_{2t} \tag{1.5.2}$$

where η_{1t} and η_{2t} are the base set of impulse responses[39]. We have essentially now constructed new shocks η''_{jt} utilizing the base shocks $p_t = \eta_{1t}$ and $q_t - \gamma p_t = \eta_{2t}$ keeping the orthogonality assumption. The new orthogonal innovations, η''_{1t} and η''_{2t} are created employing a Givens rotation as the weighting matrix. For example, if there is one Givens matrix, Q, $\begin{bmatrix} \cos\Theta & -\sin\Theta \\ \sin\Theta & \cos\Theta \end{bmatrix}$, then the converted system $\begin{bmatrix} \sigma_{\eta 1}\eta_{1t}'' \\ \sigma_{\eta 2}\eta_{2t}'' \end{bmatrix}$ is equal to

[37]Here basically ? implies that no sign information is assumed.

[38]The important question is how to identify the model if in any draw, there are two shocks, with similar impulse responses. The answer is to just accept one of them. We cannot, for instance, have two demand shocks in the market model.

[39]Here p_t, q_t, S_t, D_t represent price, output, quantity supplied and quantity demanded respectively.

$\begin{bmatrix} p_t \cos\Theta - (q_t - \tau p_t)\sin\Theta \\ p_t \sin\Theta + (q_t - \tau p_t)\cos\Theta) \end{bmatrix}$.

This being the case, $\sigma_{\eta j}$ is the standard deviation of η_{jt}. This depicts that η_{jt}'' was made to have a unit variance. Assuming that $\o_1 = \cos\Theta$ and $\o_2 = \sin\Theta$, the two equations can be written as:

$$(\o_1 + \o_2\tau)p_t - \o_2 q_t = \sigma_{\eta 1}\eta_{1t}'' \tag{1.5.3}$$

$$(\o_2 - \tau\o_1)p_t + \o_1 q_t = \sigma_{\eta 2}\eta_{2t}'' \tag{1.5.4}$$

while impulse responses of (p_t, q_t) to $\sigma_{\eta j}\eta_{jt}''$ is:

$$(\begin{bmatrix} \o_1 + \tau\o_2 & -\o_2 \\ \o_2 - \o_1\tau & \o_1 \end{bmatrix}^{-1}) = (\frac{1}{\o_1^2 + \o_2^2})(\begin{bmatrix} \o_1 & \o_2 \\ -\o_2 + \tau\o_1 & \o_1 + \tau\o_2 \end{bmatrix}) \tag{1.5.5}$$

Therefore, the sign of the impulse responses on p_t and q_t will depend on $sgn(\o_1)$ and $sgn(\o_2)$. These can be either positive or negative depending on the values driven by Θ. In this approach, we only keep the structural shocks that yield similar impulse responses to the presumed signs. However, there will be many impulse responses that satisfy sign restrictions. Each value of Θ yields a contemporary model with a new set of structural equations and innovations. Fry and Pagan (2011) deal with this difficulty by choosing impulse responses that are as close as possible to the median. In the meanwhile, they constrain the responses generated from the similar model. The model-based method of constructing sign restrictions seems to be a practical technique. The reason that this methodology is being used extensively among macroeconomists is twofold: First, it does not bind the researcher to the DSGE model and second, it has the advantage of assuring the informal approach of identification to produce robust results. However, it also mainly depends on the purpose of the researcher in conducting the VAR analysis. Fry and Pagan (2011) state that: "If one is trying to "discover" what the data says about relations then imposing sign restrictions from (say) the NK model above would not appeal as much, since one would never find (say) that interest rates had a positive impact on inflation in the data. "Puzzles" like this are sometimes the source of productive theorizing and so one should be careful about pre-determining outcomes."[40]. To test this issue, one can check the draws that produce impulse responses that are "not in line" with the sign restrictions. If there are a large number of the rejected responses, then one can conclude that the data does not support the model that is used to derive the sign restrictions.

Afterwards, different percentiles such as the 5%, 50% and 95% are also reported, along with impulse responses. These series are considered as confidence intervals in Bayesian estimations. Fry and Pagan (2005) argue that the percentile one reports is, indeed, an indication of the potential range of impulse response as the model changes. One possible

[40] See Fry, R., and Pagan, A. (2011). "Sign restrictions in structural vector auto-regressions: a critical review." Journal of Economic Literature, 49(4), 938-960.

interpretation of the median is that it is a good quantity to demonstrate as a summary of the central tendency of impulse responses across models, and which merely utilizes sign restriction information.

1.6 Sign Restrictions in Empirical Research: Monetary, Fiscal Policy and Technology Shock

Various macroeconomic literatures exercises sign restrictions in order to study monetary policy[41]. This thesis follows Uhlig (2005) and Uhlig and Mountford (2009) to identify monetary policy shocks and fiscal policy shock respectively.

1.6.1 Monetary Policy

The focus of the first chapter of this thesis is on the impacts of a contractionary monetary policy shock on the economy especially on output and exchange rate[42]. The VAR system that is used here consists of the real industrial production, exchange rate, money market rate, total reserves and consumer price index. This model is suggested by the large body of the literature. By construction, we do not impose any restrictions on the growth rate of real industrial production and that of the real exchange rate. However, we restrict the impulse responses of monetary and price variables to identify monetary policy shocks. The sign restrictions that have been employed suggest that a contractionary monetary policy would decrease price level and total reserves, however expands the short-run interest rate for five periods. In order to identify the model, "penalty function" has been applied to maintain the impulse responses that obtain the robust signs. Upper and lower bounds are depicted for each impulse response function across the models, to illustrate the results in the form of impulse responses. To tackle the multiple shocks problem, all impulse responses are kept and preserved as equal. Nevertheless, this estimation is based on the median impulse responses[43].

The following shows briefly the application of sign-restriction in the first chapter of this thesis. Any impulse vector $a \subseteq R^n$ can be restored if there exists an $n-$dimensional vector q of unit length such that $a = \tilde{A}q$ where $\Sigma_\epsilon = AA' = \tilde{A}\tilde{A}'$, and $\tilde{A}$ is the lower triangular Cholesky factor of the covariates matrix, Σ_ϵ. R^n is the matrix of impulse responses. Note that $\widetilde{A} = AQ$ where Q is an $n \times n$ orthogonal matrix.

Uhlig (2005) shows that the estimation and inference can be implemented as follows:

[41] Examples are Faust (1998), Canova and De Nicolo (2002) and Uhlig (2005).

[42] Uhlig (2005) also identifies just a monetary shock saying that there is no motivation to uncover the other primary structural shocks.

[43] Proceeding the method of Uhlig (2005), there are several papers that identify monetary policy using sing restriction approach. Rafiq and Mallick (2008) test the impacts of monetary shock on the GDP of Germany, France and Italy motivated by the notion that similar output reactions across the three countries means appropriateness for a currency union. Mountford (2005) focuses on the impacts of monetary policy on the UK whereas Vargas-Silva (2008) scrutinizes the effects of a monetary policy shock on the U.S. housing market.

a prior of the Normal-Wishart for $(\widehat{B}(L), \widehat{\Sigma}_\epsilon)$ can be constructed and the posterior draws are also obtained by the Normal-Wishart for $(\widehat{B}(L), \widehat{\Sigma}_\epsilon)$.[44] After estimating $B(L)$ and Σ_ϵ from the posterior draws, we draw $\widehat{q}_j$ from a uniform distribution, divided by its length. Then, we construct a candidate impulse response vector $\widehat{\alpha}_j = \tilde{A}\widehat{q}_j$ and compute its impulse responses by:

$$r_s = [I - \widehat{B(L)}]^{-1}\widehat{a}_j \tag{1.6.1}$$

where r_s is the vector of the impulse responses at horizon s. We account for only those draws of $\widehat{q}_j$ where the sign restrictions are not violated. We repeat this procedure until we obtain 1000 draws which satisfy the sign restrictions.

Mountford and Uhlig (2009) extend the method of Uhlig (2005) and identified at most three structural shocks. To identify an impulse matrix $[\alpha^1, \alpha^2, \alpha^3]$, they used the relevant sign restrictions $\alpha^1 = \widetilde{A}q^1, \alpha^2 = \widetilde{A}q^2$, $\alpha^3 = \widetilde{A}q^3$ and the orthogonality conditions consistent with the assumption that structural shocks are independent (i.e., $q'q^i = 0$ for $i = 1, 2$). Mountford and Uhlig (2009) show that an impulse vector α can be written as a linear combination of Cholesky decomposition of $\widehat{\Sigma}_\epsilon$ as follows. Define $r_{ji}(s)$ the impulse response of variable j at horizon s, to the i-th column of $A^m = [\alpha^1, \alpha^2, .., \alpha^m]$ where $A^m{=}\widetilde{A}Q^m$,with the $m \times n$ orthogonal matrix $Q^m = [q^1, q^2, .., q^m]$. The n-dimensional impulse response $r_\alpha(s)$ at horizon s to the impulse vector α^s is given by:

$$r_\alpha(s) = \sum q_i r_i(s) \tag{1.6.2}$$

where q_i is the i-th entry of $q = q^s$.

In practice, this implies a joint draw from the posterior of the Normal-Wishart $(\widehat{B}(L), \widehat{\Sigma}_\epsilon)$ and obtain candidate q vector. A draw is kept if all sign restrictions hold and disregarded otherwise. Errors bands were constructed from the 1000 draws that were kept.

The advantage of using sign restrictions to identify policy shocks is that the results are not affected by the ordering of the variables. That is a different ordering of the variables would not render difference in observed impulse response functions. In addition, Bayesian VAR (BVAR) is not subjected to the parameter uncertainty. This is so because a BVAR estimates the reduced-form parameters and the impulse vector simultaneously. In our investigation, we set the sign restrictions for 5 periods, $s = 5$.

1.6.2 Fiscal Policy and Technology Shock

Applications of VAR literature to investigate fiscal policy are not as common as those of monetary policy. This is somewhat as a result of the difficulty in identification of the fiscal policy inside the VAR context. Blanchard and Perotti (2002) established a

[44] $B(L)$ are coefficient matrices of size $m \times m$. As a first step, however, it is already informative to simply use the OLS estimate of the VAR, $B = \hat{B}$ and $\Sigma = \hat{\Sigma}$.

technique of identification grounded on institutional detail and adjusted elasticities that wish to isolate pure fiscal policy changes from those due to built-in stabilizers. Mountford and Uhlig (2005, 2009) claim that, the robust fiscal policy shocks will be orthogonal with the business cycle shock if a business cycle shock is accurately identified in the VAR and therefore this solves the problem of identification of fiscal policy. It is also suitable to utilize sign restrictions for this cases[45].

In the second chapter, we investigate the impacts of the different kinds of fiscal policies on a model including GDP, private consumption, total government expenditure, total government revenue, real wages, the interest rate, total reserves, a producer price index and the GDP deflator. Four shock have been classified: a business cycle shock, a monetary policy shock, a government revenue shock and a government spending shock. Furthermore, a minimal number of sign restrictions are exercised and they are not originated from any particular model. A business cycle shock is anticipated to have a positive impact on government revenue, GDP, consumption whereas a monetary policy shock has a positive impact on interest rates and negative impact on reserves and prices. The fiscal shocks are identified with government revenue and expenditure reacting positively to revenue and expenditure shocks.

In the third chapter of this thesis, we also identify technology shock simultaneously with fiscal policy shock. Turing to technology shock, a critical difference should be made concurring to whether technology shocks are expected to be long-lasting or not. If permanent, a second question would be whether there is only a single one. If there is just one permanent technology shock, the standard procedure suggests isolating this shock through long-run restrictions. For instance, Gali (1999) studied two variables namely labour productivity -which was expected to possess a unit root- and hours worked - which did not. Technology shocks were merely taken to have a long-run impact on labour productivity. He focused on the impacts of technology shocks on hours worked in the short-run.

Selected papers, such as Fisher (2007), develop in which there are two long-lasting components. Therefore, it is desirable to propose a way of discriminating between the two perpetual shocks. One method is to isolate the impacts of a pure technology shock by employing sign restrictions for that purpose, (See Francis et al (2003)). The technology shock is expected to obtain a non-zero impacts on labour productivity in the long-run as the other shock is acquired to have a zero impact. This is relatively strange because such a differentiation is what typically characterizes a persistent from a short-lived shock. It takes the implication that, for the non-technology shock, a positive impulse response at horizon j should be compensated by a matching negative one at some other horizon, so as

[45]Canova and Pappa (2007) and Dungey and Fry (2009), therefore use sign restriction to study fiscal policy.

to construct the cumulated responses sum to be equal to zero in the long-run. Once they accomplish this analysis Francis et al. (2007) attempt a different methodology that pursues to identify the shocks founded on sign restrictions. Particularly technology shocks are assumed to require both a positive long-run and short-run impact on labour productivity. Accordingly, as distinguished previously in our argument of the "multiple shock problem", it appears implausible that the two sign restrictions employed could support a reasonable identification.

Dedola and Neri (2007) say that the technology procedure does not obtain a unit root. They therefore define which signs of the effects of a technology shock are "robust" to a range of DSGE models, adjusted with a variety of parameter values. They study these signs for a sizable number of variables and impulse response horizons. Therefore, a positive technology shock usually seems to have positive influence on labour productivity, the real wage, GDP, consumption and investment for up to nineteen periods. Even though merely one shock is isolated with these sign restrictions, it appears to be highly possible that their practice of a very large number of restrictions could probably create the multiple shocks problem.

We use sign-restrictions in order to obtain the identification for the shocks. We employ Bayesian approach for the actual estimation of our model. Specifically, we apply a flat Normal-Wishart prior. In this identification scheme, orthogonal structural shocks could lead to tight identifying sign restrictions in the way that lots of draws from the Normal-Wishart posterior for the VAR parameters (β, Σ) are not accepted since they only allow the impulse matrices that fits exactly the sign restrictions. As a result, many draws receive zero prior weight, even if only few of the restrictions are mildly violated. This issue becomes more problematic if the number of orthogonal shocks as well as the number of variables included in the VAR model increases. To find a solution for this complication, we let for small deviations ε from the sign restrictions[46].

[46]See for instance, Enders et al.(2011)

Chapter 1

Investigating the effects of Monetary Policy on Output and Exchange rates using a A VAR Analysis Imposing Sign restrictions: Developed vs. Emerging Countries

2.1 Introduction

The fundamental theoretical and empirical question in monetary economics centers on understanding whether money and monetary policy have any impact on real economic activity. To that end monetary economists have been particularly interested in investigating the validity of the benchmark theories focusing on the impact of monetary policy shocks that lead to economic fluctuations. In their analysis, they often resort to using a vector autoregressive (VAR) framework, developed by Sims (1980), to describe and understand the behavior of prices, monetary aggregates, interest rates and output, as well as to conduct policy experiments.

The popularity of VAR approach can be attributable to the fact that these models validate dynamic stochastic general equilibrium (DSGE) models under certain sign restrictions.[47] In fact, it is well known that linear or log linear approximations of Markovian DSGE models around the steady state yields VAR(1) solutions which are complicated functions of the underlying preference, technology and policy parameters.[48] Hence, extracting meaningful results from a reduced form VAR is a difficult task and requires cross-equation restrictions which should be credible and uncontroversial. In general, to solve the identification problem in the model, researchers impose constraints either on the short run or the long run impact of monetary shocks on macroeconomic variables. There are two main approaches to solve the identification problem. The first approach, followed by Sims(1988), Bernanke and Blinder (1992) and Bernanke and Mihov (1998) among others, requires a recursive identification scheme known as the Cholesky decomposition where policy shock affect output with a lag. The second approach[49] achieves identification by imposing zero restrictions on the long-run impact of monetary disturbances.

However, the identification of structural economic shocks based on zero restrictions has been repeatedly stressed in the VAR literature that this approach has various shortcomings. Cooley and Leroy (1985) argue that identification based on the Cholesky decom-

[47] More concretely, Ireland (1999) show how a real business cycle model can be written as a VAR(1). The first order conditions of a DSGE model and log-linearisation around the steady state lead to a system of rational expectation (RE) model. Also note that conventional solution of RE models using Blanchard and Kahn (1980) method gives a VAR(1).

[48] See, for instance, Leeper, et al. (1996) Christiano et al. (1999) and Canova (2007) who summarize the developments of VAR models and empirical findings.

[49] see Blanchard and Quah (1989) and Gali (1992) among others.

position is unsatisfactory because this approach is not consistent with the DSGE models. Canova and Pina (1999) show that DSGE models do not imply the recursive structure imposed by the Cholesky decomposition. Cooley and Dwyer (1998) show that the long-run restrictions used by Blanchard and Quah (1989) rely on weak instruments and lead to unreliable conclusions concerning the differentiation of permanent shocks from transitory shocks. Further research[50] points out that for a certain class of DSGE models VARs are unable to trace out both the true dynamics of state variables and the true shocks even if the appropriate identification restrictions were used. This is so because the log-linearization of these models leads to a VARMA data generating process (DGP).[51] If one of the roots of the MA component is large then a finite order VAR would not necessarily capture the true DGP. However, Canova (2006) and Canova and Gambetti (2010) show that when VAR method is properly used then the true DGP can be properly recovered.

Given the criticism regarding the use of zero restrictions in identifying parameters of a VAR structure and the fact that DSGE models do not exhibit zero restrictions, researchers began to use sign restrictions to validate DGSE models. This reasoning is due to the observation that a log-linearized DGSE model rarely delivers zero restrictions to extract structural shocks, they contain many sign restrictions which could be used to identify the model[52].

In this thesis, taking into account the developments in the field, we investigate the impact of monetary shocks for three developed countries as well as three emerging economies considering a Bayesian structural VAR model as suggested by Uhlig (2005) and Mountford and Uhlig (2009). This methodology identifies structural monetary shocks by imposing sign restrictions on the impulse responses of (some) variables while allowing some other variables to be completely determined by the data. This approach is useful because it avoids some of the identification problems that arise in the traditional structural VAR models. In our case, we impose no restrictions on the responses of industrial production and exchange rate to monetary policy shocks as they are the key variables of interest in this study and we want the data to determine their path. Our dataset covers the period between January 1988 to December 2009 on a monthly bases and collected for the UK, the US and Japan as well as South Korea, Malaysia and Mexico.

An investigation of monetary transmission mechanism on developing countries is important as they are fast growing emerging economies and they play an important role in

[50] see Chari et al (2005), Giordani (2004) and Benati and Surico (2009)

[51] Benati and Surico (2009) using a three-equation New-Keynesian model show that if there is a structural change in the policy rule (i.e., from passive to active) then a VAR analysis will detect this as the variance of the shocks has changed. However, Benati and Surico (2009) can be criticized on the grounds of omitted variable problem which induces biased coefficients and overestimated variance of shocks. To that end, Canova (2006) states that an augmented VAR including a proxy of the omitted variable (i.e. expected inflation), may uncover the true DGP.

[52] see Canova (2007) page 138.

the world economy as many western countries struggle due to the impact of the 2007/08 financial crises. In the past, these economies, too, experienced periods of financial crises and bounced back with the aid of the IMF or the World Bank. As part of the financial aid package, these institutions were generally required the implementation of a set of restrictive fiscal and or monetary policies. These austerity packages were quite tough to implement as there was little prior information concerning their impact on the real economic activity causing these countries to find their way in darkness. This is in fact one of the contributions of this thesis to the literature; different from the earlier research, we also focus on the effects of monetary policy on Mexico, Malaysia and South Korea, as there is little focus on developing economies.[53] In this respect, our investigation aims to carefully examine how the macroeconomic variables in an emerging economies responds to adverse monetary shocks as we focus on data from Mexico, Malaysia and South Korea.

It is worth stressing at this point that although most of the results in the VAR literature are consistent with the economic theory, Sims (1992) using a recursive identification approach observed a positive relationship between prices and interest rate.[54] Sims argues that the price puzzle is possibly an artifact of the omitted variables problem. In other words, because the central bank has more information concerning expected inflation than a researcher can incorporate in a VAR model, the finding that interest rate rises in response to expected high inflation can only be explained due to the omission of a fundamental variable from the model. Recently, Castelnuovo and Surico (2010) show that price puzzle is the by-product of a passive monetary policy with respect to inflation. More concretely, if a central bank accommodates instead of fighting inflation, that is if a central bank follows a passive policy, then this would generate indeterminate multiple equilibria and expectations become self-fulfilling. Thus, high inflationary expectation will be fulfilled by a passive monetary policy leading to expectation for even higher inflation. This implies that the Sims argument is correct only when monetary policy is passive.

Our empirical findings for developed economies can be summarized as follows. First, similar to Uhlig (2005), we find that a "contractionary" monetary policy shock, does not necessarily lead to a fall in real GDP. For instance, in the US, we find that the real industrial output growth stays positive for the entire 5 year period following a contractionary monetary shock. In Japan the real industrial production growth does not respond much to the monetary shock for several months but then it slightly increases after the middle of the second year following the shock; however, this response is small and negligible. In

[53] Leeper et al (1996), Canova (2007), Benati (2008), Canova and Gambetti. (2010) and Cover et al. (2006) provide an extensive literature review on monetary transmission mechanism for developed economies using structural VAR. In this literature Ho and Yeh (2010) is an exception as they focus on data from Taiwan and India implementing a VAR approach.

[54] Eichengreen et. al. (1992) named this anomaly as a "price puzzle".

contrast, the real industrial production growth in the UK declines for the entire period following the negative shock. Second, although the response of prices is tainted due to the sign restriction, it is interesting to note that we do observe the price puzzle for the UK and Japan when we consider the full sample. We conjecture that the price puzzle in these two countries is not an outcome of passive monetary policy but it is related to excess bank lending over the period prior to the financial crises. Third, when we inspect the behavior of real exchange rates, we observe delayed overshooting in Japan and the exchange rate puzzle in the UK and in the US.[55],[56]

In explaining our findings for developing economies, we also address the impact of currency or financial crises that these countries experienced throughout the investigation period. Our investigation shows that the real economic activity, similar to developed economies, does not respond significantly to a contractionary monetary policy shock. We observe significant evidence for the price puzzle only for Mexico which we explain referring to the factors that led to the currency crises in 1994. When we inspect the behavior of the exchange rate, we observe an appreciation of the domestic currency for all countries up to three years: in other words we observe the delayed overshooting puzzle in all countries. However this behavior is also significant only in the case of Mexico.[57] We argue that financial liberalization, poor banking regulations, and the use of complex financial tools which undermined transparency in financial markets have led to anomalous behavior in consumer prices and exchange rates. We, therefore, claim that in macroeconomic policies aiming to stabilize inflation and fiscal sustainability will be ineffective when the financial markets are poorly regulated.

The remainder of the chapter is organized as follows. Section 2 explains the methodology, section 3 provides information on the data and illustrates the results of the VAR analysis in terms of impulse responses and variance decomposition. Finally, Section 4 offers some concluding observations.

2.2 The Bayesian VAR Methodology

We empirically investigate the impact of a contractionary monetary policy shock on the economy especially that on output and exchange rate. We construct a VAR system that consist of real industrial production, exchange rate, money market rate, total reserves and consumer price index and follow the identification approach suggested in Uhlig (2005) by

[55]For all the countries the real exchange rate is measured with respect to the US dollar whereas the real exchange rate for the US is measured against the SDR. All real exchange rate variables are drawn from the International Financial Statistics (IFS).

[56]Scholl and Uhlig (2008) report the presence of the exchange rate puzzle for US- Germany, US-UK, US-Japan.

[57]A typical delayed overshooting result predicts that exchange rate overshoots its long-run value in response to monetary shock but it reaches its peak after one to three years instead of happening immediately.

imposing sign restrictions. By construction, the growth rate of real industrial production and that of the real exchange rate are the focus of interest and we do not impose any sign restrictions on these variables. However, we restrict the impulse responses of monetary and price variables to identify monetary policy shocks.

We can show that there are several impulse responses which satisfy the sign restrictions for k=0, 1, 2,3,4,5 which k represents the months after the shock. To obtain these impulse responses, we have produced 10 000 candidate draws. Uhlig (2005) shows that sign restrictions will cut off the distribution of the initial impulse responses of prices and total reserves which have been generated by cholesky decomposition.

In all of our plots we show the median plus 16% and 84% quantiles for the sample of the impulse responses. This represents 1 standard deviation band. However, it is quite popular in the literature to use two standard deviation bands which means that using 2.3% and 97.3% quantiles. Consistent with Uhlig (2005) , since we did not identify our model completely and also for computational reason, we just use 100 draws to base our inference in pure sign restriction approach , we cannot report these quantiles as accurately as literature wants and thus we use 1 standard deviation bands rather than using 2 standard deviation band. Additionally, one standard deviation bands are also fashionable in this literature.

2.3 Data and Result

In this section, we present our results that we generate using the pure sign-restriction approach. We carry out our analysis using monthly data which covers the period between January 1988 and December 2009 for the US, the UK and Japan as well as Mexico, Malaysia, South Korea. We compare and examine the results gathered from these countries to understand how monetary policy shocks affect output, exchange rate and prices. Our empirical model is similar to that of Bernanke and Mihov (1998) and it is well studied in the literature. Our investigation makes use of real industrial production, commodity price index, total reserves, the real exchange rate and short-term interest rate. The data on the interest rate are taken from line 60b of the International Financial Statistics. Data for total reserves are taken from line 12 of the same source and it represents total reserves minus gold. Data on the consumer price index (CPI) and the industrial production are extracted from lines 64 and 66, respectively. Last but not least, the real effective exchange rate is taken from line 42. Note that the real effective exchange rates of the UK, Japan, Malaysia, Korea and Mexico are measured with respect to the US dollar. The real exchange rate for the US is given with respect to the SDR. Given the definition of the real exchange rate series, an increase indicates a real depreciation whereas a decline indicates a real appreciation. We use the logarithmic first difference of each variable in our VAR system with the exception of the short-term interest rates which is used in levels.

We built our VAR model allowing for 12 lags in the logarithmic difference form of the series with the exception of the short-term interest rates which is used in levels. To achieve identification of the VAR system, we impose that the response of inflation and growth of total reserves would not increase and that of money market rate would not decrease for the first six months following the monetary policy shock; i.e. s = 5.

2.3.1 General Observation

We have three sets of key results. The first set is about the effect of monetary policy shocks on real output. We find that a negative monetary policy shock does not necessarily lead to a contractionary effect on real industrial production. It is possible that the ambiguous effect of monetary policy on economic growth is related to the response of the financial sector to changes in monetary policy. Given our observations, it appears that transparency and a well behaving financial sector can restore the confidence in the economy so that the uncertainty surrounding the future economic growth and inflation can be deflated to a large extent. More specifically, our findings suggests that sunspots are not necessarily generated due to the implementation of passive monetary policies but due to the actions of a poorly regulated financial sector[58]. Hence, it might be more important to (re-)institute a well functioning financial system prior to meddling with the monetary policy to achieve full economic recovery.

Second, when we consider the full data, we do find evidence for the presence of the price puzzle for the UK and Japan. Evidence of the price puzzle begs an answer to the question on the underlying factors that generate this indeterminacy. Although, Castelnuovo and Surico (2010) argues that the indeterminacy is due to violation of the Taylor principle[59] their suggestion is not consistent with the adoption of inflation targeting by the BoE or the inflation averse policies followed by the BoJ.[60] We conjecture that the mechanism that generated sunspots both in the UK and in Japan was related to the excess bank lending that took place before the periods of crisis that both countries went through. A sharp increase in bank-lending accompanied by poor bank regulation can easily lead to speculation and mal-investment. Under such circumstances a crisis can easily spiral into poor economic conditions as both countries experienced. We show that this anomaly

[58]This conjecture perhaps does not correspond to the US reaction to monetary policy shocks due to its size and the way it is governed.

[59]The Taylor principle states that if the coefficient of inflation in the standard Taylor rule is smaller than one, then the rational expectations model has multiple equilibria and the expectations become self-fulfilling.

[60]Lubik and Schorfheide (2004) argue that the association of indeterminacy with passive monetary policy is model specific. Dupor (2001) shows that in a continuous time model with endogenous investment passive monetary policy is consistent with determinacy. However, in the New-Keynesian widely used in the literature to analyze the monetary transmission mechanism of interest rate shocks, passive monetary policy is the generated mechanism of indeterminacy.

disappears once the periods of crises are removed from the analysis. It seems that without establishing a well functioning and a well regulated financial sector, it would be hard to achieve economic recovery. Turning to the price puzzle in developing economies, we do not find significant evidence to that end except for the case of Mexico. We argue that significance of the price puzzle for Mexico is due to those factors which led to the financial crises that took place in 1994. In particular, we show that once the effects of financial crisis are removed from the data, the price puzzle for Mexico disappears.

Our third set of results relates to the behavior of the real exchange rates of the countries in our sample. We find that the reaction of exchange rates to monetary policy shocks is not identical across all three developed countries. In particular, there is evidence of a delayed overshooting puzzle for Japan.[61] In contrast, for the UK and the US we find evidence for the exchange rate puzzle; depreciation of the real exchange rate in response to the contractionary monetary policy.

For all three developing countries in our dataset, we observe that the response of the exchange rate to monetary policy shocks is delayed.[62] However, this behavior is significant only for Mexico.

It is worth noting that within the framework of a typical delayed over-shooting model, as demonstrated in empirical studies including that of Eichenbaum and Evans (1995) and Grilli and Roubini (1995, 1996), the value of exchange rate overshoots its long-run level in response to a monetary shock and reaches its peak after one to three years rather than instantaneously as the Dornbushs overshooting model suggests.[63] Hence there is a critical disagreement between the standard theory and the baseline evidence regarding the effects of monetary policy shocks on the behavior of exchange rates.[64] Recently, Faust and Rogers (2003) argue that the delayed overshooting is an artifact of the recursive identification scheme. In particular, they show that there is no evidence of delayed overshooting model once mild sign or shape restrictions are imposed to identify monetary policy shocks. Yet, Scholl and Uhlig (2008) restore the delayed overshooting puzzle by imposing sign restrictions on the impulse response functions.

[61]Essentially, this means a desecration of the uncovered interest parity (UIP) condition which is called as the 'forward discount puzzle'. It is important to note though that there could be a forward discount puzzle even with no delayed overshooting.

[62]A typical delayed overshooting implies that exchange rate overshoots its long-run value in response to monetary shock but it reaches its peak after one to three years instead of happening immediately as expected by the Dornbushs overshooting model. Essentially, this means a desecration of the uncovered interest parity (UIP) condition which is called as the *forward discount puzzle*. It is important to note though that there could be a forward discount puzzle even with no delayed overshooting.

[63]The delayed overshooting puzzle is also named as the forward discount puzzle due to a violation of uncovered interest rate parity. It is worth noting that a forward discount puzzle might exist even if there is no delay overshooting. See also Leeper et. al. (1996), Clarida and Gali (1994) and Kim (2001).

[64]Dornbuschs (1976) famous overshooting model, which predicts that an increase in the domestic interest rate relative to the foreign interest rate leads to an immediate appreciation followed by a depreciation of the domestic currency to its long-run equilibrium level.

2.3.2 Empirical Results

Figures in appendix 2 show the impulse responses for Japan, the UK and the US as well as Korea, Malaysia and Mexico to a "contractionary" monetary policy shock for different sample periods[65]. Figures 1, 3, 3, 6, 7 and 8 plot the impulse responses for the full sample for each country, respectively. Figure 2 presents the impulse responses of Japan to a contractionary monetary policy when we use shorter periods as we investigate the role of crises. We follow a similar strategy regarding the effects of crises periods for the UK on the response of variables to monetary policy shocks. In particular Figure 4 depicts the response of the UK economy as we exclude the periods of EMS currency crisis and the recent financial crisis.

We also have the figure 9 that show the response of the Mexican economy for the post 1994 crises data. The subsequent discussion explains the response of each economy to a contractionary monetary policy shock followed by a detailed account of the price and exchange rate puzzles in Mexico.

2.4 Results from Developed Countries

2.4.1 The Case of Japan

When we inspect Figure 1, we observe that a contractionary monetary policy shocks have unclear effects on the real industrial production of Japan. Real industrial production growth does not respond to the shock for the first two and a half years after which it starts to increase. Overall, the reaction of industrial production growth in Japan is around the baseline level suggesting that a contractionary monetary shock does not create large fluctuations in industrial production. Evidence that adverse monetary shock is not an important source of fluctuation in Japans economy is consistent with the fact that Japanese monetary authorities faced nearly-zero interest rates for most of the period that we explored in this study. Thus, when the economy experiences a recessionary shock, monetary authorities cannot stimulate the demand by decreasing interest rate since the nominal interest rate cannot go below zero. Put it differently, zero bound interest rate reduces the effectiveness of monetary policy; should the economy face a shock on aggregate supply or demand, monetary policy cannot be used to return the economy back to its equilibrium[66].

We next turn to examine the behavior of consumer prices. We put the restriction that inflation should not increase in the first 6 months following the negative monetary policy shock. But then inflation begins to exhibit an increasing trend; although inflation remains

[65] All the graphs for this chapter are located in the second appendix (Appendix 2) of this thesis.

[66] Baba et al. (2004) show that although the ratio of money base to GDP doubled after 1995, deflation has persisted. They also argue that evidence of recession and deflation was due to the low and even negative growth rate of bank loans.

below the baseline level for almost two years, it becomes positive and increases for the rest of the period. On average there is mild evidence of the price puzzle which might be an artifact of omitted variables problem as suggested by Sims (1992) and Castelnuovo and Surico (2010). In particular, Castelnuovo and Surico (2010) argue that in a New-Keynesian model the omitted variable problem is the by-product of a passive monetary policy which leads to indeterminacy. Indeterminacy, as Lubik and Schorfheide (2004) stress, is an outcome where policy shocks are not uniquely identified and sunspots become important in generating business cycles and affecting the equilibrium. Hence, structural VAR models (SVAR) would be misspecified should one mistakenly omit forward-looking variables such as expected inflation. Under such circumstances, monetary policy shocks will not be identified properly.

We presume that the price puzzle is surfacing here due to the economic crises that Japan went through over the late 1980s and early 1990s. In particular, recall that the bank of Japan (BoJ) during this period followed an expansionary monetary policy to mitigate the impact of Yens appreciation in order to comply with the 1985 Plaza Accord. The expansionary monetary policy, along with the current account surplus, led to excess liquidity in the financial system fueling financial assets and real estate prices. During this period, the Japanese monetary policy authorities were also concerned about the possibility that inflation would surge as a consequence of the developments in the economy. To counteract a potential surge in inflation, BoJ doubled the bank rate. Yet, they were then slow to reduce it. The increase in the bank rate exerted a negative impact on real estate and stock prices resulting in an increase in the number of loan defaults. The negative impact of loan defaults on the economy was further exacerbated as Japanese banks ended up with the final bill in the form of bad loans. The damage was done: bad loans, continuous increases in the number of defaults and reduction in real estate and stock prices paved way to a deflationary environment making demand side policies ineffective.

Given the negative and protracted nature of the crises in Japan, we conjecture that the presence of the price puzzle could be due to excess lending and poor banking regulation that was in effect prior to the financial crisis. To provide evidence to our conjecture, we generate the impulse responses for the post-crises period so that we can circumvent the indeterminacy possibly induced by the inclusion of this period in the analysis. Figure 2 depicts our observations for the 1992-2009 period. When we concentrate on the behavior of prices, we see that although prices fall and remain below zero for the whole period there is still a tendency in prices to increase following the third year. Once we exclude the 2007-09 period from the analysis the price puzzle disappears fully. However, while the reaction of the other variables do not change, it now appears that the adverse monetary shock has a negative effect on industrial production growth.

When we turn to analyze the movements in the real exchange rate, we observe in Figure 1 that the Japanese Yen appreciates following the monetary policy shock for a year and then settles around its baseline as the value of the currency does not appear to change much (although there is some evidence of depreciation following a year and a half of the shock, this is very mild). Thus, there is evidence of delayed overshooting following the contractionary monetary policy shock. However, the delayed overshooting in Japan might be a mirror response to the price puzzle. More specifically, exchange rate initially appreciates to mitigate the effects of expected inflation and then depreciates. Once we exclude the periods of financial crises the delayed overshooting disappears.

2.4.2 The Case of UK

We next inspect the results for the UK. Figure 3 plots the impulse responses of the variables when we use the full data. In general, we observe that the industrial production growth falls following a contractionary monetary policy shock. However, this drop is not too large. As expected, inflation initially falls due to the restriction that we impose for the first 6 months. Afterwards inflation increases reaching a peak by the end of the first year while it remains above the baseline for the rest of the period. Yet, the deviation of inflation from the baseline is negligible after the four years following the shock.

Similar as in the case of Japan, the positive relation between inflation and interest rate could be due to the fact that the UK economy went through a period of crises in early 90s. In this period, in conjunction with the German unification and the subsequent contractionary monetary policy that Germany implemented, the UK economic outlook deteriorated and unemployment increased substantially. However, to reduce unemployment, the British government could not stimulate economic growth by devaluating the British pound because the UK was a member of the ERM. The option for the UK, at that time, were either to opt out of the ERM and achieve higher economic growth by devaluing the domestic currency or to remain in the ERM and suffer a severe recession. The market bet in favor of the former option leading to a speculative attack on the British pound in September 1992. Given this panorama of the UK economy, it appears that the devaluation expectations and the subsequent inflation expectations could as well be the underlying mechanism for the price puzzle that we observe in the data. To test for this possibility, we repeat the analysis concentrating on the post 1992 EMS currency crises period to remove the immediate effects of this period of uncertainty. As in the case of Japan, we also estimate the impulse responses by excluding the recent financial crisis. Our empirical results about the period between 1995-2009 and 1995-2007 provide evidence supporting our explanation that the price puzzle disappears once periods of crises are removed from the data.

Our results are consistent with Benati (2008) who using a time-varying coefficient structural VAR (TVC-SVAR) shows that there is a violation of the "Taylor principle" during the entire decade of the 80s. The UK joined the ERM on October 1990 and opt out of the ERM in September 1992. The long- run coefficient on inflation is estimated to fluctuate between 0.7 and 0.8 before the UK joined the Exchange Rate Mechanism (ERM). During the ERM, the interest rate differential between the UK and Germany declined from 2.3 to 0.4 (see Gross and Thygesen 1998). In line with the empirical regularities, Benati (2008) estimates a temporary decrease in the long-run coefficients on inflation and output growth during the ERM period. However, after the introduction of inflation targeting in October 1992, following the suspension of the EMS membership, the long-run coefficients on inflation and output increased substantially, reaching 1.4 and 0.9, respectively. This observation suggests that the "Taylor principle" is not violated over the period following the introduction of inflation targeting to the current financial crisis. To put it in other words, although there was a violation of the "Taylor principle" before the EMS crisis, this was not the case for the period prior to the recent financial crisis.

The behavior of the British pound exhibits an interesting reaction to monetary policy shocks. We observe that the real exchange rate depreciates after a contractionary monetary policy shock in all three graphs providing evidence in favor of an exchange rate puzzle which might be consistent with the presence of a price puzzle. More specifically, within the Frankels (1979) overshooting model an increase in the interest rate will lead to depreciation only if the expected inflation is higher than nominal interest rate[67]. This explanation accords with the observations in Figure 5 where the depreciation of real exchange rate becomes explosive after two years following the monetary policy shock.

2.4.3 The Case of USA

Finally, we concentrate on the behavior of the US economy to a contractionary monetary policy shock. Figure 5 shows our observations. The reaction of the US economy to a monetary policy shock has been studied by several researchers including Uhlig (2005), Scholl and Uhlig (2008) and it is pleasing to see that our findings in general align with theirs. We observe that the industrial production growth in the US increases at first and then falls towards the baseline supporting Uhlig (2005) that a contractionary monetary policy does not necessarily lead to a contraction in the economy. When we turn to observe

[67] Frankels overshooting model suggests that the deviation of exchange rate form its equilibrium value depends on the real interest rate differential:

$$s_t = \bar{s} - \frac{1}{\Theta}[(i_t - \Pi) - (i_t^* - \Pi^*)] \quad (2.4.1)$$

where s_t is the current exchange rate, $\bar{s}$ is the equilibrium exchange rate i_t, is domestic nominal interest rate, i_t^* is foreign nominal interest rate, Π is the long-run domestic inflation rate and Π^* is the foreign long-run inflation rate.

the behavior of prices, we see that inflation falls for the first six months reflecting the restrictions that we impose. Furthermore, inflation remains below the baseline for most of the time and it does not appear to have a tendency to increase although it exhibits some cyclicality.

Similar to the UK, the real US dollar, which is measured against the SDR, exhibits the exchange puzzle: the US dollar depreciates following a contractionary monetary policy shock. This might be due to a forward discount puzzle where violation of uncovered interest rate parity (UIP) is driven by the existence of forward risk premium. Here, the risk premium implies that the forward premium is higher than the expected devaluation. This result along with the behavior of other variables in our VAR are in line with Scholl and Uhlig (2008) and Fratzscher at al. (2010) who found strong evidence for a forward discount premium in four developed countries.

2.5 Developed Countries: Evaluation of the Results

Our results have strong policy implication for all there countries but mainly for those which experience the price puzzle: the UK and Japan. Throughout the period under investigation, although both Japan and UK attempted to defuse contraction in their economies by implementing monetary and fiscal policy tools to boost demand, both countries failed to achieve their goals. Following the financial crises of the late 80s, the BoJ reduced the rate of interest to zero and kept it at that level as the government increased its expenditures to stimulate the economy. There was a reluctance to use a quantitative easing, because even when Japan experienced deflation, BoJ was averse to possible future inflation. Similarly, the recent financial crisis forced the BoE to reduce the bank rate to unprecedented low levels while, different from the BoJ, increasing the money supply to support the demand side of the economy.

When we turn to observe the reaction of the Labour government which was in power during the 2007-2009 financial crises, we see that the government implemented expansionary fiscal policies and strive hard to convince governments in continental Europe and the US to do the same. In contrast, the subsequent ToryLib-Dem coalition government that took power in 2010 restructured the fiscal policy to achieve a medium to long-term reduction of fiscal deficit and national debt. Under the current situation it is debatable that the two sets of (conflicting) policies implemented by the BoE and the government will push the country to its long-run growth path rather than to a low equilibrium where growth will be too slow for a protracted period into the future. More concretely, given that the monetary policy had limited impact on the demand side as experienced in Japan, USA and the UK[68], the coalition government might have been too quick to attempt to reduce

[68] Quantitative easing did not lead to inflation in Japan in the past.

government expenditures to keep the public expenses in check. This complete reversal of the UK fiscal policy may have further undesirable consequences as inflation in 2011 is on the rise as a result of increases in fuel and wholesale commodity prices inducing inflation expectations of the public.

Furthermore, the presence of the price and exchange rate puzzles implies that sunspots could have significant effects on the business cycle. In particular, it may be the case that pessimism about the future economic circumstances might have introduced further negative feelings on the effectiveness of monetary policy in Japan and in the UK. Although the earlier research has shown that the price puzzle or sunspot is a by-product of passive monetary policy, our observations for the UK and Japan are not consistent with this view. The reason is that over the period of investigation and importantly during the financial crisis, monetary policy makers in both countries played a very active role. Given the evidence, we suggest that the underlying factor to sunspots is excessive bank lending and poor bank regulations. In Japan banks kept funding its customers before the financial crises as long as the borrower was able to provide a collateral in the form of real estate. This strategy worked well while the real estate prices were stable or increased over time and the economy was not overheated as the asset bubble formed which eventually happened in Japan in the 1990s and in the USA in 2007. However, once the bubble burst this practice imposed immense negative effects both on financial and real economic sector. In the case of the UK, Haldane et al. (2007) show that UK banks increased their unsecured exposures along with UK households secure debt to figures around 32% of UK banks total lending. Haldane at al. (2007) also explain that households were very sensitive to adverse shocks and there were signals of stress with the number of personal insolvencies sharply increasing before the 2007-2009 financial crises.

It is also worth stressing that in the UK the price puzzle might have been the mirror response of the exchange rate puzzle and vice-versa. More specifically, expected depreciation of pound fuels expected inflation and expected inflation further increases expected depreciation. The fundamental question is why there was an expected depreciation or an increase of expected inflation in the first place. Is it due to bad policy or due to bad luck? In our view it is due to a combination of both for the UK and due to bad policy in Japan. Although in both countries the driving force behind expected inflation was excess lending prior to the crises, the new element in the 2007-2009 financial crisis is the increases in commodity prices and oil prices that happened con- currently. Under such circumstances policy makers have to identify which part of expected inflation is generated by supply shocks (i.e. oil price, food prices etc.) and which part of inflation is generated by sunspots. The latter in both countries was a result of poor bank regulation which after the crisis led to an uncertain economic environment undermining the effectiveness of monetary and fiscal policy concerning the future economic growth. Our results suggest that any decision to increase the interest rate by the BoE should be associated with demand factors that affects expected inflation. However, expected inflation is due either to supply shocks or to bad policy prior to the recent financial crisis. Thus, an increase in interest rate will not only undermine future economic growth but it might also issue wrong signals concerning the credibility of BoE monetary policy committee.

As a final step of our empirical study we perform a variance decomposition analysis. Table 1 shows the variance decomposition of all variables for all three countries in response to an interest rate shock. We can see that movements in monetary policy is responsible for a small fraction of the state variables movements in any of these countries. More concretely, monetary policy explains at about 20% of the variability of any of the variables included in the VAR system. Last but not least within each group of countries the variance decomposition is relatively the same.

Table 1: **Fraction of Variance Decompositions**

Fraction OF Variance for IP	6 month	12 month	24 month
Japan	10 %	14 %	16 %
United States	10 %	14 %	16 %
United Kingdom	11 %	17 %	20 %
Fraction OF Variance for CPI			
Japan	22 %	21 %	20 %
United States	15 %	20 %	18 %
United Kingdom	18 %	22 %	23 %
Fraction OF Variance for Exchange Rate			
Japan	11 %	13 %	17 %
United States	16 %	20 %	22 %
United Kingdom	12 %	15 %	20 %

2.6 Results from Developing Countries

2.6.1 The Case of Malaysia

Figure 6 represents the results for the Malaysia. Our results show the impact of real industrial production growth to monetary policy shocks in Malaysia. We see that the growth of real industrial production decreases after the shock. However, this fall is not significant. Inflation, measured by the log difference of CPI, also decreases following the shock. The fall in inflation becomes larger after the first year and keeps falling till the end of period. When we inspect the change in the value of the Malaysian Ringgit, we see that the currency appreciates in the first two years following the shock and depreciates afterwards. Yet its response is not significant. The initial appreciation of the real currency might be explained by the increase in bank lending which was fueled by the international banks desire to enter the East-Asian markets before the 1997 financial crises.[69] These capital inflows, used to fund private investments rather than consumption and government expenditures, led to an appreciation of domestic currency by putting an upward pressure on the prices of non-tradable goods. Hence, the behavior of the Ringgit depicted in Figure 1 is not surprising and can be described as delayed overshooting.

2.6.2 The Case of South Korea

Figure 7 displays the impact of monetary policy shocks in South Korea. In particular, we observe that the real industrial production in Korea increases slightly during the year following the shock returning to the baseline level by the end of the period. We also see that the consumer prices fall immediately after the shock as it stays around the baseline level for the remainder of the period. When we inspect the behavior of the South Korean

[69] Bank claims to private sector increased by more than 50 per cent relative to GDP, from 1991 to 1997, in Thailand, Korea and Malaysia (Source: Pilbeam, 2006, pp. 469).

Won, similar to the Ringgit, we observe that the real exchange rate appreciates nearly for three years and then depreciates till the end of period. But the movements in the exchange rate are not significant.

2.6.3 The Case of Mexico

Finally figure 8 displays our observations for Mexico. We find that a contractionary monetary shock in Mexico exerts a negative impact on the growth of real industrial production in the first year. Towards the end of the second year, the growth of the real industrial production goes back to the baseline level and then starts to increase slowly after year three. When we look at the response of prices, we see that the inflation increases following the shock and this increase lasts for about three years after which it declines. In this context, Mexican economy displays price puzzle following a contractionary monetary shock. We also observe that the value of the Peso appreciates significantly after the shock for about two years and a half and then depreciate till the end of the period. Hence, Mexico presents a case where we observe the delayed overshooting puzzle.

2.7 Understanding the Price Puzzle in Mexico

The evidence in favour of the price puzzle and of the appreciation of Mexican peso after a contractionary monetary shock is consistent with the underlying mechanisms which eventually led to the 1994 currency crisis. More concretely, after the 1982 crisis the Mexican government implemented a series of reforms to join the NAFTA. In particular, the Mexican government pegged Peso to US Dollar and begun to follow an anti-inflationary policy. However, tight monetary policy accompanied by financial liberalization resulted in increasing interest rates and capital inflows which were used to fund domestic demand. Although the domestic inflation declined after these reforms were introduced, it was still much higher than the rate of inflation in the US. As a consequence, the Peso began to appreciate in real terms and the current account deficit increased in relation to the GDP. Under such circumstances, devaluation expectations increased which later fed to the domestic prices[70].

Given the above discussion, positive reaction of prices to a contractionary policy shock reflects devaluation expectations and the subsequent high inflation that followed the devaluation of the currency. This is consistent with Sims (1992) and Castalnuovo and Surico (2010) who argue that a passive monetary policy will lead to multiple equilibria and self-fulfilling expectations. In this set up, appreciation of the Mexican peso reflects a passive

[70]Combination of high inflation and current account deficit (CAD) made it difficult for the the Mexican government to fund CAD by issuing peso-denominated bonds. They started to issue dollar-denominated bonds (tesobonos). Tesobones bought by domestic banks which used them as a collateral to attract capital from the US banks by means of tesobono swaps. However, in February 1994 when the Federal Reserve raised its interest rate there was massive capital outflows, leading peso to be evaluated by 15 per cent.

monetary policy accommodating higher inflation than that is required to restore balance of payments equilibrium. Interestingly, following the 1994 currency crisis, once the new real exchange rate equilibrium is established, the price puzzle disappears. In fact observing Figure 4, which replicates the analysis using the data for the post 1994 period, the price puzzle is not an issue of concern while our observations for the remaining variables still hold.

It is worth noting that while the Korean and Malaysian economies experience relatively similar reactions to a monetary policy shock, Mexico differs from the former two emerging economies and possibly due to differences in the evolution of the Mexican monetary policy. For instance, Mexico, under the dual exchange rate regime (from 1982 to 1991) never experienced severe capital controls. Furthermore, the central bank of Mexico, took measures to avoid the formation of black market in currency transactions by keeping the gap between the official exchange rate and market exchange rate low. In March 1988, the Mexican monetary policy changed dramatically with a comprehensive anti-inflationary view. Some economists argue that this change in the monetary policy was the main source of fluctuations in Mexico.

Contrary to this view, one can argue that the main source of exchange rate, output and price fluctuations in Mexico is mostly due to foreign shocks. Del Negro and Obiols-Homs (2001) point to the US business cycles as the primary source of disturbances to real activity in Mexico. Thus, this could be an alternative explanation as to why we observe the price puzzle in Mexico but not in Korea and Malaysia. It might also explain why the size of the Peso appreciation is different from that of Won and Ringgit. In this context, although it is out of the scope of the this thesis, it would be interesting to explore the effects of shocks emanating from foreign countries, especially the role of US monetary policy shocks on Mexico and possibly other Latin American countries.

2.8 Understanding the Exchange Rate Puzzle in Mexico

Evidence we have so far displayed shows that monetary policy shocks leads to appreciation of the real exchange rate for several quarters in Malaysia, Korea and Mexico before the value of the currency declines. Looking at the figures, although one can see the tell-tale patterns of delayed overshooting and forward discount puzzles those patterns are not significant except in Mexico. The key element that differentiates the delayed overshooting in Malaysia and Korea from that in Mexico is related to various factors which generated growth in the pre-crisis period. In the case of Mexico it was the euphoria due to the economic recovery supported by the US after the crisis in 1982 and to the structural changes such as the privatization of state-companies, trade liberalization, financial liberalization, fiscal reforms and monetary policy based on exchange rate targeting. In fact the Mexican economic recovery was called the *Mexican Miracle* as the country become the second largest importer of capital in the early 1990s (see Kuroda, Tomita and Kazuhiko (2000), p.3). However, liberalization of domestic markets increased imports far beyond that of exports and generated a current account deficit. In return, the resulting current account deficit raised devaluation expectations as the initial euphoria in the capital markets transformed into a panic which resulted in a speculative attack. Thus, the key factor towards the finding of the price puzzle and the delayed overshooting puzzle was the boom and bust of Mexican economy which was the by product of initial macroeconomic and structural reforms accompanied by poor financial regulation. From this framework, it is not too surprising to see the initial euphoria of high economic growth transforming into devaluation expectations.

The same arguments about the nature of financial crises could apply for Malaysia and Korea. However, the lack of significant evidence of delayed overshooting will raise some questions about the importance of market expectations as the main factor behind the 1997 financial crises. Here, too, although market expectations were important these two countries fell into economic crisis due to supply side shocks. In particular, trade liberalization affected the economic growth negatively in Malaysia and Korea as Chinese producers benefited greatly from such policy changes. The gloomy picture in the region was also exacerbated by a diminishing demand from Japan. A number of events further fueled the economic downturn. In 1996, Habo and Sammi steel industries and Kia motors in Korea went bankrupt. Commercial banks which lend funds to these industries also came under strong pressure. The collapse of Thai Baht as a result of a fall in property prices had domino effect, due to trade links between Malaysia, Indonesia and Philip- pines. Hence, it appears that although in all three countries the genesis of crisis was resulted from implementation of liberalization policies which was based on poor financial market regulations, Mexico mainly suffered from soft fundamentals (market expectations) while Korea and Malaysia were dragged into crises due to negative shocks impacting the real economy.

2.9 Conclusion

In this chapter we investigate the impacts of monetary policy shocks on output, exchange rate and prices using data from the UK, the US and Japan as well as Mexico, Malaysia and South Korea. We carry out our investigation implementing an agnostic identification method recently proposed by Uhlig (2005). In this framework, to achieve identification we impose sign restrictions on domestic short-term interest rates, prices and total reserves for the first six months following the contractionary shock. We apply no restrictions on real exchange rate and output so that the impulse responses of these variables are completely determined by the data. Regarding the restrictions that we impose, we follow the conventional wisdom and assume that a contractionary monetary policy shock does not lead to a fall in domestic short-term interest rates, does not increase domestic prices and does not increase total reserves. We have three sets of observations.

First, the response of real output to adverse monetary policy shocks is ambiguous in a way that in most cases it does not have a significant impact on output as the response can be positive as well as negative. Therefore, we cannot be as comfortable as before when commenting on the impact of a contractionary monetary shock on the output.

Second, among developed economies, we observe price puzzle for Japan and UK when we use the full sample period during which both countries experienced 2 two distinct periods of crises including the recent 2007-2009 financial crises. We argue that the price puzzle is an artifact of excess lending and poor banking regulations. Excess lending prior to financial crises created inflationary expectations which in the case of UK have been further enhanced by depreciation of the home currency. In other words, we conjecture that the price puzzle in Japan and the UK is not a by-product of passive monetary policy, as the central banks were active through out the sample period, but rather it is an outcome of the poor regulation of the banking system which led to a lending boom and inflationary expectations. Our results suggest that the appropriate tool to satisfy market expectations and to restore public confidence is through increasing the transparency of banking system and introducing a better financial regulatory system. For developing economies, we observe the price puzzle only for the case of Mexico. We show that this observation disappears for the post-crisis period. We argue that the price puzzle was the by-product of real exchange rate appreciation generated by a passive monetary policy accommodating higher level of inflation than that is required to achieve equilibrium in the balance of payments.

Third, we show that the exchange rate puzzle occurs in the UK and the US for developed economies while we observe the delayed overshooting for Japan. Empirical evidence suggests that in Japan exchange rate responds to mitigate expected inflation while in the UK and the US exchange rate response accommodates expected inflation.[71] For developing economies, we provide evidence that the Mexican Peso exhibits significant evidence for delayed overshooting. Overall, although these observations we present here would be of use to researchers and policy makers, as data becomes available more research on emerging economies is warranted.

Last but not least, the results in this thesis suggest that monetary policy shocks can explain only a small part of the variation in output and prices. Quantitatively, monetary

[71]In an attempt to explain empirical findings of delayed overshooting theoretical research such as Gourinchas and Tornell (1996, 2002) argue that delayed overshooting is the by- product of learning the current state and the intrinsic dynamic if interest rate reaction to monetary shocks.

policy shocks seem to have a negligible effect on exchange rate fluctuations as well as output, in contrast to some of the literature.

Chapter 2

What Are the Impacts of Fiscal Policy on Private Consumption and Wages in UK and Italy Using Sign Restriction Approach?

3.1 Introduction

What are the impacts of fiscal policy shocks on the economy? And which theory explains the response of economy to fiscal policy shocks more effectively? Fiscal policy and the analysis of the policy alike have not attracted enough attention in the literature compared to a large body of research focusing on monetary shock. It is surprising since there is a lengthy public debate on the impacts of fiscal policy that bring about arguments about the importance of government spending and taxation. The discussions about having independent organizations to implement fiscal policy, for instance, are all emphasizing that fiscal policy is believed to be effective to soothe business cycles fluctuations.

In addition, there is not a widespread agreement about which theory is able to explain the impacts of fiscal policy. As a result, researchers have been particularly keen to systematically observe the performance of benchmark theories concerning the impacts of fiscal policy. This is an important deficiency in the literature. And therefore one of the objectives of this thesis is to assess the validities of these textbook models.

Our focus is on the behavior of private consumption and wages after a fiscal shock since different theories predict contrasting behavior of these two variables. It could be said that, while it is mostly agreed that expansionary government expenditure increases output, the behaviors of wages and private consumption are ambiguous. For instance, the traditional IS-LM model assume that an expansionary government expenditure increase private consumption. Real business cycle (RBC) model, on the other hand, shows consumption falls as a consequence of negative wealth effect after the similar shock. We put private consumption as the center of attention since it is the main determinant of the aggregate demand. One of the purposes in this thesis, thus, is to investigate the comparability of these two benchmark theories.

Macroeconomists see the economy as a dynamic and stochastic system that responds to past and present random fiscal shocks. For this reason, they employ vector autoregressive (VAR) approach, initiated by Sims (1980), to understand the response of economic variables after changes in government spending and revenue. In order to get meaningful results, econometricians identify fiscal policy shock through different identification schemes. Several papers, for instance, make the assumptions that key economic variables have sluggish reaction to these fiscal shocks[72]. Others employ additional information such as institutional changes in tax systems and the role of political issues such as wars and election[73]. Different from the mentioned literature, this thesis follows Uhlig and Mountford (2009) and simply uses macroeconomic time series data to identify the model. For instance, we do not make any assumptions about timing of the institutional changes in tax systems and also do not put any restrictions on the behavior of the key economic variables such as prices, consumption, output and wages: we want to let data speak about their reactions after a fiscal shock.

There are some universal concerns in studying fiscal policy using VAR approach. First, changes in tax rates and also amendment in government expenditure is always pre-announced. Therefore this *lag* between the announcement and implementation of these policies can lead to some movements in macroeconomic variables before any actual change occurs in fiscal policy itself. We adjust our identification procedure to tackle this issue. For example for the case of government spending shock, we put a restriction that this shock should last at least for 4 quarters however after a lag of one year once the shock happens. The latter restriction controls movements that are caused by this lag between the announcement and implementation of fiscal policy shocks. Second, even though there is a general agreement that a monetary policy shock is a surprise change in short term interest rate, there is no such a thing as fiscal policy per se. To address this issue, we identify two basic fiscal policy shocks namely “government revenue” and “government spending” and require that other kinds of fiscal polices are just different linear combinations of these two basic fiscal policies. To clarify, we identify different kinds of both contractionary and expansionary fiscal policies. Finally, one should be careful in distinguishing the changes in economic variables that are caused by fiscal policy shocks from ones that are generated by monetary policy and business cycle shocks. To solve this issue, we identify monetary policy and business cycle shocks besides identifying fiscal policies and require them to be orthogonal to fiscal policy shocks.

We apply this methodology for two main European counties namely UK and Italy. Given that most of the research about fiscal policy has been done for the US, we believe that it is important to focus on European economies to enhance our understanding about the role of fiscal policy. Furthermore, after the recent financial crisis, UK and Italy apply large cuts in different sectors of the economy that leads to different demonstrations and protests from people who are going to be affected by these tight fiscal decisions. Therefore,

[72] For more details see Blanchard and Perotti (2002), Fatas and Mihov (2001a,b), Favero (2002), and Gali, Lopez-Salido, and Valles (2004).

[73] For example Romer and Romer (1994a), Ramey and Shapiro (1998), Edelberg, Eichenbaum and Fisher (1999), Blanchard and Perotti (2002), Burnside, Eichenbaum and Fisher (2003) and Eichenbaum and Fisher (2005).

we find it worthwhile to see what will be the impact of these changes for 6 coming years after this shocks happens.

To summarize our results, we find that an expansionary government spending shock lead to a significant increase in private consumption and wages. Thus, our empirical results seem to be in line with the conclusions of the models in which consumers behave in a non-Ricardian manner and hard to reconcile with those of the neoclassical theories such as RBC model.

The rest of the chapter is organized as follows. Section 2 describes our methodology as well as our assumptions. Section 3 presents our empirical results. In section 4 we analyze our findings and compare them with literature. Finally, section 5, concludes.

3.2 Literature Review

After the current financial crisis we observe that nominal interest rates are getting closer to their zero lower bound. Furthermore, firms become financially constrained to obtain credit and financial institutions' performances deteriorate during credit crunch. These cause further implementation of expansionary monetary policies to become less effective and therefore policymakers turned their attention to fiscal policy.

On this ground, a number of recent empirical papers shed some light on the impacts of changes in government expenditure and revenue on key economic variables such as unemployment and consumption. They also attempt to discriminate between the two main benchmark theories on the grounds of responses of these variables. Fiscal policy in standard textbook models changes national saving, investment, wages as well as other major economic indicators by directly affecting the demand. Accordingly, an expansionary fiscal policy boosts the demand of goods and services on impact while reducing other components of demand such as investment. This happens since total output is fixed. Yet private consumption remains unaffected since this change in fiscal policy has no impact on income. On the other hand, interest rate should increase as a result of the increase in government expenditure that reduces private investment as the consequence. This phenomenon is called " crowding out effect". This happens since government spending increases without change in taxes and therefore government has to finance its debts by borrowing from private sector. As a result, private saving falls that leads to a decrease in loanable funds available for investment. When fiscal policy is simply a decrease in taxes, we observe that disposable income and consumption rise on impact. However, this increase in private consumption accompanies a fall in private investment since factors of production and output are fixed. Moreover, one cannot investigate the impacts of fiscal policy shocks comprehensively without taking some important macroeconomic factors into account. To begin with, one needs to know what governments can and cannot do considering governments' budget constraint. Governments' budget constraint does not stop them from being always in debt. Yet, it places a constraint that the limit of present value of its debt cannot be positive. Nonetheless, there are different views about the impacts of government debt on their fiscal policy decisions.

According to the traditional theory, tax cuts reduce national saving by increasing consumption. This has a crowding out impact on investment since a fall in national saving increases interest rate. In Solow growth model, this fall in the level of investment move down steady-state capital stock and leads to a lower level of output. Therefore the economy set out with lower level of capital than in the Golden Rule steady state in the long run and private consumption declines as a consequence. To analyze the short-run impact, however, using benchmark IS-LM model, the model implies a boost in private consumption as a result of this cut in taxes. This increases demand. Since prices are sticky in the short-run, this increase in demand leads to an increase in employment. In the long run prices adjust and therefore prices and output return to their natural level.

In an open economy, investors start investing in this particular economy. This may in turn reduce the impacts of fiscal policy on capital accumulation. It can also deteriorate trade deficit as a result of an appreciation of domestic currency. According to Mundell-Fleming model, nevertheless, this has an expansionary impact on output and employment in the short run.

Our focus is simply on the impacts of fiscal policy on consumption and some other major economic indicators namely wages and output. A natural starting point to assess the literature is Keynesian theory. Put it simply, this model assuming that prices and wages are rigid, features output to be a function of demand. Therefore, an expansionary fiscal policy has a multiplier impact on output and consumption increase consequently. Furthermore, if government spending expansion accompanied by an increase in taxes, balanced budget multiplier is exactly equal to one.

Here we extend basic Keynesian theory and take into account the effects that changes in interest rate and exchange rate have on the effectiveness of fiscal policy. Therefore, in addition to the direct crowding out effect that happens to the extent that government expenditure substitutes investment with private consumption, these indirect channels also amplify the fiscal policy impacts. According to IS-LM model, private consumption has a negative relationship with interest rate. An expansionary fiscal policy if being financed by borrowing from private sector, results in higher interest rate. As a consequence, this lowers investment even further. If we also assume that the economy has international trade, exchange rate then enlarges the "crowing out effect". This happens since higher interest rate induce capital inflows that appreciate exchange rate.

By contrast, recent theories of consumer behavior argue that consumption does not depend on current income since consumers are forward looking individuals. These theories root in *Modigliani's* life-cycle model and Milton Friedman's permanent-income hypothesis. Ricardian view of fiscal policy also uses forward-looking consumers hypothesis to analyze the outputs of fiscal policy on the economy. Therefore theories that adopt this hypothesis and assume that consumers behave in Ricardian manner, such as RBC model, generally predict a fall in consumption after a rise in government expenditure. It is sensible to emphasis again that these differences in the way individuals behave after an expansionary government spending roots in how consumers are featured to act in each theory. For instance RBC model presumes that consumers are infinitely-lived Ricardian households whose choice to consume depends on their intertemporal budget constraint. In this case, expansionary government spending reduces the present value of after-tax consumers' income that in turn decreases consumption through negative wealth effect. It also raises the supply of labor at any given wage. Employment and output increase as a consequence. This being the case, wages have to fall in order to keep the equilibrium. Real business cycle basically implies that we do not understand fluctuations of the economy as much as we would think we do.

Nonetheless, central questions about the economy remain open to further discussions. Is the stickiness of prices as well as wages a crucial concept in understanding how the economy performs? Does fiscal policy have any impact to suppress fluctuations? The answers to these questions are largely dependent on the way an economist thinks about the role of fiscal policy. Economists who believe that price and wage stickiness are a natural byproduct of market imperfections are those who believe fiscal policy and monetary policy are significantly effective. In contrast, real business cycle theories argue that government just has a limited power to influence the economy. What is more, they consider business cycle as a natural reaction of the economy to amendments in technologies. In real business cycle models which is called "new classical" model as well, the invisible hand of the market leads the economy to allocate its resources efficiently.

Finally, the benchmark theories of economic fluctuations are sources of hot debates among economists and politicians. As a matter of fact, these debates and uncertainties make the science of macroeconomics interesting.

3.3 Identification of Fiscal Policy Shocks

One of the main issues in studying the impact of policies on the economy is how to identify shocks properly. This is even more controversial in fiscal policy literature. While monetary policy shock is discerned as a surprise increase in short-run interest rate, there is no such a thing as fiscal policy per se. This comes from the fact that there are wide ranges of fiscal policies induced from different sorts of taxes and government expenditure. What is more, both revenue and spending changes are often announced before being implemented. Therefore even though in monetary policy literature an unanticipated change in monetary indicator can be genuinely called as monetary policy shock, we cannot say the same thing about fiscal policy. Besides, if these pre-announced adjustments in fiscal variables do not happen systematically with changes in economic situations, there is going to be the omitted information problem in the VAR system. This leads to a misspecification of the model.

Concerning the first issue, we identify fiscal policy by a two dimensional space spanned containing government revenue and government spending innovations. We follow Uhlig and Mountford (2009) in studying fiscal policy shocks in the US. In this approach, different types of shocks are identified through distinctive linear combinations of these two basic fiscal shocks. We also address the second problem in this thesis. Due to lengthy debates that happen before the actual changes in fiscal policies, the changes in tax rates and also government spending are mostly predictable before they are implemented. As a consequence, forward-looking households and firms adjust their behavior before these shocks really happen. Our identification procedure, therefore, has been adjusted to take this shortcoming into account by simply assuming that fiscal variables change for a defined period only after a year after the shock happens.

Moreover, there is a further thorny and well-understood difficulty in identifying fiscal policy shocks. One should differentiate the movements in fiscal variables that result from other shocks such as monetary policy and business cycle shocks from those that are generated by fiscal policy innovations. We address this issue by identifying a fiscal policy shock along with monetary policy and business cycle shocks. We additionally require that these two latter shocks to be orthogonal to fiscal shocks. This extra restriction is also one of the improvements of this methodology comparing to most of the literature. Uhlig and Mountford (2009) argue that identifying business cycle shock and the requirement that fiscal policy should be orthogonal to this shock has a great impact on the robustness of the results.

We use it as an additional restriction further than merely putting restrictions on the signs of impulse responses of fiscal variables. This means that after calculating the variations in the fiscal variables, we initially check how much of these movements can be explained by business cycle as well as monetary policy shocks. Later we can conclude that whatever percentage is left unexplained is caused by fiscal policy shock.

3.3.1 Identifying Restrictions

We use GDP, private consumption, government revenue[74], government spending[75], money market rate, wages, total reserves, GDP deflator and producer price index. All variables are in levels with no exception at a quarterly frequency from 1970 to 2010, has 6 lags, no constant or a time trend. The data sources are the IMF and OECD datastream. This vector of endogenous variables are the smallest group of macroeconomic variables to study the dynamic effect of fiscal policy shocks on the economy. This model is to a large extent similar to that of Uhlig and Mountford (2009) except from our exclusion of private investment and inclusion of wage instead which is popular in the literature. GDP, private consumption and wage are focus of this thesis. Cochrane (1994) argues that the ratio of private consumption over GDP can be use to predict GDP and recommend to use private consumption in the model. As one notices here, we also have monetary variables in our model. The reason is that we identify monetary policy shock along with fiscal policy and business cycle shocks.

This thesis identifies several shocks just by putting sign restrictions on the impulse responses of some specific variables after the shock happens. Business cycle shock, for instance, is a shock where private consumption, output and government revenue move in the same way for four quarters following the shock. The assumption implies that whenever government revenue increases as a result of an increase in output, it is due to a business cycle shock rather than simply a fiscal policy shock. A contractionary monetary policy shock in this thesis is identified as a shock that reduce total reserves and prices however increases short term interest rate. Finally, fiscal shocks are mainly determined by using sign restriction. Additionally, we assume that fiscal policies are orthogonal to both monetary policy and business cycle shocks.

We start by identifying two basic fiscal policy shocks namely "government revenue shock" and "government spending shock" and then create different linear combination of these two shocks as different kinds of fiscal policy. Basic expansionary (contractionary) government revenue shock is a shock in which government revenue increases (decreases) for a defined period following the shock. Also we do not restrict the behavior of government expenditure when we are identifying government revenue shock and vice versa. It is possible, however, to restrict the behavior of the other fiscal variable when we are identifying a fiscal policy shock. For instance, we can force the government revenue to stay at its original level for a year after a government expenditure shock has happened.

[74]Total government revenues is total government tax revenues minus transfer.
[75]Total government expenditure is total government consumption.

3.4 Empirical Results

In this thesis we try to investigate the impacts of changes in government revenue and expenditure as an indicator of fiscal policy on economic activities such as private consumption, GDP and wages in the UK and Italy. We have used GDP, government revenue, government expenditure, wages, money market rate, total reserves, producer price Index, GDP deflater and final private consumption at quarterly frequencies. Data for total reserves, GDP deflater and money market rate has been obtained from IFS (International Financial Statistics) and for government revenue, government expenditure, wages, PPI and final private consumption we use data from OECD data stream. Furthermore, the definition of government revenue and government expenditure in our study is taxes minus transfer and government consumption expenditure. All the series are in level. The impulse responses for the fiscal shocks as well as other identified shocks can be accessed in appendix 3 of this thesis. In these figures, we have shown the impulse responses of all our 9 variables to the shocks we have identified where the 16th, 50th and 84th quantiles of these impulse responses are plotted at every horizon between 0 and 24 quarters after the shocks happens. Furthermore, the relevant graphs are located in appendix 3 of this thesis.

3.5 Expansionary Fiscal Policy

3.5.1 Responses to an Expansionary Basic Government Spending Shock

Figure *1* and *2* illustrate the impulse responses of the right hand-side variables to a one standard deviation shock to government spending[76]. The impulse responses are presented for a period of 24 quarters with one-standard deviation error bands. These standard deviation bands are calculated using Monte Carlo integration. Fiscal policy shocks are identified only via restricting the impulse responses of the fiscal variables in the model. Another restriction, however, is the necessity that these impulse responses are orthogonal to both business cycle and monetary policy shocks. Therefore, a basic government spending shock requires the government spending to increase for a defined period following the shock. More importantly, one should notice that there is no orthogonality restriction between the two basic fiscal shocks; government spending and government revenue shock. Therefore, there is no need to restrict the behavior of government revenue while we are identifying government spending shock and vice versa.

We start our analysis by the impact of basic government spending shock on key economic variables for the UK. For this country, we can see through the results that after an increase in government spending which should at least last for a year, GDP increases

[76]All the figures in this chapter are located in appendix 3.

slightly after 5 quarters following the shock. This increase lasts for four years after the shock happens and then it goes back to its baseline level. Private consumption follows the same path as GDP. It does not react to the shock for about one year and a half and then starts to increase which lasts till the fourth year following the shock. Wages increase significantly after the shock and lasts for nearly 25 quarters following the shock. It is important to notice that the reaction of wages after the shock is more significant comparison to those of GDP and private consumption.

Turning to Italy after the basic government spending shock, we observe that both GDP and private consumption increase after 2 quarters following the shock that last for the whole period. These reactions are identical to the UK. Wages in Italy increases significantly following the shock. To add up, basic government spending shock is defined as an increase in government expenditure that lasts for a year after the shock happens. Thus, one can see from the results that even though the reaction of GDP and private consumption in the UK and Italy are compatible, these shocks seems to last longer in he Italy comparing to the UK.

RBC model predicts that wages should fall and labor supply should increase after an increase in government purchase and spending. The reason is that changes in fiscal policy affect labor supply and therefore create a negative relationship between the supply of labor and productivity. This negative correlation, as a matter of fact, can offset the positive relationship between productivity and supply of labor that comes from the technology shock. Ee did not find any support for this prediction of RBC model for the behavior of wages, at least for basic government spending shock, in this thesis.

3.5.2 Responses to an Expansionary Basic Revenue Shock

The impacts of this shock on the UK and Italy is shown in figure *7* and figure *6* respectively. We try to investigate the changes that a decrease in government revenue is going to bring about in the economy. Restricting the impact of government revenue to be negative for a year identifies this shock. Additionally, it is required through the methodology that government revenue shock should be orthogonal to both business cycle and monetary policy shocks.

We can see that for the UK, this leads to an expansion in GDP, consumption and wages that lasts for the whole period. Prices increase too, however it increases significantly only after two and a half years following the shock.

For Italy, GDP as well as private consumption fall slightly on impact that lasts till 7th quarter and then starts to increase till the end of the period. Wages follow the same pattern in this country but start to increase later than those two variables; it increase just after 14th quarter following the expansionary fiscal policy. Interestingly, prices and wages show very similar reactions to this shock. They both increase simultaneously in Italy that can be due to higher production and consumption.

3.5.3 Responses to an Expansionary Deficit Spending Fiscal Policy Shock

We now explore the impacts of deficit spending fiscal policy shock. A deficit spending shock and basic spending shocks are different in a sense that in the latter one, we do not restrict the behavior of tax rate. However, deficit spending shock is identified so that government spending increases for 1 percent while we restrict tax rates to stay unchanged for a year after this increase in government spending.

For the UK, we can see that the sign of the reaction of GDP, private consumption and wages are the same as those reactions after basic spending shock. This can be caused by the fact that tax rate, in general, does not fluctuate significantly after a basic spending shock even when we do not put restriction on its impulse responses. This implies that restricting the behavior of taxes after a spending shock does not have a significant impact on the results. What's more, even though deficit spending shock affects GDP and private consumption slightly, its impact on wages is significant.

For Italy, most variables react similar to those in the UK after a deficit spending fiscal policy. GDP, Private consumption and wages increase after this shock happens. The behavior of prices, however, is slightly different from the UK. Prices increases for all periods following the shock in the UK however it initially falls for almost one year and a half and then increases in Italy.

3.5.4 Responses to an Expansionary Deficit Financed Tax Cuts

The deficit-financed tax cut policy shock is the shocks where government spending stays unchanged and government revenue is cut by 1 percent for a year. These results are shown through figure *16* and figure *17*. These impulses estimations are merely a linear combination of a set of basic revenue and spending shocks. Similar to Uhlig and Mountford (2009) that study the US economy, deficit financed tax cut responses for the UK are mirror image of basic contractionary revenue shock. Thus, it stimulates output and private consumption in the UK where its effect reaches to its maximum level in the third year after the shock. After that pick in the third year, its impacts on these two key economic variables starts to decline gradually. The effect of this shock on price levels is negative at the beginning of the sample however subsequently starts to get positive just after GDP starts to increase. It seems that output growth is the key determinants of the price level in the UK.

For Italy, as well, responses to deficit financed tax cuts are mirror images of the basic contractionary revenue shock in this economy. Output and consumption falls initially and then starts to increase constantly after about two years. Prices fall at the beginning and start to increase with a lag of a year following an expansion in output and consumption. Wages does not respond to this shock in the UK for about two years and then rises. In Italy, wages fall for about four years following the shock and then start to increase.

3.5.5 Responses to an Expansionary Balanced Budget Spending Shock

This shock is defined where both government expenditure and government revenue increase in the same amount at each time for 4 quarters following the shock. Following the literature, we assume that for each 1 percent increase in government expenditure, government revenue raises just slightly higher. We can see that GDP and consumption increases marginally just after one year and a half following the shock.

However, results for Italy shows different behavior of GDP and private consumption to this shock. Both of these variables increase for almost two years and a half after the shock and then fall afterwards which lasts till the end of the period. Even though wages increase in both countries, the scope of this increase in the UK is much larger compared to Italy.

3.5.6 Responses to an Expansionary Delayed Government Spending Fiscal Policy Shock

In this particular fiscal policy shock, government spending responses do not react to the shock for 4 quarters. That is why we call this shock a delayed government spending shock. After a year of delay, they are restricted to stay positive for at least 4 quarters. This thesis shows that after this shock happens in the UK, GDP falls initially but it increases slightly after the 7th quarter that lasts for the whole period. The overall reaction of private consumption is a slight increase however with some fluctuations around the baseline level. Wages, on the other hand, increases for the whole period. Italy shows a similar response for all of key variables to the delayed government spending shock as the UK.

3.5.7 Contractionary Fiscal Policy Shocks

Now we turn to the impacts of an adverse fiscal policy shock by observing the economy after a fall in government expenditure and a fall in government revenue. We also study different combinations of these two shocks.

3.5.8 Response to a Contractionary Basic Government Spending Shock

Here, we are going to investigate what is the impact of a fall in government spending on key economic variables. We identify a basic contractionary spending shock, as a decrease in government spending which by construction should at least last for a year after the shock occurs.

For the UK we observe that after a basic contractionary spending shock, GDP, private consumption and wages fall considerably for the whole period. It seems that for the UK, a reduction of government expenditures has a significant contractionary impact on the economy: the results show that the scope of these effects following the negative shock are considerably large. Prices as well, fall following this contractionary shock.

In Italy, similar to the UK, all these variables fall following a contractionary shock. However the size of these falls in the UK are considerably larger than in Italy. Prices, as well, decrease slightly after this shock in Italy.

3.5.9 Responses to a Contractionary Basic Government Revenue Shock

In order to identify a basic government revenue shock, we require this shock to be orthogonal to both business cycle and monetary policy shocks. We also define a basic government revenue shock as a shock in which government revenue changes should last for at least 4 quarters following the shock.

The results basically shows what happens to the economy when government revenue increases for a defined period following the shock and are very intuitive: GDP, private consumption and wages fall considerably after the increase in government revenue in the UK. Interest rate and prices fall in response to this shock. The responses of GDP and private consumption for the UK are compatible with the study of Uhlig and Mountford (2009) about the US. However, the responses of interest rate and prices in the UK are in the sharp contrast with the US. Furthermore, the responses of these variables in the UK after the revenue shock is considerably larger compared to their reaction in the case of a spending shock.

After an increase in government revenue in Italy, however, even though GDP and private consumption mostly fall after the shock happens, they start to increase after a year and then falls till the end of the period. Wages, on the other hand, has a different behavior and increase for nearly four years following the shock and then falls.

3.5.10 Response to a Contractionary Balanced Budget Fiscal Policy Shock

We define balanced budget fiscal policy shock when both government revenue and government expenditure falls at the same value for a defined period following the shock. This shows the impacts of contractionary government expenditure while reducing the taxes at the same time. For the UK, we can see that this leads to an expansion in GDP, consumption and wages as well as Price levels.

For Italy, the initial behavior of wages and prices are consistent with the reaction of these two variables in the UK. However, an increase in GDP and private consumption just lasts for three years in Italy following the shock and then they fall until the end of the period.

3.5.11 Responses to a Contractionary Delayed Spending Shock

Delayed spending shock is defined as a shock in which spending falls for a year however after a lag of one year following the shock. After this shock happens, GDP and private consumption increases on impact that lasts for 6 quarters following the shock and then starts to fall. Consumption, however, fluctuates more than GDP. We can see that after this shock happens, there are some periods in which private consumption increases regardless of this contractionary nature of the shock. Even though this increase in private consumption sometimes lasts up to a year, private consumptions fall in overall following this shock. Wages and prices fall considerably after this shock in the UK. For Italy, GDP and private consumption as well as wages fall considerably following this shock in a very explosive manner.

3.5.12 Responses to a Contractionary Delayed Government Revenue Fiscal Policy Shock

In this shock we assume that that government revenue increases at least for 4 quarters however with a one year delay by construction. That is why we call this shock a "delayed revenue shock".

We see that after the government revenue shock in the UK, GDP, consumption and wages fall for all the period of study. These results, not surprisingly, are very similar to a basic revenue shock in the UK.

In Italy the response of GDP and private consumption is similar to the UK; both these variables fall following an expansion in government revenues. In contrast, however, wages fall in the UK while it increases in Italy. This dissimilar reaction of wage in the UK and Italy has been observed after a basic revenue shock as well.

3.6 What do We Have in Common with the Current Fiscal Policy Literature?

This thesis tries to provide empirical evidences regarding to the economy and its reaction after fiscal policies. There is no general agreement on these issues even though they are critical topics for policymakers. For example, even though most benchmark models agree that an increase in government expenditure increase the output, they contradict each other concerning the implied impacts of an expansionary government spending on private consumption while private consumption is a key determinant of the output. The RBC model predicts that consumption should decrease after an increase in government spending. This is because RBC models predict infinitely living Ricardian household who consume at any point of time by taking into account their lifetime income and base on their intertemporal budget constraint. Therefore, an increase in government spending decreases consumption through the wealth effect and by decreasing the present value of their after-tax income. In contrast to RBC model, benchmark IS-LM models predict that private consumption increases after an expansion in government spending and hence amplify its impact on output. As a matter of fact, Keynesian model assumes non-Ricardian consumers whose consumption merely depend on their current disposable income and not on their lifetime resources.

Furthermore, these conflicts about the behavior of private consumption after a fiscal policy shock in the literature also exists in empirical research. Put it differently, there is no formal agreement about the responses of these variables after the shock happens. For example, Uhlig and Mountford(2009), in line with Burnside, Eichenbaum and Fisher (2003), find that even though private consumption does not fall after an expansion in government expenditure, it does not increase neither. Thus they find no support for neither the Keynesian nor the RBC theories for the US. On the other hand, Blanchard and Perotti (2002) and Gali, Lopez-Salido, and Valles (2004), find that not only private consumption does not fall after this shock, it actually increases significantly after this shocks supporting the predictions of the Keynesian models.

In this thesis we show that after an expansion in government spending, consistent with the Keynesian model, both output and private consumption increases for both the UK and Italy. Expansionary fiscal shocks are identified by an increase in government spending and/or a fall in government revenue through lowering taxes. Contractionary shock, on the other hand, defined as an increase in government revenue in the form of rise in taxes and also a decrease in government purchases of good and services and different linear combinations of these two.

The summaries of the results for these expansionary and contractionary shocks are as follows:

3.6.1 Expansionary Shocks

1- For the case of an increase government spending, we can see that both the UK and Italy have compatible results regarding to the behavior of GDP, private consumption and wages. In both of these countries, all three variables increase significantly after the shock. However the difference between the UK and Italy lies on the reaction of price levels. Prices increases for the whole period following the shock in the UK while it falls on impact in Italy which lasts for 10 quarters and then starts to increase. For delayed spending, we observe that even though private consumption, output and price level increase for most periods after the shock happens, they fall initially which lasts for almost two years and a half before start increasing constantly for both countries. This can imply that once we control for the lag effect by restricting an increase in government spending to happen just after one year following shock, the effectiveness of expansionary spending in the UK and Italy reduce considerably.

2- In the UK, GDP, private consumption as well as wages increase significantly after a fall in the tax rates and consequently government revenue. Prices, nevertheless, remain unchanged for almost two and a half years and then starts to increase. For Italy, once this shock happens, private consumption and GDP fall on impact that last for nearly two years and then start to increase significantly. Price level and wages both fall for almost three years and a half. However, wages start increasing immediately while price level stays in the baseline level for almost 6 months and just begin to increases at the end of the whole period. Therefore, one can conclude that the reaction of these economic variables to these two different sets of expansionary and contractionary fiscal shocks are very different in these two countries.

For delayed revenue shock we can see that after we impose the restriction that government revenue should fall just after a year following the shock, these key economic variables react differently compared to the basic revenue shock scenario in the UK. GDP and private consumption does not response to this shock for 9 and 14 quarters respectively and then increases moderately especially comparison to their scale of change in basic revenue shock scenario. Prices and wages, on the other hand, increase on impact however they start increasing more considerably after three years and a half in which private consumption, as well, starts to increase. It shows that in the UK, there is a strong connection between the behavior of the consumption, price levels and wages. In contrary, in Italy results are very different from that of the UK. GDP and private consumption increase for the whole period. Prices just increase minimally for nearly a year and a half and then starts to fall slightly that lasts for the whole period. Wages fall for the whole period in Italy as well.

Results for the UK and Italy are very different from each other. This can be due to the fact that government revenue in the UK falls just for a year before it starts going back to the baseline level and then increase gradually. In Italy, however, once government revenue starts falling, it lasts for the whole period.

3- We now turn to analyze deficit tax cuts which will enhance our understanding about the impacts of taxes on economy independently of the effects of government revenue. For both countries, this sort of shock is a mirror image of the basic contractionary revenue shock. For the UK, output increases immediately after the shock yet in the Italy, even though it increases in general, it falls initially. Consumption closely follows the output pattern.

4- Deficit financed spending shocks represents the responses where a rise in government spending is financed via a deficit. Here we can see that wages and consumption increase in both countries after this shock occurs. Fatas and Mihov (2001a) run the same experiment for the US however including different types of labor elasticity in their model namely elastic labor market and inelastic labor market. They find out that in an inelastic labor market, output response to the shock is zero on impact and then falls after a year as a result of a fall in investment. In elastic labor market, however, output increases. Uhlig and Mountford (2009) run the same experiment however without taking into account different elasticity of the labor market for the US. Their finding is similar to findings in this thesis.

Fatas and Mihov (2001a), furthermore, argue that the impact of deficit financed spending is very different from those of tax-finance shocks for the US. For the UK in this thesis, contrary to Fatas and Mihovs, deficit financed spending and tax cuts have same impacts on the economy. For Italy, however, there are some differences. For example, output and consumption falls initially after a tax-financed shock however increases constantly after 10th quarter.

3.6.2 Contractionary Shocks

5- The first set of contractionary shock is a fall in government spending for at least 4 quarters. This is called a basic contractionary spending shock. Following this shock in the UK, GDP, consumption and price level does not respond for a year and then starts to fall. While price levels falls for the whole period, GDP and private consumption starts to go back to the baseline level in the few last quarters. Wages falls considerably in the UK after this contractionary shock. The same pattern occurs in Italy however price level's reaction just differs: while it rises slightly for 9 months following the shock, it falls afterwards.

Delayed spending shock in the UK causes GDP and private consumption to increase on impact. However it returns to the baseline level immediately that lasts until 9th quarter before it starts falling. While wages fall for the whole period following this contractionary shock, prices do not change for 9 quarters and then starts to fall. The reactions of all these variables are similar to the basic contractionary shock. This implies that for a contractionary spending, whether we restrict the reaction of government expenditure to fall just after a year following the shock or not, does not affect the results in a large scale. For Italy, GDP and private consumption fall for the whole sample however wages and prices does not respond to this shock significantly and stay at the baseline level for most of the time.

6- The fourth set of shocks that we are going to explore is when government revenue increases for at least four quarters following the shock. This is due to an increase in tax rates and has a contractionary nature. For the UK, we can see that this contractionary fiscal policy will reduce GDP, private consumption as well as wages considerably however this drop occurs after the 4th quarter following the shock. Price series does not react to this contractionary shock for 11 quarters and then start to decrease. In Italy, GDP and private consumption falls on impact however they increase after a year that lasts for a year and decline just after 2 years following the shock. Wages and prices react similarly to this shock; they both increase for three years following the shock and then fall considerably. One can observe that wages and prices in most cases follow the same pattern while GDP and private consumption react similar to each other following these fiscal policy shocks. Furthermore, It seems that GDP and private consumption drive the behavior of wages and prices since at most of the times, the two latter variables react following the movements in GDP and consumption.

We now show what happens after a delayed revenue shock where revenue is restricted to increase just after a year following the shock. In the UK, GDP, prices and wages fall after the shock. Private consumption falls as well however just after three years following the shock and before that, it stays in the baseline level. In Italy, all the variables of interest fall after this shock.

In this thesis we find support for Keynesian model of predicting private consumption behavior after an increase in government spending. Private consumption increases in both countries after all sorts of expansionary fiscal policy shocks such as increase in government purchase of good and services and also decrease in tax rates. Whats more, consumption falls in all contractionary fiscal policy shock scenarios. As it is argued before, the difference in the prediction of RBC and Keynesian models for the behavior of consumption comes from their different assumption about decisions of consumers to consume and how they finance it.

The RBC model assumes that consumers behave in Ricardian fashion while the benchmark IS-LM model believes that consumers just spend according to their current income. And therefore since the implied impact of an increase in government spending hugely rely on how private consumption is financed, one can conclude that consumers behave more in a Non-Ricardian style rather than Ricardian one in this thesis. This means that their consumption depend on their current disposable income and not of their lifetime wealth and intertemporal budget constraint.

Mihov and Fatas (2001b) also argue that after comparing their result with RBC model, they find out that the major difference between this model and their empirical evidences is on the reaction of private consumption. Their finding is in line with results in this thesis that showed a rise in GDP is always accompanied by an expansion in private consumption. Private consumption in RBC model, however, always falls after an expansion in government spending even though output increases, as in Baxter and King (1993), as a result of negative wealth effect.

Keynesian, New-Keynesian and real business cycle theories predict that after a rise in government spending, there is an expansion in economic activities that lead to an increase in output and real interest rates. The empirical estimations in this thesis are to a large extent in line with these large sets of economic theories. Output increases in both countries after this shock, interest rate increases persistently in the UK and increases after two years in the Italy. We also integrated wages in our model in order to capture the impacts of fiscal policy shocks on labor market. Similar to in Mihov and Fatas (2001a), we find that wages increases after an expansionary fiscal spending shock.

In this section we focus on the empirical results of section 3 in the light of different key theories in fiscal policy literature. The difficulty in comparing results from empirical models with main theories is that we cannot produce a unique VAR model impulse response that is fully compatible with a single economic theory. However, the first things that stand out from this empirical investigation are that, not surprisingly, an expansionary government spending and contractionary government expenditure have expansionary and contractionary impacts on output respectively. Yet, there are some aspects of our results that are surprising if we want to compare them with the prediction of the RBC model and some modified version of this model which has been put forward by Baxter and King (1993) and Fatas and Mihov (2001a). According to their theoretical experiment, the increase in output after an expansionary fiscal policy comes from a significant increase in investment that compensates the fall in private consumption. However, in the estimated impulse responses in this thesis and also in Fatas and Mihov (2001a) and Uhlig and Mountford (2009) papers, the opposite scenario holds. The increase in output is always accompanied by an increase in private consumption.

There are also some issues about the impacts of government expenditure on wages. The mechanism underlying the predictions of RBC model is described in detail in Aiyagari, Christiano, and Eichenbaum (1992), Baxter and King (1993), Christiano and Eichenbaum (1992), and Fatas and Mihov (2001a) among others. They stress that an increase in (non-productive) government spending has a negative wealth effect that reduces private consumption. In the meanwhile, it causes an increase in the supply of labor at any given point of wages. This in return reduces real wages that leads to higher rate. In their model, they predict that this lower wages lead to an expansion in employment and output. If this effect is persistent enough, it can cause investment to increase as well. Returning to our empirical estimations, one can observe that contrary to this model's predictions, wages increases as a result of an expansion in government expenditure. This increase in wages is also confirmed in the study of Fatas and Mihov (2001a). In their paper, they call this behavior of wages as one of the failure of their model to predict real world. According to the prediction of their modified RBC model, employment and consumption should always react in opposite direction. However in their VAR estimations, they observe a persistent positive correlation between employment and consumption. They justify this puzzle by arguing that it must be a large increase in real wages that assuming that consumption and leisure are both normal goods, this big change in wages compensate the tendency of consumption and leisure to move in the same direction in response to change in households' wealth.

3.7 Conclusion

This thesis analyzes the reactions of key economic variables to shocks in different kinds of fiscal policies, both expansionary and contractionary shocks, in two main EU economies namely UK and Italy using quarterly data from 1970 to 2009. We show impulse responses of some main economic variables to these fiscal policy shocks using a novel methodology for distinguishing the impacts of fiscal policy innovations. We employ the methodology suggested by Uhlig and Mountford (2009) to study fiscal shocks. This approach uses the information in the macroeconomic time series data of the vector autoregression alone. Furthermore, we use as little prior assumptions as possible to identify fiscal policy innovations. Importantly, it does not restrict the impulse responses of the main variables of the interest namely GDP, private consumption and wages to fiscal policy shocks.

We compare our empirical estimations to standard real business cycle model and Keynesian model to see which model is more powerful in explaining the facts following a fiscal policy shock. We observe that a rise in government expenditure has an expansionary impact on output that is mostly driven by an increase in private consumption. When we compare our results to RBC and Keynesian models, we observe that the standard RBC model fails to fit the data.

The main discrepancy between our estimations and RBC model is in the behavior of private consumption following an expansionary fiscal policy. It seems like consumers behave in non-Ricardian fashion rather than looking at their lifetime income to decide whether to consume or not. Put it differently, contrary to the predictions of the RBC model, we find that private consumption always increases after the expansionary shock happens and data do not support the RBC predictions. Another difference between our results and the RBC model is in the response of wage to fiscal shocks. We find that wages increases after an expansionary fiscal policy rather than decreasing. The RBC models predict that after an increase in government expenditure, since after-tax lifetime income falls which lead to a decrease in consumption via negative wealth effect, supply of labor increase in any rate of wage that lead to a fall in real wages. The data that we employed does not support this prediction of RBC model again. Indeed, we find that wages increase after an expansionary government spending shock. Gambetti and Gali (2009) provide an explanation for this phenomenon. They explain how the interaction between rule-of-thumb consumers (for whom their consumption is a function of their labor income) and also sticky price (which is the assumption of New-Keynesian models) can be used to show how it is possible that an increase in government spending lead to an increase in consumption which is in line with most of the recent literature. Rule-of-thumb consumers prevent demand from a fall that would occur otherwise as a result of negative wealth effect. Real wages, in the meanwhile, increase because of sticky nature of prices even though there will be a fall in marginal product of labor after an expansionary government spending. This happens since price markups may fall to fill the resulting gap.

The impact of higher real wage together with higher employment increases current labor income and therefore boosts consumption of rule-of-thumb consumers. However, in models such as the ones that have non-competitive labor market and have the characteristic of countercyclical wage markups, consumption and hours of working increase without requiring real wage to rise. Since their model predicts a positive co-movement of private consumption and government expenditure under a totally plausible framework, they argue that their results as providing a potential solution to the seeming disagreement between empirical evidence and the predictions of existing DSGE models regarding the results of government spending shocks.

Results obtained following a decrease in tax rates, however, provide different responses. In particular even though wages increases after this fall in tax rates, it initially falls for two years in Italy and then starts to increase.

To conclude our finding, we can say that in general, most of the expansionary shocks have expansionary effects on both output and private consumption while contractionary shocks generate recessionary impacts on the economy for both UK and Italy.

Chapter 3

What Are the Impacts of Fiscal and Technology Shocks on Exchange Rate? New Evidences for the Euro Area

4.1 Introduction

What is the behaviour of the real exchange rate following fiscal policies and technology shocks? It is crucial to have a clear-cut answer to the main question in this chapter to understand the mechansim behind the exchange rate fluctuations. Real exchange rate[77] across OECD countries show significant and systematic inconsistencies from standard theories. For instance, during 1980's, in the late 1990s and also more recently in 2002 significant deviation in the United States producer-price based real exchange rate occurred[78].

Overall, the existing evidence appears to fail satisfying the predictions of both Mundell-Fleming type and intertemporal business cycle models under standard calibrations. According to benchmark theories, relative prices of domestic goods goes up following an expansionary government expenditure shocks. This happens since these shocks lead to the higher total demand for domestic goods. On the other hand, productivity gains[79] bring on lower relative prices as a result of higher supply of domestic goods.

Economists recently provide numerical estimates of the effects of an expansionary government expenditure on exchange rate and other main economic indicators mainly for the Unites States. These estimates are pivotal for policy making since they throw some light on determining the appropriate size and timing of countercyclical fiscal policy measures. Nonetheless, the empirical investigations on this central issue seem to deliver conflicting answers up to this time. Furthermore, most studies related to the impact of fiscal policy as well as technology shock on exchange rate are done for the U.S. and Euro Area seems to be neglected in this regard.

Agreeing with the textbook theories, an expansionary fiscal policy should worsen the current account and consequently appreciates the real exchange rate. The main empirical finding which shows this impact is on the United States during the first half of the 1980s and in the 2000s while the U.S was experiencing twin deficits. In contrast, more recent empirical studies such as those of Kim and Roubini (2008), Monacelli and Perotti (2006), and Ravn et al.(2007), among others, show that government spending depreciates the real exchange rate.[80] Following the productivity gains, as well, the direction and the size of

[77] Both the real exchange rate or the terms of trade are the measure of the international relative prices.

[78] Andrew Atkeson and Ariel Burstein(2008), for instance, show that during 1980's in the United States, manufactured goods prices changed by approximately 40 percent compared to a weighted average of the prices of manufactured goods made in the US chief trading partners.

[79] We consider productivity gains as "technology shock".

[80] Studies about the effects of fiscal shocks on the real exchange rate for Australia, Canada, the U.K.

the responses of main economic indices such as hours worked, employment and exchange rate are controversial.[81]

These controversies seem to root in the Real Business Cycle (RBC) model. As presented in the seminal paper by Kydland and Prescott (1982), the main assumptions of the DSGE models which are based on RBC theory, is that prices are flexible and firms are optimizing agents. In the standard RBC framework, theretofore, technology shocks changes demand for labour and raise both per capita hours worked and output and consequently lowers the relative price of domestic goods. When confronted with the data, these predictions have found little support. For example, recent empirical investigation by Corsetti et al. (2008b), Kim and Lee (2008), and Enders and Muller (2009) find that real exchange rates appreciate following a technology shock, captured by the terms of trade or the relative price of consumption across countries.

The objective of this thesis is to re-investigate the dynamic behaviour of exchange rate using a new identification approach proposed by Enders et al. (2011)[82] to identify fiscal shocks and productivity gains simultaneously within an estimated VAR model. Crucially, they employ quantitative general equilibrium model in order to determine the sign and also the time horizons of the identification restrictions.[83] The plausibility of these identification assumptions is largely related to the theoretical framework that one has chosen. Having said that, employing a fully specified DSGE model lead to choose both the sign restrictions and the periods that we have to impose those restrictions. While the model is richly identified and endures robust predictions of the reaction of several key variables, it leaves exchange rate behavior unrestricted following an expansionary government expenditure and productivity gain. Furthermore, we re-examine this controversy for the Euro Area since the impacts of these two shocks is less empirically investigated in the EU compared to the U.S.[84]

We estimate our VAR model on quarterly frequencies for the Euro Area relative to the US for post-Bretton-Woods period but before the current financial crisis. The model includes data for consumption, output, investment, government spending, government budget balance, inflation, the short term interest rate and exchange rate. Our results

and the U.S. gives somewhat mixed results, see, for example, Corsetti and Muller (2006) or Monacelli and Perotti (2008).

[81]Regarding technology shocks, proof for an appreciation is built in for U.S. data. Corsetti et al. (2008b) find an appreciation in Japan likewise. However Kim and Lee (2008) show a depreciation for the Euro area and Japan

[82]Sign restriction approach is put forward initially by Uhlig (2005) and developed later in many respects; see e.g Uhlig and Mountford (2009) and Enders et all (2011).

[83]Enders et al (2011) argue that this methodology is complementary to Corsetti et al. (2009a) study in which they use sign restrictions to identify demand and productivity gains in the manufacturing sector and investigate their impact on the real exchange rate. In their study, instead of employing a fully specified general equilibrium model, the authors exercise sector-specific data in order to achieve identification.

[84]This is indeed a clear-cut difference of this thesis with the very similar studies by Corsetti et al. (2009a) and Enders et al. (2011).

suggest that exchange rate appreciates (falls) after an expansionary fiscal policy in the EU. Following a positive technology shock, however, after an on impact depreciation (increase), exchange rate appreciates for the whole period. In overall, even though we use an identification approach which is not often used in the recent literature, our empirical findings are relatively align with the existing studies concerning the impacts of technology shocks and fiscal shocks on exchange rate. More importantly, it is in line with benchmark theories regarding to the impact of these two sets of shocks on exchange rate. It seems that the facts about the exchange rate dynamics that are widely used across different identification schemes are in particular appropriate to examine theories of the international transmission mechanism.

The remainder of this chapter is organized as follows. In section 2 we review the literature. In Section 3 we show our identification scheme and explain a quantitative business cycle model from which we determine sign restrictions. In Section 4 we illustrate our VAR specification and results. Section 5 concludes.

4.2 Literature review

Most controversies in international macroeconomics concern the real exchange rate dynamics for its fluctuations are more significant and long-lasting relative to other real variables. However, most models are unable to explain the behaviour of exchange rate. Furthermore, international financial market assumed to be complete in most benchmark models even though there is a well-documented lack of a consumption risk-sharing across countries. As a means of clarifying this important aspect of the real exchange rate and the dynamics of cross-country consumption, macro-economists turn to apply new generation of models recognized as new open Economy macroeconomics (NOEM). These models extended the literature by taking into account nominal rigidities as a feature of asset market or alternative features.[85]

The real exchange rate is characterized as the ratio of price levels between two countries. Assuming that all prices[86] are sticky, economists can explain real exchange rate fluctuations, as shown by Benigno (2004). In models which assume markets are perfect, the real exchange rate is identical to the ratio of the marginal utility of consumption across countries. These models are subject to perform poorly, even when they allow for other nominal or real rigidities. One way to solve this issue is to presume that agents cannot have access to complete markets in order to secure their assets against country-specific shocks. Chari, Kehoe, and McGrattan (2002) investigate the fluctuation and prolonged behavior of the real exchange rate by constructing a model with sticky prices. Their find-

[85] Some examples include Benigno (2009), Lane (2001) and Obstfeld and Rogoff (2000).
[86] Including domestically produced as well as imported goods.

ing suggest that monetary shocks and nominal anomalies account largely for real exchange rate volatility.

This view, however, has been challenged by studies which emphasize the significant role of fiscal shocks in explaining the fluctuations of exchange rates. Taking the empirical perspective, the impacts of fiscal shocks on real economic variables, have been characterized in different models with forward-looking agents and finite horizons. In particular, Frenkel and Razin (1986) focus on the impacts of tax cuts on the world interest rates, consumption as well as the current account in a two country economy model. Daniel (1993a,b), for instance, investigates the consequence of tax cut in a country in which the time of a future tax increase to balance the budget is unknown. Kawai and Maccini (1995) study the impacts of fiscal deficits on a small open economy when there is a floating exchange rates regime. Governments sell bonds in order to finance its fiscal deficit and is predicted to be financed in the future by either seignorage or tax increases or other combination of these two.

Canzoneri et al. (2001b) argue that it is essential to have strict fiscal discipline in common currency areas where national governments enjoy less autonomy in following their goals. They differentiate between Ricardian and non-Ricardian regimes. In the first one, the nominal anchor is determined by monetary policy and moreover the exchange rate is defined by the standard theories. In non-Ricardian regime, however, fiscal policy is being used as the nominal anchor and appoints the exchange rate.

Looking further in the literature, one can see that even though closed-economy RBC models[87] have been successful to some extant in explaining the U.S. macroeconomic data, open-economy versions of these models that have integrated international relationships[88] have been less productive in replicating basic determinents of macroeconomic time series. The closed-economy versions come from the fact that countries play a role in international markets. However they dismiss the evidence that open economies have the privilege of sharing nation-specific volatilities with other economies through the exchange of goods and financial assets.

For instance, the extension of the Kydland-Prescott model to a two-country framework by Backus et al.(1994) lead to a riskier investment than is shown in the industrialized countries. Open-economy models, as well, lead to mixed results in replicating main characteristics of international data. Countries which participate in international trade can affect their economies' behavior by shattering the tie between its production and its spending on consumption and investment. This allows an economy to experience

[87] See Kydland, F., E. and Prescott, E., C., (1982) and Prescott, (1986).

[88] See Enrique G. Mendoza, (1991); David K. Backus et al., (1992); Marianne Baxter and Mario J. Crucini, (1993) for more details.

smoother consumption during the time compared to a closed economy. They also have larger response of investment to movements in expected rates of return. This is why models which are featured by shocks to technology show[89] larger changes in relative prices in open-economy models relative to the corresponding closed-economy versions. This also clarifies why technology shocks induce significant movements in the balance of trade and exchange rate in those models. Yet, previous models comes from the fact that nearly half of a country's output is made of non-traded goods. This evidence is possibly an important missing factor of existing RBC since it helps reconstruct the link between a country's output and its spending. As a result of all these controversies in the literature, this thesis aims to study the implications of fiscal policy in the determination of the real exchange together the impacts of technology shock on this key economic variable.

4.2.1 Business cycle model

Here we go through the business cycle model from which we draw our sign restrictions. The model we are using here is widely used in this literature and it features two-country specific model in which some frictions exist.[90] We employ Gali(1999) model in which there is some degree of sticky prices that will alter the transmission of real shocks. Additionally, one of the assumptions is that each country is specialized in producing a particular type of good. Consumers, on the other hand, in both countries consume both goods however in different extent. Moreover, the extension of their consumption in each country will determine relative prices which consequently derives real exchange rate fluctuations. We followed Engel (1999), Chari et al. (2002) and Enders et al. (2011) and did not take non-traded goods into account for the US.

Before describing our sign restrictions we briefly explain the structure of the model. The world consists of two different countries called "home" and "foreign" country.

Households

In each country the representative household allocate some of its resources to consume some goods and also supply labour. There is also an endogenous discount factor in this model which means that leisure and consumption is higher than its steady state if thee discount factor is higher. Labour and capital are not mobile internationally. Household in each country rent the capital they own to intermediate firm. It is also costly to adjust the level of investment. The law of motion for capital is given by

$$k_{it+1} = (1-\sigma)k_{it} + [1-\Psi(I_{it}/I_{it-1})]I_{it} \tag{4.2.1}$$

[89]Here the assumption is that technology shocks create changes in the expected return to investment.

[90]See, e.g., Chari et al. (2002) and Kollmann (2002).

Where σ denotes the depreciation rate. Across countries, trade is in the form of bonds denominated in the currency of each country. Each representative household in each country has a budget constraint. Also in each country consumers maximize their preference function subject to law of motion of capital, their budget constraint as well as a non-ponzi scheme condition.

Final good firms

We assume that investment and consumption are composite goods that households buy from final good firms. These firms are in perfect competition market and purchase their inputs from monopolistic competitive firms. One of the other important assumptions here is that we assume that the law of one price holds for the firms and therefore we have:

$$P_{It}^{B}(j) = S_t P_{2t}^{B}(j); P_{1t}^{A}(j) = S_t P_{2t}^{A}(j) \tag{4.2.2}$$

let $A_{it}(j)$ and $B_{it}(j)$ denote the amount of good j which respectively is made in country *1* and *2* and used in country i to assemble the relevant final goods. These are produced under a technology level which depends on the elasticity of substitution between foreign and home goods and the elasticity of substitution between goods manufactured within the same country. It also depends on the home bias in the composition of final goods.

The problem of this firm is to minimize expenditures in combining intermediate goods subject to the technology that it is using. Furthermore, assuming that we are in the home country, we define the real exchange rate as follows:

$$RX_t = S_t P_{2t} / P_{1t} \tag{4.2.3}$$

therefore an increase corresponds to a depreciation. [91]

Fiscal Policy

For fiscal policy we assume that government spending consists of the basket of intermediate goods. More importantly we assume that government goods are made with the same technology that final good firms uses except that merely goods which are manufactured domestically enter the consumption bundle of the government. This evidence is put forward by Corsetti and Muller (2006). They argue that the import goods as part of government expenditure is in general less than half the import content in private spending. Government consumption evolves as follows:

$$G_{it} = (i - \rho_g) G_i + \rho_g G_{it}^{1} + \varphi_y (Y_{it} - Y_i) - \varphi_d (D_{it} - D_i) + \varepsilon_{it}^{g} \tag{4.2.4}$$

[91] The terms of trade are defined as the price of imports relative to the price of exports: P_{it}^{B}/P_{it}^{A}

letters without time subscript refer to steady-state values; ρ_g shows persistence and φ_y and φ_d demonstrate the extent in which government expenditure reacts to the deviation of output and debt from their steady-state values. ε^g_{it}, is an i.i.d. shock to current government spending, which may have been robustly predicted n periods in advance because, say, of institutional features of the legislative process. We also assume that tax rates adjust to the level of debts. The government budget constrain in country i is as follows:

$$D_{it} + P^G_{it} G_{it} = \tau_{it}(W_{it}H_{it} + R^{it}_k K_{it} + \Upsilon_{it}) + D_{it} + R^{-1}_{it} \tag{4.2.5}$$

P^G_{it} is the price index of government consumption.

4.3 New evidence on the behavior of Euro Area real exchange rates

4.3.1 Data and baseline specification

We estimate the VAR model (1) on time series data for the Euro Area relative to the U.S. We include a constant and 4 lags of endogenous variables in the VAR model. The vector of endogenous variables consists of, in logs and real terms, private consumption, GDP, private investment, government spending as well as the primary budget balance scaled by GDP, inflation (measured using the GDP deflator), the nominal short-term interest rate and the log of the real exchange rate. Data for real output, private consumption, government spending, the GDP deflator, and private fixed investment are taken from the OECD Economic Outlook database. Government spending consists of government spending on goods and services (government consumption), however it does not include investment and transfers.[92] The data ranges from 1975Q1 to 2007Q4. We dismiss the first two troublesome years after the collapse of the Bretton-Woods system.[93]

For all the variables we used the data for Euro Area relative to the U.S. However exchange rate is an exception.[94]

We use our baseline specification and identify a shock in government spending together with productivity gains while the backbone of our identification procedure is the sign restrictions summarized in Table 1.

[92] Additionally, we use the same source of data to achieve the short-term interest rate, the government balance (measured in percent of GDP), exports of goods and services (value, local currency), imports of goods and services (value, local currency), and GDP (market prices) for the U.S. Net exports, as a fraction of GDP, are computed on the basis of these series. For the Euro area we obtain several series from the ECB's AWM database. For more details of where to get relevant data, see Fagan et al.(2001) and Enders et al.(2011). We take the CPI-based real effective exchange rate for the U.S. from the Main Economic Indicators of the OECD.

[93] Euro area growth rates consists of West-Germany for just before 1990Q4, and unified Germany from 1991Q1 afterwards.

[94] We apply the short-term interest rate (STN), the deflator of exports of goods and services (XTD), the deflator of imports of goods and services (MTD), and the government primary surplus (GPN-YEN). In case OECD data is used, similar adjustments have been applied in constructing the AWM database. Weights are based on PPP adjusted values for the year 2000, as reported in the World Economic Outlook database (2007) of the IMF.

Table 2: Expansionary Innovations in Euro Area

Variables	Government Spending	Technology Shock
Consumption	unrestricted	+8
Output	+2	+8
Investment	-4	+4
Gov.Spending	+4	unrestricted
Gov.Budget	-4	+0
Interest Rate	+4	-4
Inflation	+0	-0
Exchange Rate	Unrestricted	unrestricted

4.3.2 Empirical results

Figs. 1 to 16 shows the impulse responses to the shocks in government spending and technology given the estimated VAR model. We can see in all the figures the median and also the 16% and 84% quantiles of the posterior distribution of impulse responses. Crucially the results are considered as "significant" whenever both quantiles are either above or below zero at a specific point in time. The horizontal axis shows periods (in quarters) after each shock while the vertical axis, on the other hand, represents the percentage that the responses depart from its baseline values. We show the periods in which we impose sign restriction as shaded area in the figures.

Figures 1 to 8 shows the impulse responses of the variables in the model to an expansionary shock in government expenditure. The impulse responses of all variables display the response of relative variables to a domestic innovations[95] however the only exception is real exchange rate which shows the reaction of the domestic variable. Relative government expenditure increases persistently for almost 12 quarters. However it is likely to decrease in later periods. Enders et al. (2011) argue that this happens as a result of systematic cut in response to higher public debt. GDP rises for nearly three quarters on impact however it also falls afterwards. Succeeding the evidence reported by Perotti (2005) for a post-1980 data and also by Mountford and Uhlig (2009) and Enders et al.(2011) for the U.S, this thesis shows a very temporary expansion in output as a result of government spending shocks this time for Euro Area. Indeed, GDP increases just for the period that its respond is restricted to be non-negative. In contrast to the case of US, however, GDP keeps falling for all the periods following a fiscal shock. The government budget deteriorates for at least 14 quarters. Private consumption, in the same manner, decreases for the most period of the study however after an initial rapid increase which lasts for 8 months. Gali et al. (2007) suggest that private consumption rises after an increase in government expenditure

[95] This means that variables are the difference between the reaction of a domestic variable (here European Union) and its foreign partner (United States). We used relative variables in this thesis since we focus on the behavior of the real exchange rate, which is defined by these relative variables.

only if there is either a labor market friction or when the majority of individuals consume disposable rather than permanent income. Our results document that government spending crowds out private investment for the whole period and reduces inflation after it increases initially for roughly 5 quarters. Therefore, investment decline, while inflation rises slightly for 5 quarter and then declines. Interest rates, in turn, increase initially as long as they are restricted to respond non-negatively, but falls constantly thereafter. The reaction of real exchange rate after the shock is that it appreciates (falls) continually. The size of these exchange rate dynamics, however, is not considerable. Under standard assumptions, exchange rate appreciates following an expansionary government spending in business cycle models as well as textbook modifications of the Mundell-Fleming model. As discussed in methodology section, we do not restrict exchange rate impulse responses and as a result, we find interesting evidences: align with standard models of exchange rate behavior, an expansionary government spending appreciates (decreases) the real exchange rate. Furthermore, this finding is in contrast with the number of studies which investigate the same issue using different identification schemes. Blanchard and Perotti (2002) identify their model assuming that government spending is predetermined. Kim and Roubini (2008) as well as Monacelli and Perotti (2006) analyze U.S. data and Australia, the U.S., the U.K and Canada respectively. They find evidence that government spending shocks depreciate the real exchange rate. Canada, however, was an exception.[96]

Figs 9-16 reveals how our variables reacts to a technology shock, i.e., productivity gain. Government spending decreases initially for nearly 6 quarters however rises for 20 quarters afterwards. The budget does not decrease on impact and indeed increases for the whole period. Enders et al. (2011) generate the same result for the US and argue that it is likely to be the byproduct of the fact that tax revenues are procyclical. The response of consumption is positive for the whole period. GDP increases for the intial 12 quarters howevers it falls sharply afterwards. Private investment responses increases for 16 quarters before its start to fall. Nominal interest rate, as the model imposes, falls for 6 quarters however it starts to increase afterwards for nearly 10 quarters before it starts to fall sharply again. Inflation after a technology shock follows the pattern of nominal interest rate.

Real exchange rate after a technology shock, similar to that of fiscal policy, appreciates (falls) for most of the periods however after an initial depreciation which lasts for 9 quarters. One of the exceptions of the standard collaboration of the RBC model is called

[96]Beetsma et al. (2008) employed a methogology suggested by Ramey and Shapiro (1998) to identify shocks in the Euro Area. Their results suggest that the real exchange rate appreciates after an expansionary government expenditure in this area. This methodology according to the litrature is a well-documented substitution to the Blanchard-Perotti method. Monacelli and Perotti (2006) used the same identification approach and report that government spending decreases, while the real exchange rate depreciates. They argue that this happens as a result of the Carter-Reagan military build-up.

the Balassa-Samuelson effect. The Balassa-Samuelson effect argues that exchange rate may appreciate following an improvement in the technology of the production of traded goods. This happens through the impact of these technology shocks on the price of non-traded goods. 0ur results, in line with Balassa-Samuelson effect, document that exchange rates appreciate (fall) considerably in most quarters after a productivity gain however after an on impact depreciation which lasts for 10 quarters. These movements of exchange rate, on the other hand, contrasts evidences obtained from the rest of the litrature which use long-run restrictions to identify technology shocks. The exchange rate medium-term movements in this thesis shows that exchange rate depreciates (increases) just for the several initial quarters. Subsequently, the exchange rate falls beyond its steady-state level before the shock happens. The same medium-term patterns for the exchange rate is also confirmed in the study of Enders et al. (2011) for the US.

4.3.3 Our Results and *further* issues in the literature

This chapter investigates the dynamic response of a series of euro area macroeconomic variables to fiscal policy and technology shocks employing structural VAR models. The similar studies for the euro area, however, mostly concentrate on monetary policy rather than fiscal policy. For instance, Peersman and Smets (2001) merely analyze monetary policy shocks, and Peersman and Straub (2004) estimate both monetary and technology shocks using model-based sign restrictions. In contrast to those papers, we identify fiscal policy shocks as well as technology shock simultaneously by imposing theoretically-consistent restrictions in line with Enders et al.(2011).

The identification of impulse responses that built on structural VAR models aims not just at calculating the properties of the data. It also tends to determine the set of shocks that should be integrated in dynamic general equilibrium models. A controversial debate in the literature is to understand the impacts of positive technology shocks on main economic indicators such as hours worked under different specifications.[97]

Sousa et al. (2012) investigate the impacts of a one-standard deviation positive technology shock and argue that it induce a steady increase in the output. Furthermore, wages, consumption and investment also react positively to a technology shock. These results has been confirmed in most benchmark theories. The difference between their study and ours, however, is that they study the impact of monetary policy together with technology shock while our focus is on the effects of fiscal policy and technology shock. We also find a continuing development in private consumption after a technology shock however GDP and private investment merely increases for initial 12 and 16 quarters respectively

[97]Several studies have been done in this regard, namely Basu and Kimball (2004) and Gali (2004). Also see Erceg, Guerrieri and Gust (2005) for a compehensive study of the reliability of identifying technology shocks using long-run restrictions on a VARs.

following the shock and then they start to fall till the very end of the period. Both studies affirm each other on the reaction of inflation to a technology shock. Inflation's reaction is mainly contemporaneous and the largest response happens on impact. Besides, this reaction is not statistically important and it is not different from zero[98]. They finally conclude that positive technology shocks create a permanent drop in the number of labor input employed in the economy. Sousa et al. (2012) finally suggest that hours worked are procyclical which calls into question the reliability of the RBC paradigm. Indeed, if productivity gains were the major drivers of business cycles in the economy then their VAR results would show a negative relationship of hours worked and output growth and not the positive one evidenced in their study, (Enders et al. (2011))[99]. Christiano et al.(2003), as well, show that a technology shocks induce an increase in consumption, investment and output. Hours per capital's reaction, however, is in a sharp contrast with the evidences reported in a large body of literature in which per capita hours worked decreases following a positive technology shock. These papers utilize a reduced form time series models employing minimal identifying assumptions to estimate a technology sock's impact on the economy. Their results are significant since they cast doubt upon the basic properties of many structural business cycle models which imply that per capita hours worked increase after a permanent shock to technology. Concurrently, they imply that permanent technology shocks does not have any significant role in explaining business cycle fluctuations. After all, technology might produce quantitatively significant impacts if one accepts the traditional growth models theories. Dedola and Neri (2007), furthermore, examine U.S time series data for the postwar period and argue that a positive technology shock push U.S. hours worked per capita after one year. Contrary to Christiano et al.(2003), their results confirm the significant role of a technology shock in determining output dynamics and are in line with the predictions of standard RBC models. One of the main differences between DeDola and Neri (2007) and Christiano et al.(2003) is that the former use sign-restriction approach in identifying the technology shock.

In the fiscal policy literature, we investigate the impacts of the changes in government expenditure on key economic indicators such as private consumption. This is a crucial issue since fiscal policy is believed by policy makers to have an important impact on individuals' welfare given that private consumption is the largest portion of the aggregate demand. Macroeconomic theories, in contrast, do not have a universal opinion about the welfare implications of the fiscal shocks. According to the textbook Keynesian theories,

[98] In their model however, they also include per capita hours and show that it seems to fall permanently which is similar to the one reported by Gali (2004) for the euro area.

[99] Their results from VARs model which are based on restrictions are in line with the conclusions reported in Christiano, Eichenbaum and Vigfusson (2004), the response of hours to a technology shock would also change substantially if hours worked were found to be stationary.

private consumption increases following a positive shock in government spending. It is however argued that the impact of a fiscal policy shock on aggregate output depends on the changes in investment. Additionally, investment broadly relies on the monetary policy determination of the interest rate. This model assumes that economic agents maximize their utility function and finance their consumption out of their present income. Most modern-day macroeconomic models, on the other hand, follow the neoclassical theories and assume that consumers are infinitely lived consumption-smoothing agents. These models predict a fall in consumption following an increase in government expenditure through negative wealth effect. This effect comes from the fact that economic agents predict an increase in tax rates in future by governments in order to finance their current fiscal expansions. The empirical literature, however, provide conflicting answer to the question of the impact of fiscal policy on consumption.

Gali et al. (2007) and Erceg et al. (2006) suggest that their results confirm the presence of the "hand-to-mouth" consumers who their consumption behavior leads to the crowding in of the private investment. A study by Rossi et al. (2004), however, could not find enough support for the Gali et al. (2007) findings after replicating their results by assuming that individuals are rule-of-thumb consumers if taxation is distortionary instead of being lump-sum. Our results in this thesis, in contrast, shows that consumption falls following an on impact increase of this variable which merely lasts for 8 quarters after an expansionary government expenditure. Coenen et al. (2007a) also shows an increase in consumption following an expansionary fiscal shock which is negligible. Horvath (2009), align with this thesis, notice that an increase in private consumption after a rise in government expenditure is not generally an character of the economy under optimal stabilization. This holds even when one's definition of the consumer behavior is different from conventional macroeconomic theories. Indeed, he argues that a "crowding-in" effect of consumption following a government expansion merely happens in situations that might be hard to reconcile with realities in advanced countries.

4.4 conclusion

In this chapter, we investigate international relative prices and its impact on the behavior of a couple of important economic variables after an expansionary government expenditure and technology shock in Euro Area. More specifically, the center of interest here is on the effects of productivity gains and fiscal shocks on exchange rate. The real exchange rate is an important factor since it contains important information regarding the international transmission mechanism, (Enders et al. (2011)). Furthermore, the role of fiscal shocks and technology shocks altogether in particular had not previously been studied in the case of the Euro Area. The results in his literature to a large extent depend on the estimated VAR models in which identification is obtained either by short-run or long-run restrictions. These models are widely just based on a standard collaborations, which exclusively provides evidences by construction. We employ sign restrictions derived from the DSGE models in this chapter in order to identify structural shocks and more specifically technology shock. More importantly, the existing evidence on the reaction of exchange rate following a technology and government spending shocks is controversial and and seems to call into question the predictions of international business cycle models.

We document evidences for 15 countries in the Euro Area using a different identification method which involves Bayesian econometrics and sign restrictions. For obtaining robust sign restrictions, following Enders et al. (2011) we achieve 100,000 simulations of parameters based on a quantitative business cycle. To identify shock simultaneously, several variables have been restricted by our identification scheme while we leave the response of the exchange rates to be determined by the data. Standard models predict that government spending and technology shocks appreciate and depreciate exchange rates respectively. Our results confirm the predictions of the benchmark models about the exchange rate in particular about the impact of fiscal policy. We could not, however, find enough support for the alternative calibrations of these models which assumed a low trade price elasticity.

Assessing a VAR model on time series data for the Euro Area relative to the U.S. economy, the results suggest that expansionary government spending shocks appreciates (decreases) the real exchange rate. Furthermore, the real exchange rate depreciates (increases) after a positive technology shock however just for a short period of time. With regard to the basics, our empirical results to some extent can justify the predictions of standard business cycle models. More importantly, it seems like different parametrization of the model we used does not necessarily lead to different behavior of exchange rate responses to both shocks. Corsetti et al. (2008a) document that robust wealth effects after a technology shocks push the demand for domestic goods further than supply and therefore appreciate the exchange rate.

Conclusion

The recent position of central banks is one of the most misleading statuses to aid the economy recover the output or employment. In the meanwhile, expansionary fiscal policies are constrained. This restriction is as the result of fears about the level of public sector debt, deficits and increasing in the population of old people. In this circumstance, with the fiscal expansion being restrained, it is an exceeding pressure on central banks to implement expansionary monetary stimulus by politicians. Furthermore, Goodhart et al. (2012a) argue that the central banks independence has always been limited to "operational independence" and not "goal independence". Policy makers hence have always the final power to set the goals of central banks. For instance, recently, after long debates about the significant amendment in the goal of the Bank of Japan in delivering monetary policy, BOJ merely has changed inflation target from one percent to two percent to be consistent with the Bank of England (BOE) and European Central Bank (ECB). Even though the issue of the independency of the central banks is not the focus of this thesis, it is recommended for the further study. In this thesis, on the other hand, we are mostly interested to empirically investigate the impacts of different shocks on the economy.

The impacts of monetary policy on main economic indicators such as output, price levels and the exchange rate is a controversial issue in the literature. After the great depression at the start of the 1980s, for example, economists take it as a fact that a contractionary monetary shock can create severe recession. Basic econometrics approaches also simply confirm these findings and show that an increase in the federal funds rate is followed by falls in output. These results, however, can not be reproduced once using multiple time series analysis. In the first chapter of this thesis, we study the effects of the monetary policy shocks on output, exchange rate and prices for the UK, the US and Japan as well as three emerging countries namely Malaysia, Mexico and Korea. We accomplish our study applying an identification method recently proposed by Uhlig (2005). In this context, to achieve identification we levy sign restrictions on domestic short-term interest rates, prices and total reserves for the first six months following the contractionary shock. We put no restrictions on real exchange rate and output so that the impulse responses of these variables are entirely ruled by the data. Concerning the restrictions that we enforce, we succeed the benchmark theories and presume that a contractionary monetary policy shock does not lead to a decrease in domestic short-term interest rates, does not raise domestic prices and does not jump total reserves. We have three sets of remarks.

First, for all the countries in this study, the reaction of real output to adverse monetary policy shocks is ambiguous. Therefore in most cases it does not have a substantial effect on output as the response can be positive as well as negative. Thus, we cannot be as comfortable as before when remarking on the impact of a tightening monetary shock on the output. Second, we see price puzzle in developed economies, for Japan and UK when we use the full sample period during which both countries involved in two different periods of crises including the recent 2007-2009 financial crises. We explore that the price puzzle is an artifact of excess lending and poor banking regulations. Excess lending prior to financial crises produced inflationary expectations that in the case of UK have been broadened by depreciation of the home currency. Put it differently, we speculate that the price puzzle in Japan and the UK is not a result of passive monetary policy, as the central banks were active through out the sample period, but rather it is an effect of the poor regulation of the banking system that bring about a lending boom and inflationary expectations. Our results imply that the right tool to fulfill market expectations and to restore public confidence is through increasing the transparency of banking system and introducing a better financial regulatory system. For emerging countries, we perceive the price puzzle merely for the case of Mexico. We show that this observation disappears for the post-crisis period. We suggest that the price puzzle was the result of real exchange rate appreciation produced by a passive monetary policy accommodating higher level of inflation than that is needed to achieve equilibrium in the balance of payments.

Third, in developed countries, we show that the exchange rate puzzle happens in the UK and the US while we detect the delayed overshooting for Japan. Empirical support indicates that in Japan exchange rate reacts to mitigate expected inflation while in the UK and the US exchange rate response accommodates expected inflation[100]. For emerging countries, we offer evidence that the Mexican Peso displays momentous evidence for delayed overshooting. Generally, while these observations we present here would be of use to researchers and policy makers, as data becomes available more research on emerging economies is warranted. Finally, the results in this thesis recommend that monetary policy shocks can explain only a small fraction of the variation in output and prices. Quantitatively, monetary policy shocks appear to have a trivial impact on exchange rate fluctuations as well as output, in contrast to some of the literature.

Relative to the large empirical works on the properties of monetary policy, fiscal policy has attracted less attention in the literature until very recently. This is indeed in contrary with the public debates that provoke the macroeconomic importance of government spending and taxation. The discussions around the Balanced Budget Amendment in the US, the deficit limits of the Growth and Stability Pact under EMU, or the possibility of

[100]In an attempt to explain empirical findings of delayed overshooting theoretical research such as Gourinchas and Tornell (1996, 2002) argue that delayed overshooting is the by- product of learning the current state and the intrinsic dynamic if interest rate reaction to monetary shocks.

having independent institutions overseeing fiscal policy are all grounded in the assumption that fiscal policy is an efficient instrument for stabilizing business cycles variations. The necessity for empirical evidence to explicate the concerns in these debates prompted a large body of new research, which can be roughly classified in three groups. First, a group of economists dedicated to exclusive episodes, fiscal consolidations, to analyze the macroeconomic influences of large cuts in the budget deficit. The second line of research study the stabilizing competence of fiscal policy variables, i.e. to what degree the tax and transfer system delivers protection against particular regional shocks and how well it soothes macroeconomic fluctuations in the aggregate. Lastly, the dynamic outcomes of discretionary fiscal policy on macroeconomic variables - a classical matter in the enormous macroeconometric models of the 1960s and 1970s was just revived within the context of vector autoregressions in the work of Blanchard and Perotti (1999).

In the second chapter of this thesis, we investigate the responses of important economic variables to shocks in diverse types of fiscal policies; both expansionary and contractionary. We investigate the impacts of fiscal policy innovations by employing a methodology put forward by Uhlig (2005) for studying monetary policy. This methodology merely uses the information in the macroeconomic time series data and employs as little prior assumptions as possible to identify fiscal policy innovations. Crucially, it imposes no restrictions on the impulse responses of the chief variables of the interest namely GDP, private consumption and wages following a fiscal shock. We therefore study two main EU economies namely UK and Italy using quarterly data from 1970 to 2009.

We associate our empirical estimations to standard real business cycle model and Keynesian model to comprehend which model is more influential in describing the evidences following a fiscal policy shock. We note that an increase in government expenditure has an expansionary effect on output that is mostly as a result an upturn in private consumption. Turning to RBC and Keynesian models, we notice that the standard RBC model fails to fit the data. The leading difference between our estimations and the RBC lies in the performance of private consumption after an expansionary fiscal policy. It appears that consumers behave in non-Ricardian fashion rather than looking at their lifetime income to decide whether to consume or not. In other words, dissimilar to the RBC model that predicts that private consumption drops following an expansionary government spending, we find out that it indeed increases constantly after this expansionary shock happens. The further difference is in the response of wage to a fiscal shock where we find that wages increases after an expansionary fiscal policy rather than decreasing.

Following the RBC models, one should expect that after an increase in government purchase, labor input rise in any given rate of wage that consequently lead to a fall in real wages[101]. This prediction is not confirmed in this piece of work. In contrast, we find that wages increase following an expansionary government spending shock. Gali et al. (2007) offer a neat explanation for this phenomenon: they basically use the relationship between rule-of-thumb consumers (for whom their consumption is a function of their labor income) and sticky prices (which is the assumption of New-Keynesian models) to show how an increase in government spending lead to an increase in consumption. Furthermore, this is in line with most of the recent literature. Rule-of-thumb consumers reduce their consumption as an impact of negative wealth effect. Real wages, in the meanwhile, increases because of sticky nature of prices even though there will be a fall in marginal product of labor after an expansionary government spending. This happens since price markups may fall to fill the resulting gap.

Both higher real wage and higher employment raises current income and therefore boosts consumption of rule-of-thumb consumers. However, in models where the labor market is not competitive and wage mark-ups are countercyclical, consumption and hours of working increase without requiring real wage to increase. Since these models conventionally assume positive co-movements of private consumption and government expenditure, they believe their results are providing a candidate explanation to the existing conflict between empirical evidence and the predictions of existing DSGE models concerning the impacts of government spending shocks. After a tax-cut, however, responses are totally different. While wages increase for most of the period after a tax-cut in this thesis, it initially falls for two years in Italy and then starts to increase.

Finally, it is worthwhile to stress that three types of fiscal policy shocks has been studied in this chapter: a deficit financed spending shock, a balanced budget spending shock (financed with higher taxes) and a deficit financed tax cut, in which revenues increase but government spending stays unchanged. Furthermore, we study most of these shocks both in contractionary and expansionary scenarios. To conclude our finding in a nutshell, one can see that most of the expansionary shocks have an expansionary effects on both output and private consumption while contractionary shocks generate recessionary impacts on the economy for both UK and Italy.

The last chapter of this thesis attempts to understand how the real exchange rate react to government spending and technology shocks. This question is fundamental to shed some light on the international transmission mechanism and has become the topic of a substantial discussion. Inclusively, the current evidence seems to be difficult to merge with the forecasts of both Mundell-Fleming type and intertemporal business cycle models under standard settings. In this chapter, we attempt to form latest evidences on the performance

[101] It is justified by the assumption that after-tax lifetime income drops after an expansionary government expenditure which result in a fall in consumption via negative wealth effect.

of couple of main economic variables after an expansionary government expenditure and technology shock in Euro Area. Precisely, it spotlights the outcomes of productivity gains and fiscal shocks on exchange rate. Exchange rate dynamics in fact contain important information concerning the international transmission mechanism. Likewise, the role of fiscal shocks and technology shocks altogether in particular had not formerly been studied in the case of the Euro Area. This evidence is to a large degree depends on the estimated VAR models in which identification is pursued either by imposing short-run or long-run restrictions. Recent empirical models are simply roots in standard collaborations of the theoretical frameworks. This basically implies that they might exclusively offer evidences by construction. We engage sign restrictions originated from the DSGE models in order to identify structural shocks. Besides, the existing literature about the response of exchange rate following a technology and government spending shocks is controversial and contrasts the predictions of real business cycle models.

We provide indications for the countries in the Euro Area using a different identification technique that contains Bayesian econometrics and sign restrictions. For acquiring robust sign restrictions, we succeed 100,000 simulations of parameters based on a quantitative business cycle. To identify both government spending and technology shocks, we restrict the responses of several variables while leave the response of exchange rates unrestricted. Textbook models predict that government spending and technology shocks appreciate and depreciate exchange rates correspondingly. As a consequence, one may deem our results align with these benchmark models, chiefly in the case of fiscal policy, and in contract with alternative calibration that assume a low trade price elasticity.

Assessing a VAR model on time series data for the Euro Area relative to the US economy, the results imply that expansionary government spending appreciates (decreases) the real exchange rate. Moreover, the real exchange rate depreciates (increases) after a positive technology shock however just for a short period of time. With regard to the basics, our empirical results to some level can rationalize the predictions of standard business cycle models. More crucially, it appears like different parameterization of the model we expended does not necessarily result in different behavior of exchange rate responses to both shocks. Corsetti et al. (2008a) argue that robust wealth effects after a technology shocks push the demand for domestic goods more than supply and consequently appreciate the exchange rate.

1.1 Limitations and Policy Implications

This final section addresses the issues regarding the failures of standard macroeconomics. It therefore elaborates the reasons that macroeconomics has failed so significantly and then discusses some of the implications of the analysis. Structural vector auto-regressions (SVAR) are employed as a reliable tool to study the impacts of different shocks empirically. The first step in using SVAR is to choose a theory. This theory will be employed to derive restrictions and then impose these restrictions on the model to identify the shocks. However, there is not a unique theory that is accepted by macroeconomists as a universal model in explaining the economy. This has a significant adverse effect on empirical research since researchers cannot universally agree on a specific theory that can explain the economy after these shocks. Identification of the shocks in the SVAR system, therefore, becomes unreliable since they are identified based on controversial assumptions. This thesis is tackled this issue by going from data to theory and letting the data determine which theory explains economic fluctuations more coherently. The sign-restrictions that have been utilized here are not generated by a particular theory. Rather, merely the assumptions that are well-documented in the literature are employed in this study, regardless of which theory they belong to. The results find little support for the predictions of the RBC model after technology, monetary policy and fiscal policy shocks. The data, however, does seem to confirm the interpretations of the new-Keynesian model to some extent. More importantly, they suggest that the theories such as the NCM model is more successful in explaining the impacts of shocks on the economy. One could therefore confidently employ the predictions of the NCM model in achieving identification in the future.

In this thesis, one observes that the theories rooted in the frictionless market assumptions fail to satisfy the reality. Other theories which take into account different frictions and imperfections in the market explain the data more successfully. This might imply that the economy is not necessarily stable nor self-correcting. This conclusion has been exemplified by the current financial crisis. Furthermore, in this study one observes that the macroeconomic models that are simplistic in explaining the data largely focused on exogenous shocks. On the contrary, it seems that a large proportion of the macroeconomic fluctuations come from endogenous sources which are long-run structural and persistent shocks. Therefore, the models that just concentrate on exogenous shocks tend to perform poorly in explaining the data. These results show that the majority of the really big shocks are generated within the economy. This might be the reason that most standard economic theories failed to predict the occurrence of the financial crisis in 2008.

The other important interpretation is that markets by themselves do not lead to efficient and stable outcomes, (Stiglitz (2011a)). Therefore even though policies might help economies to better accommodate more trivial shocks, in reality they weaken the economy's ability absorb bigger shocks. This probably holds for most of the integrations within the financial market that help the economy dealing with some of the smaller shocks, but apparently make the economy more vulnerable to much bigger shocks. Furthermore, even though the literature is largely focused on “too big to fail” banks, it has not literally talked about the issue of “ too correlated to fail”, (Haldane (2011)). It is therefore worth paying more attention on the relationship between financial stability and financial integration in future macroeconomic research.

There are some important lessons to learn from the current financial crisis and the implications of this study. The current financial crisis, has indeed been the materialization of the failure of macroeconomic modeling. It is very clear that the standard macroeconomic models did not work very well. But, what did go wrong that we could not use models properly? And is there anything that we can learn from it? The fact that economic models did not work should be apparent to everyone; economics is regarded as a science and therefore, the facts in economics should be tested. However, many economists and economic models failed to predict the most important economic phenomenon of the last decades. Conventional macroeconomic models, therefore, are believed to stand in the way of conventional wisdom. For example, most models of conventional monetary policy assume that price stability is necessary for the economic stability. The deficiency is that these models are largely grounded on the assumption of price distortions. They, therefore, widely associate monetary policy as a tool to tackle low and medium inflation rates and ignore the fact that the loss function of the economy is the financial crisis. Financial crisis in fact costs much more than high inflation, which is the centre of attention in all inflation targeting models. The scope of disaster created by the financial crisis is not comparable with the costs of high inflation. For example, many countries were experiencing very high inflation before financial crisis in 2008, but then it was mostly the inflation of food and energy. If one uses the inflation targeting models, one would have to destroy the entire economy (Stiglitz (2013)). These models should not be accepted because they are not based on robust assumptions. On the contrary, they are used globally by the central banks and politicians.

DSGE models have been used in this thesis for empirical estimation. This approach, however, has some significant limitations. Goodhart et al. (2012), among others, argue that the recent financial crisis proves how unsatisfactory DSGE models perform by concentrating on the wrong variables. To understand this failure, one might study the state development of the current macroeconomic models. During the 1950s and the 1960s, macroeconomists started creating computerized models of the economy based on the income-expenditure Keynesian model. This is called “reduced-form” equations using a Keynesian framework. Lucas (1998), nevertheless, claims that these equations tend to produce incoherent results. Additionally, it contains no genuine microeconomic foundations. This is called the “Lucas critique”. Therefore, his followers began setting up macroeconomic models based on the microeconomic foundations. Furthermore, economists from that period started noticing the detachment between microeconomics and macroeconomics. It was also a natural desire to reconcile these two strands of economic thought. There were therefore two approaches to connect macroeconomics with microeconomics. The first approach was to accept that microeconomics is rooted in wrong assumptions and try to make it realistic. The other way was to assume that microeconomic assumptions such as perfect competition and perfect information are robust and therefore use these assumptions as the foundation to study macroeconomics (Stiglitz and Greenwald (1988)). The latter approach was taken by mainstream economists. This is, however, a controversial task. One of the important issues is that these models are not able to capture the probability of "default" among financial participants. This happens since economists presume a "representative agent" to make DSGE models easy to estimate. This assumption simply rules out the possibility of default since then either the whole financial system does not exist, or nobody at all defaults. Eliminating default implies that all agents are willing to borrow or lend at a risk-less rate. Furthermore, there are no risk premiums in this economy since all participants are totally credit-worthy. In other words, everyone is as credit-worthy as the government in these models and hence there is no need for financial intermediaries. There is therefore no banking sector or money in this model. Consequently, everything that central banks ought to be interested in, such as default, financial frictions and banks are excluded from the DSGE models.

The other important point is that high level macroeconomic systems might have contrasting properties from the low level microeconomics system which they are based on. The DSGE models, in fact, have broken down in different aspects and future macroeconomics research should study the unrealistic assumptions that have caused this failure to occur. For example, economists should re-investigate assumptions concerning risk and uncertainty, representative agent assumption, rational expectations etc. Stiglitz (2011a,b) proposes to try different models and drop some of the critical assumptions to test them empirically. This being the case, the focus of the future macroeconomic modeling would be to examine the assumptions that are the most crucial reasons in generating the unrealistic outcomes and find a solution for them. Even though the literature is not well-grounded yet in this matter, it has been confirmed in some studies that the current version of the "rational expectations hypothesis" and "wage rigidity assumption", for instance, have led to many false conclusions. Stiglitz (2013) argues that wage rigidity is indeed a very wrong assumption because if wage rigidity is the problem, then the solution is to make labor wages more flexible. More importantly, these kind of economic results have some very significant political impacts in the real world. For example, the People's Bank of China has recently talked about lowering wages as the solution to reviving the economy. Nonetheless, even in the Keynesian economics context, lowering wages leads to less aggregate demand and worsens the situation by creating debt deflation. Stiglitz and Greenwald (2010) furthermore claim that debt inflation in fact has more explanatory power for economic fluctuation than wage rigidity. It also plays a significant role in the models that inform central bankers and made them aware of the current mess.

However, Sims (2012a,b) argues that sometimes criticizing DSGE models is an easy way to satisfy the readers. The first thing to consider is that there is as yet no alternative for what DSGE models are offering to central banks. Central banks have just a few months to decide their next action. Many of the central banks therefore extensively use the models that play an important role in understanding the state of the economy and the likely impacts of their various policy actions. It is true to argue that before DSGE models were introduced, the old models were doing the same task for central banks. However, it is absolutely important for policy decision-making to utilize the large amount of data coming in. This can indeed, in some coherent way, contribute to the discussion of the state of the economy and options for policy making. The important aspect of DSGE model is its competence in organizing the data. Put differently, the advtange of DSGE models is that they employ rational expectations hypothesis in their analysis. Therefore, they capture expectations and intertemporal budget constraint in an internally consistent way. Sims (2012a) claims that even though DSGE models still do not perform in a way they should, the theories that were used before behave much worse in these respects. In many cases, their match to the data as models of the joint times-series behavior of large collection of the variables are much more reliable than the previous models. In this respect, at least, no model can be considered as the DSGE model competitor to up to this time.

Sims (2012a,b), nonetheless, agrees with the critiques of the DSGE model that unfortunately some of these models that include central banks, have literally left out financial sectors. However, there is a new-Keynesian DSGE model which contains a straightforward financial friction inside the model that includes investment financed by collateralized debt. This implies that it does not have a representative agent of the kind that Stiglitz et al. (2012), for instance, criticized. It simply has investors on one side and firms on the other side and the institutional frictions occur in transferring funds from one side to the other. These models show that the shocks to collateral requirements have considerable effects on the business cycle. Furthermore, the existence of the collateralized-debt finance in the economy has significant implications on financial stability and policy effects. Additionally, one important issue to investigate further is to test whether inflation targeting, which is usually used in conjunction with the DSGE models, is indeed a deficient policy in the face of the exogenous shocks in price levels. The discussion regarding this question is beyond the scope of this thesis; however it could be a potential topic to investigate in the future.

Last but not least, the main tools of monetary policy is the interest rate on overnight loans between banks. This holds in normal times when overnight interest rates are considerably sensitive to the level of excess reserves. Nevertheless, since the current financial crisis began in 2008, the Federal Reserve's target for the fed funds rate has been virtually zero. Hamilton and Wu (2012) argue that: "The level of reserves, which had typically been around 10 billion dollars prior to the financial crisis, has been maintained in the neighborhood of a trillion dollars"[102]. Therefore, neither lowering the short-term interest rate nor raising the quantity of reserves any further can expand aggregate demand and output. Since the central bank's traditional instruments are no longer able to further boost the economy, it is of considerable interest to ask, in further research, what other options central banks have to implement monetary policy.

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2 Appendix 1

2.1 A: Priors

Most empirical research on Bayesian estimations of DSGE models apply rather informative prior distributions. The purpose of using the prior is to implement other kinds of information that are not directly introduced in the likelihood function. A number of priors might be used with the VAR system. Priors change regarding to three subjects: First, VARs are not parsimonious models as they have a great many coefficients. For instance, the number of observations can exceed a few hundred on every variable in quarterly data. Choosing not to use prior information makes it really difficult to achieve reliable estimates of so many coefficients. Features such as impulse responses and forecasts could also be estimated inaccurately[103]. Second, the priors employed with VARs vary depending on whether priors are used to generate results for the posterior and predictive densities, or whether Markov chain Monte Carlo (MCMC) approaches are indeed required to do this Bayesian inference[104]. Third, the priors differ in how robustly they are able to deal with deviations from the unrestricted VAR[105].

2.1.1 The Independent Normal-Wishart Prior

The prior that has been used in this thesis is Normal-Wishart prior. Bayesian inference in VAR models demand posterior simulation algorithms for example the Gibbs sampler. The

[103] i.e., posterior or predictive standard deviations can be large.

[104] Koop and Korobilis (2009) argue that:"with the VAR, natural conjugate priors lead to analytical results, which can greatly reduce the computational burden. Particularly if one is carrying out a recursive forecasting exercise which requires repeated calculation of posterior and predictive distributions, non-conjugate priors which require MCMC methods can be very computationally demanding."

[105] This literally means permitting different equations to have different explanatory variables, letting VAR coefficients differ over time, allowing for heteroskedastic structures for the errors of various sorts, etc.

natural conjugate prior has $\vartheta|\Sigma$ being Normal and Σ^{-1} being Wishart[106]. The fact that the prior for ϑ relies on the value of σ means that ϑ and σ are not independent from each other. Therefore, we use a prior that possess VAR coefficients and the error covariance being orthogonal to each other and therefore is being called "independent NormalWishart prior".

We then re-write each equation of the VAR as[107]:

$$y_{mt} = z'_{mt}\beta m + \varepsilon_{mt} \tag{2.1.1}$$

where $t = 1, ..., T$ observations for $m = 1, ..., M$ variables vector. y_{mt} is the tth observation on the mth variable. z_{mt} is a K_m-vector holding the tth observation of the vector of explanatory variables related to the mth variable. βm is the supplementary Km-vector of regression coefficients.

By allowing z_{mt} to fluctuate across equations, it essentially permits some of the coefficients on the lagged dependent variables to be restricted to zero. This is called the "restricted VAR".

We can pile every equation into vectors and matrices as follows:

$$y_t = \begin{pmatrix} y_{1t} & y_{2t} & \dots & y_{Mt} \end{pmatrix}' \tag{2.1.2}$$

$$\varepsilon_t = \begin{pmatrix} \varepsilon_{1t} & \varepsilon_{2t} & \dots & \varepsilon_{Mt} \end{pmatrix}' \tag{2.1.3}$$

$$\beta = \begin{pmatrix} \beta_1 \\ \dots \\ \beta_M \end{pmatrix} \tag{2.1.4}$$

$$Z_t = \begin{pmatrix} z'_{1t} & 0 & \dots & 0 \\ 0 & {z_{2t}}' & \dots & 0 \\ \dots & \dots & \dots & 0 \\ 0 & \dots & 0 & {z_{Mt}}' \end{pmatrix} \tag{2.1.5}$$

where β is a $k \times 1$ vector. Z_t is $X \times K$ and $k = \sum_{j=1}^{M} k_j$. We might write the (possibly restricted) VAR by the new notations as:

$$y_t = Z_t\beta + \varepsilon_t \tag{2.1.6}$$

piling as:

[106]Conjugate prior is widely used in the literature.

[107]Please note that we have amended marginally some of the indexation of the VAR equations in this section for describing the prior.

$$y = \begin{pmatrix} y_1 \\ ... \\ y_T \end{pmatrix} \tag{2.1.7}$$

$$\varepsilon = \begin{pmatrix} \varepsilon_1 \\ ... \\ \varepsilon_T \end{pmatrix} \tag{2.1.8}$$

$$Z = \begin{pmatrix} Z_1 \\ ... \\ Z_T \end{pmatrix} \tag{2.1.9}$$

we can write:

$$y = Z\beta + \varepsilon \tag{2.1.10}$$

where ε is $N \sim (0, I \otimes \Sigma)$.

It can be shown that the restricted VAR can be composed as a Normal linear regression model with an error covariance matrix of a particular form. A very typical prior for this model is the independent Normal-Wishart prior as follows:

$$p(\beta, \Sigma') = p(\beta)p(\Sigma') \tag{2.1.11}$$

$$\beta \sim N(\bar{\beta}, \bar{V}_\beta) \tag{2.1.12}$$

$$\Sigma^{-1} \sim W(\bar{S}^{-1}, \bar{\nu}) \tag{2.1.13}$$

It is important to note that this prior permits the prior covariance matrix, $\bar{V}_\beta$, to be exactly what the researcher wants.

Employing this prior, the collaborative posterior $p(\beta, \Sigma^{-1}|y)$ does not show a feasible form that could lead to easy Bayesian analysis. For instance, posterior means and variances do not have analytical forms. Nevertheless, the conditional posterior distributions $p(\beta|y, \Sigma^{-1})$ and $p(\Sigma^{-1}|y, \beta)$ do represent computable forms:

$$\beta|y, \Sigma^{-1} \sim N(\vec{\beta}, \vec{V}_\beta) \tag{2.1.14}$$

$$\vec{V}_\beta = (\bar{V}_\beta^{-1} + \sum_{t=1}^{T} Z_t' \Sigma^{-1} Z_t)^{-1} \tag{2.1.15}$$

$$\vec{\beta} = \vec{V}_\beta(\bar{V}_\beta^{-1}\bar{\beta} + \sum_{i=1}^{T} Z_t' \Sigma' y_t) \tag{2.1.16}$$

In addition:

$$\Sigma^{-1}|y, \beta \sim W(\vec{S}^{-1}, \vec{\nu}) \tag{2.1.17}$$

$$\vec{\nu} = T + \bar{\nu} \tag{2.1.18}$$

$$\vec{S} = \bar{S} + \sum_{t=1}^{T} (y_t - Z_t\beta)(y_t - Z_t\beta)' \tag{2.1.19}$$

Consequently, a Gibbs sampler that successively draws from the Normal $p(\beta|y, \Sigma)$ and the Wishart $p(\Sigma'|y, \beta)$ can be computed in a straightforward way. Like any Gibbs sampler, the subsequent posterior simulator outcome might be utilized to quantify posterior properties of any function of the parameters, marginal likelihoods (for model comparison) and/or to make predictions.

Remember that, for the VAR system, Z_t will hold lags of variables and, therefore, have information dated $\tau - 1$ or prior. The one-step ahead predictive density[108], conditional on the parameters of the model would be:

$$y_\tau | Z_t, \beta, \Sigma \sim N(Z_t\beta, \Sigma) \tag{2.1.20}$$

This outcome, besides a Gibbs sampler yields draws $\beta^{(r)}$ and $\Sigma^{(r)}$ for $r = 1, \ldots,$ R that leads to predictive inference. For example, the predictive mean (a popular point forecast) will be computed as:

$$E(y_\tau|Z_\tau) = \frac{\sum_{r=1}^{R} Z_t\beta^{(r)}}{R} \tag{2.1.21}$$

and further predictive moments might be quantified in a similar approach. Otherwise, predictive simulation could be achieved at each Gibbs sampler draw; however this can be computationally difficult. For prediction horizons larger than one, the direct approach might be employed.

2.2 B: Posteriors and Marginal Likelihood in Bayesian method

Suppose that we have M models symbolized by M_1 till M_M. Every model possess a parameter vector θ_i a fitting prior distribution $p(\theta_{(i)}, M_i)$ for the model parameters, and prior probability $\pi_{i,0}$. The posterior model probabilities are given by:

$$\pi_{i,T} = \frac{\pi_{i,o} p(Y_{1:T}|M_i)}{\sum_{j=1}^{M} \pi_{j,o} p(Y_{1:T}|M_j)} \tag{2.2.1}$$

$$p(Y_{1:T}|M_i) = \int p(Y_{1:T}|\theta_{(1)}, M_i) p(\theta_i|M_i) d\theta_{(i)} \tag{2.2.2}$$

$p(Y_{1:t}|M_i)$ is the marginal likelihood or data density related to model M_i. Providing the likelihood functions $p(Y_{1:T}|\theta_{(i)}, M_i)$ and prior densities $p(\theta_{(i)}|M_i)$ are correctly normalized for each model, the posterior model probabilities are satisfactory defined. As for any model M_i

$$lnp(Y_{1:T}|M_i) = \sum_{t=1}^{T} ln \int p(y_t|\theta_{(i)}, Y_{1,t-1}, M_i) p(\theta_{(i)}|Y_{1,t-1}, M_i) d\theta_{(i)} \tag{2.2.3}$$

log marginal likelihoods may be translated as the sum of one-step-ahead predictive scores. The expressions on the right-hand side of the above equation deliver a decomposition of

[108] i.e., the one for predicting at time τ given information through $\tau - 1$.

the one-step-ahead predictive densities $p(y_t|Y_{1:t-1}, M_i)$. This decomposition emphasizes the point that interpretation about the parameter θi is based on time *t-1* information, when making the prediction for y_t. It is beyond the scope of this thesis to deliver a universal discussion of the procedure of posterior model probabilities or odds ratios for model comparison[109].

It is important to notice that in practice priors are repeatedly based on presample information. As in time-series models data have a natural ordering, we might consider observations $Y_{1:\ddot{T}}$ as presample and $p(\theta|Y_{1,\ddot{T}})$ as a prior for θ that integrates these presample facts. Conditional on $Y_{1:\ddot{T}}$, the marginal likelihood function for succeeding information $Y_{\ddot{T}+1:T}$ is provided by

$$p(Y_{\ddot{T}+1:T}|Y_{1:\ddot{T}}) = \frac{p(Y_{1:T})}{p(Y_{1:\ddot{T}})} = \int p(Y_{\ddot{T}+1:T}|Y_{1:\ddot{T}}, \theta)p(\theta|Y_{1:\ddot{T}})d\theta. \tag{2.2.4}$$

The density $p(Y_{\ddot{T}+1:T}|Y_{1:\ddot{T}})$ is usually referred to as predictive marginal likelihood and might substitute the marginal likelihood we obtained before in the building of posterior model probabilities, if the prior model probabilities are likewise amended to replicate the presample information $Y_{1:\ddot{T}}$. As previously, it is significant that $p(\theta|Y_{1:\ddot{T}})$ is a suitable density. In the framework of a VAR, a correct prior might be attained by substituting the dummy observations $\ddot{Y}$ and $\ddot{X}$ with presample observations.

Posterior model probabilities happen to be usually employed to choose a model specification upon which any subsequent implication is conditioned. Although it is normally desirable to average across every model specifications with nonzero posterior probability, a model selection method could deliver a fitting estimation if the posterior probability of one model is extremely close to one, the probabilities accompanying with all other specifications are sufficiently trivial, and the loss of providing suggestion or resolutions grounded in the highest posterior probability model is not too large if one of the low probability models is indeed accurate.

2.2.1 Empirical estimation of the Marginal Likelihood for SVARs

Bayes factor has normally been used for model comparison in forecasting exercise. In our context, we can compute Bayes factor on reduced form VAR. However, computing Bayes factor for SVAR, which implies that we need to compute marginal likelihood after we put restrictions on impulse response functions, is computationally demanding. The main problem is that selecting a model based on the Bayes factor does not necessarily imply that its impulse response functions are consistent with the underlying theoretical model. More concretely, the best performing model in terms of Bayes factor might perform poorly in terms of theoretical model. This might be the main reason why the MATLAB

[109] A survey is provided by Kass and Raftery (1995).

and the RATS softwares that we used in this thesis in our empirical work do not provide the marginal likelihood.

Koop and Korobilis (2009), similarly, argue that the focus of the macroeconomics literature is on estimation and prediction rather than model comparison or hypothesis testing. Macroeconomists are mostly interested in letting the data speak and then finding a fitting model. Therefore, estimating several parsimonious models and computing statistical approaches to pick a single one is not desirable in macroeconomics research. Furthermore, marginal likelihoods in multi-dimensional models such as SVARs could be too sensitive to the prior that the researcher picks. Therefore, many software packages that are used to compute SVAR do not report marginal likelihoods for high dimensional models since estimating the marginal likelihood is computational demanding.

2.3 C: Givens Matrices

Assuming that we have 3 VAR variables in our macro model, a 3×3 Givens matrix, Q_{12} is the following:

$$\begin{bmatrix} \cos\Theta & -\sin\Theta & 0 \\ sin\Theta & \cos\Theta & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

Q_{12} is referred to as Givens rotation. This matrix is an identity matrix and the block consisting of the first and second columns and rows has been swapped by cosine and sine factors. Θ lies between 0 and $\pi \setminus 2$. Therefore, $Q'_{23}Q_{23} = I_3$ given this mathematical rule that $\cos^2\Theta + \sin^2\Theta = 1$. There are therefore three different Givens rotations for a three variable VAR model; Q_{12}, Q_{13} and Q_{23}. Each of them depends on a separate parameter Θ_k. In empirical studies, most researchers accepted the multiple of the basic set of Givens matrices as Q. For instance, in the three variable example we would adopt:

$$Q_G(\Theta) = Q_{12}(\Theta_1) \times Q_{13}(\Theta_2) \times Q_{23}(\Theta_3) \tag{2.3.1}$$

Q_G is orthogonal and therefore shocks generated as $\eta_t'' = Q_G\eta_t$ are going to be uncorrelated and their impulse response on Z_t will be $\hat{T}'' = \hat{T}Q'_G$.

The matrix Q_G described above depends on three different Θ_K. Canova and de Nicolo (2002) argue that we can make a grid of M values for each Θ_K between 0 and π. Afterwards, one needs to calculate all the possible Q_G. All these models recognized by various numerical values for Θ_K are observationally similar. Their similarity lies in the fact that they all generate an exact fit to the variance of the data on z_t[110]. Simply, only those Q_G yielding shocks that are in line with the provided sign restrictions are kept.

[110]It is presumed in the study that the z_t has been mean corrected prior to the VAR being fitted.

2.4 D: Householder Transformation

Another way of constructing an orthogonal matrix Q is to compute some random variables W from an $N(0, I_3)$ density (for a three variable VAR for instance). Afterwards, one needs to decompose $W = Q_R R$ where Q_R is an orthogonal matrix and R is a triangular matrix. Householder transformation of a matrix is employed to decompose matrix W. The algorithm that generates Q_R is referred to as a Q_R decomposition. $Q_R = I$ relates to the matrix employed in recursive orderings. Runio-Ramirez et al. (2005) who put forward this idea show that as the size of the VAR system grows, this approach is more capable of computing impulse responses relative to the Givens approach. Fry and Pagan (2007) argue that both approaches can be considered as equally effective and the criteria for choosing between these two would be computational speed.

Appendix 2*

*I want to thank Dr.Karoglou from Aston University for his contributions to our joint paper by producing the sensitivity analysis for the UK and the US.

Figure 1: Japan Full Sample

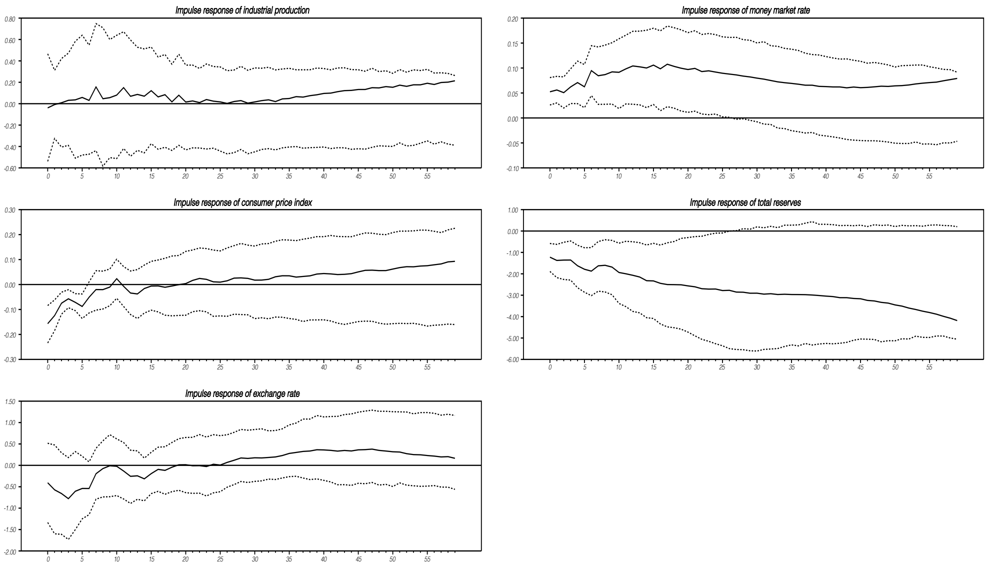


Figure 2: Japan 1992-2007

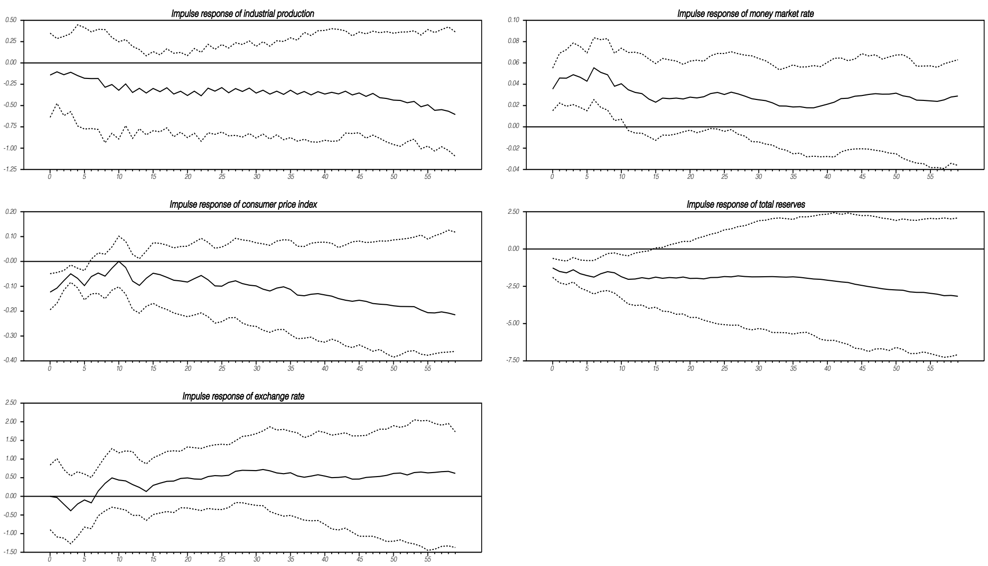


Figure 3: UK Full Sample

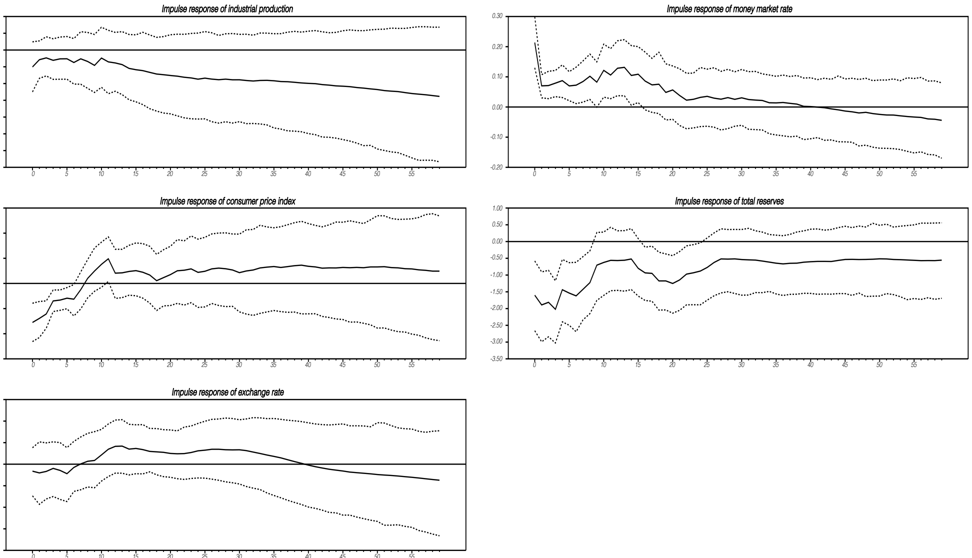


Figure 4: UK 1995-2007

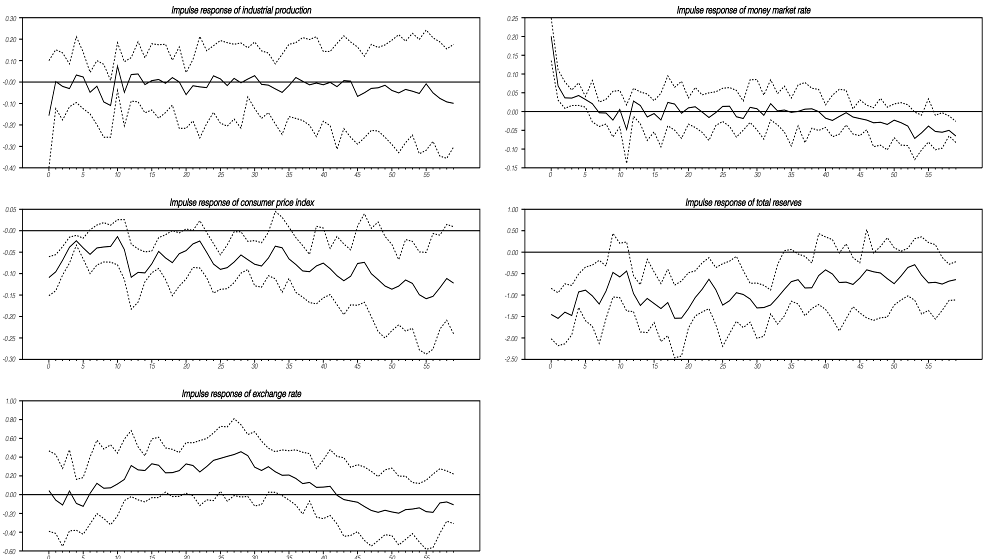


Figure 5: USA Full Sample

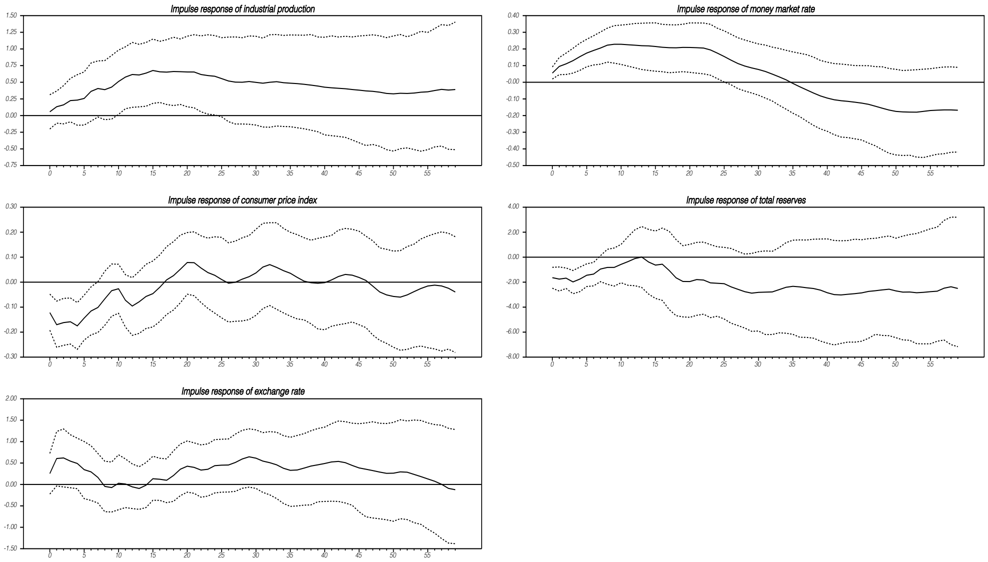


Figure 6: Impulse Responses Malaysia

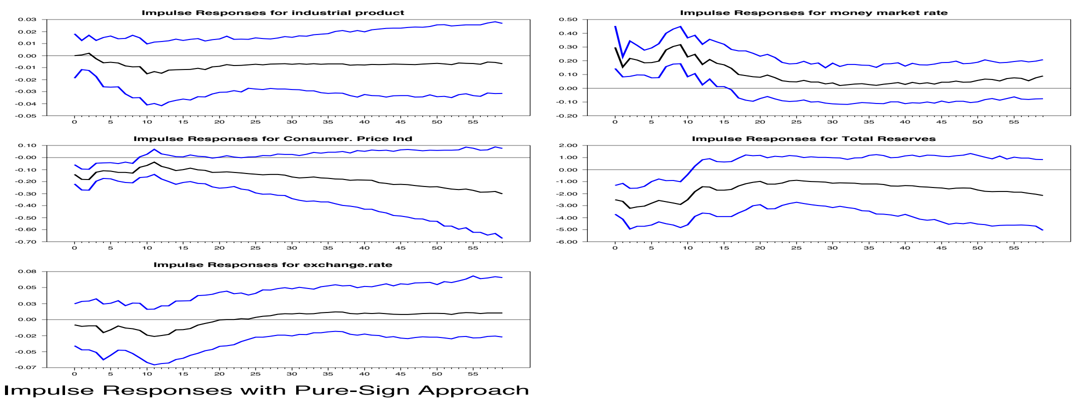


Figure 7: Impulse Responses Korea

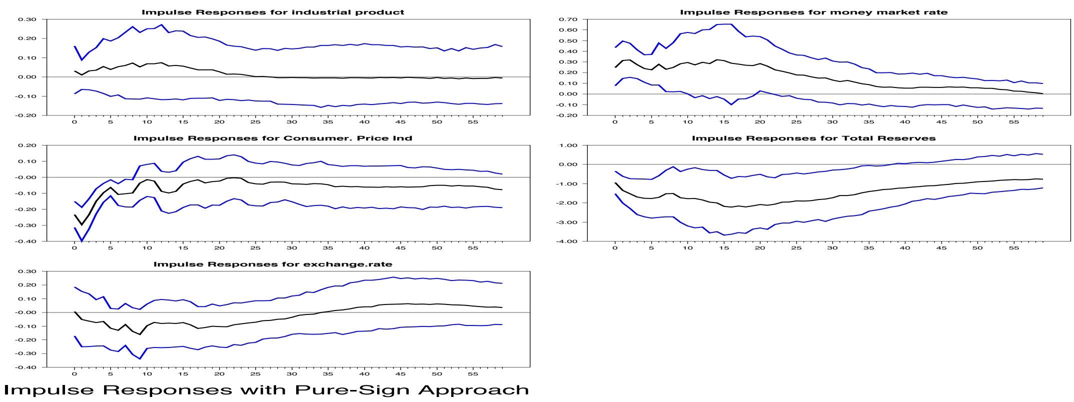


Figure 8: Impulse Responses Mexico

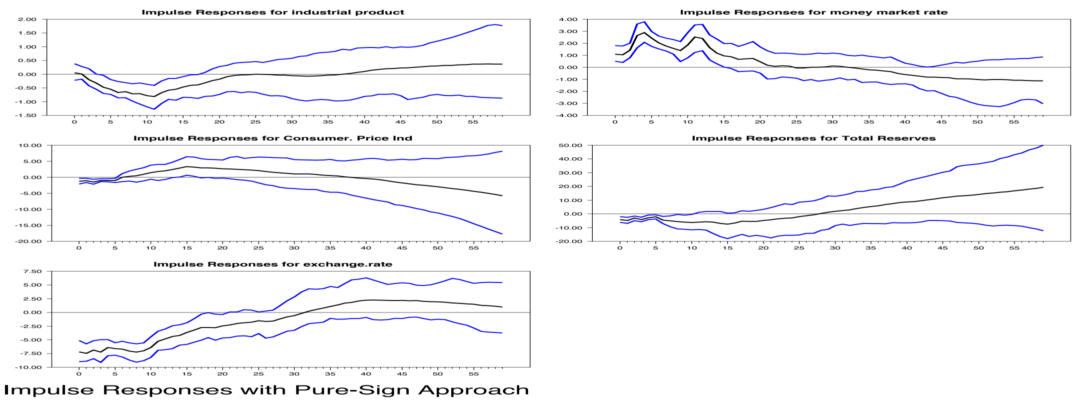


Figure 9: Impulse response Mexico (1995m1-2009m11)

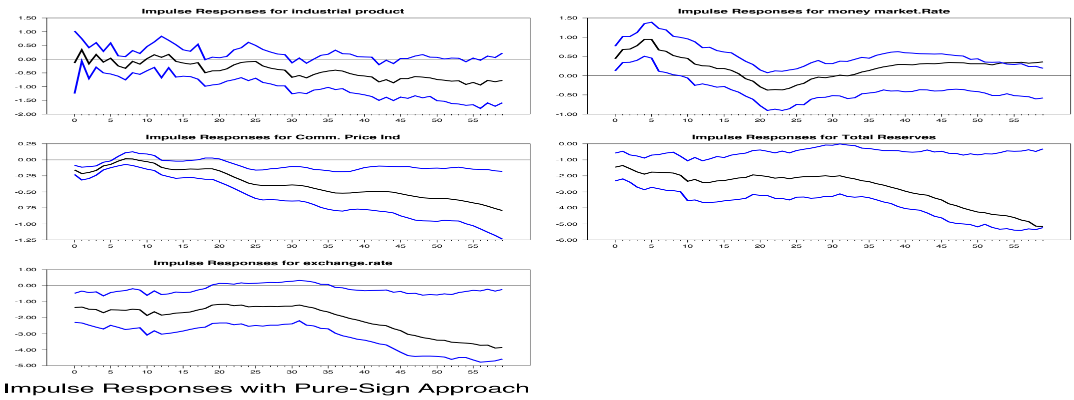


Figure 10: Sensitivity analysis for the UK impulse response

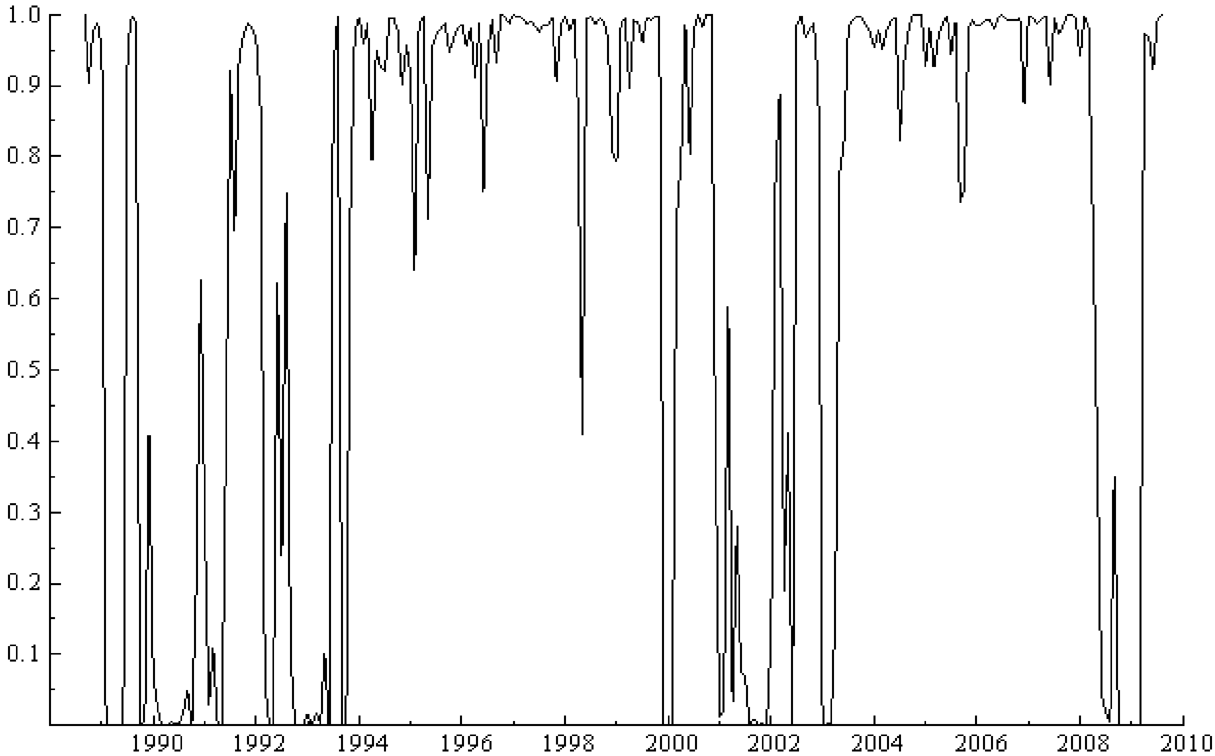
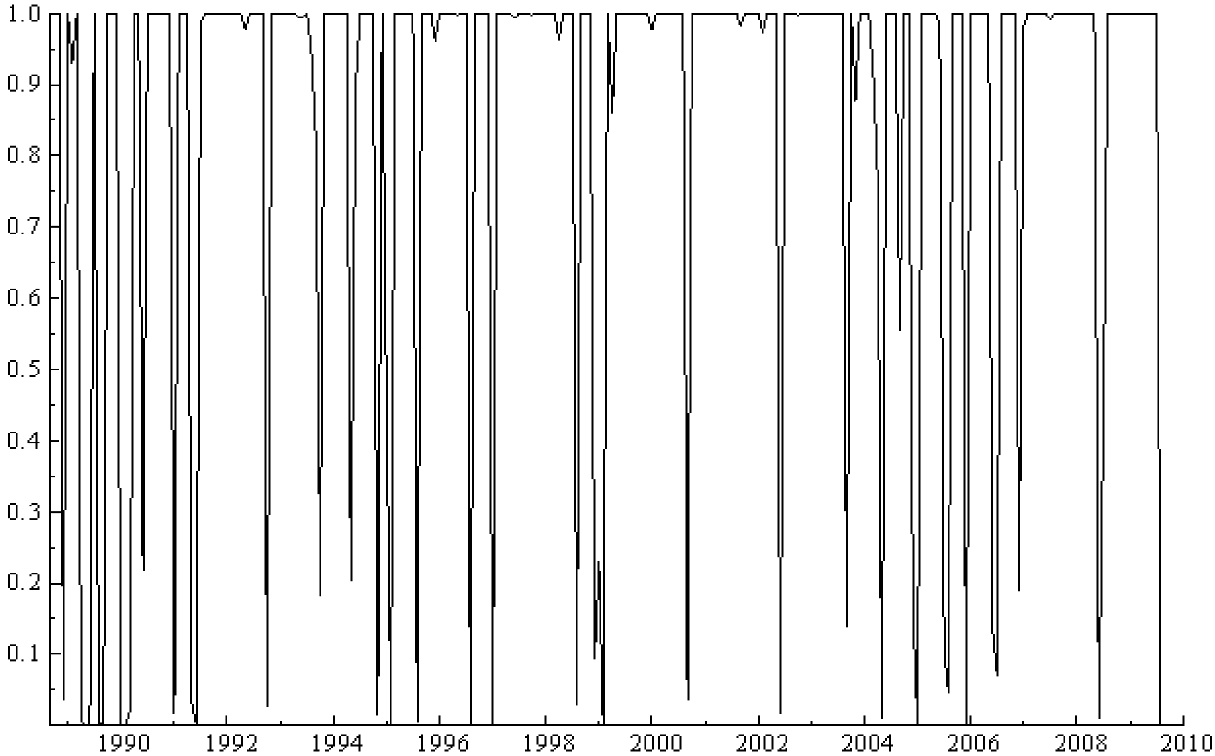


Figure 11: Sensitivity analysis for the US impulse response



Appendix 3

Figure 1: Expansionary Spending Fiscal Policy Shock in UK

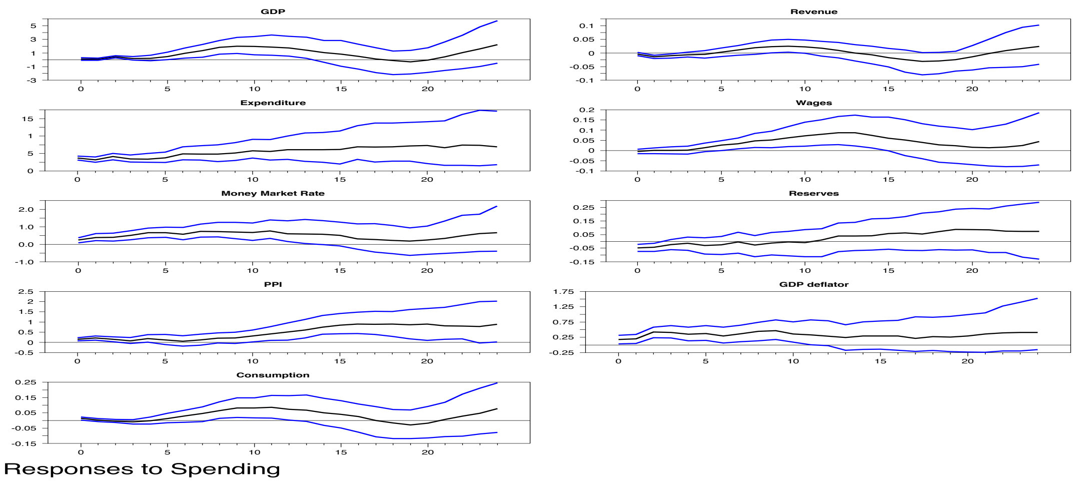


Figure 2: Expansionary Spending Fiscal Policy Shock in Italy

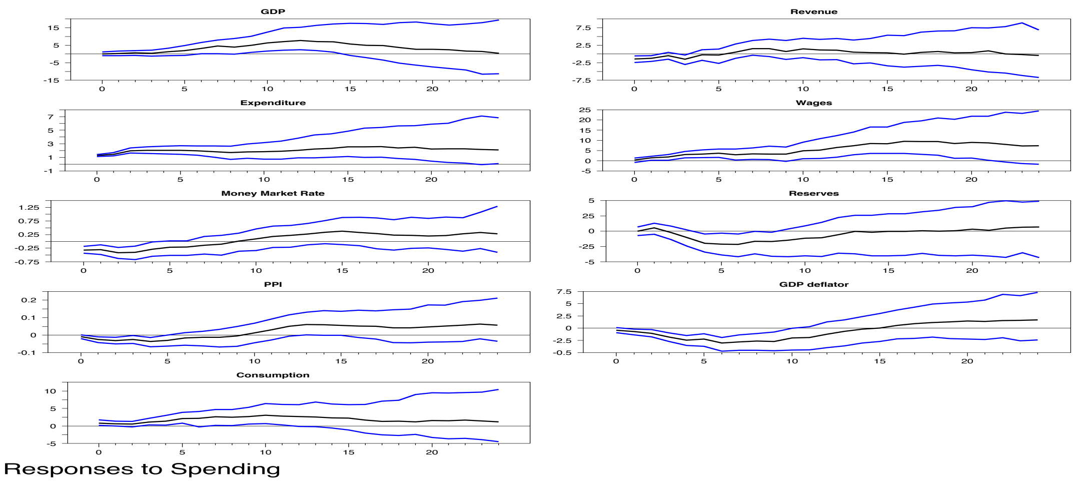


Figure 3: Expansionary Delayed Spending Fiscal Policy Shock in UK

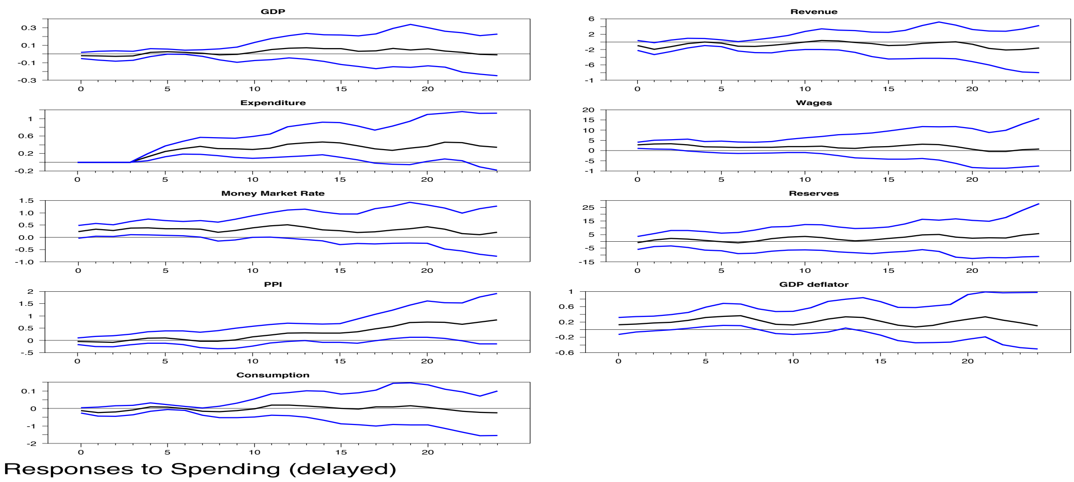


Figure 4: Expansionary Delayed Spending Fiscal Policy Shock in Italy

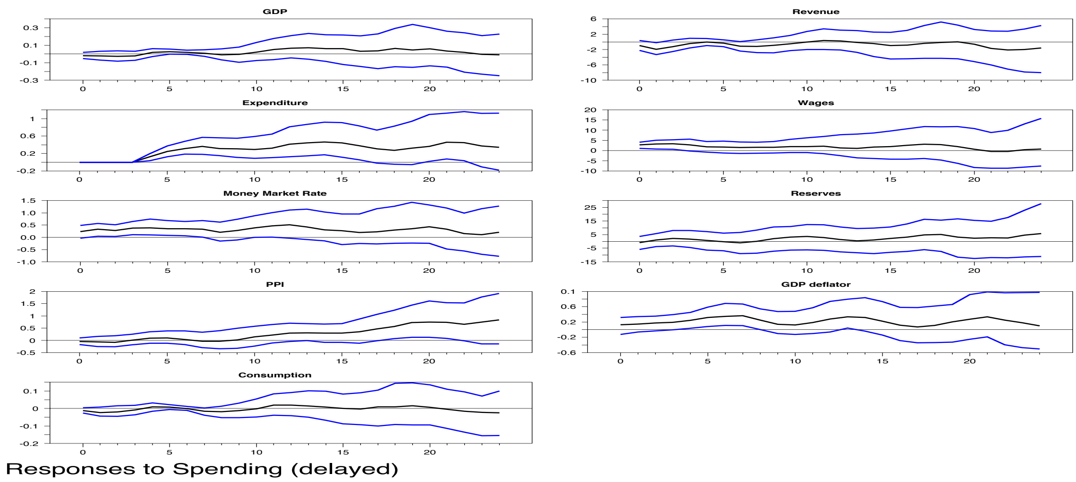


Figure 5: Expansionary Basic Revenue Fiscal Policy Shock in UK

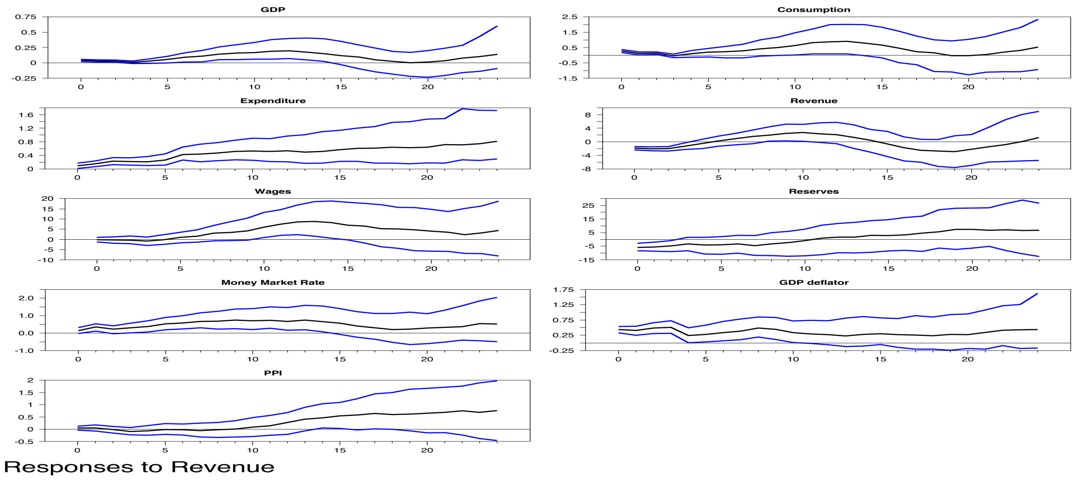


Figure 6: Expansionary Basic Revenue Fiscal Policy Shock in Italy

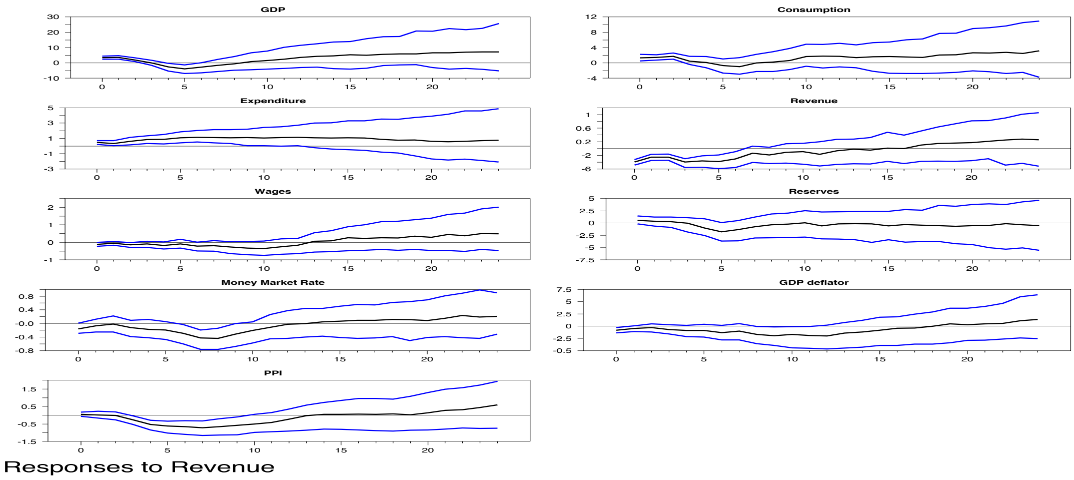


Figure 7: Expansionary Delayed Revenue Fiscal Policy Shock in UK

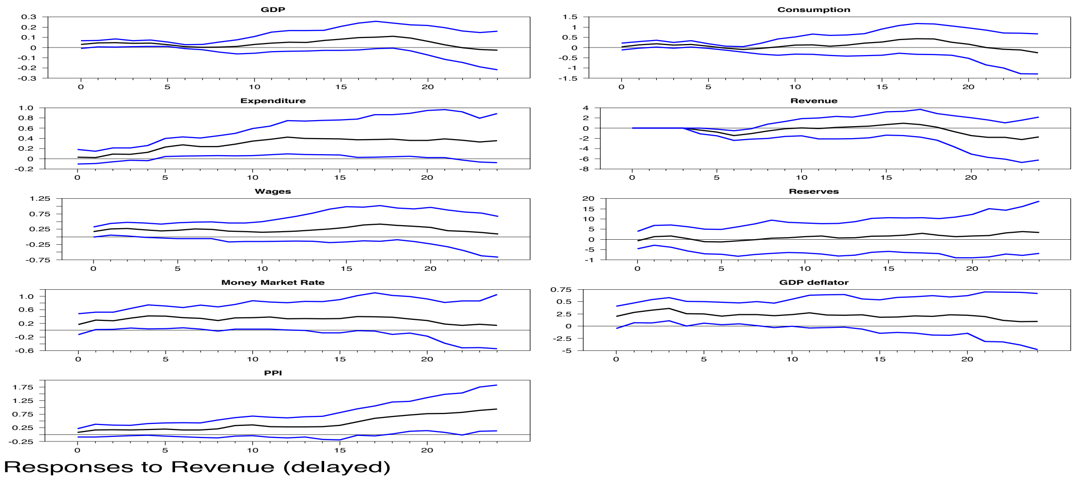


Figure 8: Expansionary Delayed Revenue Fiscal Policy Shock in Italy

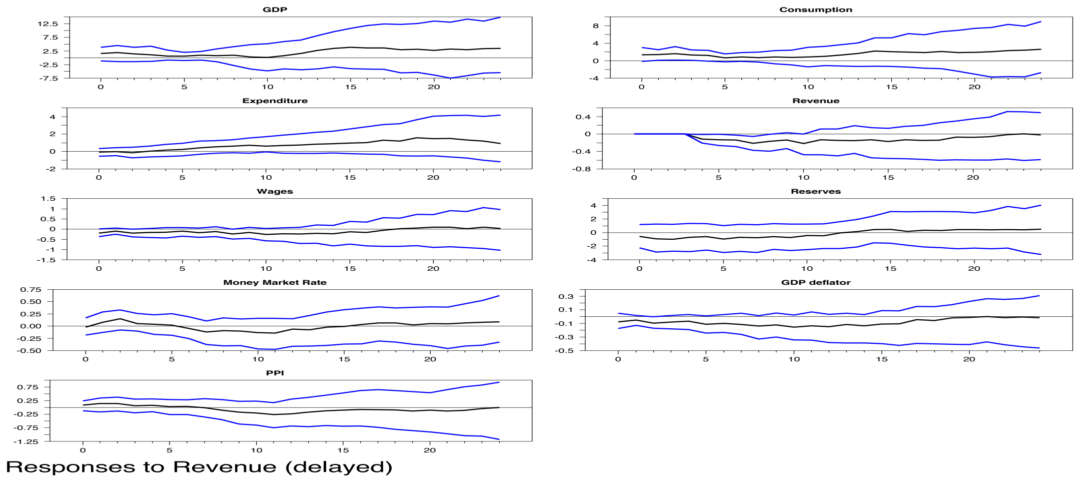


Figure 9: Contractionary Basic Spending Fiscal Policy Shock in Italy

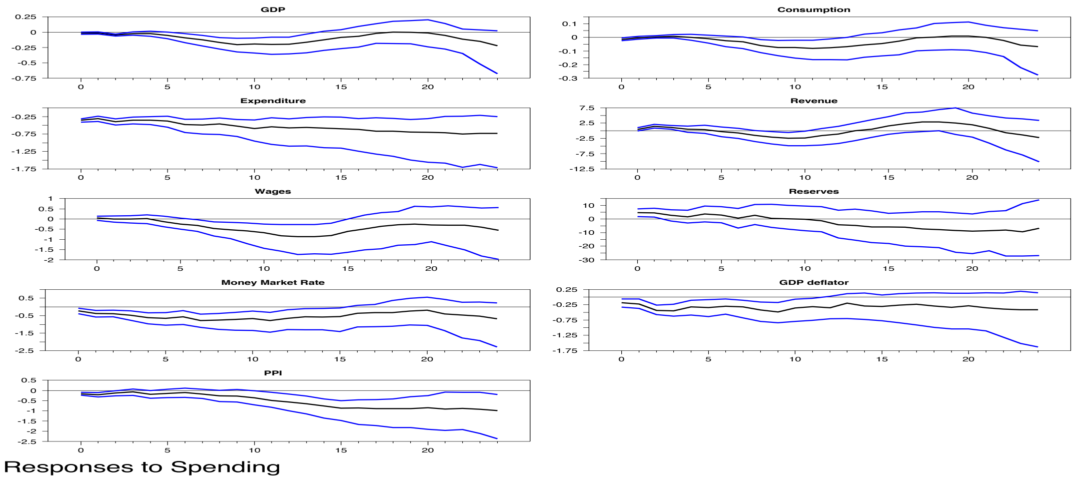


Figure 10: Contractionary Delayed Spending Fiscal Policy Shock in UK

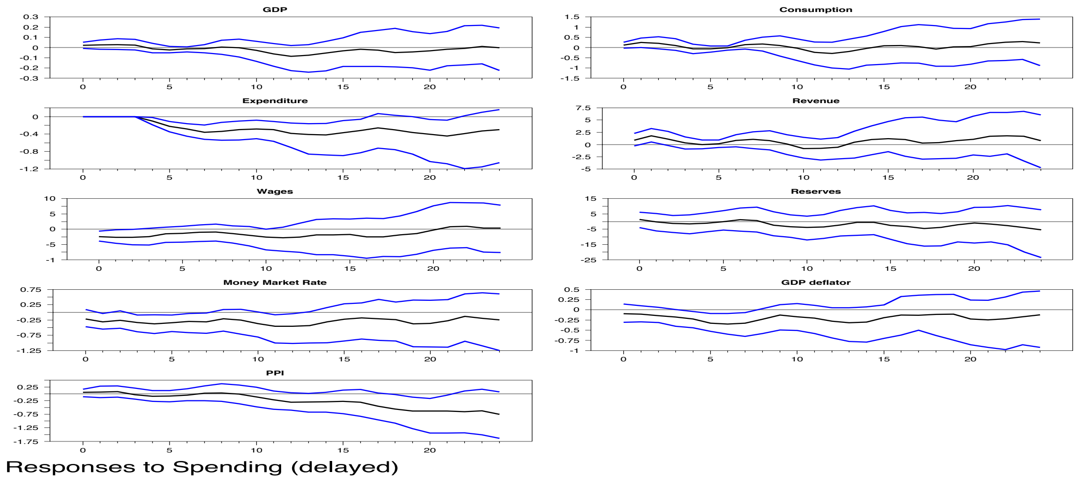


Figure 11: Contractionary Delayed Spending Fiscal Policy Shock in Italy

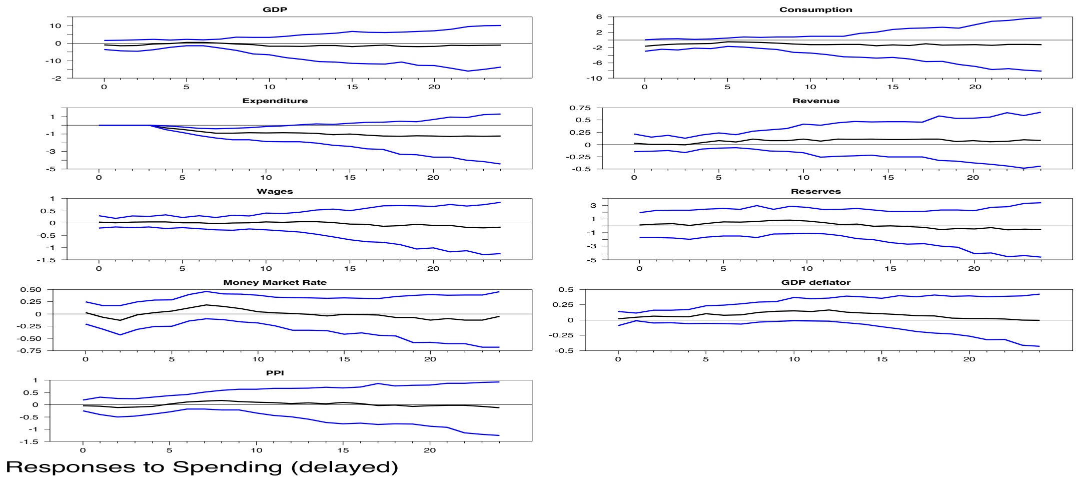


Figure 12: Contractionary Revenue Fiscal Policy Shock in UK

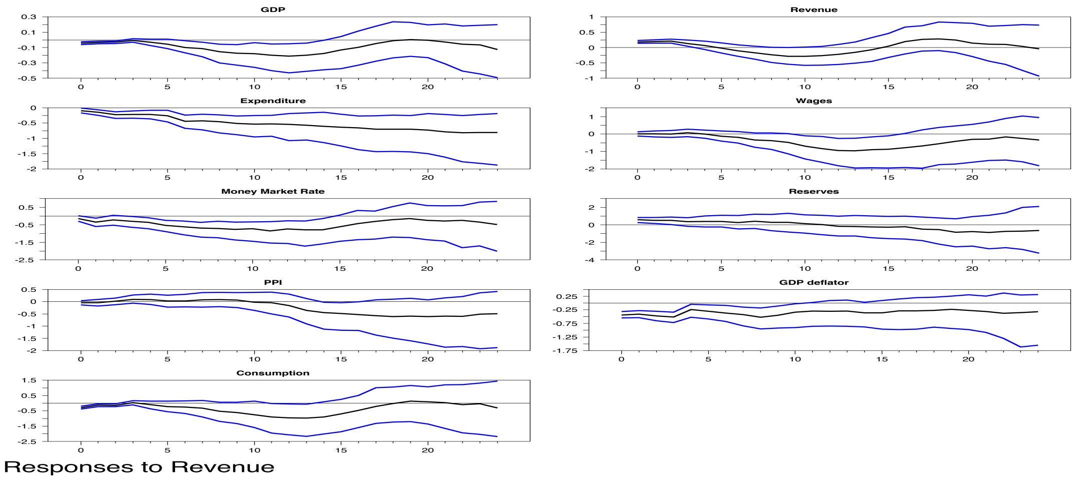


Figure 13: Contractionary Revenue Fiscal Policy Shock in Italy

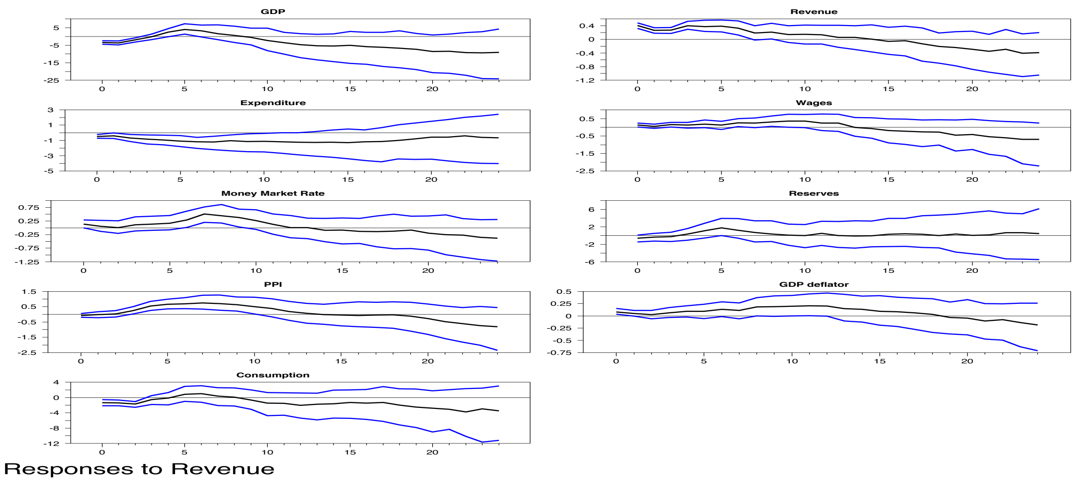


Figure 14: Contractionary Delayed Revenue Fiscal Policy Shock in UK

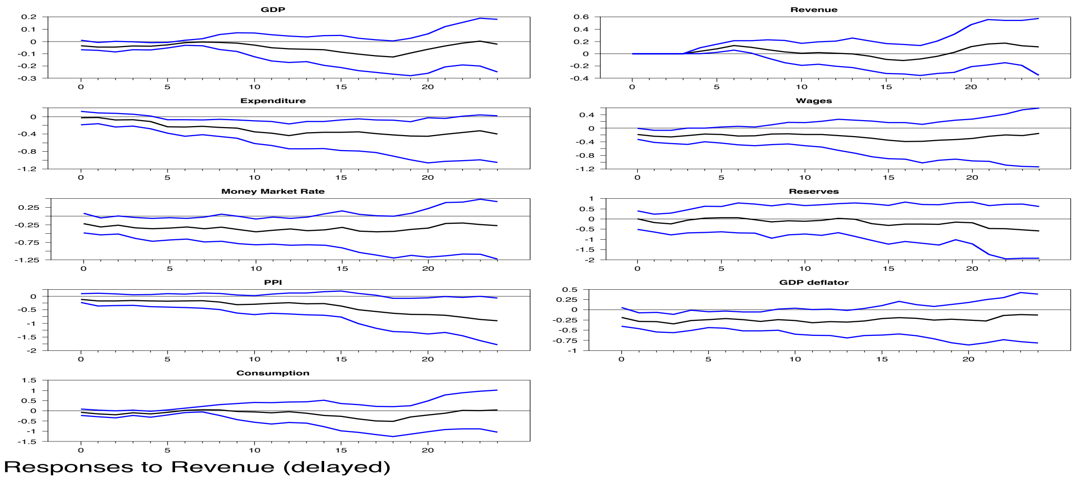


Figure 15: Contractionary Delayed Revenue Fiscal Policy Shock in Italy

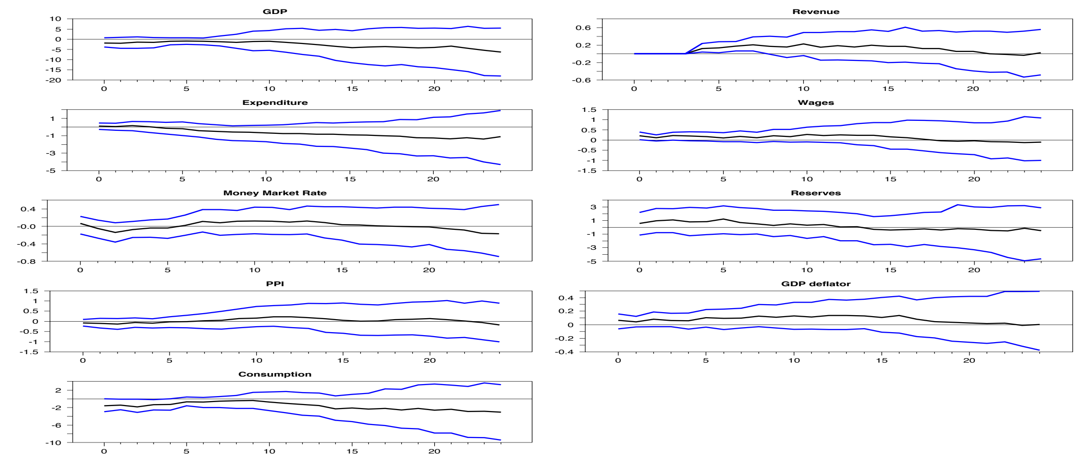


Figure 16: Deficit Tax Cuts in UK

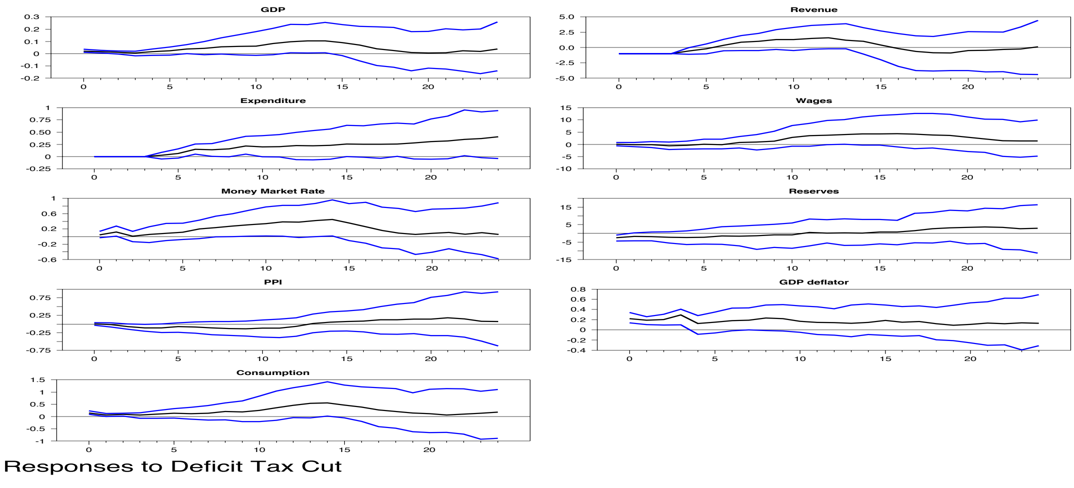


Figure 17: Deficit Tax Cuts in Italy

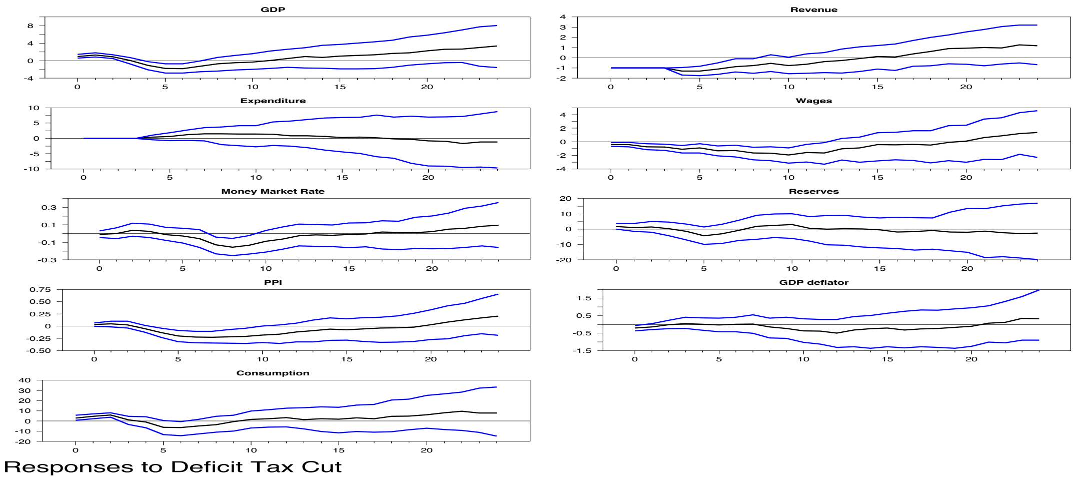
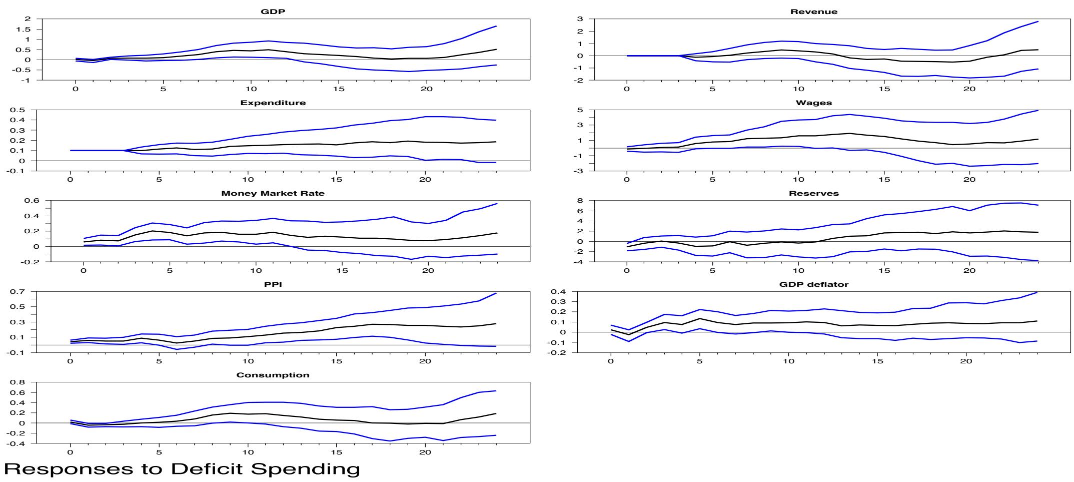


Figure 18: Deficit Finance Spending Increase in UK



Appendix 4

Figure 1: Europe's Private Consumption Impulse Response Relative to the US after an Expansionary Fiscal Policy

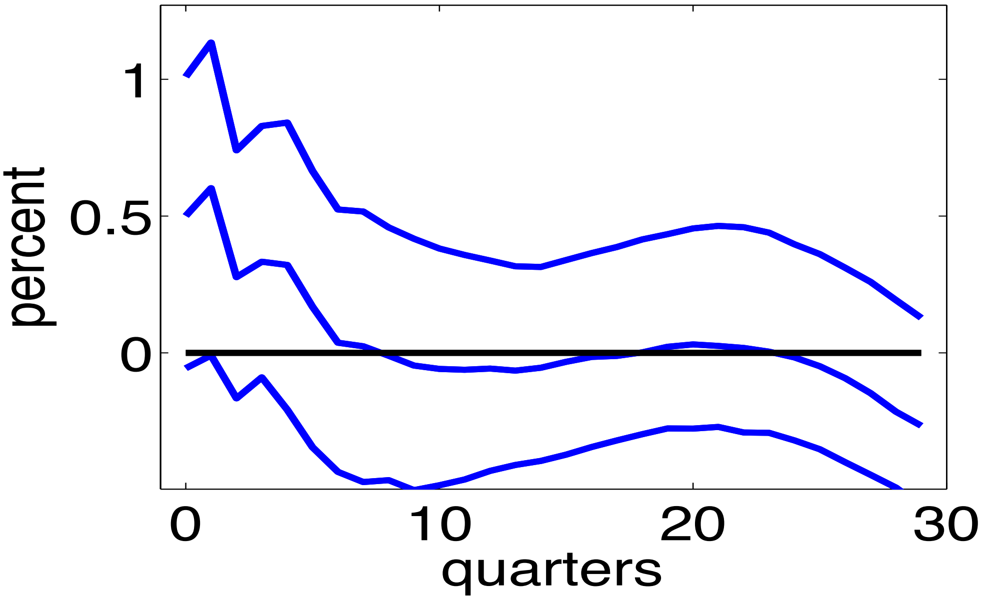


Figure 2: Europe's Exchange Rate Impulse Response Relative to the US after an Expansionary Fiscal Policy

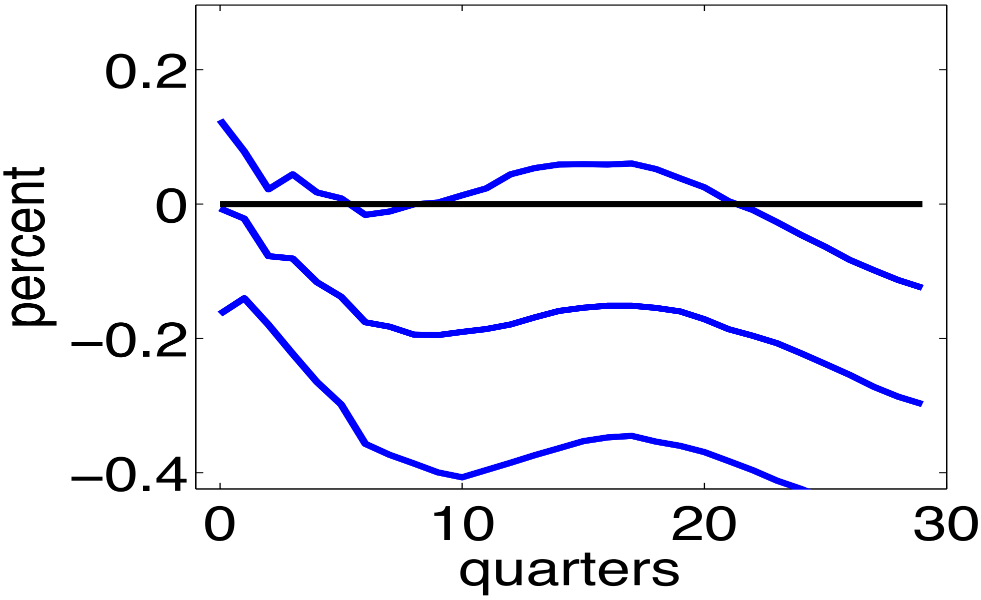


Figure 3: Europe's GDP Impulse Response Relative to the US after an Expansionary Fiscal Policy

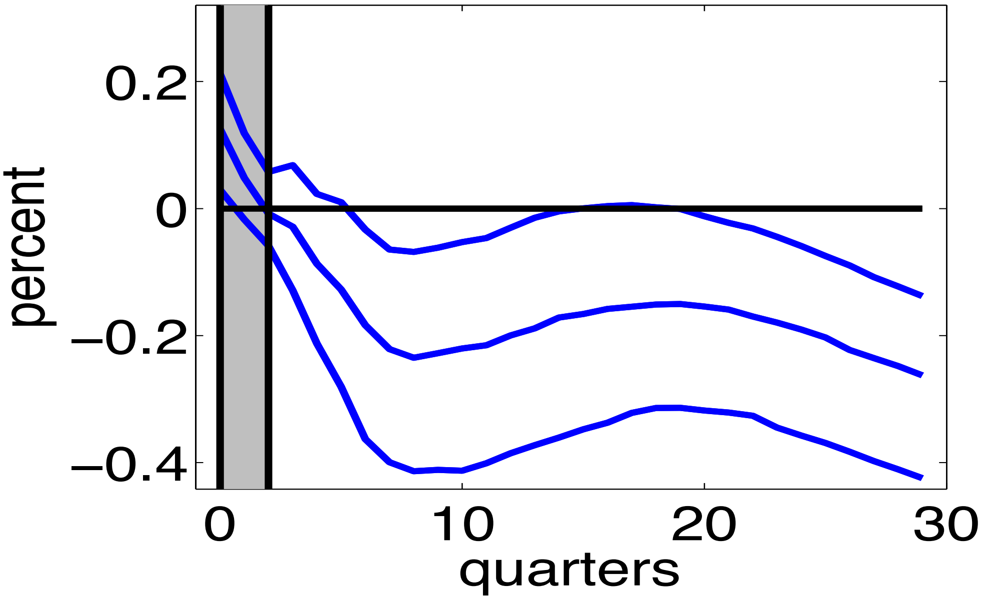


Figure 4: Europe's Government Budget Impulse Response Relative to the US after an Expansionary Fiscal Policy

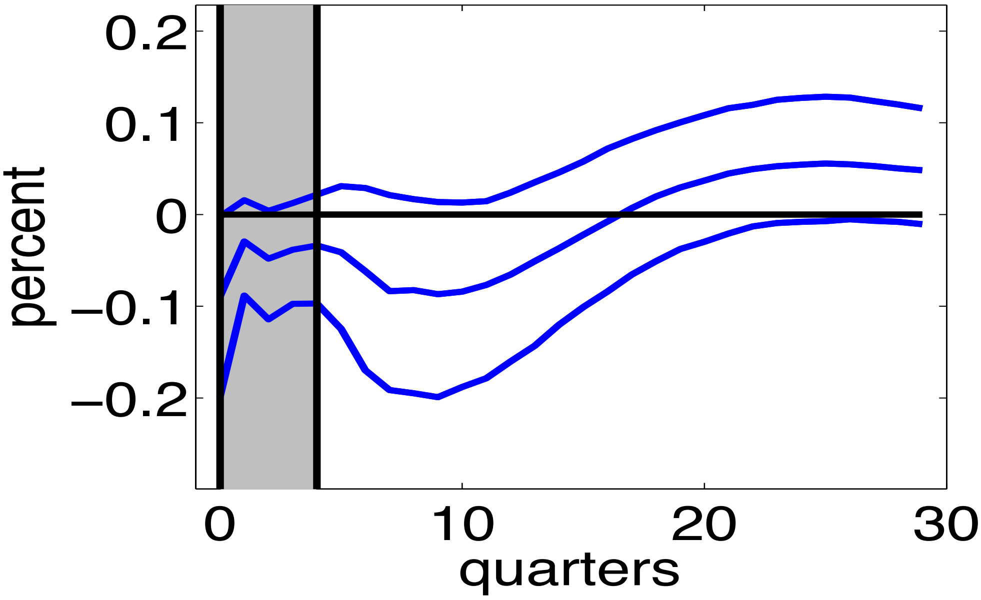


Figure 5: Europe's Government Spending Impulse Response Relative to the US after an Expansionary Fiscal Policy

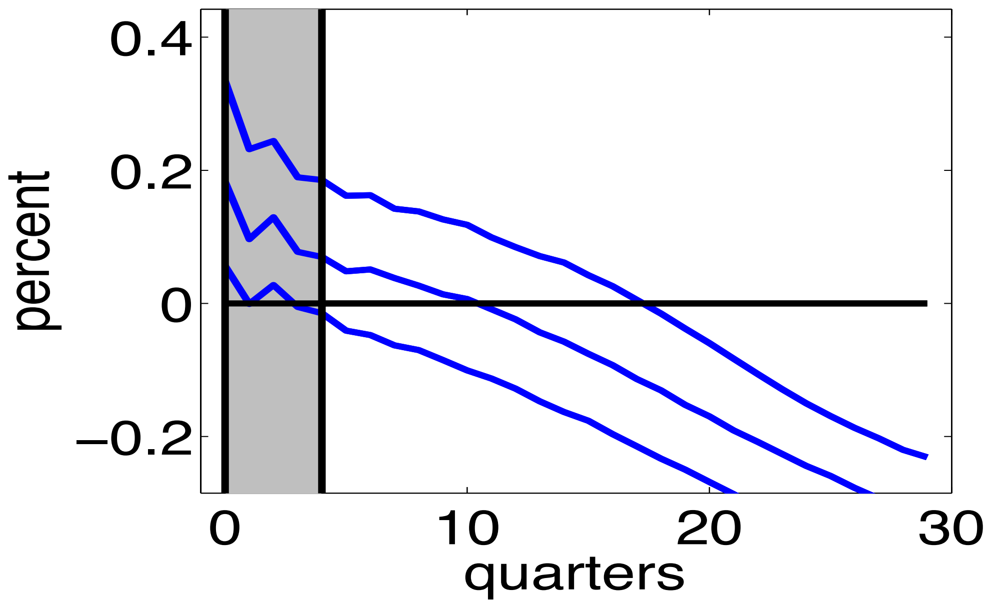


Figure 6: Europe's Inflation Impulse Response Relative to the US after an Expansionary Fiscal Policy

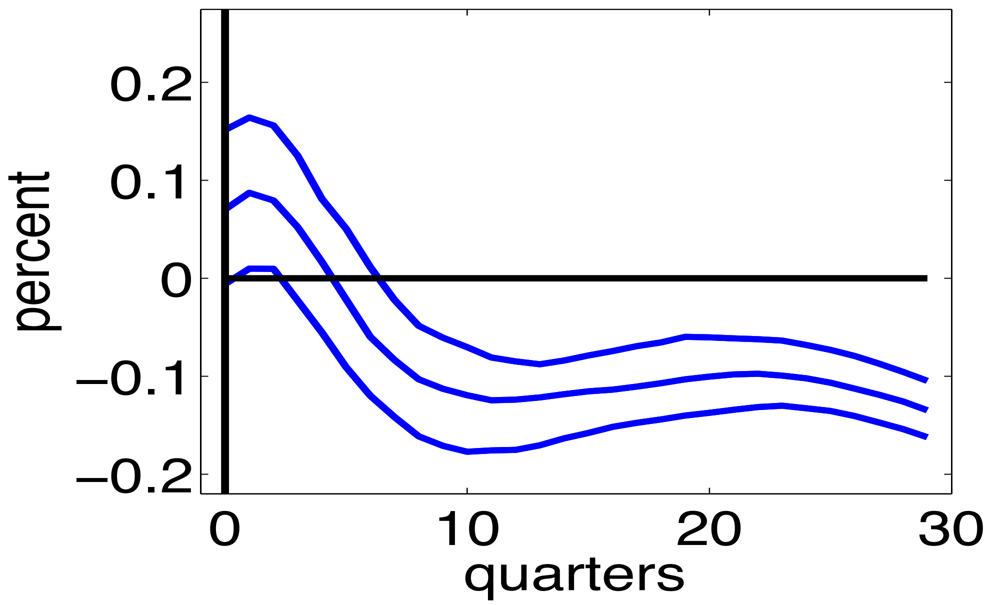


Figure 7: Europe's Interest Rate Impulse Response Relative to the US after an Expansionary Fiscal Policy

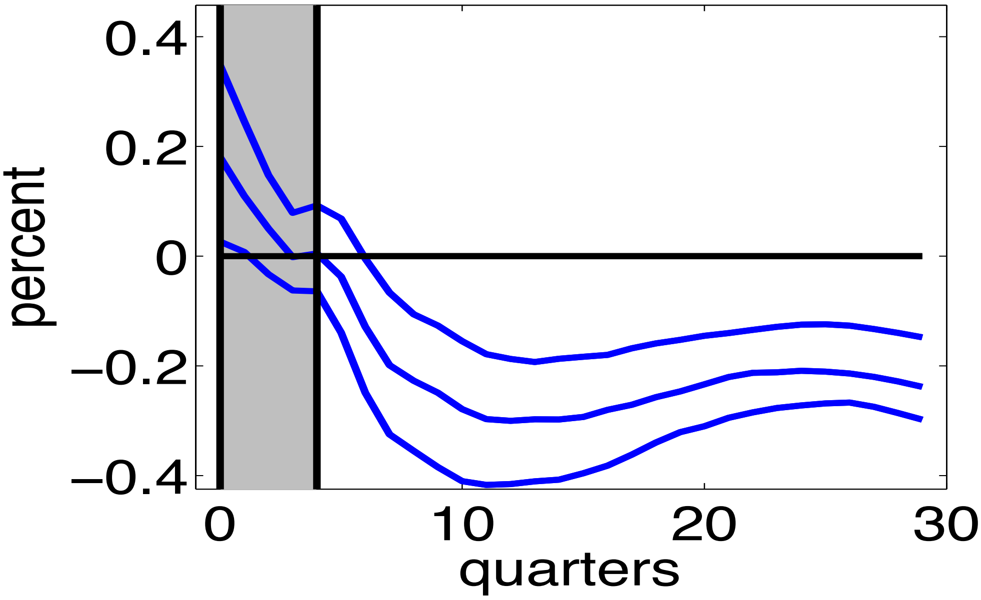


Figure 8: Europe's Private Investment Impulse Response Relative to the US after an Expansionary Fiscal Policy

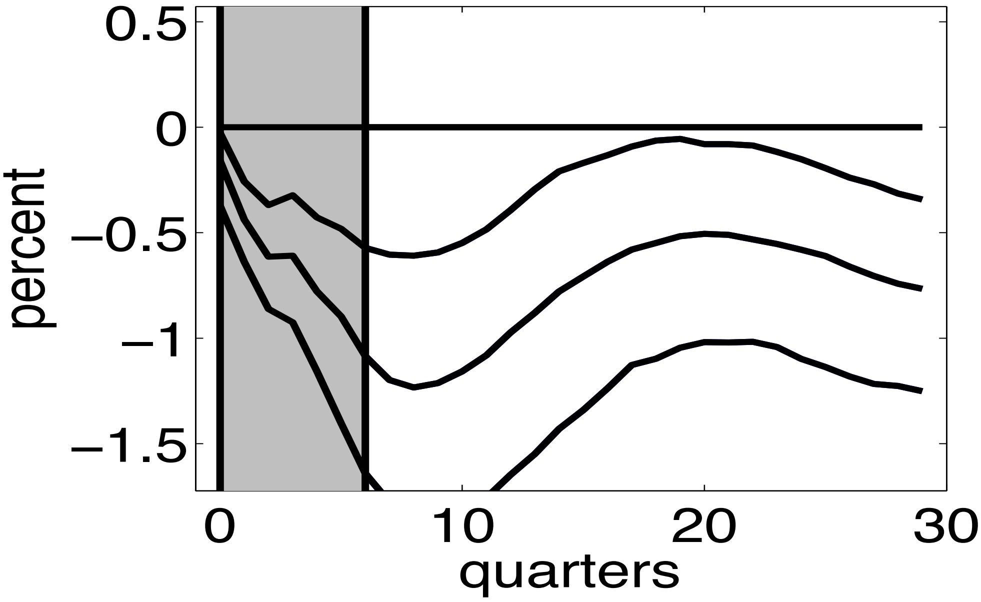


Figure 9: Europe's Private Consumption Impulse Response Relative to the US after a Technology Shock

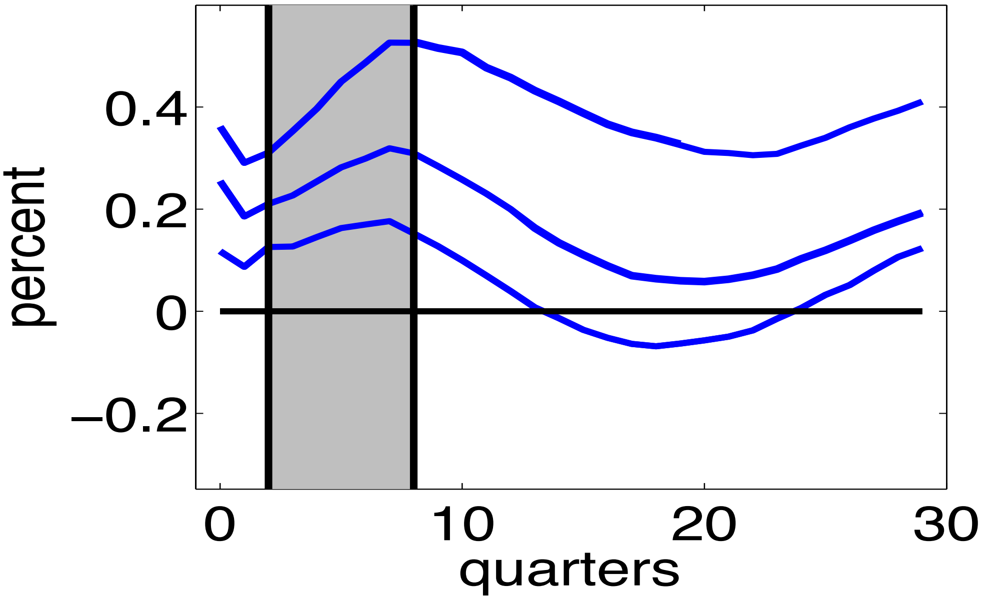


Figure 10: Europe's Exchange Rate Impulse Response Relative to the US after a Technology Shock

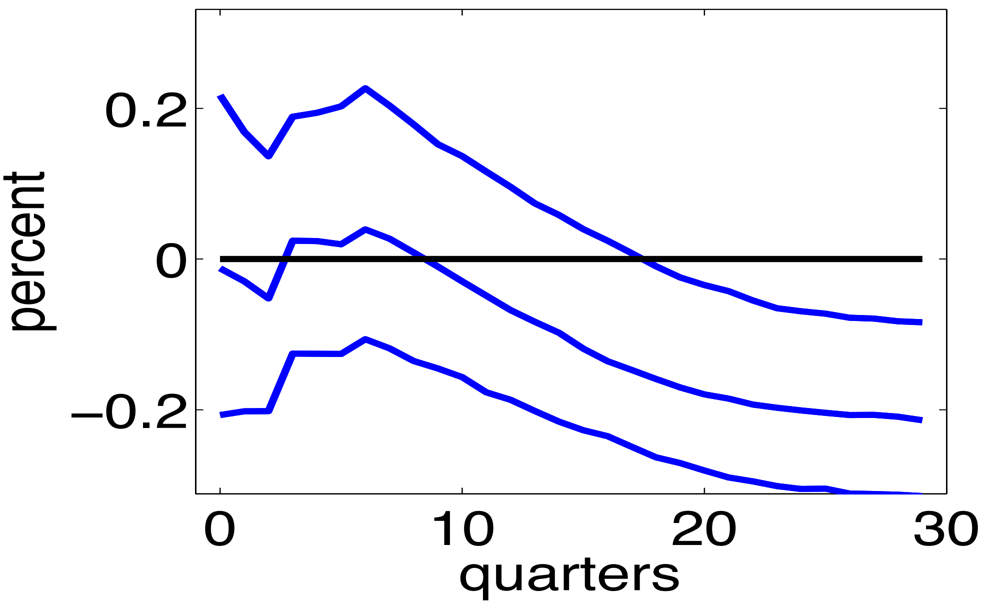


Figure 11: Europe's GDP Impulse Response Relative to the US after a Technology Shock

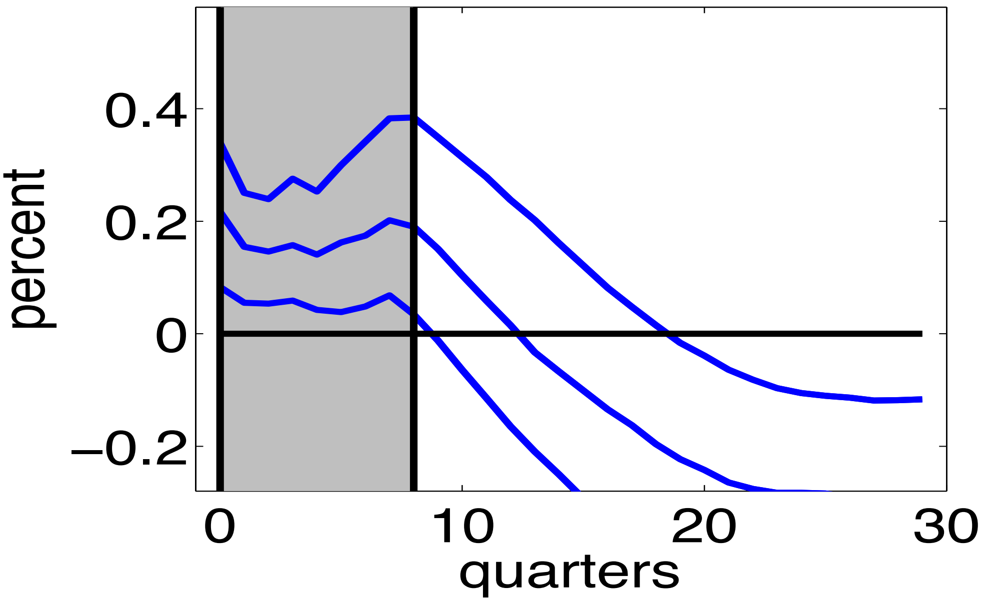


Figure 12: Europe's Government Budget Impulse Response Relative to the US after a Technology Shock

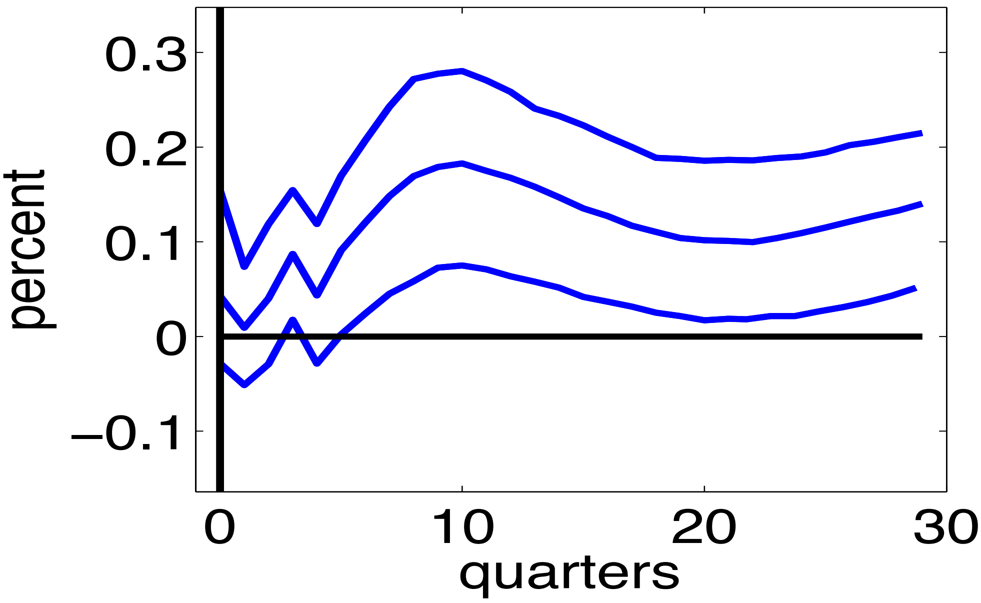


Figure 13: Europe's Government Spending Impulse Response Relative to the US after a Technology Shock

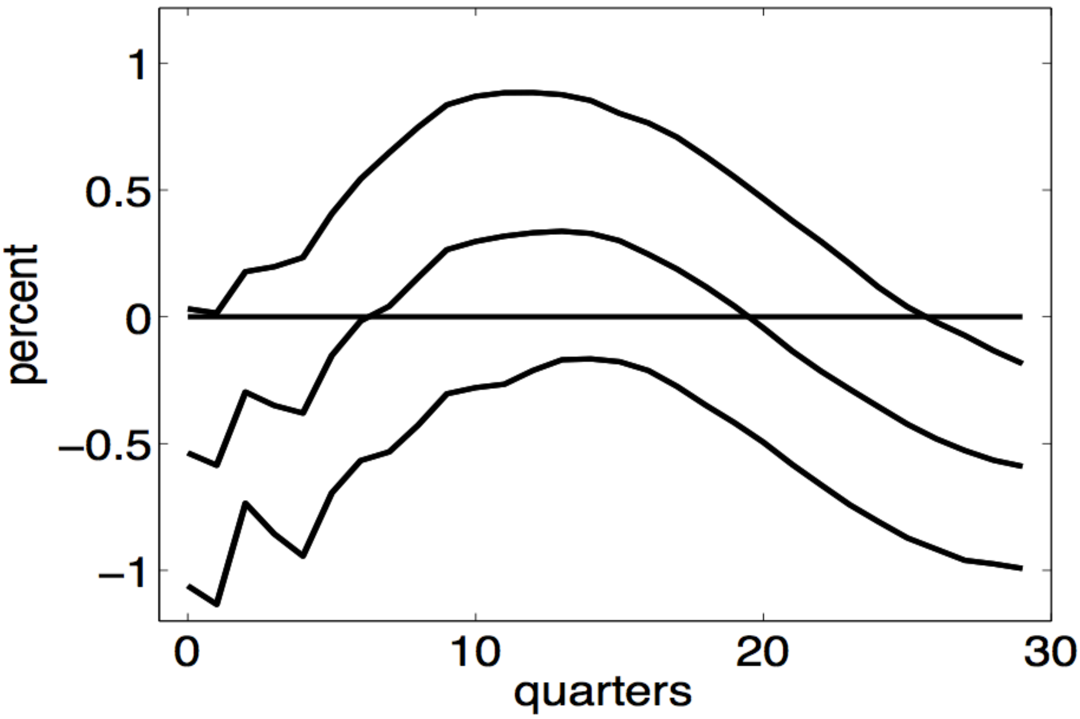


Figure 14: Europe's Inflation Impulse Response Relative to the US after a Technology Shock

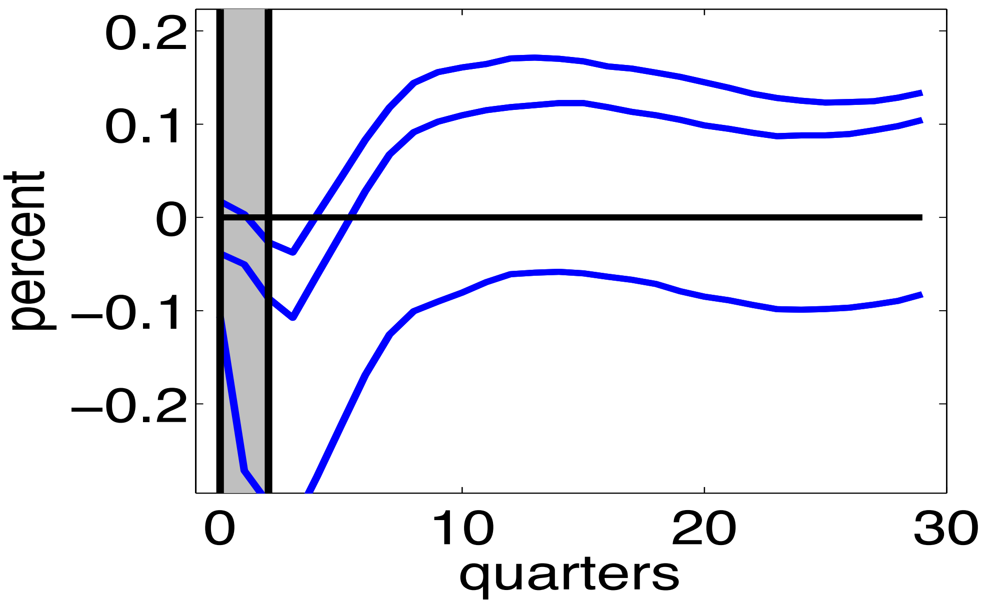


Figure 15: Europe's Interest Rate Impulse Response Relative to the US after a Technology Shock

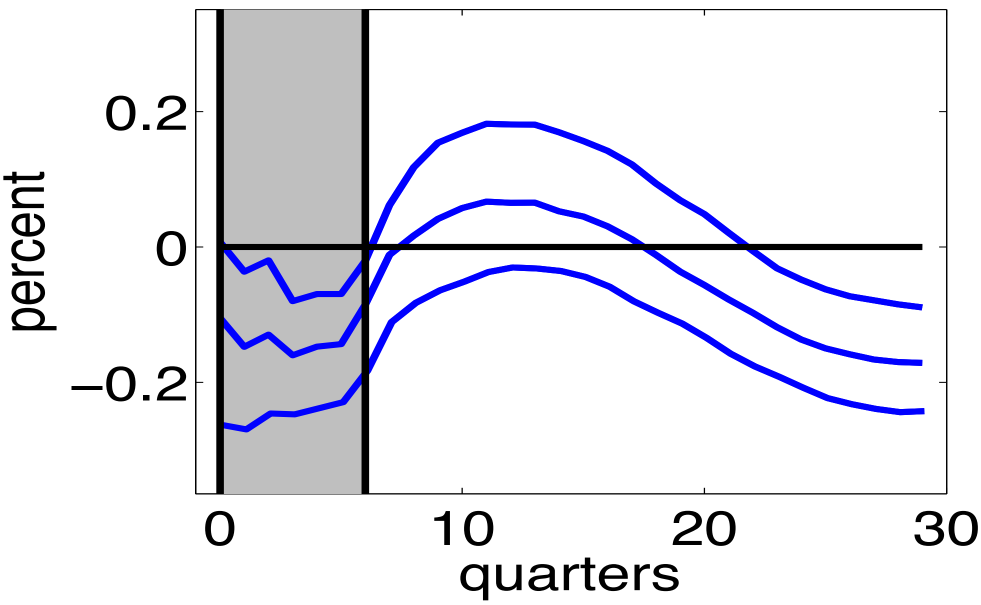


Figure 16: Europe's Private Investment Impulse Response Relative to the US after a Technology Shock