The Size and Transmission of Fiscal Spillovers: an Empirical Characterisation

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Abstract:

The aim of this study is to provide an up-to-date quantification of the domestic and international effects of fiscal policy for 15 OECD countries. I theoretically assess the transmission channels through which fiscal policy affects the economy. Building upon an original study by Beetsma et al. (2006), I estimate two vector autoregression blocks, one to measure the impact of fiscal shocks on the domestic economy and one to measure the impact of domestic output shocks on bilateral exports from other countries. Connecting the two blocks, I quantify the international spillovers of fiscal policy via the trade channel. I show that domestic multipliers of fiscal policy are substantial and significant and that the price channel and the interest rate channel play important intermediary roles. Using impulse response functions, I show that the international spillovers of fiscal policy are significant and moderately sized, following a U-shaped pattern over time. Country size, economic openness and distance turn out to be important determinants of the relative magnitude of fiscal spillovers. Since the analysis takes place within the context of a sovereign debt crisis, I use the results to conduct a policy experiment involving simultaneous fiscal shocks in multiple countries. Finally, I make some policy recommendations with regard to anticyclical fiscal policy, fiscal policy coordination and the interaction between fiscal and monetary policy.

Keywords: fiscal policy, monetary policy, multiplier, transmission channels, international spillovers, fiscal coordination.

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"*I want to emphasise strongly the point about economics being a moral science. I mentioned before that it deals with introspection and with values. I might have added that it deals with motives, expectations and psychological uncertainties. One has to be constantly on guard against treating the material as constant and homogeneous. It is as though the fall of the apple to the ground depends on the apple's motives, on whether it is worthwhile falling to the ground, and whether the ground wanted the apple to fall, and on mistaken calculations on the part of the apple as to how far it was from the centre of the earth.*"

John Maynard Keynes, 16 July 1938, in a letter to Roy Harrod

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Introduction

The management of public money directly affects people and has always excited much interest and debate. It is interesting to see how the views regarding the subject have evolved over the centuries. As early as the 5th century BC, we hear about a newly appointed governor of Judah, Nehemiah, who faced the people's complaints about the harsh tax policies of his predecessors. He called a public assembly to deal with the problem. Later he wrote in his diary: 'Each governor before me had been a burden to the people by making them pay for his food and wine and by demanding forty silver coins a day. Even their officials had been a burden to the people. But I respected God, and I didn't think it was right to be so hard on them.'

Another story about public finance, seen from the perspective of the businessman, is told by the Greek historian Xenophon in the 4th century BC. In his dialogue on the art and science of household management *Oeconomicus* (The Economist) Socrates admonishes his interlocutor, the gentleman-farmer Critobulus, to run his estate more efficiently in order to be able to fulfil his civic duties: 'I perceive that the state enjoins upon you various large contributions, such as the training of choruses, the superintendence of gymnastic schools, or consular duties, as patron of resident aliens, and so forth; while in the event of war you will have further obligations laid upon you in the shape of ship money, and war taxes so onerous, that you will find difficulty in supporting them. Remissness in respect of any of these charges will be visited upon you by the citizens of Athens no less strictly than if they caught you stealing their own property.' As both stories show, in ancient times public finance was primarily seen from an ethical point of view.

In the 16th century, the era of increasing trade and prosperity, scholars and state officials started thinking more systematically about fiscal and monetary policy. For instance, the Spanish scholar Juan de Mariana formulated in his brief treatise *De Monetae Mutatione* (On the Alteration of Money, 1609) a preliminary version of the quantity theory of money: 'If the legal value of the currency is reduced, the prices of all goods will, without fail, rise in the same proportion.' He warned for the destabilising effects of currency debasement and demanded stable fiscal policies for a good business environment: 'As the first principle of fiscal policy, after reducing all superfluous spending, the prince must impose moderate taxes.' A contemporary of De Mariana

conceived four principles of just taxation (Chafuen, 2003), namely: (1) Need: is there a necessity for new tax laws? (2) Opportunity: is this the right moment to impose such laws? (3) Form: are the new taxes proportionate and equitable? (4) Level: are the new taxes moderate? The 'laissez-faire' view that fiscal and monetary actions of the governing class should cause as little economic distortion as possible has persisted until the late 19th century.

It was during the Great Depression of the 1930s and the ensuing horrors of the Second World War that economists, notably John Maynard Keynes, advocated a more active role for fiscal and monetary policy in pursuing economic and social goals. Interestingly, the proponents of interventionism did so by explicitly and implicitly reviving the notion that economic policy has an ethical dimension. For example, the Nobel Prize winning Dutch economist Jan Tinbergen wrote in 1956: 'The shaping or reformulation of the aims of economic policy which are only vaguely felt may be exemplified in the aim of *social justice* [emphasis added by Jan Tinbergen]'. In the same book, Tinbergen expounds several economic models that are purposefully designed to show whether and how a given number of policy instruments can attain certain policy objectives, such as regulating employment or redistributing real incomes (Tinbergen, 1956).

At present, during the first decade of the 21st century, extraordinary economic conditions have spawned a new series of policy dilemmas. Not only are economies more intertwined than in the past, the world has also experienced the worst financial and economic crisis since the Great Depression. Economic policy played an important role in mitigating the effects of this global crisis. Authorities a applied monetary expansion in order to stimulate the flow of credit, and a fiscal expansion in order to stimulate aggregate demand. Many commentators believe that these interventions were reasonably successful: they prevented a total meltdown of the financial system, and to some extent dampened the recession (Eggertsson, 2009). However, only a few months later new troubles arose: with nominal interest rates hitting the zero lower bound the scope for monetary policy is severely reduced, and with high and rising government debt ratios the scope for fiscal policy is also severely reduced (Eggertsson and Krugman, 2011). Meanwhile, economic circumstances continue to be tough and the European single currency is under great pressure.

Despite the fact that most OECD countries are not fully out of recession, many governments have chosen to implement large fiscal consolidation programmes. A pressing question facing academics and policymakers is: what are the risks and consequences of these simultaneous, negative fiscal shocks? How much would further austerity measures hurt economic growth for individual countries? And how much do simultaneous, negative fiscal shocks hurt neighbouring countries? How substantial is the risk that uncoordinated fiscal shocks in several countries exacerbate the economic crisis that is already so difficult to contain? These questions

that are so relevant for the economic future of many millions of people require sound, in-depth research in order to be able to find valid solutions.

In these turbulent times, I seek to investigate three specific elements of economic policy that require renewed attention from academics and policy-makers, namely: (a) the cross-border effects of fiscal policy, (b) the effectiveness of fiscal policy in times of crisis, and (c) the interaction between fiscal and monetary policy. The main emphasis of my research will be on the first item, fiscal spillovers. I will both explain their origins and quantify their consequences. Accordingly, the first part of this study is dedicated to a theoretical analysis of the impact of fiscal policy on the economy, at a national level and at an international level. The second part of this study is dedicated to an empirical analysis of fiscal policy. Specifically, I make detailed calculations about the magnitude of the fiscal multiplier and the impact of domestic fiscal shocks on bilateral trade relationships with other countries. I compose a new, up-to-date dataset and use the most recent econometric techniques to gauge the relationships between the various variables.

For my empirical analysis, I owe much to a previous study by Beetsma et al. (2006), who developed a two-block econometric approach to quantify international spillovers of fiscal policy. They found that fiscal spillovers are substantial. Another important study in this field is written by Blanchard and Perotti (2002), who devised a precise and practical method to identify discretionary fiscal shocks, which is one of the main methodological hurdles a researcher has to take in order to quantify the effects of fiscal policy on the economy.

The results of my analysis are very relevant and at some points even surprising. For instance, I find stronger support for the effectiveness of fiscal policy than most authors do, and I also find that the effectiveness of fiscal policy depends more on monetary conditions than other authors suggest. Furthermore, I show that international spillovers of fiscal policy for individual countries are significant but moderately sized, and I also show that the spillover effects of simultaneous fiscal shocks in multiple countries can become quite large. These and other findings lead to interesting policy recommendations, some of which I describe in this study, others I leave for the reader and future researchers to elaborate upon. In short: the intellectual journey of Nehemiah, Xenophon, de Mariana, Keynes, Tinbergen and others is to be continued…

Part 1: Theoretical analysis

The main objective of this study is to quantify the international spillovers of simultaneous fiscal shocks within a monetary union. The number of articles on this particular subject is surprisingly small; the range of used methodologies surprisingly wide. Combine these two facts and we are likely to arrive at arbitrary conclusions and vague or contradictory policy recommendations. How to avoid these undesirable scenarios in this study?

As I shall explain below, *before* a researcher starts quantifying the effects of fiscal shocks, he or she should first unravel the exact relationship between a fiscal shock in country A and, for example, net exports from country B to country A. The nature of this relationship is by no means unambiguous. In fact, there are many possible channels through which the effects of fiscal shocks can be transmitted. It is important to distinguish theoretically which channels are relevant, so that the empirical model can be properly designed.

What makes the analysis of transmission channels complicated is the fact that transmission channels do not operate independently from one another but are often interdependent. For example, the workings of the trade channel may be mitigated — or even cancelled out — by the workings of the price channel and the interest rate channel. These interdependencies should be taken into account in the empirical analysis, for example by using control variables.

For these reasons I begin this study with an extensive theoretical analysis focused on the various transmission channels of fiscal policy. Chapter 1 explores theories on the effects of fiscal policy at a domestic level. In Chapter 2, the analysis is extended to an international level. Chapter 3 forms the intellectual bridge between the theoretical and the empirical part of this study by presenting an overview of existing empirical evidence about the relative importance of the different transmission channels.

Chapter 1: Domestic transmission channels of fiscal policy

In this chapter I will describe the theoretical aspects of the domestic channels through which the effects of fiscal policy are transmitted. Even though the focus of this study is on *international* spillovers, it is important to examine domestic transmission channels first, because they form an important part of international transmission channels and provide some basic intuitions that also apply to international spillovers.

As is often the case in economics, a great part of the final outcomes depends on assumptions that are made. As a result, the literature can roughly be divided into two types of models: the new-Keynesian models which focus on the demand-side effects of fiscal policy, and the neoclassical models which focus on the supply-side effects of fiscal policy, especially the labour market channel. I will first elaborate a bit on the general characteristics of fiscal policy. Then I will describe the new-Keynesian and neoclassical models and their respective emphasis on the demand and the supply channels of fiscal policy. After that, I will assess the role of monetary policy and the relative importance of domestic transmission channels. Finally, I will pay attention to the question how economic crises change the role of fiscal policy.

1.1 Characteristics of fiscal policy

Fiscal policy is the purposeful use of government spending and taxation by politicians or other policymakers. Fiscal policy can be used to attain economic, social or cultural goals that a society fosters. Economists, who are mostly interested in the economic goals of fiscal policy, disagree about the exact effects of fiscal policy in two important ways: the benefits and the costs of fiscal policy.

On the benefit side of the argument, economists disagree whether government spending or taxation is an effective instrument to influence the state of the economy. Studying the transmission channels of fiscal policy is an important way to assess the effectiveness of fiscal policy and settle the debate. On the cost side of the argument, economists disagree about the distorting effects that fiscal policy could have on the market mechanism. In other words: the efficiency with which fiscal policy promotes its goals is also a relevant question. Economists in this field of study seek the optimal structure of government spending and taxation.

Though the focus of this study is not so much on the efficiency of fiscal policy as on the effectiveness of fiscal policy, there are a few remarks that I have to make about optimal government spending and taxation, because the structure of the government budget turns out to have important consequences for the effectiveness of fiscal policy.

An important theory about the optimal structure of the government budget is the Ricardian equivalence, named after the famous British economist David Ricardo. The Ricardian equivalence means that it is economically irrelevant whether a government finances its expenses through debt or through taxes. The intuition behind this is that when a government finances its expenses by issuing government bonds, households will have to pay more taxes in the future — which presents households with a liability — but since these bonds are bought by the same households, they also own an asset of exactly the same size. In other words, when the Ricardian equivalence holds, government deficits just mean a redistribution of wealth between current and future generations; nothing more, nothing less (Romer, 2006).

However, it is generally doubted whether the Ricardian equivalence holds in practice. The main reason for this is the existence of distortion costs. Both raising revenue through taxes and raising revenue through government debt create their own distortions. For example, it is well known in theories of public finance that imposing taxes skews economic preferences and is therefore not entirely economically efficient (Stiglitz, 1986). Furthermore, issuing government debt involves the risk of default, so that governments have to pay a higher risk premium on bond markets. In addition, when the risk of a fiscal crisis rises, people will decrease their level of consumption in order to increase their level of precautionary savings, which in turn forms a drag on economic growth (Blanchard, 1990).

According to Barro (1979), governments have to weigh the distortion costs of taxation against the distortion costs of debt in order to achieve an optimal debt-income ratio. Barro has built a simple model to describe this optimisation process and found that there may be a certain bandwidth within which the debt-income ratio can move without escalating the distortion costs of either taxes or debt. However, when the debt-income ratio exceeds the limit on the upper side

of the bandwidth, the risk of default will negatively affect government finances and the rest of the economy. Interest rates will rise, investment will fall and the real exchange rate will depreciate. In practice, policymakers have interpreted the work of Barro as a recommendation to smooth taxes over time, so that the long-term commitments of government, rather than the short-term commitments of government, are met. In this way, government debt management becomes a 'tool' of optimal taxation.

However, as Werning (2007) recently pointed out, this interpretation of debt management is neither as necessary nor as advantageous as its proponents think. The reason for this is that the Barro model does not take income redistribution into account. When income redistribution is incorporated into overlapping generation models of optimal taxation, the economic imperative for proportional taxation disappears, so that average and marginal taxes no longer have to coincide and tax smoothing no longer is an economic imperative (Werning, 2007). In short, the roles of government deficits and taxation can be seen from different angles.

The side effects of taxation and government deficits are relevant, because they are likely to influence the workings of fiscal transmission channels. The effect of fiscal policy on interest rates is considered so important, that economists refer to it in the literature as an independent channel: the interest rate or debt channel. The current European sovereign debt crisis confirms the importance of economic research in this field. When we take into account the interest rate channel or other side effects of fiscal policy, we often find that the size or even the sign of fiscal policy spillovers changes, especially in the event of a fiscal crisis. The complex interactions between the different transmission channels mean that the real magnitude of the multiplier or accelerator effect may be quite different from its theoretical magnitude. It is important to bear this in mind when we try to quantify the magnitude of multipliers later on.

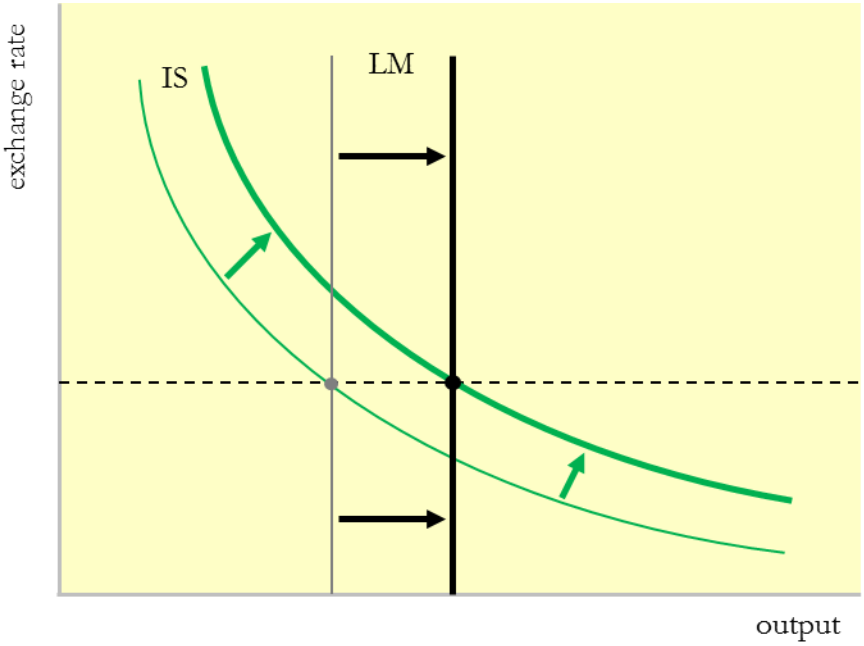
1.2 Demand channel

In this section I will describe the effects of fiscal policy via the demand channel. The workings of the demand channel can be explained by the well-known Mundell-Fleming model. The Mundell-Fleming model is the standard IS/LM model — which is based on autarky — extended to an open-economy setting with a balance of payments. Since it is a new-Keynesian model, we assume that prices are sticky, at least in the short run. Since this study is about fiscal spillovers within a monetary union — specifically: the European Union (EU) — we assume that exchange rates are

fixed. This assumption makes sense, because a fiscal shock in an individual (European) country will have a negligible impact on the common currency (the euro).

When we study the IS/LM model with sticky prices and a fixed exchange rate, a fiscal expansion will lead to an increase in output; a fiscal contraction will lead to a decrease in output. The precise mechanism is displayed in Figure 1 below. An increase in government spending has a direct and an indirect effect: the direct is effect is through government purchases themselves, the indirect effect is through consumption, since higher government expenditure leads to higher firm revenues and household incomes.

FIGURE 1 — Fiscal expansion with fixed exchange rates in Mundell-Fleming model



Source: Mankiw (1992)

Figure made by author.

The upward shift of the goods market equilibrium is depicted by the rightward shift of the IS-curve in Figure 1. Ceteris paribus, the shift of the goods market equilibrium would lead to an appreciation of the exchange rate. Therefore, in order to maintain the fixed exchange rate monetary authorities have to intervene by expanding the money supply. The upward shift of the money market equilibrium is depicted by the rightward shift of the LM-curve.

As we see, the overall effect of the fiscal expansion is an increase in output. Since the rise in demand will feed back or 'resonate' multiple times in the economy, the final increase in output may be larger than the amount of the initial fiscal stimulation. This multiplier effect plays an important role in Keynesian economics.

Characteristically for new-Keynesian models, income, private investment and private consumption are the main drivers behind these effects. This brings us to an important criticism about new-Keynesian models brought about by neoclassical economists, namely that the emphasis on private consumption is misguided. As Blanchard and Perotti (2002) put it, new-Keynesian econometric models *assume* rather than *record* positive demand effects from a fiscal expansion on output.

I think this criticism is rather unfair, because John Maynard Keynes himself, in his *General Theory* — as well as his followers in their respective works — closely studied the so-called 'marginal propensity to consume' that underpins the positive demand effect of a fiscal expansion (Keynes, 1936). They also gathered empirical evidence about the question which part of a fiscal stimulus is consumed and which part is saved. They found that the propensity to consume, for example after the introduction of a fiscal stimulus package, depends on the size of the output gap and the level of consumer confidence. When the output gap is negative and consumers perceive the downturn to be temporary — which should be the case in a normal business cycle — it is reasonable to assume that consumers will consume more in reaction to a fiscal stimulus.

Nevertheless, neoclassical economists offer an interesting alternative to the demand-driven Keynesian models. They suggest that private investment explains the output response to fiscal shocks better than private consumption. I will examine this claim below in detail.

1.3 Supply channel

The starting-point for the neoclassical analysis is, contrary to Keynesian analysis, not income but wealth. The mechanism is as follows. When government spending increases, the government's intertemporal budget constraint requires that future taxation must increase by the same amount (Perotti, 2004). Assuming that at least part of the fiscal expansion is financed by government bonds, and assuming that at least part of the government bonds are purchased by foreign buyers, domestic private wealth falls. Note that both assumptions are subtle but important refinements of Barro's model, in which all government bonds are purchased domestically.

Assuming that goods and leisure are both normal goods, consumers will compensate their loss of wealth by putting in more labour. This leads to an outward shift of the labour supply curve. Using a standard — for example, Cobb-Douglass — production function, we can derive that an increased labour supply will lead to lower real wages and a higher marginal product of capital. In the short run this will cause an increase in investment, an effect which is enhanced by

the so-called accelerator effect (Baxter & King, 1993). This resonance effect, equivalent to the multiplier, means that rising investment in one industry will generate more orders in other industries, higher profit expectations and higher business confidence, which in turn leads to even more investments, et cetera.

Since the labour market plays a crucial role in the neoclassical chain of events described above, the channel is often referred to as the labour-market channel. Similarly to the new-Keynesian models, the inferences of the neoclassical wealth and labour-market effects of fiscal policy are heavily debated. Do people really perceive an increase in the budget deficit as a loss of wealth? Of course, much depends on cultural preferences and the credibility of the policy intervention. But, as Alesina and Perotti (1996) demonstrated in their empirical study of fiscal adjustments in OECD countries, the labour market in general and unit labour costs in particular often react significantly to fiscal adjustments. Though the precise mechanism is still debatable, this suggests that the labour market is indeed a relevant transmission channel, just like the Keynesian demand channel is.

What are the indirect consequences of the neoclassical accelerator effect? A higher marginal product of capital will lead to a higher short-term interest rate, so that in the long run there will be higher capital and labour inputs but the capital/labour ratio remains unchanged. A higher capital and labour input will lead to higher output and investment in the long run; consumption, however, will fall (Baxter & King, 1993).

The wealth effect has other implications too. A particularly interesting implication deals with expectations. If economic agents expect fiscal changes to be permanent, the wealth effect will be stronger and thus output and investment will react more strongly as well. If people expect fiscal changes to be temporary, the effect will be weaker (Ramey & Shapiro, 1998).

The same applies to the composition of fiscal packages. If, for example, a government decides to cut spending on government programmes that are known to be very sensitive to the public, economic agents will judge this government's fiscal commitments to be more credible, generating a positive wealth effect. In some exceptional cases — mostly in countries that have experienced a fiscal crisis and implemented drastic reforms to recover from the shock — this credibility effect can be so strong that it counteracts or even reverses the negative demand effect of the fiscal consolidation programme and the reforms (Alesina & Perotti, 1996). This phenomenon is aptly called 'expansionary austerity'. Well-known examples of negative multipliers are Denmark and Ireland in the 1980s (Giavazzi & Pagano, 1990).

Another factor which complicates neoclassical analysis is the way in which fiscal policy changes. If fiscal policy expands or contracts through the implementation of a tax cut or tax rise,

then unit labour costs are *directly* affected, which means that the bargaining power of labour unions will be strengthened or weakened. Thus a fiscal stimulus through a tax cut may encourage wage moderation, stimulating output and reducing inflation (Ardagna, 2004). If, on the other hand, fiscal policy changes through an adjustment of government spending, the opposite effect occurs. For example, due to increased government spending, government wages and government employment will go up, causing tighter labour markets and more bargaining power for labour unions. Therefore, a fiscal stimulus enacted through an increase in government spending may *discourage* wage moderation, decreasing output and increasing inflation (Ardagna, 2004).

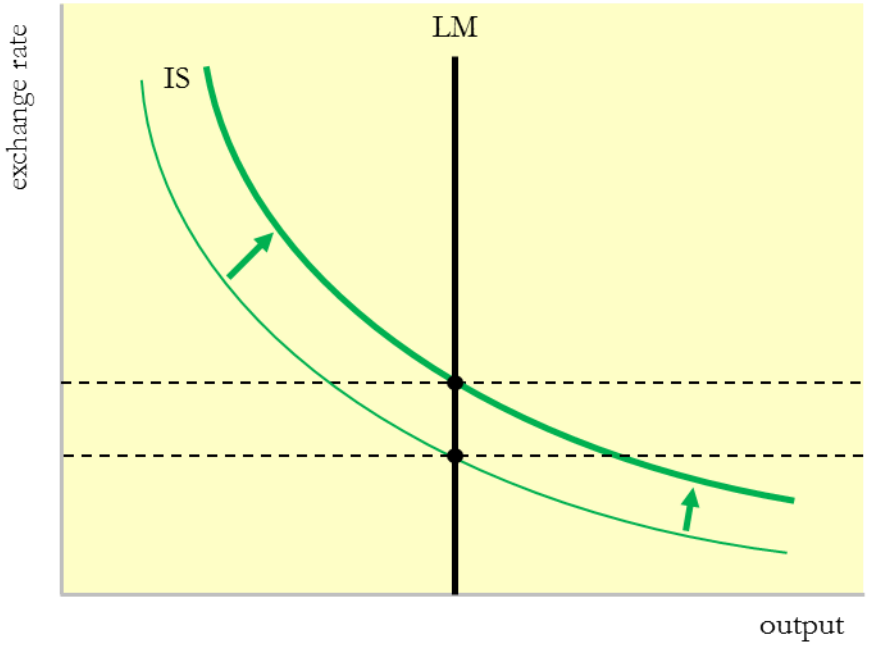
1.4 The role of monetary policy

Another economic factor that should be taken into account when we study the effects of fiscal policy is monetary policy. If in the Mundell-Fleming model fiscal policy is accompanied by accommodating monetary policy, fiscal policy can become more effective. The Mundell-Fleming model predicts that due to the accommodating effects of monetary policy, fiscal policy is more effective under fixed exchange rates than under flexible exchange rates. I will briefly explain the reasoning, as depicted in Figure 2 below.

Under flexible exchange rates a fiscal expansion shifts the IS-curve to the right, as it did under fixed exchange rates. The reduction in national saving will cause an appreciation of the exchange rate. The appreciation — which is, contrary to the economy under a fixed exchange rate regime, not offset by a monetary policy intervention — leads to a loss of international competitiveness and a decrease in net exports. As a consequence, income will remain unchanged at a higher exchange rate level, which leads to the conclusion that fiscal policy is less effective under flexible exchange rates.

Since within the Eurozone exchange rates are fixed, we would expect multipliers in Eurozone countries and spillovers between Eurozone countries to be larger than in other countries. However, what complicates this theoretical prediction is the fact that (a) within the European Union monetary policy is centralised in one common interest rate policy, so that individual countries do not have their own monetary instruments anymore and (b) in the EU monetary and fiscal policy are separately decided upon. In order to be able to make a more precise prediction about the effectiveness of fiscal policy within a monetary union, we have to delve a little bit deeper into the interaction between fiscal and monetary policy.

FIGURE 2 — Fiscal expansion with flexible exchange rates in Mundell-Fleming model



Source: Mankiw (1992)

Figure made by author.

Most economists agree on the fact that in the long run inflation depends on the aggregate money supply. However, as the data show, in the short to medium run there are large deviations in the relationship between inflation and the money supply (Lewis and Mizen, 2000). The theory mentions at least two important factors that could explain these deviations. First, we have to consider the fact that output capacity — long-run aggregate supply — is fixed in the short run. Second, we have to take into account expectations about inflation. When we combine these two factors, we can grasp some of the mechanisms that lead to short-run changes in the price level.

When the economy is in equilibrium and produces at full capacity — i.e. the output gap is zero — a further rise in aggregate demand cannot be fulfilled, at least not in the short run (Burda and Wyplosz, 2005). Theoretically, firms do not have market power, but in reality many firms do have market power. This means that entrepreneurs have the ability to react to surplus demand by raising prices.

Furthermore, when the output gap is zero, it is likely that unemployment is around its natural level, which implies that employees and unions have relatively much bargaining power. The interaction between the market power of firms and bargaining power of the suppliers of labour can lead to inflation. When workers expect rising prices, they will anticipate by demanding higher wages. Since workers have enough bargaining power, wages will indeed rise to a certain extent, so that firms are faced with higher costs. Employers react to rising wage costs by raising prices, thus making the workers' expectations a self-fulfilling prophesy. Since there is excess

demand and firms have some market power, prices will indeed rise to a certain extent. This process is called the wage-price spiral (Burda and Wyplosz, 2005). Naturally, the central bank, whose duty it is to curb inflation, feels obliged to intervene. Therefore, the central bank will raise the interest rate, which in turn mitigates the growth of consumption and investment and diminishes the output gap.

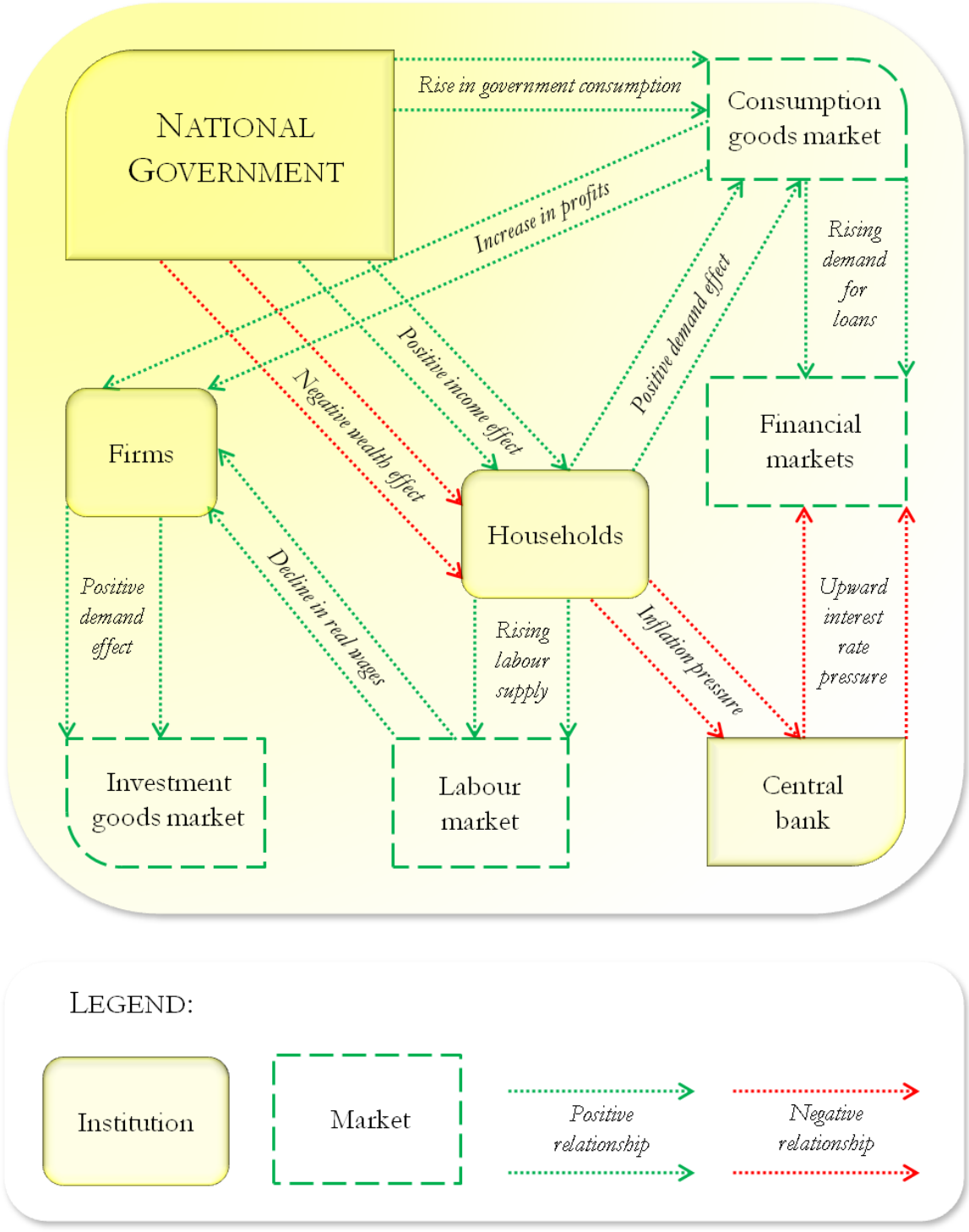
When the economy is near equilibrium and the output gap is small, a fiscal stimulus can easily lead to a positive output gap, especially when the initial multiplier — the so-called impact multiplier — is large. Thus a fiscal expansion potentially causes or amplifies a wage-price spiral. Furthermore, we should take into account that an expansion of government has two additional effects, namely: (1) an increase in public sector employment and (2) an increase in public sector wages in order to attract people from the private sector to the public sector (Baumol, 1967). This implies that the domestic labour market becomes tighter, so that the wage increase in the public sector easily spills over to the private sector, further amplifying the potential wage-price spiral. Again, the central bank can anticipate these inflationary side-effects of fiscal policy, so that it decides to raise the interest rate. In this way, interventions of monetary authorities can counteract those of fiscal authorities (Gros & Hobza, 2001).

What do the potentially inflationary repercussions of fiscal policy and the ensuing reaction of monetary policy mean in the context of a monetary union like the European Monetary Union? To sort things out, Dixit and Lambertini (2001) have built a model based on game theory that simulates the interaction between monetary and fiscal policy in the European Union. They assumed that the European Central Bank (ECB) is more conservative than governments of member countries, which led to the conclusion that a possible race between a more expansionary fiscal policy and a more contractionary monetary policy causes relatively more extreme levels of both output and inflation.

1.5 Relative importance of domestic transmission channels

At this point it is useful to make a few remarks about the relative importance of the various transmission channels of fiscal policy that we have come across. Naturally, this classification is mostly context-specific. For example, when there is a large negative output gap, fiscal policy will generate most of its effects through the demand channel. In Figure 3 below, I present an overview of all the relevant fiscal policy channels and their relations.

FIGURE 3 — Domestic transmission mechanisms



Note: this diagram is only intended to clarify the causal relationships between different phenomena, *not* as a circular flow diagram that represents the complete flows of income and expenditure.

Figure made by author.

In general, the following inferences can be made. In open economies the demand channel will be weaker, because in open economies a large part of the fiscal stimulus will leak to other countries. During large fiscal overhauls the role of expectations and precautionary saving becomes bigger and the supply channel becomes more important for fiscal policy. Another relevant determinant of the relative strength of the supply channel is the intertemporal elasticity of substitution of goods and leisure: the higher the intertemporal elasticity of substitution of goods and leisure, the stronger the impact of fiscal policy through the supply channel (Ramey & Shapiro, 1998). When a country has high government debt or — worse — is on the brink of bankruptcy, fiscal policy will have its biggest impact through the interest rate or debt channel.

It is likely that the relative importance of transmission channels not only differs per country but also changes over time. I will mention a few interesting examples. Due to financial liberalisation and globalisation the role of the demand channel will probably have become smaller compared to the supply channel (Bénassy-Quéré, 2006). Furthermore, households nowadays enjoy far better savings and credit facilities, so that they are better able to smooth consumption over time. This means that the permanent income hypothesis becomes more realistic, which leads again to the conclusion that the role of the demand channel has probably become smaller compared to the supply channel (Bénassy-Quéré, 2006).

1.6 Fiscal policy in times of crisis

In the analysis so far we have tacitly assumed that fiscal policy is implemented in normal economic circumstances. However, as we all know, the current economic circumstances are far from normal. The financial crisis of 2008 has pushed the world into the worst economic crisis since the Great Depression of the 1930s. The Great Recession, as contemporary economists call the current crisis, has a profound impact on the workings of the economy and the effectiveness of fiscal and monetary policy. I will therefore briefly describe the causes and effects of the crisis and the relevance it bears for fiscal policy.

In Figure 4 below I show the chain of events that led to the Great Recession. The three main mechanisms bear some resemblance to the mechanisms that led to the Great Depression, though there are also important differences.

FIGURE 4 [next page] — The nature and origins of the Great Recession

The economy suffers from overindebtedness but economic agents are too optimistic to realise this. Suddenly, an exogenous reduction in the debt limit becomes apparent (the so-called Minsky moment). Firms, banks and households are confronted with massive balance sheet problems, leading to large uncertainties and downward spirals in key markets:

Fisher debt deflation

Deleveraging firms

Firms aim at debt minimisation rather than profit maximisation

Large-scale debt liquididation

Money interest on safe loans falls; money interest on unsafe loans rises

Distress selling of assets

Reduction in the velocity of money

Increase in bankruptcies and unemployment

Downward economic spiral with deflationary pressure

Liquidity trap

Deleveraging banks

Lack of trust and lack of demand for loanable funds; money markets do not clear

Temporary negative natural rate of interest

Central bank drastically lowers interest rates, injects money into banks

Nominal interest rates hit the zero lower bound

Consumption, investment and prices fail to react to monetary stimuli

Downward economic spiral with deflationary pressure

Paradox of thrift

Deleveraging households

Declining propensity to consume; increasing propensity to save

Excess supply of loanable funds

Sharp decline in short-term interest rates

Collapse in aggregate demand

Decrease in economic growth and incomes

Further decrease in aggregate demand while nominal interest rates hit the zero lower bound

Downward economic spiral with deflationary pressure

Real interest rates should decline for private investment and consumption to adjust, but zero bound interest rates and price rigidities prevent this from happening. In the meantime, monetary policy has become less effective or even impotent.

The result: incomplete factor utilisation and a large negative output gap, leading to a rapid increase in unemployment and a further downward spiral.

Sources: Fisher (1933); Keynes (1936); Minsky (1992); Koo (2009); Eggertsson and Krugman (2011)

The Great Recession

Figure made by Paul Schenderling.

As we can see in Figure 4, the Great Recession is a typical balance sheet recession (Koo, 2009). This means that we have to focus on the financial sector first. As Minsky (1992) described in his famous Financial Instability hypothesis and Keynes (1936) wrote before, in the capitalist system money connects lenders and borrowers and finances projects through time. Entrepreneurs and companies buy assets with borrowed money and the actual owners have claims, not on the actual assets, but on money (Keynes, 1936). The financial sector — the intermediary sector which creates and manages money — has the responsibility of structuring the amount of debt and dating payment commitments over time (Minsky, 1992).

After a period of prolonged economic optimism, economic agents start overestimating their capacity for creating wealth and too much debt is issued in one or several sectors of the economy. Slowly the economy 'transits from financial relations that make for a stable system to financial relations that make for an unstable system', as Minsky (1992) put it.

Then, unexpectedly, an exogenous reduction in the debt limit becomes apparent — the so-called Minsky moment — and firms, banks and households face the painful and difficult task of deleveraging their balance sheets. The massive and rapid deleveraging efforts by firms, banks and households have detrimental effects on the rest of the economy. I will describe for each sector the main consequences.

When firms start deleveraging, they temporarily replace their objective of profit maximisation with the objective of debt minimisation (Koo, 2009). As a result, the velocity of money slightly decreases and a process of debt liquidation starts (Fisher, 1933). The money interest on safe loans falls and the interest on unsafe loans rises, causing more bankruptcies and distress selling of assets. As pessimism spreads from firms to consumers more and more people start hoarding money, which reduces the velocity of money even further (Fisher, 1933). This leads to a downward spiral with falling output and falling prices, a process called Fisher debt deflation, named after the famous economist Irving Fisher who analysed this process during the Great Recession.

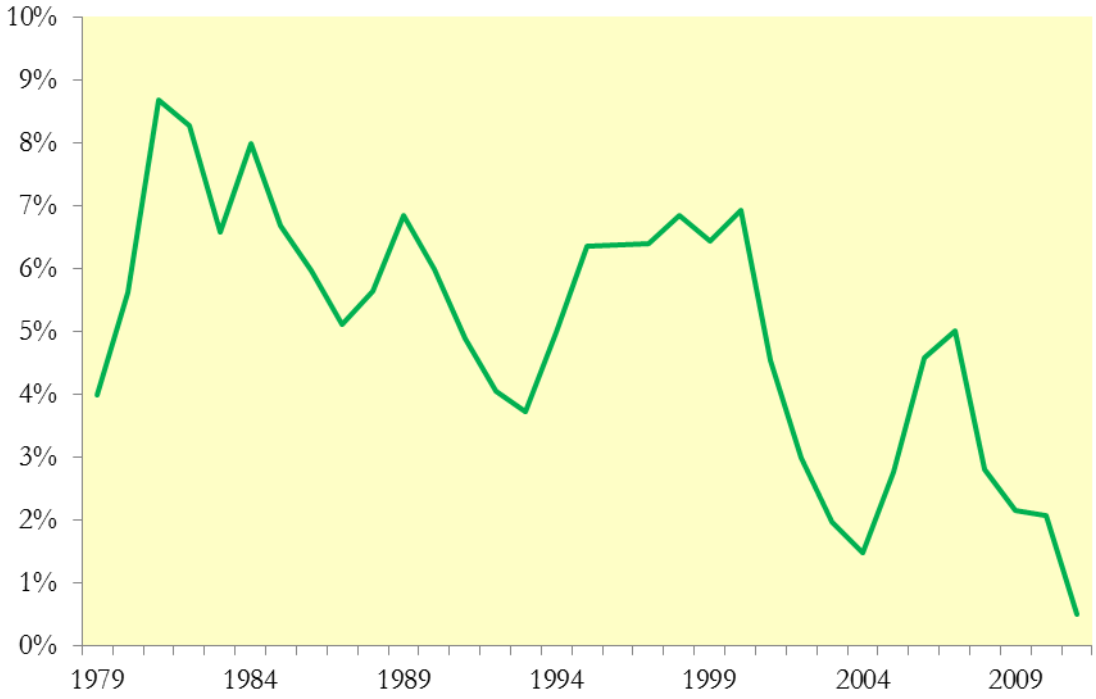
When banks start deleveraging — which they did on a massive scale in the immediate aftermath of the financial crisis of 2007 — there is excess supply of loanable funds in the money market. Due to a lack of trust, money markets do not clear, which can lead to bankruptcy of financial institutions and other disastrous consequences. Therefore, monetary authorities have to intervene in the money market by drastically lowering interest rates and providing emergency loans to banks, a step that all monetary authorities in the affected countries have taken.

However, at some point interest rates hit the zero lower bound and it becomes more and more difficult for monetary authorities to increase the money supply in order to keep the

economy going (Eggertsson and Krugman, 2011). In other words: a severe banking crisis can make the tools of monetary policy blunt, a process which is called the liquidity trap.

When households start deleveraging, the supply of loanable funds increases while consumption expenditure decreases (Ueda, 2012). This has the double effect of decreasing short-term interest rates and decreasing aggregate demand. When the decline in demand is particularly sharp, economic growth and household incomes could drop to a level that actually *reduces* people's ability to save (Eggertsson, 2009). This paradoxical process is aptly called the paradox of thrift. Similarly to the situation of deleveraging banks, monetary authorities could intervene by quickly decreasing interest rates. However, when the zero lower bound has been reached, the liquidity trap looms.

FIGURE 5 — Real interest rate in the United States (1979-2011)



Source: World Bank Development Indicators

Figure made by author.

What could be the role of fiscal policy in extraordinary circumstances like these? Recently, Eggertsson (2009) conducted a theoretical study into the effectiveness of fiscal policy during a balance-sheet recession like the current one. Interestingly, he found that the fiscal multiplier becomes much bigger. The reason behind this is the liquidity trap. As we can see in Figure 5 above, real interest rates have fallen sharply, both in the United States (pictured) and in other

countries. Unfortunately, in spite of the big monetary expansion, output and employment did not catch up quickly enough and in 2012 many economies are still in a recession. The situation bears some resemblance to the 'lost decade' that Japan recently experienced, with deflationary pressure and prolonged economic stagnation (Ueda, 2012).

With the capacity for monetary policy largely exhausted and the threat of deflation still looming a fiscal expansion — even a big one — is unlikely to cause a rise in interest rates, which means that the risk of crowding out private investment, as described earlier in this study, is nearly absent. This means that in these circumstances the multiplier will be larger than normal.

There are two important caveats to this story. First, the type of fiscal expansion matters much. A tax cut is far less effective than an increase in government spending, because due to the increased propensity to save people will not spend the proceedings of a tax cut (Eggertsson, 2009). Since an increase in government spending flows directly into the economy, the multiplier of increased government spending will be bigger. In the new-Keynesian model by Eggertsson (2009) the multiplier for government spending at the zero lower bound is 2.27 while the multiplier for a tax cut at the zero lower bound is even negative: -0.81.

Second, though the magnitude of the multiplier is high in times of crisis, the emergence of the sovereign debt crisis that recently struck the European Union poses policymakers with a fresh problem (Lane, 2012). As the interest rate spreads on government bonds clearly show, financial markets are signalling their worries about the magnitude of rich-world government debts. This means that unless monetary authorities plan further interventions rising borrowing costs and the potential costs of fiscal crises could offset the potential benefits of a further fiscal stimulus. At the moment of writing there is still no solution to this policy dilemma.

The outcomes of this study could help to solve the dilemma in at least two respects: first, by providing an up-to-date quantification of fiscal multipliers, and second, by quantifying the international spillovers of fiscal policy. When fiscal spillovers are particularly large, this could form an additional consideration in the fiscal policy debate.

This completes the theoretical analysis of domestic transmission channels of fiscal policy. In the next chapter I will extend this chapter by analysing international transmission channels.

Chapter 2: International transmission channels of fiscal policy

In this chapter I investigate the theoretical aspects of international transmission channels of fiscal policy. It is helpful to present an overview of the main channels through which fiscal policy changes in one country affect economic conditions in other countries. Weyerstrass et al. (2006) distinguish five different spillover channels.

The first and most obvious spillover channel is the trade channel. When domestic output changes due to a fiscal shock, consumption and investment will change accordingly. Since income is partly is spent abroad, demand for foreign imports will change as well.

The second spillover channel is the price channel. As we saw in the previous chapter, fiscal policy can affect wage expectations and thus the level of inflation. The level of domestic inflation can also affect inflation in other countries; this phenomenon is called pass-through.

That brings us to the third spillover channel: the interest rate channel. When a change in government spending alters inflation, monetary authorities are likely to react by changing the interest rate. Furthermore, when government spending is debt-financed and debt levels are high, short-term interest rates on bond markets will rise as well. As we shall see below, the interest rate channel is particularly relevant in the European Union, since the EU has closely integrated markets, a single monetary authority and a high risk of financial contagion.

The fourth channel is the exchange rate channel. The intuition behind this is straightforward: a change in government spending induces a change in (a) the money supply, (b) net imports, and (c) prices. All of these intermediate factors exert influence on the exchange rate, so the exchange rate will necessarily change as a result of a change in fiscal policy. The exchange rate movement, in turn, influences the international competitiveness, exports and welfare.

The fifth and last channel is the structural (reform) channel. This channel deals with (changes in) the structure of the production capacity of a country. Governments are capable of redesigning production structures by influencing the allocation of capital. They can do this directly, by allocating government funds, for example funds for education or research and development (R&D), or indirectly, by implementing reforms or imposing legislation that changes the direction of investment flows. These supply-side measures enhance competitiveness, which influences economic growth, demand for foreign imports and interest rates. Furthermore, structural reforms in one country put pressure on governments in other countries to reform their economies as well.

In the remainder of this chapter I give an overview of the main theories regarding international spillover channels and describe how these different channels interact (see also Figure 6 below). At the end of the chapter I will give an indication of the relative importance of the various spillover channels and of the factors that determine the magnitude of spillovers. The focus will be on the context of a monetary union such as the European Union.

2.1 Trade channel

In a linear time-frame, the relationship between fiscal policy and international trade seems quite simple. Our findings about the domestic demand channel tell us that consumption — and thereby output — will rise after an increase in government spending, which implies that demand for foreign goods, mostly consumption goods, will rise as well. Though the mechanism is different, our findings about the supply channel tell us a similar story: if a government increases spending or cuts taxes, investment — and thereby output — will rise, which again implies that demand for foreign goods, mostly production inputs, will rise as well. Thus we would expect that a fiscal expansion generates positive spillovers for other countries.

However, we must depart from this line of reasoning, because these kinds of relationships are not that simple. In macroeconomics assuming linear time-frames — A causes B causes C — is deceptive and should be avoided. The truth is that economic aggregates move *simultaneously* and *feed back* into the system. Macroeconomic relationships, such as fiscal spillover mechanisms, are interdependent and thus cannot be effectively described in linear terms.

FIGURE 6 [next page] — International transmission mechanisms

Note: the diagram is only intended to clarify the causal relationships between different phenomena, *not* as a circular flow diagram that represents the complete flows of income and expenditure.

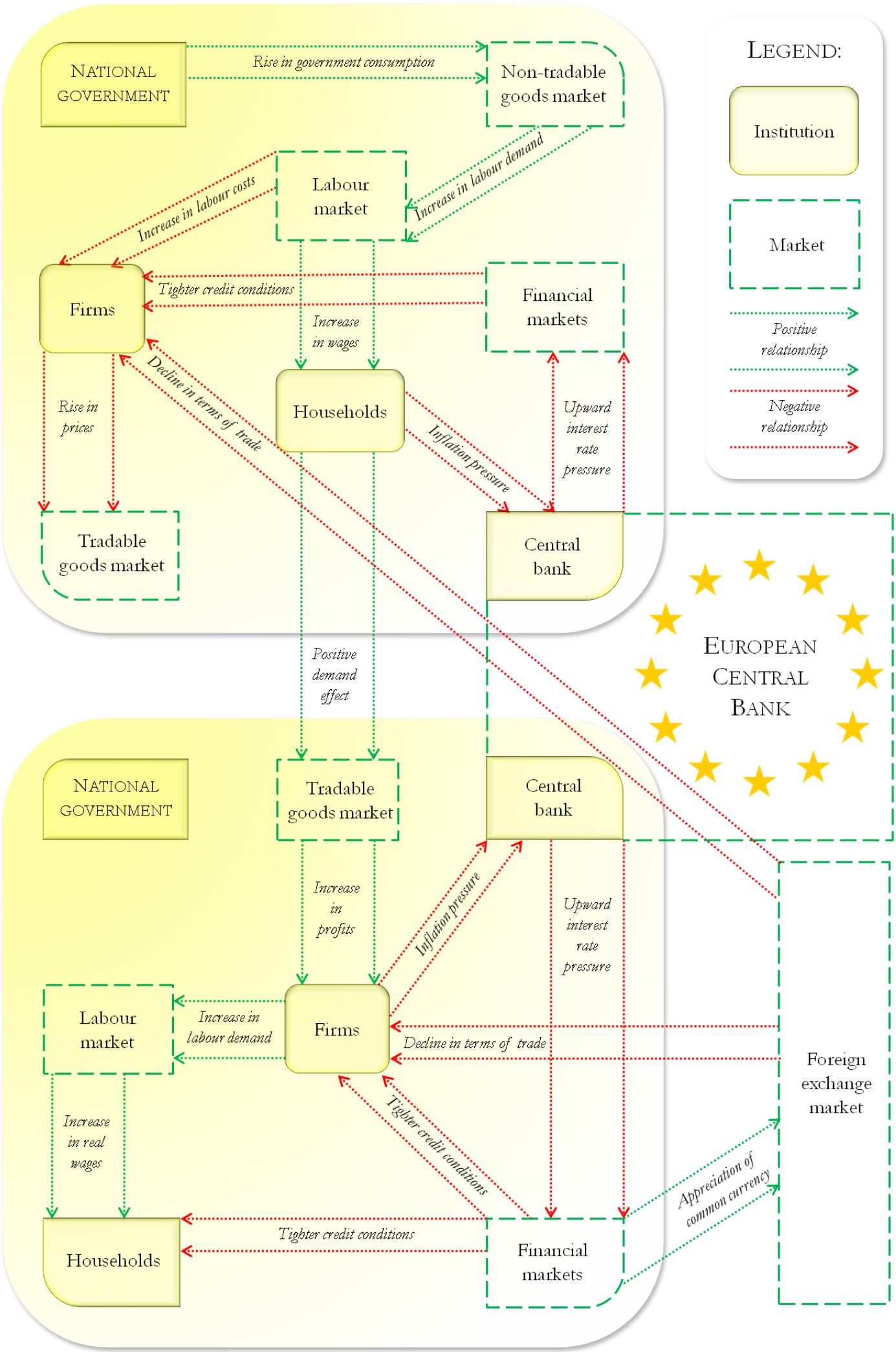


Figure made by Paul Schenderling

In the case of fiscal spillovers, the interdependence between transmission mechanisms can be shown using the fact that *both* the government budget *and* the current account react endogenously to the intermediate variable national output. Concretely, the government budget is procyclical and the current account is countercyclical (Kim & Roubini, 2008). Ergo: we cannot describe the relationship between fiscal policy and the current account in linear terms.

How then do we find out how fiscal policy and the current account interact? The current account is equivalent to net foreign investment, which is equal to the difference between national savings and national investments. National savings, in turn, can be divided into private saving and government saving (see Figure 7 below). When government saving increases — i.e. the government slashes the budget deficit — ceteris paribus net foreign investment (net exports) will rise. The opposite is also true: when government saving decreases, ceteris paribus net foreign investment (net exports) will fall (Kim & Roubini, 2008). Therefore, most theoretical models predict a *negative* relationship between a fiscal expansion and the current account.

FIGURE 7 — National Saving and Investment

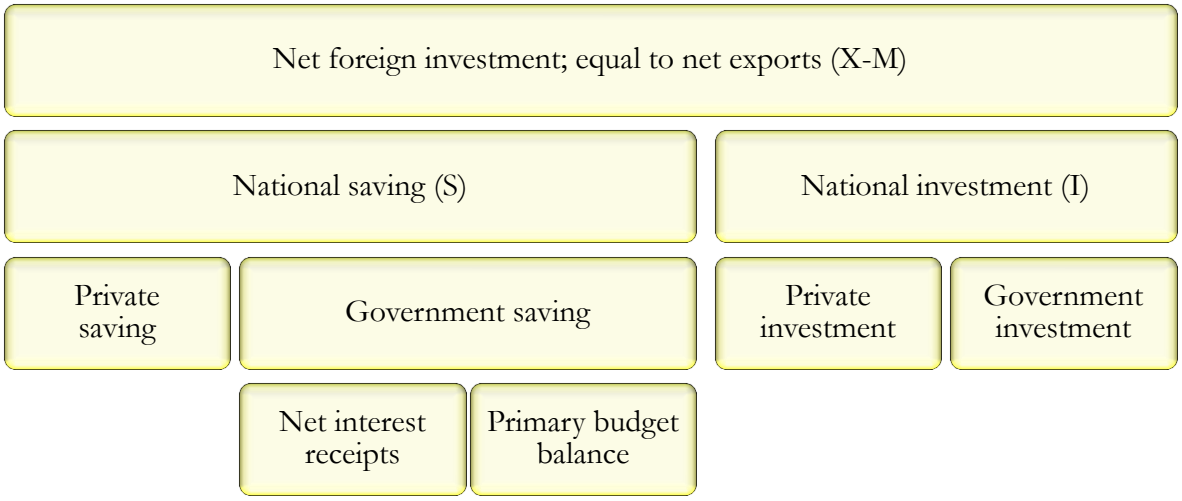


Figure made by author.

2.2 The role of the real exchange rate

Let us look more closely at the precise chain of events. The crucial intermediate variable between a fiscal expansion and the current account — the variable that, so to speak, 'balances' the net foreign investment position — is the real exchange rate (Romer, 2006).

In order to explain the interaction between fiscal policy, the balance of payments and the exchange rate, I return to Figure 7. After a deficit reduction (fiscal expansion) government saving falls (rises), so that the domestic economy is likely to experience a fall (rise) in its capital and financial account surplus (Romer, 2006). The reason behind this is that the country is moving from a situation in which foreigners buy a large (small) amount of domestic assets to the situation in which they buy substantially less (more) domestic assets. When this is the case, the logic of the balance of payments tells us that when the capital and financial account surplus falls (rises) the trade balance has to rise (fall) as well. As a consequence, the real exchange rate has to depreciate (appreciate) to bring the balance of payments back to equilibrium (Romer, 2006). Naturally, this reaction to fiscal shocks can only be significant when the shock is sufficiently large, since for most countries only a limited share of government bonds is bought by foreigners.

In a flexible exchange rate regime, the exchange rate reaction to fiscal shocks is quite immediate, since the exchange rate constantly adjusts to changing circumstances. In a fixed exchange rate regime, however, this reaction tends to be a bit slower, since the whole shock has to be absorbed by the price level while prices are sticky in the short run.

In the medium run, exports rise (decline) as a result of the exchange rate depreciation (appreciation), and output returns to its equilibrium. During this adjustment process, the real exchange rate slowly appreciates (depreciates) again and returns to its equilibrium level as well.

This brings us to another relevant question: what determines the strength of the reaction of the real exchange rate to a fiscal shock, and thus the magnitude of fiscal spillovers? In order to answer this question we need to decompose the adjustment process — the adjustment of the real exchange rate in particular — into its components. What is the precise sequence of events? Does it matter whether the economy is characterised by a flexible or a fixed exchange rate regime? Again, new-Keynesian and neoclassical economists sometimes agree and sometimes disagree about the components and sequence of events of the adjustment process. I will first look at the new-Keynesian analysis of international spillovers and then at the neoclassical analysis.

2.3 Relative prices and the demand channel

The starting-point for new-Keynesian analysis is again the multi-country Mundell-Fleming model with fixed exchange rates. When we assume that most of the government budget is spent on domestic goods, a fiscal expansion will lead to inflationary pressure, so that home prices will rise relative to foreign prices. If we also assume that, in the initial situation at least, private spending is

home-biased, the strength of the jump in relative prices depends on the *inter*temporal elasticity of substitution of private goods relative to the *intra*temporal elasticity of substitution between home and foreign goods (Müller, 2008).

Intertemporal elasticity of substitution of private goods means that due to the negative change in terms of trade domestic private consumption will fall (in favour of domestic private consumption in the future). Intratemporal elasticity of substitution between home and foreign goods means that due to the appreciation in terms of trade private consumption will shift from domestic to foreign goods. Suppose that the intertemporal elasticity of substitution of private goods is low and the intratemporal elasticity of substitution between home and foreign goods is high, then a relatively large amount of domestic resources is reallocated from home to foreign markets and net exports will decrease sharply. If, on the other hand, the intertemporal elasticity of substitution of private goods is high and the intratemporal elasticity of substitution between home and foreign goods is low, then a relatively small amount of resources is reallocated from home to foreign markets and net exports will not change much. In other words, according to new-Keynesian economists, the magnitude of spillovers mainly depends on consumer preferences in general and expectations about the future in particular.

2.4 Relative prices and the supply channel

Neoclassical models also begin with the assertion that most of the government budget is spent on domestic goods. Neoclassical models also emphasise that *within* the domestic goods sector governments spend most of their budget on non-tradable goods, specifically on wages in sectors such as education, public administration or healthcare. Therefore, an increase in government spending will lead to upward wage pressure in the non-tradable goods sector, a pressure that eventually spills over to the tradable goods sector. This phenomenon is often referred to as the 'crowding out' of the tradable goods sector by the government.

As a result of the crowding out of the private sector, the international competitiveness of a country deteriorates. In a flexible exchange rate regime competitiveness deteriorates faster and further, because the exchange rate will appreciate. In a fixed exchange rate regime this effect is more limited (Lane & Perotti, 1998). As Baumol (1967) theorised in a classic paper, if the government crowds out the private sector on a structural basis, productivity growth could be severely hampered, so that a country structurally lags behind in terms of competitiveness. Furthermore, neoclassical economists state that the reallocation of capital accompanying fiscal

expansions or contractions is not costless. As a result of the costly reallocation process, the effect of fiscal shocks on output is magnified and interest rates can become temporarily lower instead of higher (Ramey & Shapiro, 1998).

Not only is the size of a fiscal adjustment important but also its composition. We should take account of the notion that in a neoclassical setting the adjustment process following a tax cut is different from the adjustment process following an increase in government spending. Namely, a tax cut leads to an increase in output and a real appreciation of the exchange rate *without* the negative side effect of crowding out the tradable goods sector, so that it leads to the most efficient reallocation of capital (Lane & Perotti, 1998). Therefore, neoclassical economists prefer tax cuts over an increase in government spending as a means of fiscal expansion.

As a means of fiscal contraction, however, neoclassical economists prefer a spending cut over a tax increase. The reason is that a tax increase drives up wages in both the tradable goods sector and the non-tradable goods sector, which hurts the international competitiveness of a country more than a spending cut, because a spending cut mainly falls on the non-tradable goods sector without having many repercussions on inflation (Lane & Perotti, 1998).

2.5 Monetary policy and the interest rate channel

The analysis so far pointed towards the conclusion that fiscal spillovers can be quite large. The trade channel, price channel and exchange rate channel all more or less reinforce each other, yielding strong theoretical predictions. However, this is not the case for the next channel that I will analyse: the role of monetary policy and the interest rate channel. Especially within a monetary union, positive trade spillovers tend to be cancelled out by monetary interventions, via the short-term interest rate (Corsetti et al., 2010).

The intuition behind this should be familiar. A fiscal expansion (contraction) increases (decreases) aggregate demand while aggregate supply is fixed in the short run. Thus a fiscal expansion can induce (reduce) a wage-price spiral. The central bank of the monetary union will react to this inflationary (deflationary) pressure by raising (lowering) the common interest rate. The higher (lower) interest rate, in turn, depresses (increases) consumption and investment, creating an economic force that works in the exact opposite direction of the trade channel.

In addition, a higher interest rate leads to an appreciation (depreciation) of the common currency, which negatively (positively) affects the trade balance of the whole monetary union and further diminishes the potential effect of the trade spillovers (Gros & Hobza, 2001).

2.6 Other determinants of the magnitude of fiscal spillovers

Now that I have explored the general properties of fiscal spillovers, I would like to make a few remarks regarding the specific setting of this study — namely, fiscal spillovers within a monetary union — and indicate how this setting influences the magnitude of fiscal spillovers.

As Beetsma et al. (2008) point out: a monetary union such as the European Union forms an ideal setting for fiscal spillovers. European markets are highly integrated and intra-European trade is substantially larger than European trade with the rest of the world. Capital and financial markets are highly integrated as well and there is a common monetary policy, so that the reaction of interest rates to a fiscal shock in an individual country is weaker than it would have been if each country had its own central bank. As a result, trade spillovers are less likely to be cancelled out by interest rate movements. Furthermore, in a monetary union the exchange rate between member states is fixed. This factor too leads to stronger spillover effects (Hebous & Zimmermann, 2010).

Which insights does the literature provide regarding differences in the magnitude of fiscal spillovers between members of the same monetary union? A few relevant observations can be made. First, bigger countries exert a stronger influence on the common interest rate, so in these countries spillovers are smaller, because they are more likely to be cancelled out by interest rate movements. Second, the exact size of fiscal spillovers between two member states depends on the size of the trade flows between these two countries. As the well-known gravity model of trade predicts, the size of the trade flows between two countries mainly depends economic weight of the two countries and the distance between the two countries (Bergstrand, 1985). Third, as Cooper et al. (2010) demonstrate in a multi-region overlapping generations model, spillovers tend to be larger for countries that have more frictions in their economy. For example, if labour market adjustments are particularly slow or prices are particularly sticky, the adjustment process following a fiscal shock becomes less smooth and as a result of that spillovers become larger. Fourth, as a recipient country, small, open economies tend to be more sensitive to fiscal shocks in neighbouring countries than bigger countries (Ivanova & Weber, 2011).

2.7 Simultaneous fiscal changes

At the end of this chapter, I briefly pay attention to the effects of simultaneous fiscal shocks. Do simultaneous fiscal shocks reinforce each other or not? Unfortunately, the literature points in

different directions. Gros and Hobza (2001), who study fiscal policy spillovers in the European Union, argue that the average size of simultaneous spillovers will be about the same. Their argument is that there is no linear relationship between average spillovers in the Eurozone and the economic weight of the countries experiencing a fiscal shock.

A second point of view is presented by Corsetti et al. (2010). As we saw, the size of fiscal spillovers is mitigated by monetary policy interventions that accompany a fiscal shock. When a fiscal shock takes place simultaneously in more than one country, the reaction by the central bank will probably be stronger. This means that spillovers via the trade or the exchange rate channel are more likely to be cancelled out, so that simultaneous spillovers will be smaller.

The third point of view comes from Ivanova and Weber (2011). They reckon that simultaneous movements of the business cycle amplifies the effects of simultaneous fiscal shocks. When for example countries in the European Union undertake fiscal consolidations at the same time and these countries are at the same point in the business cycle, a reduction in domestic demand cannot be fully offset by an increase in net exports. As a result, countries could end up in a vicious cycle with amplified spillovers.

That completes the theoretical analysis of international spillovers of fiscal policy. In the next chapter I will present an overview of existing empirical evidence on fiscal multipliers and fiscal spillovers. This encounter between theory and empirics forms a final preparation for my own empirical model.

Chapter 3: Existing empirical evidence on fiscal spillovers

In this chapter I explore the existing empirical evidence about fiscal multipliers and fiscal spillovers. Like other authors in this field of research, it struck me that there is a substantial amount of empirical evidence about multipliers, but very little evidence about spillovers. Furthermore, most of the evidence deals with the United States, whereas only a few studies deal with the European Union. A lack of data plays a role as well as econometric issues.

The structure of this chapter is as follows. First, I summarise the main findings in the literature about domestic transmission channels and multipliers. After that, I turn to some results about the trade channel. Finally, I look at the results of empirical studies about fiscal spillovers.

3.1 Multiplier results

When comparing the results of different studies that quantify fiscal multipliers, it is important to be aware of contextual differences between studies, because the context can have a quite strong impact on the magnitude of a fiscal multiplier. For example, multipliers tend to be larger for bigger countries (Spilimbergo et al., 2008). Multipliers are negatively correlated with import penetration ratios, indicating that open economies have smaller multipliers (Barell et al., 2007).

In general, multipliers are larger than 1, though not much larger. A much-cited study by Baxter and King (1993) forms a solid confirmation of this result. They find long-run multipliers that exceed 1. An important determinant of multipliers is the intertemporal substitutability of leisure: the higher the intertemporal elasticity of substitution of leisure, the larger the multiplier. Another finding from Baxter and King is that permanent fiscal changes are associated with larger multipliers than temporary ones. This confirms the neoclassical hypothesis that wealth and expectations are important channels for fiscal policy. Additional evidence is presented by

Guajardo et al. (2011), who find that fiscal consolidations that are preceded by high perceived risk of a fiscal crisis have a less negative impact on GDP. Barell et al. (2007) also emphasise that the magnitude of multipliers and spillovers depends on expectations formation.

Empirical studies also state that the magnitude of the multiplier has declined over time. Perotti (2004) divided his sample about fiscal policy in OECD countries in two parts and found that before 1979 government spending had its strongest effects, whereas after 1980 multipliers have become smaller. I think that a possible explanation might be that after the collapse of Bretton Woods in 1973 more and more countries abandoned fixed exchange rate regimes and adopted flexible exchange rate regimes. As I observed in Chapter 1, fiscal policy is more effective under fixed exchange rates. Another explanation might be that after the disastrously high levels of inflation in the 1970s, central bankers have become stricter in their fight against inflation. This too has made fiscal policy, especially expansionary fiscal policy, less effective. I will present some additional evidence for this explanation later in this chapter.

Ivanova and Weber (2011) add the relevant insight that multipliers tend to be larger in times of financial stress, since in this situation interest rates are close to the zero bound.

3.2 Domestic transmission channels

An important issue in Chapter 1 was the relative importance of various transmission channels. What do empirical results tell us about it? There is ample evidence for both the demand channel and the supply channel. With regard to the demand channel, Blanchard and Perotti (2002) describe in a much-cited paper that consumption indeed increases after a fiscal expansion. Investment, on the other hand, does not move. This relationship is confirmed by Guajardo et al. (2011) who find that a fiscal contraction has a significantly negative effect on private consumption. With regard to the supply channel, Alesina and Perotti (1996) find that unit labour costs react significantly to fiscal shocks, suggesting that the labour market is indeed an important channel through which fiscal policy impacts the economy.

Romer and Romer (2010) make an important contribution to the literature by using an entirely different methodology for the identification of fiscal shocks. Since the government budget, consumption and investment all react endogenously to changes in GDP these variables have to be detrended (see the next chapter for an extensive explanation). The authors that I cited so far, all used statistical techniques, such as VAR analysis, to detrend their variables. Romer and Romer, however, decided to use the so-called narrative approach. This means that they used

historical sources in order to distinguish which fiscal shocks were endogenous reactions to GDP and which ones were discretionary decisions by the government. The most important result of the study by Romer and Romer is that investment reacts much stronger to exogenous fiscal shocks than consumption does. This leads to the conclusion that though there is evidence for both the demand and the supply channel, the supply channel is more important. The authors explain their findings by showing that investment heavily depends on cashflows, whereas consumption smoothing — helped by better financial facilities that households have at their disposal — has made consumption less dependent on current income.

Many studies predict that taxes would affect economies differently than changes in government spending. Empirical studies confirm this hypothesis. Blanchard and Perotti (2002) find that government spending is positively related to GDP, whereas taxes are negatively related to GDP. Romer and Romer (2010) find similar results: tax increases affect output negatively but government spending does not necessarily have a negative impact on output.

3.3 The interest rate channel and the role of monetary policy

To what extent does monetary policy influence the impact of fiscal policy? A large majority of authors concludes that the interaction between monetary and fiscal policy is strong. For example, Kim and Roubini (2008) demonstrate that real interest rates rise after a fiscal expansion. This is consistent with the theory. It is therefore no surprise that Gros and Hobza (2001), Corsetti et al. (2010) and Müller (2008) all conclude that monetary policy dampens the effect of fiscal policy.

Interestingly, the empirical analysis conducted by Guajardo et al. (2011) shows that the difference in impact between tax changes and changes in government spending that I described earlier is probably caused by a difference in monetary response. Central bankers probably interpret spending cuts as a stronger commitment to fiscal discipline than tax increases.

Furthermore, as we saw in the previous chapter, a tax increase can induce a wage-price spiral, whereas spending cuts do not (severe spending cuts might even lead to deflationary pressure). As a result, central bankers are more willing to relax monetary policy in case of a spending cut than they are in case of a tax increase. This finding is confirmed by empirical research by McDermott and Wescott (1996), who discovered that short-term interest rates tended to decline during successful fiscal consolidations, but increase during unsuccessful ones.

We should be cautious, however, to apply the conclusions about monetary policy that are drawn in the previous paragraphs too easily to the context of a monetary union. As Weyerstrass

et al. (2006) demonstrate, if a country makes an attempt at fiscal expansion (or fiscal consolidation) through an increase (decrease) in government spending, the resulting rise (drop) in interest rates is small and insignificant. In other words, due to the monetary union, the central bank cannot accommodate monetary policy in reaction to a fiscal shock in an individual country. As a result, multipliers and spillovers are likely to be bigger within a monetary union. This has important consequences for the interpretation of my empirical analysis, later on.

3.4 Trade channel and the real exchange rate

The empirical evidence that I have studied so far suggests that the impact of fiscal policy on the domestic economy is more or less proportional: a change in fiscal policy of 1 per cent of GDP will impact GDP by about 1 per cent as well. To what extent is this impact transmitted to other countries? The literature provides a nice rule of thumb: about a third of the increase (decrease) in government saving — which is equivalent to a decrease (increase) in the budget deficit — is reflected in the trade deficit/surplus (Müller, 2008). Individual empirical studies about the trade channel confirm this rule of thumb. Müller (2008) himself, for example, finds that an increase in government spending leads to an increase in net exports of 0.1 per cent of GDP. Blanchard and Perotti (2002) find a stronger impact. They calculated that after a positive fiscal shock, imports increase by 0.64 per cent of GDP and exports increase by 0.2 per cent of GDP.

The positive relationship that Blanchard and Perotti (2002) and Müller (2008) found between government spending and import is consistent with the theory; the positive relationship between government spending and export, however, is *not*. Neoclassical theory in particular stresses that increased government spending crowds out the tradable goods sector, which would depress exports. Do the data refute this hypothesis?

According to Perotti (2004) this is indeed the case. He too does not find any systematic evidence that government spending crowds out exports. In fact, the only papers that I came across that show a significantly *negative* relationship between fiscal expansion and export are the papers by Lane and Perotti (1998) and Beetsma et al. (2006). These papers, however, do not deal with government spending in general but specifically with government wage consumption. As we saw in the previous chapter, government wage consumption is strongly associated with economy-wide wages, which explains the negative relationship between government wage consumption and exports. In the same paper, Beetsma et al. find that a tax cut leads to an increase in exports,

so we can safely stick to the conclusion that in general a fiscal expansion does not depress exports at all.

Furthermore, using modern impulse response functions — a special component of VAR analysis, which I will explain in the next chapter — Kim and Roubini (2008) established that after a positive (negative) fiscal shock, the current account improves (deteriorates) for about one year and then returns to equilibrium.

About the response of real interest rates to a fiscal shock the literature is not conclusive at all. Lane and Perotti (1998) and Corsetti et al. (2010) find an *appreciation* of the real exchange rate following a fiscal expansion. Corsetti and Müller (2011), Müller (2008) and Kim and Roubini (2008), on the other hand, find a *depreciation* of the real exchange rate following a fiscal expansion. How to interpret these contradictory results? I think that we have to turn again to the monetary policy reaction for a plausible explanation. As we saw in the previous chapter, a fiscal expansion can lead to inflationary pressure, which, in turn, can lead to a depreciation of the exchange rate. If, however, monetary authorities intervene by raising interest rates, this will not happen and the real exchange rate could appreciate.

3.5 Fiscal spillovers and their magnitude

In the second part of this chapter, I will summarise the main empirical findings about international spillovers. Since there are very few papers that quantify fiscal spillovers, I will treat each paper in more detail than in the previous part of this chapter. For the sake of convenience, I treat the relevant papers in chronological order. For a general overview of all results see Table 1 below. Please note that all spillovers in the table are measured as a percentage of GDP of the foreign country.

One of the first large-scale attempts to quantify fiscal spillovers was made by Gros and Hobza (2001). They simulated the cross-border effects of fiscal policy using four different macroeconomic models, namely the macroeconomic model used by the European Commission (QUEST II), the macroeconomic model of the National Institute for Economic and Social Research (NiGEM), the model of the CEPII (Marmotte), the dynamic macroeconomic model by the IMF (MULTIMOD Mark III). The region that Gros and Hobza study is the Euro area.

TABLE 1 — Magnitude of fiscal spillovers in the literature

Year	Authors	Method used	Fiscal aggregate	Type of spillover	Q[†]	Sign[‡]	Lower bound	Upper bound
2001	Gros and Hobza	QUEST II model	Increase in government consumption in Germany	Output spillover	4	-	-0,10 (Spain)	0,04 (Nether-lands)
2001	Gros and Hobza	Marmotte model	Increase in government consumption in Germany	Output spillover	4	+	0,02 (Ireland)	0,22 (Belgium)
2001	Gros and Hobza	NiGEM model	Increase in government consumption in Germany	Output spillover	4	-	-0,11 (Spain)	0,01 (Nether-lands)
2006	Beetsma et al.	Panel VAR analysis	Increase in government spending in Germany	Trade spillover	1	+	0,050 (Greece)	0,39 (Belgium)
2006	Beetsma et al.	Panel VAR analysis	Net tax cut in Germany	Trade spillover	1	+	0,014 (Greece)	0,112 (Belgium)
2006	Beetsma et al.	Panel VAR analysis	Increase in government in Germany spending	Trade spillover	8	+	0,096 (Italy)	0,448 (Belgium)
2006	Beetsma et al.	Panel VAR analysis	Net tax cut in Germany	Trade spillover	8	+	0,033 (Italy)	0,153 (Belgium)
2010	Hebous and Zimmer-mann	Multi-country GVAR	Positive budget balance shock in Germany	Output spillover	0	-	-0,161 (Greece)	0,203 (Nether-lands)
2010	Hebous and Zimmer-mann	Multi-country GVAR	Positive budget balance shock in Germany	Interest rate spillover	1	-	-0,321 (Luxem-bourg)	0,149 (Nether-lands)
2010	Hebous and Zimmer-mann	Multi-country GVAR	Positive budget balance shock in Germany	Trade spillover	0	-	-0,215 (Finland)	0,471 (Luxem-bourg)
2010	Hebous and Zimmer-mann	Multi-country GVAR	Positive budget balance shock in Germany	Output spillover	4	-	-0,200 (Italy)	0,135 (Luxem-bourg)

2010	Hebous and Zimmer-mann	Multi-country GVAR	Positive budget balance shock in Germany	Interest rate spillover	4	-	-0,292 (Greece)	0,076 (Nether-lands)
2010	Hebous and Zimmer-mann	Multi-country GVAR	Positive budget balance shock in Germany	Trade spillover	4	+	-0,105 (Nether-lands)	0,152 (Ireland)
2011	Ivanova and Weber	Multipliers and import elasticities	*Reduction* in government spending in Germany	Trade spillover	8	-	-0,16 (Austria)	-0,01 (Greece)
2011	Corsetti and Müller	VAR model	Increase in government spending in the United States	Output spillover	4	+/-	-0,5 (United Kingdom)	0,5 (Euro area)
2011	Corsetti and Müller	VAR model	Increase in government spending in the United States	Trade spillover	4		-0,05 (United Kingdom)	0,05 (Euro area)

Table made by author.
All spillovers are measured as a percentage of the GDP of the foreign country;
† Q = Quarter after fiscal shock; ‡ Sign = average sign.

The result of the simulations by Gros and Hobza (2001) is that fiscal spillovers are small but significant. Spillovers from Germany to other European countries range from 0.02 per cent of GDP (Ireland) to 0.22 per cent of GDP (Belgium). Confusingly, the sign of the spillovers differs per model. The Marmotte model finds predominantly *positive* spillovers following a fiscal expansion; the QUEST and NiGEM models find predominantly *negative* spillovers following a fiscal expansion. This shows how important assumptions are for the final outcomes of a model. The paper by Gros and Hobza, though informative, still remains too theoretical; in other words, their approach is not really an empirical approach. An important endeavour to fill this gap in the literature is made by Beetsma et al. (2006). Recall from the introduction of this chapter that it is very difficult to empirically verify the existence of fiscal spillovers. Beetsma et al. use a very innovative and ingenious approach to solve this problem.

First Beetsma et al. apply a panel VAR analysis with historical OECD data to calculate the effect of exogenous fiscal policy changes to domestic output. The identification method Beetsma et al. use to distinguish endogenous and exogenous — discretionary — fiscal shocks is worth

explaining, but I leave that for the next chapter. After they calculated the exact multipliers, the authors use a panel VAR analysis with a gravity model structure to calculate how changes in domestic GDP affect net exports of other economies in the Euro area. As a final step, they combine the parameters of the two empirical models to quantify the precise effect that a fiscal shock in country A has on net exports of country B.

The results of the empirical analysis by Beetsma et al. (2006) show that fiscal spillovers are non-negligible. Over a two-year horizon, a fiscal expansion in Germany of 1 per cent of GDP leads to an average annual increase in net bilateral exports of 2.2 per cent for its European trading partners. Measured as a percentage of foreign output, trade spillovers from Germany to other European countries range from 0.05 per cent of GDP (Greece) to 0.9 per cent of GDP (Belgium). Trade spillovers are smaller when they originate in countries smaller than Germany — between 0.02 and 0.1 per cent of GDP. These magnitudes are broadly consistent with the theory. In addition, all trade spillovers that Beetsma et al. find are positive, which is also in line with the theory. Another interesting finding is that multipliers and spillovers for government spending are slightly larger than multipliers and spillovers for tax changes. This indicates that governments that want to stimulate output should use an increase in spending to attain the maximum effect.

A few years later, Hebous and Zimmermann (2010) came up with a new approach to quantify spillovers: the multi-country global vector autoregression (GVAR) method. The GVAR approach was developed by Pesaran et al. (2004) and is in many ways similar to the VAR method. The main difference between the methods is that the GVAR method uses country-specific vector error correction models, whereas the VAR method uses one correction method for all countries.

The results of the GVAR model by Hebous and Zimmermann (2010) are broadly in line with the findings of Beetsma et al. (2006). There are, however, considerable differences in the sign and magnitude of the spillovers that are detected. Concretely, Beetsma et al. find mostly *positive* spillovers, whereas Hebous and Zimmermann mostly find mostly *negative* spillovers. Measured as a percentage of foreign output, the effect of a 1 per cent fiscal expansion in Germany on the GDP of other European economies ranges from -0.20 per cent of GDP (Italy) to 0.13 per cent of GDP (Luxembourg). What explains the differences in spillovers? The answer is that Beetsma et al. studied *trade* spillovers (the effect of a fiscal change in country A on net exports in country B), whereas Hebous and Zimmermann studied *output* spillovers (the effect of a fiscal change in country A on output in country B via various transmission channels). Therefore, it is logical that they found different signs for their spillovers.

Fortunately, Hebous and Zimmermann decomposed the parameters of their output spillovers into parameters for three different spillover channels, so that we can deduce even more

precisely why their spillovers are negative. It turns out that spillovers via the trade channel are positive for almost all countries — ranging from -0.041 per cent of GDP (Italy) to 0.104 per cent of GDP (Luxembourg). Spillovers via the interest rate channel are negative for almost all countries — ranging from -0.133 per cent of GDP (Austria) to 0.076 per cent of GDP (the Netherlands). Spillovers via the exchange rate channel are positive for most countries — ranging from -0,251 per cent of GDP (Belgium) to 0,226 per cent of GDP (Netherlands). These results are consistent with both the theory and with the analysis by Beetsma et al. (2006).

Another piece of empirical guidance that the literature offers is a paper by two IMF economists, Ivanova and Weber (2011). Since the paper is written in our current 'era of austerity' (2008 to present), the authors specifically focus on the effects of (simultaneous) deficit reduction plans in OECD countries. Like Beetsma et al. (2006), they use a two-step approach concentrating on spillover effects via the trade channel. In the first step, the authors use estimates of fiscal multipliers obtained from other studies to build a framework that accounts for the effect of fiscal changes on domestic GDP, including carry-over effects from fiscal changes in previous years. In the second step, they use import elasticities obtained from other studies to calculate the effect of output changes in one country on the trade balance of its trade partners. They use the following example to illustrate their approach: 0.7 per cent of total German imports come from Portugal; Germany's marginal propensity to import (out of income) is 0.5; ergo: every additional euro of income in Germany leads to extra imports from Portugal of 35 cents.

The spillover results are as expected, though a bit smaller than spillovers from other studies. Because Ivanova and Weber (2011) deal with a fiscal contraction rather than an expansion, all spillovers are negative. The effect of a German fiscal contraction of 1 per cent of GDP on the trade balance in other OECD countries ranges from -0.01 per cent of GDP (Greece) to -0.16 per cent of GDP (Austria) over a two-year period. For countries smaller than Germany, spillovers to other countries are smaller, often zero.

A final fiscal spillover study worth mentioning is a VAR model by Corsetti and Müller (2011). Unfortunately, the authors only calculated fiscal spillovers for three trade blocks — the United States (US), the Euro area (EA) and the United Kingdom (UK) — and not for individual countries. Therefore, I will not describe their analytical framework in detail but only summarise their most important conclusions. Corsetti and Müller estimate that a fiscal expansion in the US of 1 per cent of GDP leads to an increase in output of about 0.5 per cent of GDP in the EA and 1 per cent in the UK. The authors think that these spillovers are not transmitted through the trade channel but mostly through the interest rate channel and the exchange rate channel.

3.6 Policy implications

At the end of this chapter, I will take a brief look at the various policy recommendations that authors draw from their empirical investigations.

The main recommendation of Beetsma et al. (2006) is that policymakers who neglect spillovers will make inefficient decisions. If their aim is to use fiscal policy in order to raise or reduce output as a response to an exogenous output shock, they have a tendency to overshoot, making fiscal policies too expansive or too contractive. They should take account of the fact that fiscal policy feeds back into the current account, thereby helping to reduce the output gap. The authors, however, think that the scope of their analysis is too limited to draw conclusions about coordination of fiscal policy in the Euro area.

Weyerstrass et al. (2006) add the interesting recommendation that economists should rethink the merits of a monetary union. Namely, within a monetary union real exchange rates and interest rate spreads are only marginally affected by a change in fiscal policy. Therefore, after an ambitious fiscal consolidation plan is implemented, both the drop in the interest rate spread and the drop in the real exchange rate are small and insignificant, so that the country benefits little from its painful choices. Weyerstrass et al. (2006) further recommend coordinating fiscal policies within monetary unions, because that reduces free-riding of other countries on efforts at fiscal consolidation in one country.

Barell et al. (2007) and Corsetti et al. (2011), however, disagree with this recommendation. They think that the case for fiscal consolidation is weak, because spillovers are rather small and the trade channel is not as strong as policymakers think.

That marks the end of this chapter and the first part of this study. The conclusions and hypotheses from these first chapters provide me with a firm basis to conduct my own empirical analysis, which can be found in the next part of the study.

Part 2: Empirical analysis

Part 1 of this study was dedicated to a theoretical disentanglement of the relationship between fiscal policy and various macroeconomic aggregates both at home and abroad. In Part 2 of this study I will use this knowledge to build my own empirical model. The final goal is to obtain precise and valid estimates of the magnitude of domestic multipliers and international spillovers of fiscal policy.

Building a model always involves compromise. My own model is no exception to this rule. Nevertheless, I think my model forms a valuable contribution to the literature. The heart of this contribution lies in the methodology. I carefully studied the methodologies that other economists have used in the past decade and tried to uncover the weak spots in their models. Using this information I focused my modelling efforts on the elimination of some of these deficiencies. Though the individual improvements that I made may be rather small, I am confident that the cumulative effect of many incremental changes is quite substantial.

Apart from the intellectual efforts there were some circumstances which turned out to be favourable for the successful completion of my model. The first of these circumstances is the advancement of statistical computer software. Over the past three decades, the availability of powerful computers has unleashed a quiet revolution in econometric techniques, and econometric techniques, in turn, have refined computer applications. Second, data availability has also improved much. European integration and perhaps the succession of economic crises in the last few years have put pressure on statistical agencies to collect better data. For these reasons, I reckon that the kind of analysis that I conducted would not have been possible 10 years ago.

In Chapter 4 I will give a detailed description of my methodology and compare it with the methodologies of other authors. In Chapter 5, I will present a formal version of my model and its main outcomes. In Chapter 6, I will interpret the results and conduct a policy experiment.

Chapter 4: Methodology

In this chapter I will describe the econometric tools that I used to build my empirical model. In order to make my modelling choices transparent, I will not only describe my own methodology but also the methodologies used by other authors. Mutual comparison will enable us to clarify the relative merits of the different methodologies.

Apart from relative performance, are there any objective measures with which we can judge the performance of different models? Though complete objectivity is impossible, there are several ways to approximate objectivity as closely as possible. First of all, the performance of models can be tested by applying so-called robustness checks. How do the outcomes of a model change when one of the inputs or assumptions is changed? Second, a model can be tested by making predictions of the future using simulation techniques. How closely does reality resemble the predictions of the model? Third, the mechanisms of a model can be tested by the application of logic. Is the model able to operate without circular references and other logical flaws?

I will now turn to the formal treatment of my methodology. First, I will highlight the choice between structural and unstructured models. Then I will turn to the characteristics of the dataset and the choice of variables. Third, I will discuss several transformations that I made to the data and my solution to the so-called identification problem of the fiscal policy variable. After that I will describe the characteristics of the main econometric method that I applied to the data: vector autoregression (VAR).

4.1 Structural versus unstructured models

Theoretical insights can be incorporated in empirical models, for example through coefficients or elasticities. Therefore, the first important choice an empirical researcher faces is the extent to which he or she incorporates the theory into the empirical model. Models that incorporate more theoretical insights tend to be more precise in their description of the underlying mechanisms

and can be calibrated at a more detailed level. However, these models also carry more of the biases that the theory embodies, thereby diminishing the validity of the results. Models that incorporate *less* theoretical insights tend to be less precise and detailed in its outcomes, but the results it generates are less affected by possible biases in the theory and therefore more valid. The former type of model in which relationships between variables are based on theory is called a structural model, the latter type of model in which relationships between variables are entirely based on the data is called an unstructured model (Pindyck and Rubinfeld, 1998).

The trade-off between a structural and an unstructured model often depends on the field of study. For example, the workings of monetary policy can be expressed relatively unambiguously by theoretical rules, such as the famous Taylor Rule. Therefore, monetary policy is relatively suitable for analysis within a structural model, yielding precise results without compromising its validity too much (Perotti, 2004). In this way, central banks have been able to control inflation successfully over the past three decades or so.

Unfortunately, as we have seen in the previous chapters of this study, the workings of fiscal policy cannot be expressed unambiguously by theoretical rules. The effects of fiscal policy are transmitted through many transmission channels, some of which reinforce each other and some of which cancel each other out. Therefore, building a structural model of fiscal policy is particularly hard and the results are not very consistent across different models.

Because of these theoretical difficulties and other uncertainties, a majority of authors in the field of multiplier and spillover quantification chose to build an unstructured model, though a substantial minority still uses a structural model. I will name a few exemplary studies for each group. In the structural model group of authors, Barell et al. (2007) employs a new-Keynesian dynamic stochastic general equilibrium (DGSE) model, which strikes a balance between theory and data. Hollmayr (2011) uses a new-Keynesian model with steady states derived from a global vector error correction model (GVECM).

In the unstructured model group, Blanchard and Perotti (2002), Beetsma et al. (2006), Kim and Roubini (2008), Weyerstrass et al. (2009) and Corsetti and Müller (2011) all employ vector autoregression (VAR) models that entirely depend on the data. Hebous and Zimmermann (2010) use a global vector autoregression (GVAR) model, which also depends on the data. The study by Ivanova and Weber (2011) is a special case: these authors just 'borrow' and combine multiplier values and export elasticities from other models, which I find, academically speaking, a rather weak approach, because in this way they cannot account for the full methodology of their model. Furthermore, the multiplier values and export elasticities could be incompatible.

Surveying all options, I chose to build an unstructured model — a vector autoregression (VAR) model to be precise. The main reason for this is that, as I stated before, econometric software and data availability have both improved much over the past decade, which enables me to build a model that is more precise than earlier models without sacrificing reliability and validity.

4.2 Data and frequency

How to build a decent VAR model? Earlier VAR models in the literature provide many useful insights about the composition of the dataset, the choice of variables, transformations of the data, et cetera. Therefore, I use these studies as a starting point.

The main achievement of the VAR model made by Blanchard and Perotti (2002) is their very precise quantification of the multiplier and its various components. Therefore, many authors who quantify multipliers use this study as a benchmark study. The main limitation of the study by Blanchard and Perotti is the fact that it only quantifies the domestic effects of fiscal policy in the US. Though the authors do include the effect of fiscal policy on the domestic current account, this is not enough to estimate the magnitude of international spillovers. The same applies to Kim and Roubini (2008): they provide an excellent procedure for estimating multipliers but they omit the cross-border effects of fiscal policy and use a small number of countries.

An important paper that studies the effects of fiscal policy both on a national and an international scale is the paper by Beetsma et al. (2006). As Beetsma et al. explain and as McKibbin (1997) confirms, international spillovers of domestic economic policies are so small, that it is hard to measure directly the effects of domestic economic policy on foreign economies. The problem is that the effects amount to only a few tenths of a per cent, so that a simple regression does not yield significant results. Beetsma et al. solve this intricate problem by dividing their calculations into two parts that probably do yield significant effects and combining the two models within one estimation. The reasoning of Beetsma et al. is that a fiscal expansion will stimulate the domestic economy, which will in turn lead to higher domestic imports and thus to higher exports from other countries. In other words, Beetsma et al. estimate two separate models: a fiscal block and a trade block. The fiscal block consists of a VAR analysis that quantifies the effect of fiscal policy on domestic GDP. The trade block, on the other hand, consists of a VAR analysis that quantifies the effects of a domestic output shock on bilateral exports from the foreign to the home country. Combining these two effects gives the international spillovers of fiscal policy through the trade channel.

As far as I know, Beetsma et al. (2006) were the first authors to use this original and innovative approach; two later spillover studies, Weyerstrass et al. (2009) and Corsetti and Müller (2011), more or less followed this practice. Though the twin block approach is only suitable for the measurement of spillovers via the trade channel, the approach offers a very good compromise between precision and validity, so I decided to use the same approach.

Beetsma et al. (2006) use yearly data, because according to them yearly data yield stronger results. However, Blanchard and Perotti (2002), Kim and Roubini (2008) and Weyerstrass et al. (2009) all agree that quarterly data are more suitable, because it makes the identification of discretionary fiscal policy shocks more accurate. Normally, it takes longer than a quarter for fiscal policy to respond to an output shock, which makes it easier to separate the cyclical part of fiscal time series from discretionary shocks. Blanchard and Perotti thus consider quarterly data essential for the correct identification of fiscal shocks. Since I think this is a relevant argument, I deviated from the approach by Beetsma et al. and chose to collect quarterly data instead of yearly data.

I focused my data collection efforts on finding data for the European Union. In Chapter 2 we saw that multipliers and spillovers are likely to be more sizable within a monetary union like the European Union. Furthermore, most studies to data are focused on the US, which makes it more interesting to study the EU. Thirdly, the EU is at present in the middle of a sovereign debt crisis, which is complicated by the aftermath of the financial crisis of 2008. Many European governments are forced to cut their budget deficits simultaneously. Therefore, an objective of my study is to investigate the magnitude of spillovers in the case of a simultaneous fiscal shock.

The countries that I included in my dataset are: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, Spain, Sweden, United Kingdom; 15 countries in total. Most of these countries are a member of the European Monetary Union (EMU); Denmark, Sweden and the United Kingdom are not. I also included one non-European in the dataset: the United States. Probably the United States are the only non-European country large enough to produce fiscal spillovers that will affect Eurozone countries and vice versa.

Another important choice concerning the dataset is the timespan. Again, there is a trade-off involved. The longer the timespan, the more significant the results of the econometric analysis will be. However, the longer the timespan the larger the risk becomes that the dataset contains so-called regime changes. A regime change is a major change in the workings of the institutions that support and surround economic aggregates. Regime changes are econometrically dangerous, because they change the internal mechanism of the model somewhere in the middle of the process. The consequence is that the results of the model become less comparable, since the model mixes up several internal mechanisms that should have been separated.

Since Beetsma et al. (2006) chose to use yearly data instead of quarterly data they needed a very long timespan to obtain significant results. As a matter of fact, they even needed to pool the time series of individual countries into a panel dataset in order to compensate for the low frequency of their data. The dataset of Beetsma et al. starts in 1960 and ends in 2004. During those years several regime shifts took place. For example, the collapse of Bretton Woods, the introduction of floating currencies, two oil crises and the formation of the European Monetary Union. All these regime shifts make the analysis by Beetsma et al. very vulnerable.

To avoid regime-shift related problems as much as possible, I decided to set the starting point of my dataset 20 years later, on the first quarter of 1979. I chose this particular date, since I suspect that after the sustained high inflation of the 1970s monetary authorities in the developed world have become permanently stricter. This stricter monetary policy will almost certainly have affected the effectiveness of fiscal policy, since the theory states that at least part of the effect of fiscal policy can be cancelled out by monetary policy. The fact remains that since the 1980s central bankers have achieved a prolonged period of low inflation.

Marcellino (2002) confirms that macroeconomic studies show 'substantially different effects after the 1970s' and sends a clear warning that researchers should focus on the period after the 1970s 'in order to avoid a serious bias'. Therefore, the year 1979 as a starting point is a safe choice. The end point of my dataset is of course the latest available data point, being the last quarter of 2011 for most datasets. Since this date is after the financial crisis and in the middle of the current debt crisis, I hope that this up-to-date dataset will enable me to shed some light on the effects of fiscal policy in these extraordinary times.

4.2 Variables and operationalisation

With regard to the choice of variables that are included in the VAR analysis of the fiscal block and the trade block one has to be careful to choose the right number of variables. If one includes too few variables, the effect on the dependent variable can be attributed to the wrong independent variable. If one includes too many variables it will be more difficult to establish the significance of the effect of the independent variables on the dependent variables. In the literature, most authors use three to six variables. I will now discuss which variables to include.

I begin with the fiscal block. As we saw in the previous chapters, the theory states that fiscal policy has a direct effect on output and an indirect — multiplier — effect on output via the demand channel. We also learned that there are two major channels which mitigate the effect of

fiscal policy on output: the interest rate channel and the inflation channel. For this reason, most VAR specifications in the literature include, apart from a fiscal variable and an output variable, an inflation variable and an interest rate variable to control for these two mitigating circumstances. Since we are dealing with the contemporary effects of fiscal policy, it is sensible to choose the short-term interest rate (Kim and Roubini, 2011).

Having made the choice of variables, the next step is to operationalise the variables. Output can be operationalised quite easily as real GDP, measured in millions of US dollars. Fiscal policy is more difficult to operationalise. Some authors choose net primary government revenues, others choose government expenditures and yet others choose the net government deficit. Since I am most interested in the size of the multiplier and not primarily interested whether fiscal policy is financed through debt or taxes, I chose government expenditures in millions of US dollar as an operationalisation of fiscal policy. I was not able to use other fiscal variables such as taxes or government deficits as an operationalisation of fiscal policy, because government expenditure was the only variable for which quarterly data are available. I operationalised inflation by taking the consumer price index (CPI), with the year 2005 as the base year. Finally, I operationalised the short-term interest rate by taking the 3-month money market rate, because it takes an intermediary position between the central bank discount rate and the long-term interest rate.

Fortunately, there are very good quarterly data available for real GDP, government expenditure, the CPI and the 3-month money market rate. Quarterly output and government expenditure data can be found via the OECD, quarterly CPI data can be found via the International Financial Statistics (IFS) database of the IMF and quarterly 3-month money market rates can be found via Eurostat, the statistical agency of the EU, complemented with data from Timetric, a commercial statistical agency.

With regard to the trade block, excellent guidance on the choice and operationalisation of variables is provided by the well-known gravity model of trade (Bergstrand, 1985). Apart from output and trade variables, Bergstrand includes the exchange rate, trade costs, trade distance and a dummy for membership of the European Economic Community (EEC). Since Beetsma et al. (2006) conclude that most of the variables turn out to be unimportant for the quantification of spillovers I will only use output, bilateral exports and the exchange rate as variables.

As in the fiscal block, I operationalised output with real GDP data from the OECD. Bilateral trade can be operationalised with bilateral export data in millions of US dollar, taken from the IMF Direction of Trade Statistics (DOTS) database. I operationalised the exchange rate by taking the index of the real effective exchange rate as calculated by the International Financial Statistics (IFS) department of the IMF. Again, I chose the year 2005 as the base year.

4.3 Transformation and identification issues

Before I could use the variables that I summed up above, I applied several transformations to the data in order to avoid problems with the VAR analysis in a later stage of the process. Since a VAR analysis is basically a complicated series of ordinary least squares (OLS) procedures it is important that the data are linear, homoscedastic and non-skewed (Pindyck and Rubinfeld, 1998). Since macroeconomic aggregates such as output are likely to be non-linear, skewed and heteroscedastic I corrected real GDP, government expenditures and bilateral exports by applying a natural log transformation of the time series.

The output data and the government expenditure data had both already been CPI-corrected by the OECD, but the bilateral exports data from the IMF had not yet been corrected for inflation. Therefore, I took a CPI time series from the IMF and corrected the bilateral exports for inflation myself (I made sure that I used the same reference year as the OECD used, namely 2005). I did so according to the following formula, which I derived from Beetsma et al. (2006) and which is also used by Bun and Klaassen (2007):

$$x_{ij,t}^{\text{real}} = \ln\left(X_{ij,t}^{\text{nominal}} / \left(\frac{P_{i,t}}{100}\right)\right)$$

where $x_{ij,t}^{\text{real}}$ is the natural log of real bilateral export from country i to country j in period t, $X_{ij,t}^{\text{nominal}}$ is nominal bilateral export from country i to country j in period t, and $P_{i,t}$ is the consumer price index for country i in period t.

As I briefly mentioned above, a difficult step in the analysis of fiscal policy is the identification of discretionary fiscal shocks. Fiscal variables can be decomposed into three parts: automatic responses to output, systematic discretionary responses to output and random discretionary shocks (Perotti, 2004). I give an example of each component. The first component can be seen as the so-called automatic stabilisers: for given tax rates, tax revenues will rise when output rises. An example of the second component is a standard, semi-automatic decision by policymakers to extend the period of unemployment benefits when a recession strikes. The third component could be a decision taken by a government of some different ideological flavour to change the size of government, irrespective of the state of the economy.

The purpose of identification methods is to remove the cyclical components of fiscal policy from the data. There are four ways to do this. The first approach consists of identifying structural shocks by sign restrictions on the impulse response functions of a VAR model. This

means for example that a positive fiscal shock is identified when tax revenues increase while government expenditures do not (Perotti, 2004). Disadvantages of this approach are that it is no longer possible to establish the timing of a shock, and that restrictions are often too strong. I did not come across authors who use this approach.

A second approach relies on the Cholesky ordering property of VAR analysis. When conducting a VAR analysis, a researcher imposes the ordering of variables in the model. The model will attribute all of the effect of any common component to the variable that comes first in the imposed Cholesky ordering. When for example the researcher decides to put the fiscal variable first, this is equivalent to assuming that all elasticities of the other variables are zero, because the effect of any common components is attributed to the fiscal variable. A disadvantage of this approach, according to Perotti (2004), is that it assumes complete crowding out of private variables by the fiscal variable, whereas in practice the crowding out effect is probably not that strong. Müller (2008) uses this particular identification method.

The third approach is the so-called 'narrative approach', pioneered by Romer and Romer (1989). The narrative approach consists of manually tracing discretionary policy shocks in various policy documents. According to Romer and Romer (2010), all identification methods except the narrative approach contain substantial cyclical components. This 'bias', as they call it, leads to significantly different results: the negative output effect of a tax increase is larger using the narrative approach. There are, however, three disadvantages of the narrative approach. First, arbitrariness: it is the researcher who determines which fiscal policy decisions are discretionary, not the data. Second, there is the risk to overlook small but significant fiscal events, because not all policy decisions are properly recorded. Third, there is the possibility that other fiscal shocks might have occurred at the same time, distorting the results (Perotti 2004). Apart from Romer and Romer, the narrative approach is also used by Ramey and Shapiro (1998), who assess the economic impact of large military build-ups during the last few decades.

The fourth approach, pioneered by Blanchard and Perotti (2002) and Alesina et al. (2002), is to compute the value of each component of fiscal policy as if output were at its trend level. First, one needs to detrend output data and obtain trend output levels. Second, one needs to calculate the elasticities of each component of fiscal policy with respect to the output gap. This elasticity of course differs per fiscal component: income taxes respond differently to output shocks than social transfers do. The third step is to use the elasticities to correct each fiscal component proportionally to the output gap at each period of time. The trend-correction method offers a good compromise between precision and practicality, so that after 2002 the approach has

become quite popular among fiscal policy researchers. For example, Perotti (2004), Kim and Roubini (2008) and Beetsma et al. (2006) use this identification method.

Since I decided to use this fourth and last identification method myself, I will delve a little deeper into the mechanisms behind this method. Concerning the computation of trend output levels from normal output levels there are several options. Alesina et al. (2002) and Beetsma et al. (2006), among others, obtain trend output by regressing output on a constant, linear and a quadratic trend. Another way of obtaining trend output, which I prefer for its greater precision, is the Hodrick-Prescott filter (Marcellino, 2002). The Hodrick-Prescott filter is an algorithm that minimises the variance of a (macroeconomic) variable around its trend, subject to a penalty called lambda (λ) that constrains the second difference of the trend variable (Pindyck and Rubinfeld, 1998). The formula for the Hodrick-Prescott filter looks as follows:

$$\min \sum_{t=1}^{T} \left(y_{i,t} - y_{i,t}^{\text{trend}}\right) + \lambda \left(\left(y_{i,t+1}^{\text{trend}} - y_{i,t}^{\text{trend}}\right) - \left(y_{i,t}^{\text{trend}} - y_{i,t-1}^{\text{trend}}\right)\right)$$

where $y_{i,t}$ is a certain macroeconomic variable for country i at period t, and $y_{i,t}^{\text{trend}}$ is the trend of that variable. As lambda approaches infinity, the trend variable approaches a linear trend. There is quite a debate among econometricians about the right value of lambda. A much-cited rule of thumb is offered by Ravn and Uhlig (2002):

$$\lambda^{*} = \left(\left(\frac{\text{total number of periods}}{\text{total number of years}}\right)/4\right)^{4} * 1600$$

Since I use quarterly data, the fraction within the brackets becomes 4 and the formula recommends a lambda of 1600. Using this lambda I obtained trend values for real GDP.

With regard to the elasticities of fiscal policy with respect to the output gap many authors rely on elasticity estimations provided by the OECD in the study by Van den Noord (2000). Van den Noord provides elasticities for each of the following fiscal components: corporate tax, personal tax, indirect tax, social security contributions and current expenditures. Fortunately, the OECD recently updated their elasticity estimations in a paper by Girouard and André (2012), which enables me to detrend my fiscal variable even more precisely than earlier authors could.

Since I only use a government expenditure variable for the fiscal block of my analysis, I only explain how Girouard and André (2012) derived this particular elasticity. Girouard and André reckon that unemployment related spending is the only cyclical component of government

spending. Therefore, Girouard and André calculate the elasticity of unemployment to the output gap and incorporate this proportionally in the amount of unemployment related spending. As a final step they retrieve the share of unemployment related spending in total government expenditures and use this relative weight to calculate the elasticity that removes the cyclical part of unemployment related spending from total government expenditures.

The elasticities of government expenditure with respect to the output gap are rather small, ranging from -0.04 in Italy to -0.23 in the Netherlands. In general, countries with generous social facilities such as the Nordic countries have larger elasticities. For almost all countries, the elasticities that Girouard and André (2012) arrive at are significantly smaller than the elasticities that Van den Noord (2000) arrives at. The explanation for the declining elasticities is that governments have acquired more functions over the past decades, making unemployment related spending as a percentage of total government expenditure smaller.

Having obtained both the trend level output and the elasticity of government expenditures with regard to the output gap for all the countries in my dataset, I was able to construct for each country a detrended government expenditure series. I did this with the following formula, which I derived from the study by Alesina et al. (2002):

$$g_{i,t}^{\text{detrended}} = g_{i,t} * \left(\frac{y_{i,t}^{\text{trend}}}{y_{i,t}} \right)^{\xi}$$

where $g_{i,t}^{\text{detrended}}$ is cyclically-adjusted government expenditure for country i at time t, $g_{i,t}$ is government expenditure in country i at time t, $y_{i,t}$ is real GDP for country i at time t, $y_{i,t}^{\text{trend}}$ is trend real GDP for country i at time t, and ξ is the elasticity of government expenditure to output as derived by Girouard and André (2012).

4.4 Vector autoregression analysis

Over the last century, macroeconomic theory has dominated macroeconomic empirics for a long time. Only since the 1960s models based on the data rather than theories have gained some prominence, notably due to the pioneering work of Nobel laureate Jan Tinbergen of Rotterdam. In the 1960s and 1970s econometrics, as the new branch of economics was called, became a common tool to test macroeconomic hypothesis to reality. Though there was much progress in econometric techniques, the magnitude of fiscal policy multipliers was still very hard to verify

empirically, mainly because of the absence of advanced computers. Therefore, until the late 1970s economists had to rely on structural models to calculate multipliers. The main modelling method of those days was called 'comparative dynamic simulation' (Stevans and Sessions, 2010).

As one can imagine, the evidence from those kinds of models was far from conclusive. One of the main problems was the endogeneity problem. Since most models relied on ordinary least squares (OLS) optimisation, one could never be sure whether the perceived impact on a certain variable was caused by the explanatory variable or endogenously, by the 'autonomous' movement of the variable itself. Inserting control variables into models may help, but it still does not reveal the extent to which autocorrelative forces might be at play.

In order to solve this problem, an econometrician can decide to insert some lagged variables into the model in order to capture some of the dynamic behaviour of the variables (Pindyck and Rubinfeld, 1998). Though this is helpful, a major complication is that fiscal policy is far too complicated to derive the appropriate lag structure from the theory, so that the econometrician still has no objective way to test the effects of fiscal policy.

This is where vector autoregression comes in. Vector autoregression was developed by Sims (1980). The modelling technique greatly enhanced the empirical debate between monetarists and Keynesians about the magnitude of the fiscal multiplier (Stevans and Sessions, 2010). The VAR structure solved the econometrician's problem of finding an appropriate lag structure, because in a VAR structure the *data*, rather than the econometrician's inferences from the theory, specify the dynamic structure of the model (Pindyck and Rubinfeld, 1998).

In a VAR model the endogenous variables are regressed on their lagged values and on all other endogenous variables and their lagged values. Thus a VAR model assumes that all endogenous variables interact with each other. In the original model by Sims (1980) there were only endogenous variables; nowadays it is also possible to include exogenous variables.

When the variables are specified the only additional information that is required is the minimum and the maximum number of lags. The minimum number of lags is usually 1, the maximum number of lags should be so chosen, that the model captures most of the dynamic effects that the variables have on each other. However, there is — again — a trade-off: the higher the number of lags, the better the model is able to capture the dynamics of the system, but also the fewer degrees of freedom it has (Pindyck and Rubinfeld, 1998).

Formally, a VAR model can be described as follows (Pindyck and Rubinfeld, 1998); for the sake of simplicity I leave out the exogenous variables:

$$z_{1,t} = \alpha_{10} + \sum_{j=1}^{p} \alpha_{11j} z_{1,t-j} + \sum_{j=1}^{p} \alpha_{12j} z_{2,t-j} + \ \ldots \ + \sum_{j=1}^{p} \alpha_{1nj} z_{n,t-j} + e_{1t}$$

$$\vdots$$

$$z_{n,t} = \alpha_{n0} + \sum_{j=1}^{p} \alpha_{n1j} z_{1,t-j} + \sum_{j=1}^{p} \alpha_{n2j} z_{2,t-j} + \ \ldots \ + \sum_{j=1}^{p} \alpha_{nnj} z_{n,t-j} + e_{nt}$$

where $z_{i,t}$ are the endogenous variables, $a_{i,k,j}$ are the coefficients and $e_{i,t}$ are the residuals.

The formula shows that the higher number of lags, the higher the number of parameters that has to be estimated. How to make a decision about the optimal number of lags? Fortunately, there are guidelines, such as the Akaike information criterion, that add some objectivity to the researcher's choice. The Akaike information criterion uses the model's residuals to measure goodness of fit. When, for example, goodness of fit declines after adding more lags, the researcher would be prudent to stop adding more lags. An alternative to the Akaike criterion is the Schwartz information criterion. I will explain my model specification and lag structure in the paragraph below.

4.5 Model specification and lag structure

With regard to my own model specification, I will follow the matrix notation of Beetsma et al. (2006), since matrix notation is shorter and provides a better overview of the variables and coefficients. I will first concentrate on the fiscal block before turning to the trade block. The VAR specification for the fiscal block is:

$$A_0 Z_{i,t} = A(L) Z_{i,t-1} + e_{i,t}$$

where A_0 is the coefficient matrix describing the contemporaneous relationships between the endogenous variables, $Z_{i,t}$ is the (4 x 1) vector of endogenous variables, $A(L)$ is a matrix capturing the relationships between the variables and their lagged values, $Z_{i,t-1}$ is the (4 x 1) vector of lagged endogenous variables, and $e_{i,t}$ is the (4 x 1) matrix of the residuals of the endogenous variables. Filling in the variables and coefficients gives:

$$\begin{pmatrix} 1 & \alpha_{gP} & \alpha_{gI} & \alpha_{gy} \\ \alpha_{Pg} & 1 & \alpha_{PI} & \alpha_{Py} \\ \alpha_{Ig} & \alpha_{Ip} & 1 & \alpha_{Iy} \\ \alpha_{yg} & \alpha_{yP} & \alpha_{yI} & 1 \end{pmatrix} \begin{bmatrix} g_{i,t} \\ P_{i,t} \\ I_{i,t} \\ y_{i,t} \end{bmatrix} = A(L) \begin{bmatrix} g_{i,t-1} \\ P_{i,t-1} \\ I_{i,t-1} \\ y_{i,t-1} \end{bmatrix} + \begin{bmatrix} e_{i,t}^{g} \\ e_{i,t}^{P} \\ e_{i,t}^{I} \\ e_{i,t}^{y} \end{bmatrix}$$

where the α-terms are the coefficients, $g_{i,t}$ is the natural log of government expenditure, $P_{i,t}$ is the price index, $I_{i,t}$ is the three-month nominal interest rate, $y_{i,t}$ is the natural log of real GDP, and the e-terms are the residuals. Since the coefficients describing the relationship between a variable and its lagged values — matrix $A(L)$ — are not very relevant for the further analysis, I did not fill in this matrix.

An important difference between my model specification and the specification by Beetsma et al. (2006) — a difference that cannot be inferred from the formulas above — is the fact that Beetsma et al. have built a panel VAR model, whereas I did not. A panel VAR means that the time series of all countries in the dataset are stacked into one single time series for each variable. Subsequently, Beetsma et al. conducted a VAR analysis based on these stacked variables and thus obtained only *one* set of coefficients for all countries. The reason for this is that due to their use of yearly data instead of quarterly data Beetsma et al. did not have enough datapoints to conduct a VAR analysis for each country individually. As a result of this, Beetsma et al. in fact impose a homogeneity restriction on the effects of fiscal policy on the domestic economy. However, as Beetsma et al. admit, there are many reasons to assume that in reality the economic reaction to fiscal policy differs per country. Therefore, the homogeneity restriction forms a severe handicap when the results of the fiscal block are used in combination with the trade block to calculate the magnitude of spillovers. Fortunately, since I use quarterly data I have sufficient datapoints — 132 per time series, to be precise — to conduct a VAR analysis for each of the 15 countries in my dataset individually. This means that I do not have to impose a homogeneity restriction, so that my final results will be more accurate than the results of Beetsma et al. (2006).

When running some preliminary estimates of the 15 VAR specifications, I also studied some of the Akaike information criteria and Schwartz information criteria that were yielded. For most countries, the Akaike information criterion and the Schwartz information criterion suggested a maximum number of lags somewhere between 2 and 6. Therefore, when running the definitive VAR specifications I choose a maximum number of lags of 4.

The VAR specification for the trade block is the same as the VAR specification for the fiscal block and needs no further explanation:

$$A_0 Z_{i,t} = A(L) Z_{i,t-1} + e_{i,t}$$

I will also fill in the variables and coefficients. The variables and coefficients for the trade block are of course specified differently, according to the following formula:

$$\begin{pmatrix} 1 & \alpha_{yx} & \alpha_{yR} \\ \alpha_{xy} & 1 & \alpha_{xR} \\ \alpha_{Ry} & \alpha_{Rx} & 1 \end{pmatrix} \begin{bmatrix} y_{j,t} \\ x_{ij,t} \\ R_{i,t} \end{bmatrix} = A(L) \begin{bmatrix} y_{j,t-1} \\ x_{ij,t-1} \\ R_{i,t-1} \end{bmatrix} + \begin{bmatrix} e^{y}_{j,t} \\ e^{x}_{ij,t} \\ e^{R}_{i,t} \end{bmatrix}$$

where the α-terms are the coefficients, $y_{j,t}$ is the natural log of real GDP in country j, $x_{ij,t}$ is bilateral export from country i to country j, $R_{i,t}$ is the real effective exchange of country i, and and the e-terms are the residuals.

Since there are 15 countries in my dataset, I had to run $15^2 = 125$ VAR specifications to compute all 125 bilateral export relationships. Before I ran the definitive VAR models I took a look at the Akaike information criteria and the Schwartz information criteria for the bilateral export relationships. In most cases, the Akaike information criterion and the Schwartz information criterion suggested a maximum number of lags somewhere between 2 and 6. Therefore, when running the definitive VAR models I choose a maximum number of lags of 4.

This completes the explanation of my methodology. In the next chapter I will describe the main results of the VAR models for both the fiscal block and the trade block. Furthermore, I will 'tie' the results of the two blocks together to achieve the most important result: the international spillovers of fiscal policy.

Chapter 5: Results

This chapter can be compared to 'an hour of truth', in at least two respects: first of all, in this chapter it will be confirmed whether the methodology that I set up in the previous chapter yields plausible results; second, in this chapter the data will tell us which theoretical claims will be confirmed. There are two other factors that influence our expectations: first, the fact that the dataset is very much op-to-date, which could lead to interesting policy recommendations; second, the fact that the methodology is so designed that 'the data speak for themselves', i.e. with as little interference from theoretical assumptions as possible. As I will show presently, these factors lead to an interesting contribution to the literature.

I will first describe the results of the fiscal block, including the multiplier effects. After that, I will turn to the results of the trade block. Then I will combine the results of the two blocks and calculate the international spillovers of fiscal policy. Finally, I will assess several robustness checks and other validity tests that can be applied to the analyses.

5.1 Impulse response functions

As I briefly mentioned in the previous chapter, one of the advantages of VAR analysis over other econometric techniques is its ability to capture the dynamics of a system. The method by which a VAR model reveals the dynamic relationships between variables is called the impulse response function. Put simply, the impulse response technique uses historical data and the interaction between (the lags of) the different variables to compute the general pattern that occurs when one variable affects itself or another variable. Subsequently, these patterns or 'impulse responses' can be used for simulations and predictions of future patterns of the data.

A simulation works as follows. A researcher can define a numerical shock to apply to one or several variables and the impulse response functions will yield the patterns in which other variables react. The question is: how does the researcher know the robustness of this response?

In order to gauge the reliability of the results, the researcher can perform a stochastic simulation. Since the process involves the random addition of error terms, it is also known as a 'Monte Carlo simulation', named after the gambling resort in Monaco (Pindyck and Rubinfield, 1998).

The first step in a Monte Carlo simulation is the specification of a probability distribution of each coefficient (α) and each error term (e). Since a VAR model is basically a series of autoregressive equations solved by ordinary least squares (OLS) estimation, the assumption is that each coefficient follows a joint normal distribution (Pindyck and Rubinfield, 1998). The mean of each coefficient is given by the value estimated by the model; the standard deviation of each coefficient is given by its estimated standard error (Pindyck and Rubinfield, 1998).

After that, a shock is applied to one of the endogenous variables and a large number of simulations is performed, in which the values of both the coefficients and the error terms are randomly drawn from their respective probability distributions. Finally, the researcher uses the simulated coefficients and error terms to trace out a probability distribution for each endogenous variable (Pindyck and Rubinfield, 1998). The responses of the endogenous variables and their respective confidence bands can be displayed within a time frame, which provides the researcher with an insightful overview of the mechanisms within the model and their reliability.

Though the above mechanisms behind the impulse response functions are treated as given, the definition of the initial shock has to be chosen by the econometrician. I chose the so-called Cholesky degrees of freedom adjusted shock as a definition, because it is one of the most commonly used shock definitions. Since I am solely interested in the proportionality between impulse and response — this proportionality, indeed, is the definition of the multiplier — the size of the initial shock does not matter much. I therefore set the size of the initial shock simply to one standard deviation (SD).

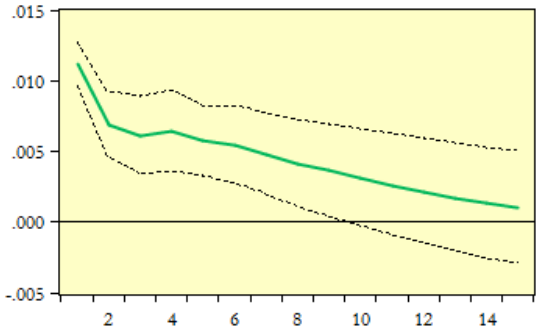
As a final step, the econometrician has to define the Cholesky ordering of the impulse response function. As I explained in the previous chapter, the model attributes all of the effect of any common component to the variable that comes first in the Cholesky ordering. Following Kim and Roubini (2008), the Cholesky ordering that I chose is: first the fiscal variable (i.e. government expenditure) and then the other variables (i.e. real GDP, then consumer price index and the short-term interest rate).

5.2 Results of the fiscal block

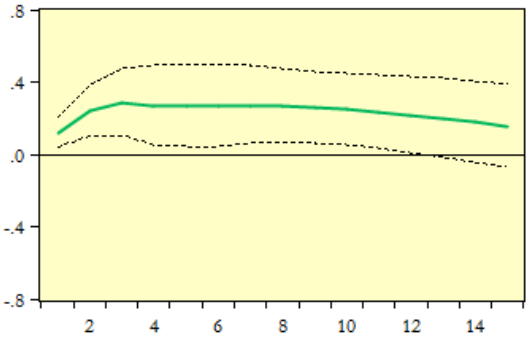
Since impulse response functions are such a convenient way to describe the patterns within a VAR model, I will now use this method to present the results of my empirical analysis.

FIGURE 8 — Impulse response functions for Germany

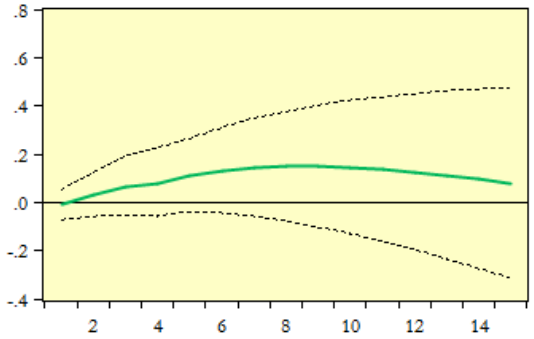
(A) Response of government expenditures to government expenditures



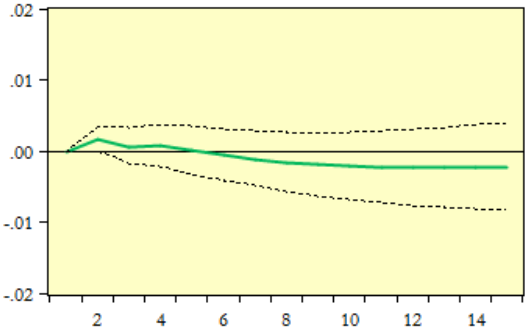
(D) Response of short term interest rate to real GDP



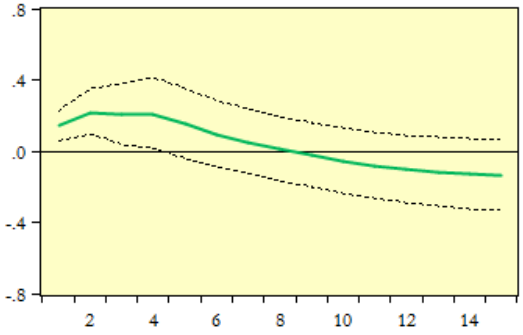
(B) Response of consumer price index to government expenditure



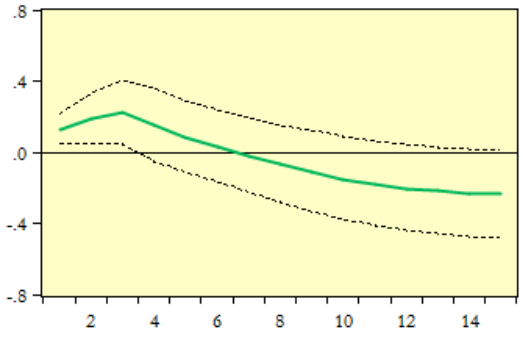
(E) Response of real GDP to short term interest rates



(C) Response of short term interest rate to consumer price index



(F) Response of short term interest rate to government expenditures



Notes: the graphs depict the response of the specified response variable to a Cholesky one standard deviation innovation in the impulse variable. The dotted lines depict the 95 per cent confidence interval, based on a Monte Carlo simulation with 1000 replications.

Calculations and lay-out made by author.

First, I will assess the results from the fiscal block. Since Germany is probably the most important country in the Eurozone at this moment, I will use the results for Germany to describe the general intuitions behind the model. The intuitions for the other countries in my sample are often quite similar to those of Germany. When the intuitions for Germany deviate from those of other countries, I will not fail to mention that. In Figure 8 above, I show the most important impulse response functions for Germany. The impulse response functions for Italy can be found in Figure 9 below and for other countries the figures can be found in the Appendix.

As can be seen in panel (A) of Figure 8, fiscal expansions in Germany tend to decline quickly. After 3 quarters the size of the impulse is roughly halved and in the next 4 quarters government expenditures gradually return to their old level. When I compare this reaction to other countries, it strikes me that German governments are generally more conservative than in other countries, since fiscal expansions in other countries are sustained for a much longer period. Take for example a typical expansion of Italian government expenditure, as depicted in Figure 9, Panel (A). This implies that the German multiplier is probably smaller than for other countries.

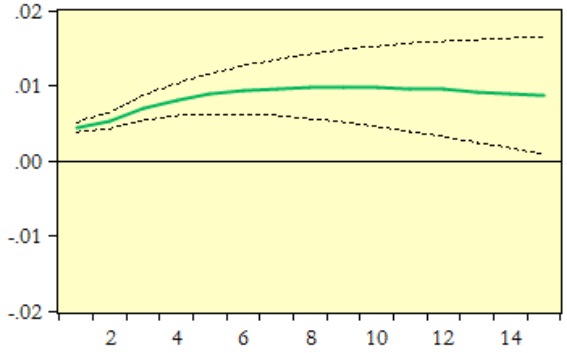
Panel (B) of Figure 8 shows that as a result of a fiscal expansion prices in Germany rise for a prolonged period. This is consistent with the theory about the price channel and the possibility of government expenditure crowding out private expenditure. The graph also shows that the reaction of prices to the shock in government finances is not immediate: only after 3 or 4 quarters the reaction becomes significant. Thus the model also confirms that prices are indeed sticky in the short run, which is in line with Keynesian economics.

However, in countries other than Germany prices react differently to an increase in government expenditures. For example, in Austria, France and the United Kingdom, the rise in prices is small and insignificant. In Greece, Italy and the Netherlands prices even decline after an increase in government expenditure — see Panel (B) of Figure 9 for example. It is important to take this heterogeneity of price responses into account, because, as we shall see presently, prices are an important determinant of the behaviour of short-term interest rates, which in turn influences the magnitude of fiscal multipliers.

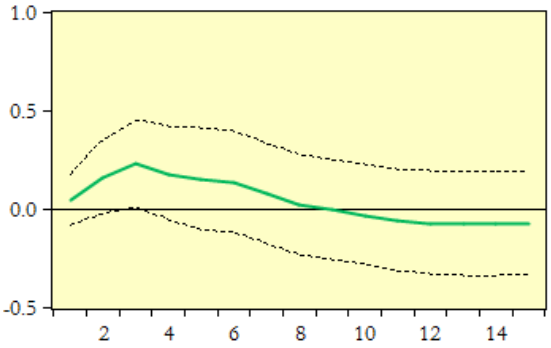
As Panel (C) of both Figure 8 and Figure 9 shows quite clearly, short-term interest rates react strongly and positively to a rise in price level. The rise in short-term interest rates is significant, since the 95 per cent confidence bands are well above zero. As the theory indicates, an important factor that propels the rise in interest rates is monetary policy. The central bank reacts to rising prices by contracting monetary policy. After about 4 quarters, monetary policy is loosened again and after another year short-term interest rates are below their pre-shock level.

FIGURE 9 — Impulse response functions for Italy

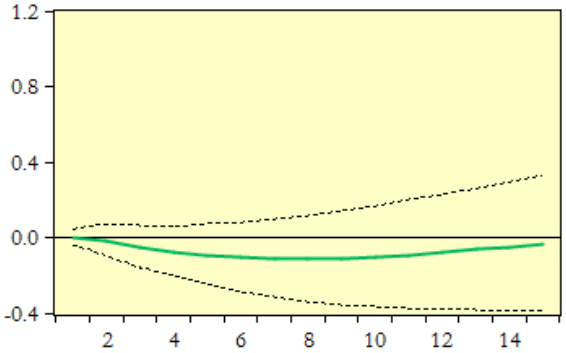
(A) Response of government expenditures to government expenditures



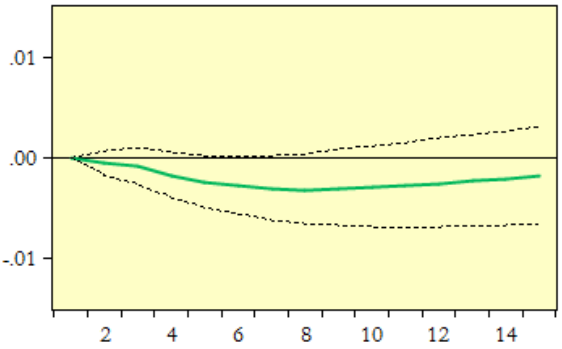
(D) Response of short term interest rate to real GDP



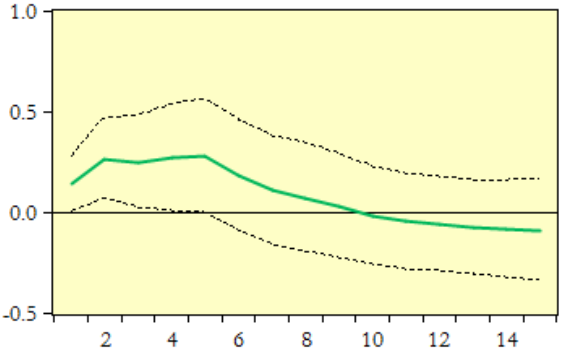
(B) Response of consumer price index to government expenditure



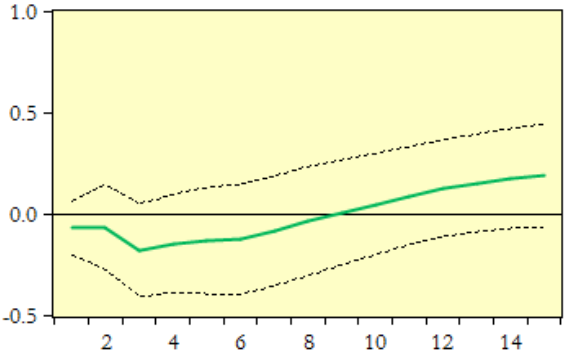
(E) Response of real GDP to short term interest rates



(C) Response of short term interest rate to consumer price index



(F) Response of short term interest rate to government expenditures



Notes: the graphs depict the response of the specified response variable to a Cholesky one standard deviation innovation in the impulse variable. The dotted lines depict the 95 per cent confidence interval, based on a Monte Carlo simulation with 1000 replications.

Calculations and lay-out made by author.

Though the magnitude of the response differs per country, all countries exhibit a positive relationship between prices and interest rates. Panel (D) of Figures 8 and 9 confirm this result, showing that economic booms are associated with higher interest rates. The reaction is sustained

for almost 14 quarters. Though the reaction is not always significant, economic booms are associated with higher interest rates in all countries in my sample.

According to economic theory, rising interest rates have a decelerating effect on economic growth. This is confirmed in Figure 8, Panel (E), where we can see that after 4 quarters rising interest rates are indeed associated with a decline in real GDP. The reaction is not very strong, though. Contrary to the rather weak reaction of German GDP to a rise in short-term interest rates, in other countries the reaction is much stronger. Austria, Belgium, Denmark, Finland, France, Greece, Ireland, Italy, the Netherlands, Spain, Sweden and the United Kingdom all show a significantly negative reaction of real GDP to a rise in short-term interest rates.

Combining two of the above patterns, we arrive at another interesting observation from the data. One the one hand, we have seen that consumer prices and short-term interest rates are strongly correlated, on the other hand we have seen that the reaction of consumer prices to a fiscal shock differs per country. Therefore, we would also expect substantial differences between countries in the reaction of the short-term interest rate to a fiscal expansion. The data confirm that this is indeed the case. As we can see in Panel (F) of Figure 8, German interest rates rise after a fiscal expansion, whereas Panel (F) in Figure 9 shows that Italian interest rates *decline* after a fiscal expansion.

A decline in short-term interest rates seems counterintuitive but can be explained by the intermediary role of monetary policy. As Laxton et al. (1998) put it: 'There is no such thing as a pure fiscal shock'. According to Gros and Hobza (2001) the short term effect of fiscal policy is strongly influenced by the reaction of monetary policy that follows the fiscal shock. In countries where the risk of inflation following a fiscal expansion is high, monetary authorities will not accommodate the fiscal shock and short-term interest rates are likely to increase; in countries where the risk of inflation following a fiscal expansion is low, monetary authorities will accommodate the fiscal shock and short-term interest rates could decline. This finding is confirmed by Perotti (2004) who finds that in some cases short-term interest rates decline after a positive fiscal shock and that this is probably due to accommodating monetary policy. Interestingly, Perotti also finds that in recent years monetary policy has become less accommodating than in earlier decades. This is consistent with the hypothesis that I formulated in Chapter 3 that monetary authorities have probably become stricter over time.

Since a higher interest rate negatively affects real GDP, the interest rate response has important implications for the magnitude of the multiplier. In countries like Germany, where monetary policy is less accommodating and interest rates tend to rise as a result of a fiscal expansion, we would expect a smaller fiscal multiplier, whereas in countries like Italy, where

monetary policy is more accommodating and interest rates tend to decline as a result of a fiscal expansion, we would expect a larger fiscal multiplier. So we arrive at the core result of the fiscal block, namely: the reaction of real GDP to an increase in government expenditure.

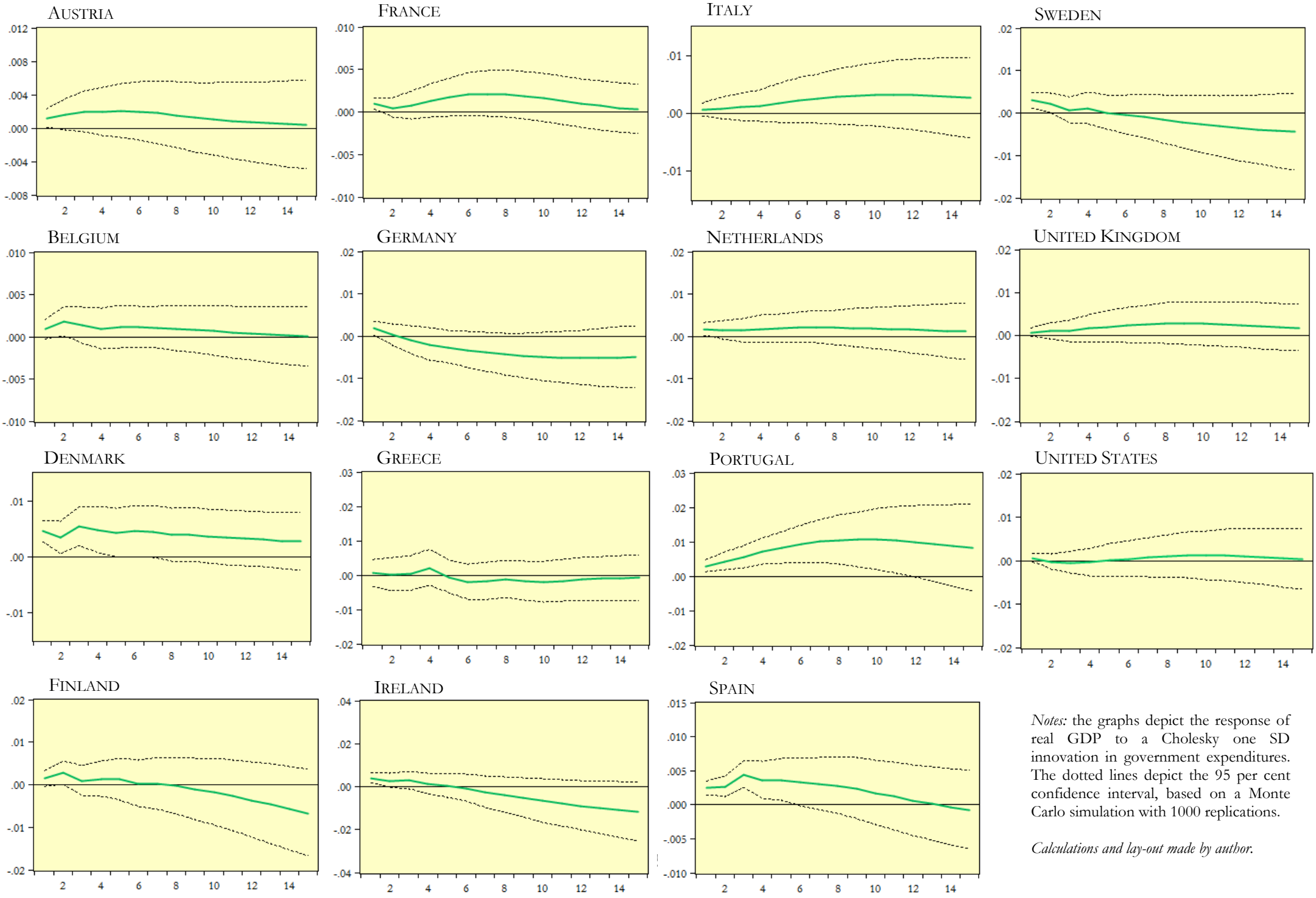
In Figure 10 below I display the responses of real GDP to government expenditure for all 15 countries in my sample. The results are very interesting. For most countries in my sample, real GDP reacts positively to a fiscal expansion. In most cases both confidence bands are well above zero, which indicates that the increase in real GDP is significant at a 5 per cent level. In other words, the data show that for most countries in the period 1979 to 2011 the (new-) Keynesian demand effect of fiscal policy dominates the neoclassical crowding-out effect of fiscal policy.

Despite the similarities, there are also some notable differences between countries in the way that real GDP reacts to a fiscal expansion. In some countries the rise in GDP accelerates after the shock occurred, whereas in other countries the rise in GDP decelerates after the shock. Accelerating growth of GDP is most clearly visible for countries like Austria, France, Italy, Spain and Portugal. Decelerating growth of GDP is visible for countries like Belgium, Denmark, Finland, Germany, Ireland and Sweden. For Greece, the Netherlands, the United Kingdom and the United States GDP growth neither accelerates nor decelerates after a fiscal shock.

I will look a little bit more closely at the countries which exhibit decelerating growth after a fiscal shock. How long does it take for GDP to return to its old, pre-shock level? In Germany, the return to equilibrium is quick: after only 3 quarters, GDP has moved back to its old level. In Sweden and Ireland it takes 5 quarters; in Belgium, Denmark and Finland even longer.

As I described earlier in this Chapter, the weak of even negative reaction of GDP to a fiscal expansion may well be explained by the adverse interest rate effect. This is in line with the theory, which predicted that conservative monetary policy can cancel out the effects of fiscal policy. It is quite likely that before the start of the European Monetary Union in 1999, central banks in Belgium, Denmark, Finland, Germany, Ireland and Sweden — northern-European countries — were stricter than central banks in France, Italy, Spain and Portugal — southern-European countries. This explains why fiscal policy has a weaker effect in the former group of countries and a stronger effect in the latter group of countries. Monetary policy is of course not the only explanation but the data suggest that it is a major one.

FIGURE 10 [next page] — Impulse response functions: fiscal policy on real GDP



Notes: the graphs depict the response of real GDP to a Cholesky one SD innovation in government expenditures. The dotted lines depict the 95 per cent confidence interval, based on a Monte Carlo simulation with 1000 replications.

Calculations and lay-out made by author.

5.3 Magnitude of the multiplier

Though the graphs of the impulse response functions are very informative, for the purpose of this study it is necessary to calculate in detail the effect of government expenditure on real GDP. Concretely, I am interested in the numerical value of the multiplier at different points in time. The multiplier is basically a ratio that indicates the proportionality between the marginal increase in government expenditure and the marginal increase in real GDP. For example, when the multiplier is 1.5 this means that when the government increases spending by 1 dollar, output will increase by an additional 1.5 dollars.

Mathematically, the multiplier is defined as $\frac{\Delta Y}{\Delta G}$. However, what I obtained from the impulse response functions that I generated in my VAR models is the ratio $\frac{\Delta \ln(Y)}{\Delta \ln(G)}$. As we know, the change in the natural logarithm of a variable is equivalent to the growth rate of that variable (Sydsaeter and Hammond, 1995). Thus the ratio $\frac{\Delta \ln(Y)}{\Delta \ln(G)}$ can be written as:

$$\frac{\Delta \ln(Y)}{\Delta \ln(G)} = \frac{\Delta Y/Y}{\Delta G/G} = \left(\frac{\Delta Y}{\Delta G}\right)\frac{G}{Y}$$

Therefore, in order to arrive at the multiplier, we have to multiply the ratio $\frac{\Delta \ln(Y)}{\Delta \ln(G)}$ with the average ratio of real GDP to real government spending. The exact formula looks as follows:

$$m_{i,t} = \frac{\Delta Y}{\Delta G} = \left(\frac{\Delta \ln Y}{\Delta \ln G}\right)\frac{Y}{G} = \left(\frac{y_{i,t}^{\text{response}}}{g_{i,1}^{\text{impulse}}}\right)\frac{Y_i^{\text{average}}}{G_i^{\text{average}}}$$

where $m_{i,t}$ is the multiplier value for country i at time t, $y_{i,t}^{\text{response}}$ is the natural log of the response value of real GDP for country i at time t, $g_{i,1}^{\text{impulse}}$ is the natural log of the impulse value of government expenditure for country i at time $t = 1$, and $\frac{Y_i^{\text{average}}}{G_i^{\text{average}}}$ is the average ratio of real GDP to real government spending for country i over the period 1979Q1 to 2011Q4.

In Table 2 below I present the multiplier results for all 15 countries in my dataset. I calculated multipliers at three points in time: after 1, 4 and 12 quarters. As can be seen in the table, most of the multiplier values are between 0 and 3. This is comparable with results from other VAR studies about fiscal multipliers. The magnitude of the multiplier changes in the same

direction over time as the impulse response functions in the paragraph above, so I refer to that paragraph for the intuition behind the results.

TABLE 2 — Magnitude of fiscal multipliers

Country	Impact multiplier	Multiplier after 4 quarters	Multiplier after 12 quarters
Austria	1.1178	1.8051	0.6567
Belgium	0.6312	0.6785	0.2647
Denmark	2.2017	2.2909	1.5487
Finland	0.8305	0.7325	-0.9890
France	1.2969	1.7185	1.3257
Germany	0.8183	0.1204	-0.9235
Greece	0.1181	0.4393	-0.2455
Ireland	1.9251	0.6188	-1.2334
Italy	0.5540	1.3491	3.4518
Netherlands	0.6453	0.6632	0.6311
Portugal	1.7772	4.2500	4.9547
Spain	1.4492	2.1499	0.3596
Sweden	1.1771	0.4399	-1.4213
United Kingdom	0.3229	0.7019	1.0462
United States	0.0168	-0.0105	0.0269

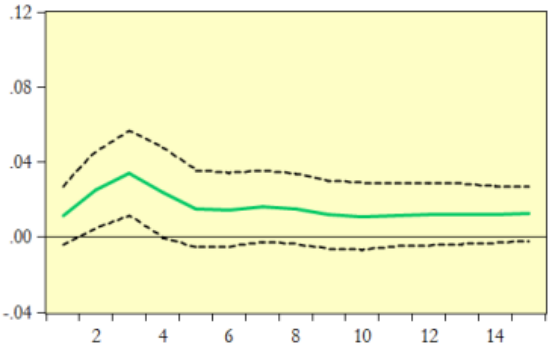
Table and calculations made by author.

5.4 Results of the trade block

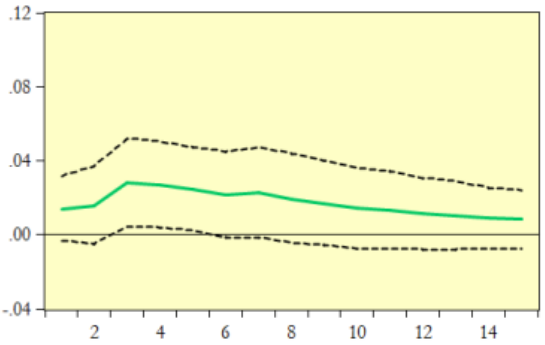
In the second block of my empirical analysis — the trade block — I examined the effect of a change in real GDP in one country to real bilateral exports from another country. Since I conducted a VAR analysis for 125 bilateral trade relationships, it is not possible to present all impulse response functions due to a lack of space. I will therefore present the results with the help of three exemplary countries, a northern-European country, a southern-European country and a Nordic country, namely: Germany, Italy and Denmark. In Figure 11 below, I present the impulse response functions of the two main variables.

FIGURE 11 — Impulse response functions: real GDP on real bilateral export

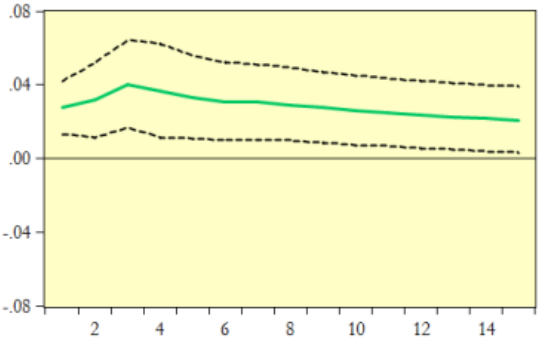
(A) Response of real bilateral exports from Denmark to Germany to a change in German real GDP



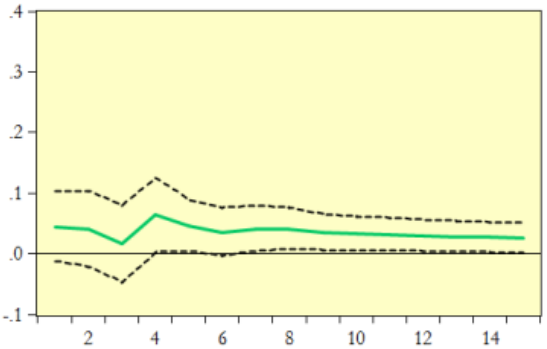
(B) Response of real bilateral exports from Denmark to Italy to a change in Italian real GDP



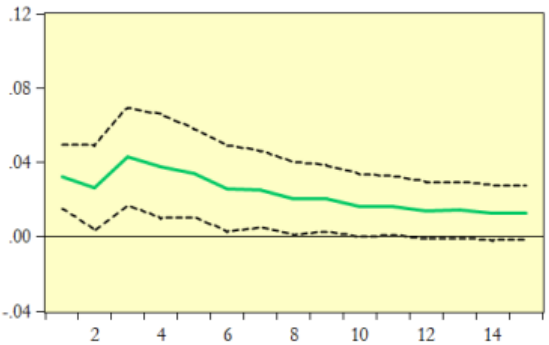
(C) Response of real bilateral exports from Germany to Denmark to a change in Danish real GDP



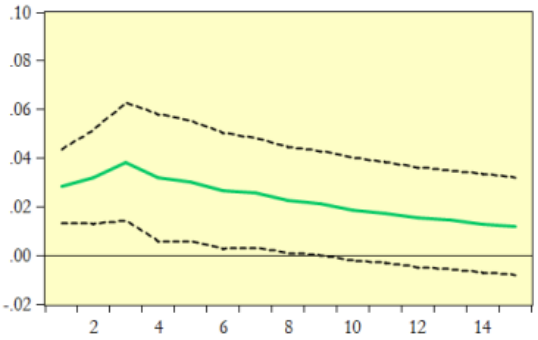
(D) Response of real bilateral exports from Germany to Italy to a change in Italian real GDP



(E) Response of real bilateral exports from Italy to Denmark to a change in Danish real GDP



(F) Response of real bilateral exports from Italy to Germany to a change in German real GDP



Notes: the graphs depict the response of the specified response variable to a Cholesky one standard deviation innovation in the impulse variable. The dotted lines depict the 95 per cent confidence interval, based on a Monte Carlo simulation with 1000 replications.

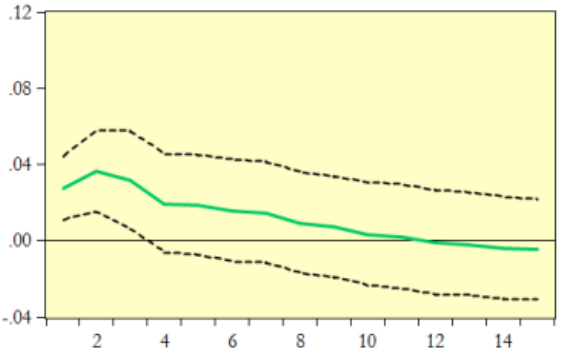
Calculations and lay-out made by author.

Figure 11 shows that in all countries the reaction of real bilateral exports to a shock in real GDP follows a remarkably similar pattern: real bilateral exports immediately rise; the rise in real bilateral exports accelerates for 2 or 3 quarters; after a year real bilateral exports slowly decline but they remain well above the pre-shock level of exports. Thus we can conclude that an increase in real GDP in the home country leads to a permanent increase in real bilateral exports. In almost all cases the confidence bands are well above zero, which indicates that the increase in real bilateral export is also significant at a 5 per cent level. These results are in line with the theory and with earlier empirical studies in the literature.

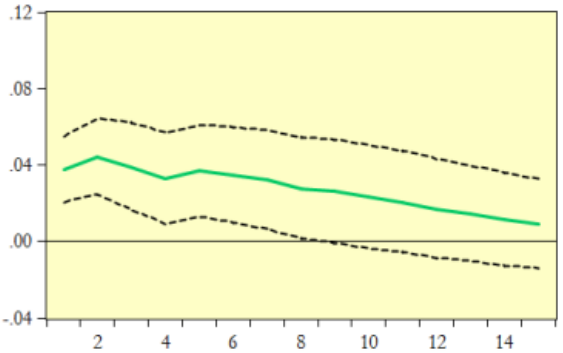
Another variable that I included in the trade block is the real effective exchange rate. Did this variable significantly influence the results, as the theory would predict? As it turns out, this is indeed the case. In Figure 12 below I present two examples of the response of real bilateral exports to a change in the real effective exchange rate. We see that real bilateral export typically reacts positively to an increase in the real effective exchange rate of the exporting country. (Please recall that the real effective exchange rate is represented in European rather than British convention, which implies that an increase in the real effective exchange rate means a real depreciation.) Taking Panel (A) of Figure 12 as an example, a rise in the Italian real effective exchange rate means a real depreciation, which makes Italian export goods more competitive on world markets; hence, real bilateral exports from Italy to Denmark rise. The confidence bands in both Panel (A) and Panel (B) of Figure 12 are above zero, so the rise is also significant.

FIGURE 12 — Impulse response functions: exchange rate on real bilateral export

(A) Response of real bilateral exports from Italy to Denmark to a change in Italian real effective exchange rate



(B) Response of real bilateral exports from Denmark to Italy to a change in Danish real effective exchange rate



Notes: the graphs depict the response of the specified response variable to a Cholesky one standard deviation innovation in the impulse variable. The dotted lines depict the 95 per cent confidence interval, based on a Monte Carlo simulation with 1000 replications.

Calculations and lay-out made by author.

As is the case with the impact of real GDP on real bilateral exports, there is a short lag in the reaction of real bilateral exports to the real effective exchange rate: in the first 2 quarters after the shock the rise in real bilateral exports slowly accelerates, after that, it gradually decelerates. The impact of a rise in the real effective exchange rate is not permanent: ceteris paribus after 2 or 3 years real bilateral export has returned to its old, pre-shock level.

5.5 Robustness checks

Before I combine the results of the fiscal block and the trade block in order to arrive at the international trade spillovers of fiscal policy I do some robustness checks in order to make sure that the fiscal block and the trade block form a reliable basis for further computation.

Many authors replace their modelled variables with alternative specifications of the respective variables in order to assess the robustness of the results (Kim and Roubini, 2008; Alesina et al., 2002; Ivanova and Weber, 2011). Unfortunately, since quarterly data turn out to be rare, there are no alternative specifications for most of my variables. As far as I know, the OECD is the only institution offering quarterly data for government expenditures and the IMF is the only institution offering quarterly data for bilateral export. Therefore, I had to rely on other kinds of robustness checks. I mention three types of robustness checks that I applied.

First, following Beetsma et al. (2006), I tested the homogeneity of the dataset by splitting the fiscal block and the trade block into different subsamples for different time periods; from 1979Q1 to 1999Q1 and from 1999Q1 to 2011Q4. The results of modelling the subsamples were slightly different for both the fiscal block and the trade block, but they remained within the original confidence bands. I therefore conclude that my dataset is sufficiently homogeneous and there are no major structural breaks in my dataset.

Second, I rechecked all the different stages of my (VAR) methodology, as described in Chapter 4, and made some small changes to the different procedures. For example, I changed the maximum number of lags for both the fiscal block and the trade block from 4 to 2 or 6 and assessed how it impacted the results. The changes in final outcomes were very small. I also changed the method of stochastic simulation from the usual Monte Carlo simulation to the so-called analytic-asymptotic simulation to see whether my estimated confidence bands would change. Again, the changes were minimal. Furthermore, I changed the Cholesky ordering of the impulse response functions to see whether this would affect outcomes. It did, but the results remained within the original confidence bands.

Third, I assessed the residuals from the VAR analyses that I conducted. Residuals have to be normal and homoscedastic. In order to check whether this is the case, I conducted a White heteroscedasticity test (including cross terms). In the fiscal block, the White test is significant at a 5 per cent level for about half of the 15 models and insignificant for the other half of the models. In the trade block the White test proved to be insignificant for a large majority of the 125 VAR models. Therefore, heteroscedasticity of residuals is an issue, though not a very serious one.

Overall, my conclusion is that my results are reasonably reliable. I also think that the results of the fiscal block and the trade block are sufficiently valid to combine them in a computation of international trade spillovers, which I endeavour in the next paragraphs.

5.6 Computation of trade spillovers

The fiscal block asserts that government expenditure has a significant impact on output. The trade block asserts that output in one country has a significant impact on bilateral exports from other countries. Ergo: government expenditure in one country has a significant impact on bilateral exports from other countries. In order to be able to combine the results of the two VAR modelling blocks, the measurement unit of the main variables have to be the same. Therefore, I made sure in an earlier stage of the methodological process that the main variables in the two modelling blocks — namely, government expenditure, real GDP and real bilateral exports — are all measured in millions of US dollars.

Combining the fiscal and the trade block, I used the following formula to calculate the exact size of fiscal spillovers:

$$s_{ji,t} = \frac{\left(e^{x_{ij,t}^{\text{response}}} - e^{y_{j,1}^{\text{impulse}}}\right)\left(\frac{Y_{j,t}}{100} m_{j,t}\right)}{Y_i}$$

where $s_{ji,t}$ is the size of the spillover from country j to country i measured as a percentage of real GDP of country i, $x_{ij,t}^{\text{response}}$ is the natural log of the response value of real bilateral exports from country i to country j at time t, $y_{j,1}^{\text{impulse}}$ is the natural log of the impulse value of real GDP for country j at time $t = 1$, $Y_{j,t}$ is real GDP of country j at time t in millions of US dollars, $m_{j,t}$ is the multiplier for country j at time t, and Y_i is real GDP of country i in millions of US dollars.

Please note that in this formula country j is the country where the fiscal spillover originates and country i the partner country to which the spillover is directed.

I will give a precise description of the function of each mathematical term in the formula. The numerator of the fraction contains two terms. The first term $\left(e^{x_{ij,t}^{\text{response}}} - e^{y_{j,1}^{\text{impulse}}}\right)$ represents the percentage change in real bilateral exports from country i to country j when government expenditure in country j increases with 1 per cent of GDP. The second term $\left(\frac{Y_{j,t}}{100} m_{j,t}\right)$ does two things: first, it takes account of the fact that the initial impulse in government expenditure is magnified by the multiplier ($m_{j,t}$); and second, it converts the *percentage* change in real bilateral exports into the *dollar* change in real bilateral exports by multiplying the previous terms by $\left(\frac{Y_{j,t}}{100}\right)$, which is simply 1 per cent of GDP of country j, measured in dollars.

The denominator of the fraction contains a third term, (Y_i), which has the function of converting the numerator of the formula — which represents the dollar amount by which real bilateral exports from country i to country j change when government expenditure in country j increases with 1 per cent of GDP — into a spillover measured as a percentage of GDP of partner country i. That completes the description of the formula.

I elaborate a bit more on the first term in the numerator. It is based on the familiar mathematical rule that the difference between two natural logs is equal to its ratio (Sydsaeter and Hammond, 1995): $\ln(X) - \ln(Y) = \ln\left(\frac{X}{Y}\right)$. It is this latter ratio that we are interested in, since it gives us the percentage change in real bilateral exports from country i to country j when government expenditure in country j increases with 1 per cent. However, the results from impulse response functions of the two VAR-blocks are not given by $\ln(X)$ and $\ln(Y)$ but by $\Delta\ln(X)$ and $\Delta\ln(Y)$. Recall that in mathematical terms the natural log of a variable is the growth rate of that variable (Sydsaeter and Hammond, 1995), so that we are in fact dealing with the growth rate of the growth rate. Therefore, I took the base e in order to arrive at the correct term as denoted in the numerator of my formula.

TABLE 3 [next page] — The magnitude of international trade spillovers

Notes: the coefficients in the table represent the impact of an increase in government spending of 1 per cent of GDP of the country where the fiscal shock originates (denoted by 'from') on bilateral exports, measured as a percentage of GDP of the partner country where the additional export flows originate (denoted by 'to' on the vertical axis).

Calculations and lay-out made by author.

TABLE 3 — International trade spillovers — Panel (A) — Impact effect (period 1)

To ↓ \ From →	Austria	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy	Nether-lands	Portugal	Spain	Sweden	United Kingdom	United States
Austria		0.0017%	0.0212%	0.0040%	0.0923%	0.1366%	0.0036%	0.0082%	0.0493%	0.0166%	0.0288%	0.0730%	0.0284%	0.0003%	0.0037%
Belgium	0.0104%		0.0119%	0.0111%	0.0657%	0.0928%	0.0013%	0.0050%	0.0534%	0.0003%	0.0071%	0.1909%	0.0063%	0.0119%	0.0007%
Denmark	0.0324%	0.0048%		0.0117%	0.0919%	0.0252%	0.0032%	0.1152%	0.0387%	0.0225%	0.0273%	0.0098%	0.0076%	0.0920%	0.0247%
Finland	0.0440%	0.0172%	0.0534%		0.0746%	0.3643%	0.0104%	0.0544%	0.0456%	0.0179%	0.0221%	0.0611%	0.0079%	0.0060%	0.0455%
France	0.0016%	0.0014%	0.0039%	0.0010%		0.0131%	0.0002%	0.0000%	0.0079%	0.0003%	0.0058%	0.0232%	0.0043%	0.0004%	0.0007%
Germany	0.0013%	0.0018%	0.0022%	0.0006%	0.0138%		0.0000%	0.0003%	0.0126%	0.0004%	0.0009%	0.0127%	0.0139%	0.0005%	0.0002%
Greece	0.0167%	0.0338%	0.0230%	0.0117%	0.2237%	0.0133%		0.0822%	0.0419%	0.0161%	0.0717%	0.1445%	0.0402%	0.0314%	0.0481%
Ireland	0.0635%	0.0007%	0.0663%	0.0254%	0.1788%	0.1164%	0.0041%		0.1384%	0.0519%	0.0349%	0.0591%	0.0163%	0.0076%	0.0089%
Italy	0.0034%	0.0014%	0.0049%	0.0015%	0.0024%	0.0271%	0.0002%	0.0029%		0.0016%	0.0042%	0.0428%	0.0046%	0.0002%	0.0008%
Netherlands	0.0185%	0.0092%	0.0117%	0.0056%	0.1698%	0.0371%	0.0007%	0.0049%	0.0329%		0.0051%	0.0678%	0.0193%	0.0108%	0.0051%
Portugal	0.0101%	0.0220%	0.0151%	0.0526%	0.3639%	0.0967%	0.0014%	0.0057%	0.0536%	0.0080%		0.2200%	0.0001%	0.0189%	0.0228%
Spain	0.0021%	0.0033%	0.0186%	0.0035%	0.0121%	0.0357%	0.0008%	0.0078%	0.0243%	0.0090%	0.0006%		0.0025%	0.0107%	0.0001%
Sweden	0.0291%	0.0315%	0.0226%	0.0194%	0.1687%	0.1301%	0.0066%	0.0270%	0.0622%	0.0226%	0.1030%	0.1622%		0.0048%	0.0079%
United Kingdom	0.0019%	0.0025%	0.0029%	0.0012%	0.0252%	0.0151%	0.0001%	0.0010%	0.0054%	0.0001%	0.0112%	0.0220%	0.0034%		0.0011%
United States	0.0003%	0.0002%	0.0002%	0.0001%	0.0005%	0.0001%	0.0000%	0.0004%	0.0005%	0.0005%	0.0004%	0.0006%	0.0002%	0.0002%	

TABLE 3 [continued] — International trade spillovers — Panel (B) — Effect after 1 year (period 4)

To ↓ \ From →	Austria	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy	Nether-lands	Portugal	Spain	Sweden	United Kingdom	United States
Austria		0.0280%	0.0314%	0.0138%	0.4654%	-0.2438%	0.0076%	0.0070%	0.2414%	0.0356%	0.1056%	0.5860%	0.0227%	0.1830%	-0.0264%
Belgium	0.0481%		0.0156%	0.0153%	0.3939%	-0.1629%	0.0066%	0.0074%	0.2008%	0.0171%	0.1484%	0.3204%	0.0194%	0.1804%	-0.0093%
Denmark	0.0379%	0.0288%		0.0219%	0.8208%	-0.2117%	0.0053%	0.0179%	0.2571%	0.1201%	0.2853%	0.6487%	0.0192%	0.0512%	-0.0091%
Finland	0.1947%	0.0809%	0.0102%		1.1730%	-0.5381%	0.0205%	0.0059%	0.6781%	0.0478%	0.4764%	1.1196%	0.0238%	0.3162%	-0.0456%
France	0.0095%	0.0053%	0.0041%	0.0023%		-0.0366%	0.0012%	0.0023%	0.0363%	0.0063%	0.0259%	0.0543%	0.0039%	0.0306%	-0.0025%
Germany	0.0067%	0.0038%	0.0037%	0.0016%	0.0504%		0.0001%	0.0009%	0.0464%	0.0037%	0.0203%	0.0543%	0.0007%	0.0185%	-0.0026%
Greece	0.0152%	0.0239%	0.0506%	0.0026%	0.8734%	-0.0553%		0.0032%	0.0409%	0.0072%	0.1083%	0.0483%	0.0391%	0.0536%	-0.0110%
Ireland	0.1525%	0.0106%	0.0961%	0.0140%	0.7796%	-0.1566%	0.0243%		0.2742%	0.0550%	0.2250%	0.7917%	0.0320%	0.1747%	-0.0213%
Italy	0.0086%	0.0048%	0.0065%	0.0026%	0.0709%	-0.0362%	0.0006%	0.0030%		0.0048%	0.0247%	0.1092%	0.0049%	0.0340%	-0.0040%
Netherlands	0.0469%	0.0062%	0.0047%	0.0101%	0.1841%	-0.0997%	0.0023%	0.0035%	0.1082%		0.0556%	0.1923%	0.0127%	0.0608%	-0.0061%
Portugal	0.0428%	0.0602%	0.0036%	0.0192%	0.3620%	-0.4703%	0.0109%	0.0082%	0.3377%	0.0109%		0.6350%	0.0192%	0.1519%	-0.0180%
Spain	0.0168%	0.0080%	0.0058%	0.0031%	0.0818%	-0.0459%	0.0058%	0.0021%	0.0514%	0.0053%	0.0190%		0.0054%	0.0361%	-0.0043%
Sweden	0.0583%	0.0367%	0.0020%	0.0066%	0.1232%	-0.2047%	0.0179%	0.0112%	0.2277%	0.0306%	0.1078%	0.5473%		0.1262%	-0.0154%
United Kingdom	0.0107%	0.0052%	0.0005%	0.0016%	0.0583%	-0.0349%	0.0007%	0.0008%	0.0323%	0.0025%	0.0215%	0.0499%	0.0020%		-0.0011%
United States	0.0003%	0.0005%	0.0002%	0.0007%	0.0083%	-0.0055%	0.0003%	0.0001%	0.0051%	0.0004%	0.0025%	0.0036%	0.0001%	0.0020%	

TABLE 3 [continued] — International trade spillovers — Panel (C) — Effect after 2 years (period 8)

To ↓ \ From →	Austria	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy	Nether-lands	Portugal	Spain	Sweden	United Kingdom	United States
Austria		0.0178%	0.0132%	-0.0027%	0.6936%	-0.4483%	-0.0024%	-0.0264%	0.5622%	0.0254%	0.1392%	0.5202%	-0.0185%	0.2830%	0.0557%
Belgium	0.0357%		0.0131%	-0.0041%	0.7308%	-0.3685%	-0.0015%	-0.0336%	0.4921%	0.0181%	0.1969%	0.3892%	-0.0210%	0.1916%	0.0201%
Denmark	0.0100%	0.0060%		-0.0058%	0.5777%	-0.1684%	-0.0015%	-0.0547%	0.3657%	0.1314%	0.3053%	0.6684%	-0.0159%	0.0732%	0.0495%
Finland	0.0846%	0.0450%	0.0057%		1.6293%	-0.8373%	-0.0040%	-0.0385%	1.3070%	0.0540%	0.5493%	1.1581%	-0.0221%	0.5877%	0.0728%
France	0.0063%	0.0030%	0.0026%	-0.0006%		-0.0594%	-0.0005%	-0.0078%	0.0700%	0.0049%	0.0406%	0.0661%	-0.0045%	0.0534%	0.0045%
Germany	0.0044%	0.0026%	0.0021%	-0.0004%	0.0784%		0.0000%	-0.0034%	0.0625%	0.0041%	0.0319%	0.0556%	-0.0012%	0.0338%	0.0036%
Greece	0.0081%	0.0246%	0.0232%	-0.0005%	0.9870%	-0.2257%		-0.0238%	0.1311%	0.0149%	0.0088%	0.1356%	-0.0302%	0.0879%	0.0256%
Ireland	0.0950%	0.0366%	0.0741%	-0.0049%	1.4192%	-0.3275%	-0.0073%		0.8890%	0.0540%	0.3895%	0.8878%	-0.0417%	0.3891%	0.0574%
Italy	0.0052%	0.0027%	0.0017%	-0.0006%	0.0990%	-0.0449%	-0.0003%	-0.0088%		0.0032%	0.0399%	0.1048%	-0.0045%	0.0400%	0.0038%
Netherlands	0.0215%	0.0026%	0.0062%	-0.0029%	0.1778%	-0.2091%	-0.0003%	-0.0134%	0.2531%		0.0682%	0.2235%	-0.0149%	0.0934%	0.0123%
Portugal	0.0231%	0.0224%	0.0035%	-0.0049%	0.2847%	-0.2852%	-0.0036%	-0.0225%	0.7193%	0.0012%		0.6336%	-0.0222%	0.2298%	0.0287%
Spain	0.0109%	0.0055%	0.0036%	-0.0008%	0.1404%	-0.1256%	-0.0005%	-0.0069%	0.1500%	0.0058%	0.0366%		-0.0055%	0.0302%	0.0051%
Sweden	0.0153%	0.0037%	0.0074%	-0.0022%	0.2199%	-0.1506%	-0.0025%	-0.0055%	0.3256%	0.0166%	0.1169%	0.3698%		0.1388%	0.0199%
United Kingdom	0.0036%	0.0022%	0.0015%	-0.0003%	0.0618%	-0.0391%	-0.0001%	-0.0030%	0.0505%	0.0005%	0.0181%	0.0506%	-0.0015%		0.0026%
United States	0.0002%	0.0002%	0.0001%	-0.0001%	0.0107%	-0.0097%	0.0000%	-0.0005%	0.0052%	0.0004%	0.0021%	0.0013%	-0.0001%	0.0037%	

TABLE 3 [continued] — International trade spillovers — Panel (D) — Effect after 3.5 years (period 14)

To ↓ \ From →	Austria	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy	Nether-lands	Portugal	Spain	Sweden	United Kingdom	United States
Austria		0.0019%	0.0028%	-0.0320%	0.1099%	-0.4694%	-0.0013%	-0.0650%	0.4851%	0.0059%	0.0780%	-0.0646%	-0.0030%	0.1461%	0.0233%
Belgium	0.0100%		0.0088%	-0.0840%	0.1515%	-0.4302%	-0.0002%	-0.0953%	0.4006%	0.0104%	0.1339%	-0.0463%	-0.0398%	0.0451%	0.0107%
Denmark	0.0051%	0.0003%		-0.1149%	0.0391%	-0.0917%	-0.0007%	-0.1063%	0.0739%	0.0576%	0.2164%	-0.0972%	-0.0274%	0.0497%	0.0205%
Finland	0.0131%	0.0029%	0.0060%		0.1918%	-0.5598%	-0.0011%	-0.0469%	0.6766%	0.0358%	0.3163%	-0.1426%	-0.0197%	0.1298%	0.0257%
France	0.0015%	0.0001%	0.0013%	-0.0120%		-0.0460%	-0.0001%	-0.0189%	0.0178%	0.0010%	0.0271%	-0.0097%	-0.0078%	0.0277%	0.0015%
Germany	0.0014%	0.0003%	0.0008%	-0.0057%	0.0140%		-0.0001%	-0.0087%	0.0372%	0.0024%	0.0211%	-0.0075%	-0.0027%	0.0166%	0.0012%
Greece	0.0017%	0.0027%	0.0164%	-0.0166%	0.1114%	-0.4784%		-0.0773%	0.3164%	0.0189%	0.0290%	-0.0131%	-0.0105%	0.0211%	0.0178%
Ireland	0.0224%	0.0064%	0.0480%	-0.1144%	0.2989%	-0.4398%	-0.0016%		1.0058%	0.0288%	0.2999%	-0.1245%	-0.0985%	0.2385%	0.0371%
Italy	0.0009%	0.0002%	0.0000%	-0.0066%	0.0137%	-0.0139%	0.0000%	-0.0175%		0.0003%	0.0259%	-0.0121%	-0.0043%	0.0059%	0.0003%
Netherlands	0.0054%	0.0007%	0.0053%	-0.0671%	0.0349%	-0.2179%	-0.0002%	-0.0431%	0.2061%		0.0552%	-0.0325%	-0.0278%	0.0440%	0.0069%
Portugal	0.0018%	0.0015%	0.0072%	-0.0574%	0.0326%	-0.1621%	-0.0021%	-0.0158%	0.4681%	0.0065%		-0.0724%	-0.0065%	0.0443%	0.0064%
Spain	0.0028%	0.0005%	0.0041%	-0.0177%	0.0246%	-0.1437%	-0.0005%	-0.0193%	0.1290%	0.0021%	0.0280%		-0.0093%	0.0216%	0.0002%
Sweden	0.0001%	0.0004%	0.0002%	-0.0364%	0.0383%	-0.1382%	-0.0008%	-0.0081%	0.0562%	0.0008%	0.0203%	-0.0285%		0.0227%	0.0046%
United Kingdom	0.0001%	0.0000%	0.0013%	-0.0005%	0.0032%	-0.0034%	-0.0001%	-0.0037%	0.0073%	0.0009%	0.0033%	-0.0049%	-0.0013%		0.0015%
United States	0.0001%	0.0000%	0.0001%	-0.0006%	0.0008%	-0.0051%	-0.0001%	-0.0014%	0.0027%	0.0000%	0.0001%	-0.0002%	-0.0001%	0.0017%	

In Table 3 above I present the results of my calculations: the magnitude of international trade spillovers. I estimated international trade spillovers at four different points in time; they are displayed in Panel (A) to Panel (D) of the table. Before I comment on the results, I mention a caveat with respect to the interpretation of the results: though spillovers are measured as a percentage of real GDP, this does *not* mean that real GDP of the recipient country rises by the same amount. Only real exports will rise and since real exports and real GDP are different aggregates, a rise in real exports does not translate one-for-one in a rise in real GDP.

The fiscal spillovers that I find are moderately sized. On average, the fiscal spillovers from my empirical analysis are slightly smaller than the trade spillovers found by Beetsma et al. (2006) and roughly the same size as the trade spillovers found by Hebous and Zimmermann (2010) or Ivanova and Weber (2011). It is, however, difficult to compare the magnitudes of trade spillovers exactly, because the above authors are not entirely transparent about their results, only displaying spillovers from a few large countries and omitting the rest.

Similar to Beetsma et al. (2006), I mostly find positive trade spillovers. Only if the multiplier turns negative — which is the case for some countries, especially after 8 or 12 quarters — then the trade spillovers turn negative as well. Interestingly, the magnitude of international trade spillovers follows the same U-shaped pattern that the impulse response functions in both the fiscal block and the trade block often follow: in the first quarter spillovers are rather small; 2 or 3 quarters after that spillovers grow at an accelerating rate; approximately 1 year later, in period 4, spillovers do not become any larger; in second year spillovers remain roughly constant; after 8 quarters spillovers gradually decline; at the end of the measurement period, after more than 3 years, spillovers have either become as small as they were at the beginning of the measurement period or they have become negative. From this we can conclude that spillovers are neither a short-run nor a long-run phenomenon but typically a medium-run phenomenon.

What does Table 3 tell us about the determinants of the magnitude of spillovers? Naturally, spillovers originating in small countries are smaller. Furthermore, spillovers originating in moderately sized countries and directed to smaller countries are larger, because spillovers are expressed as a percentage of GDP of the recipient country. In the next chapter I will elaborate a bit more on the determinants of the magnitude of fiscal spillovers.

Chapter 6: Discussion

What are main implications from the results of my empirical analysis? That is the central question in this chapter. I put the results into perspective by comparing them to the theory and to other empirical findings. I will also indicate the strengths and limitations of my research. Furthermore, I will conduct a few policy experiments involving the occurrence of simultaneous fiscal shocks in multiple countries. Finally, I will list some policy recommendations that follow from my results.

6.1 Results compared to the theory and the literature

As I showed in the theoretical part of this study, in the literature there are many disagreements about the workings of multipliers and spillovers. I will shed some light on these issues with the results from my empirical analysis.

The first major issue that I mention is the debate about the size of the multiplier. For a long time mainstream economists have held the position that fiscal multipliers tend to be larger for bigger countries and have decreased over time (Spilimbergo et al., 2008). I want to challenge that position. My empirical model, using very recent data, shows that multipliers are still quite sizable. Indeed, due to the financial and economic crises of recent years fiscal multipliers could even have become slightly larger.

Furthermore, in my analysis it is far from obvious that the size of a country is the most important determinant of the magnitude of the multiplier. Rather, my results show that the structure of fiscal policy, the reaction of prices and the reaction of monetary authorities are more important for the size of the multiplier. I will give an example these mechanisms. When fiscal authorities fear an increase of the budget deficit they quickly contract fiscal policy after a fiscal expansion, reducing the magnitude of the multiplier. When prices rise quickly as a result of increased government spending, monetary authorities may quickly respond to this by raising

interest rates, again reducing the magnitude of the multiplier. Therefore, like Barell et al. (2007), I recommend that fiscal policy researchers should devote more attention to price stickiness, expectations formation and the behaviour of central bankers in reaction to fiscal policy changes.

A second issue that I address is: how do we interpret the international spillover results? The first thing that strikes me is the fact that the results validate once more the undiminished relevance of the 'old' gravity model. Though many people relish talking about the world that has supposedly become flat and the decline of transportation costs that has supposedly brought about the 'death of distance', my empirical results show that distance and economic weight are still important determinants of trade and trade spillovers. For example, when we look at the size of trade spillovers in Table 3, we see that spillovers between neighbouring countries are often larger than spillovers between non-neighbouring countries and spillovers from big economies such as Germany and the United States are larger than spillovers from smaller economies.

Results from other empirical studies confirm that economic gravity continues to be relevant. For example Hummels (2007), who conducted an extensive and influential empirical study about the development of transport costs, found that while transport costs have steadily declined in real dollars per tonne, they did not fall relative to the *value* of the transported goods. Overall, Hummels's conclusion is that transport costs in ad valorem terms have remained more or less unchanged over the past 50 years. In addition, Berthelon and Freund (2008), who built an empirical model to assess the determinants of international trade, found that since 1985 — the year in which Bergstrand published his gravity model of trade — the elasticity of trade to distance has significantly *increased* rather than decreased. In short, we should not be surprised by some of the familiar patterns that emerged from the trade block and the spillover results.

A third issue is the inquiry into the determinants of spillover magnitudes. An important factor that explains differences in spillover magnitudes is openness to trade. Trade openness influences the magnitude of spillovers in two directions. On the one hand, open economies have a higher import penetration, which usually leads to smaller fiscal multipliers (Barell et al., 2007). On the other hand, open economies have larger export sectors, which makes their economies more susceptible to fiscal spillovers from other countries. Therefore, we would expect spillovers from open economies to be relatively smaller and spillovers to open economies to be relatively larger. To validate this interpretative hypothesis I present in Figure 13 below an overview of trade as a percentage of GDP. Comparing Figure 13 with the spillover results, we observe that open economies such as Belgium and the Netherlands are indeed more strongly affected by fiscal spillovers than similarly sized but relatively closed economies such as Sweden and Portugal. Thus there is ample support for the hypothesis that spillovers to open economies are relatively larger.

However, it is not obvious from Figure 13 and my analysis that spillovers originating in relatively open economies are smaller than spillovers originating in relatively closed economies. The reason for this is that, apparently, monetary policy, inflation mechanisms and expectations formation are stronger determinants of the magnitude of the multiplier than trade openness. Thus, provided that monetary policy accommodates a fiscal shock, a relatively open economy can still have a large multiplier. A good illustration of this argument is Denmark, which is a relatively open economy but due to favourable monetary and other circumstances still has a large multiplier.

FIGURE 13 — Total trade in merchandise and services as a percentage of GDP

Source: United Nations Conference on Trade and Development (UNCTAD)

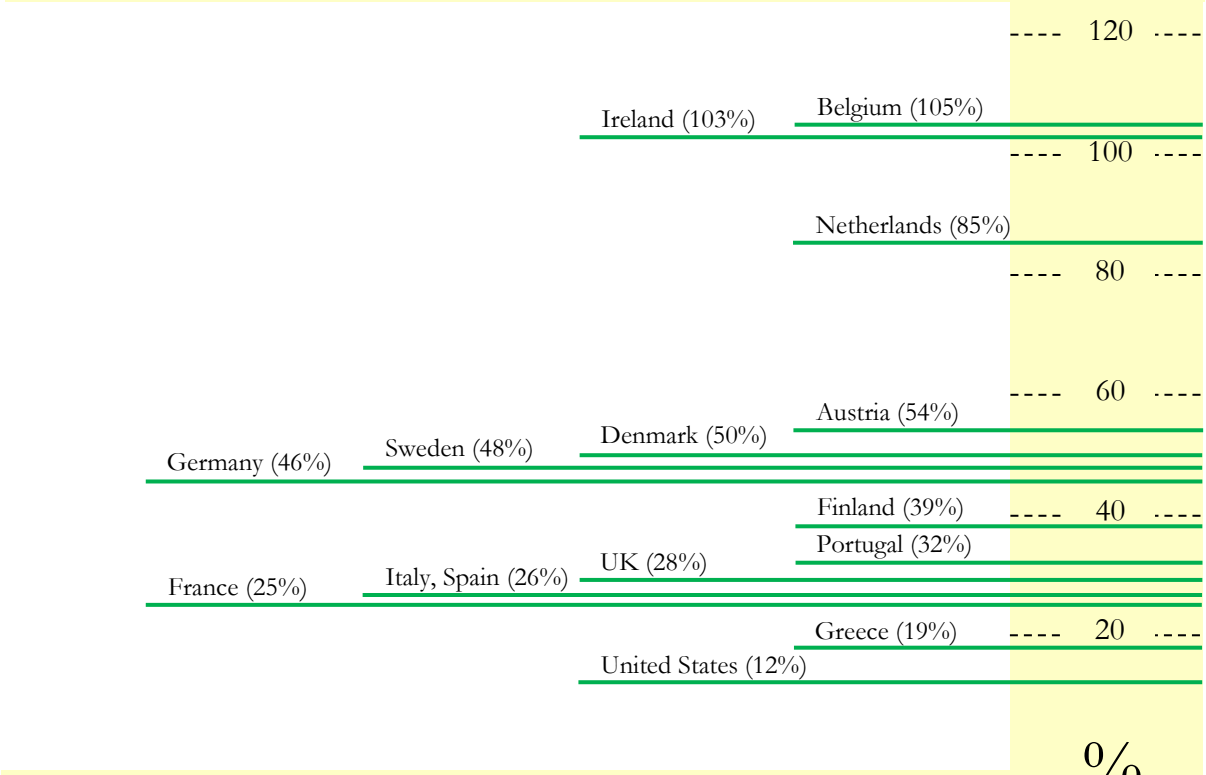


Figure made by author.

A final issue that I could elaborate upon is the relationship between exports and output: how do spillovers, transmitted via exports, influence foreign output? However, as Beetsma et al. (2006) note, the relationship between the current account and export is a very complicated issue, therefore beyond the scope of this study.

6.2 Strengths and limitations of this study

Evaluating the conclusions of this study not only requires an 'outward' look at other papers, but also an 'inward' look at the study itself. What are the main strengths and limitations of this study?

One of the main strengths of this study is that theory and empirics complement each other rather well. The theory provides crucial insights about the transmission of fiscal policy. Some of these insights can be tested in my empirical analysis. The results of the empirical analysis can in turn be interpreted with the help of the theory. It is crucial for a fertile interaction between theories and empirics that the empirical analysis is 'data driven'. My methodology provides this basis. My methodology has other advantages too. The dataset contains quarterly data, which makes identification of fiscal shocks more precise and enables me to estimate the effects of fiscal policy for each country separately, instead of having to aggregate the data. Furthermore, the dataset contains recent data and focuses on the EU, whereas most other studies use older data and focus on the US. Last but not least, the identification of fiscal shocks is further improved by the use of newly calculated elasticities of government expenditure.

This study has limitations too. The most obvious limitation is that this study only quantifies spillovers that are transmitted via the trade channel and neglects other types of spillovers. Another limitation is that my calculations may not capture the entire spillover effect, since they do not account for feedback effects among economies.

Yet another limitation is that due to a lack of quarterly data I have not been able to insert more control variables into my model or replace variables as a robustness check. Furthermore, since I calculate spillovers combining two different blocks of VAR models, I have only been able to show confidence bands for the separate models, but not for the combined model.

6.3 Simultaneous fiscal shocks

During the years 2010 to 2015 most developed countries are struggling to complete large fiscal consolidations. This means that that large, simultaneous fiscal shocks take place in countries of great economic importance; a quite unique situation. Policymakers face an enormous difficulty: should they follow their own fiscal consolidation path, regardless of simultaneous fiscal shocks that take place in other countries, or should they adjust their fiscal consolidation path, because simultaneous fiscal shocks in other countries have a deteriorating effect on their home country? Obviously, the risks involved are very large: if the international spillover effects of simultaneous

fiscal shocks are substantial, the negative effects on economic growth can be so large, that they destroy the whole purpose of the fiscal consolidation plan.

In order to find out whether international spillovers of simultaneous fiscal shocks poses a significant threat to individual countries, I designed a policy experiment based on the spillover results of my empirical analysis. Before I turn to the results of the policy experiment, I will briefly describe the steps that led me to the results.

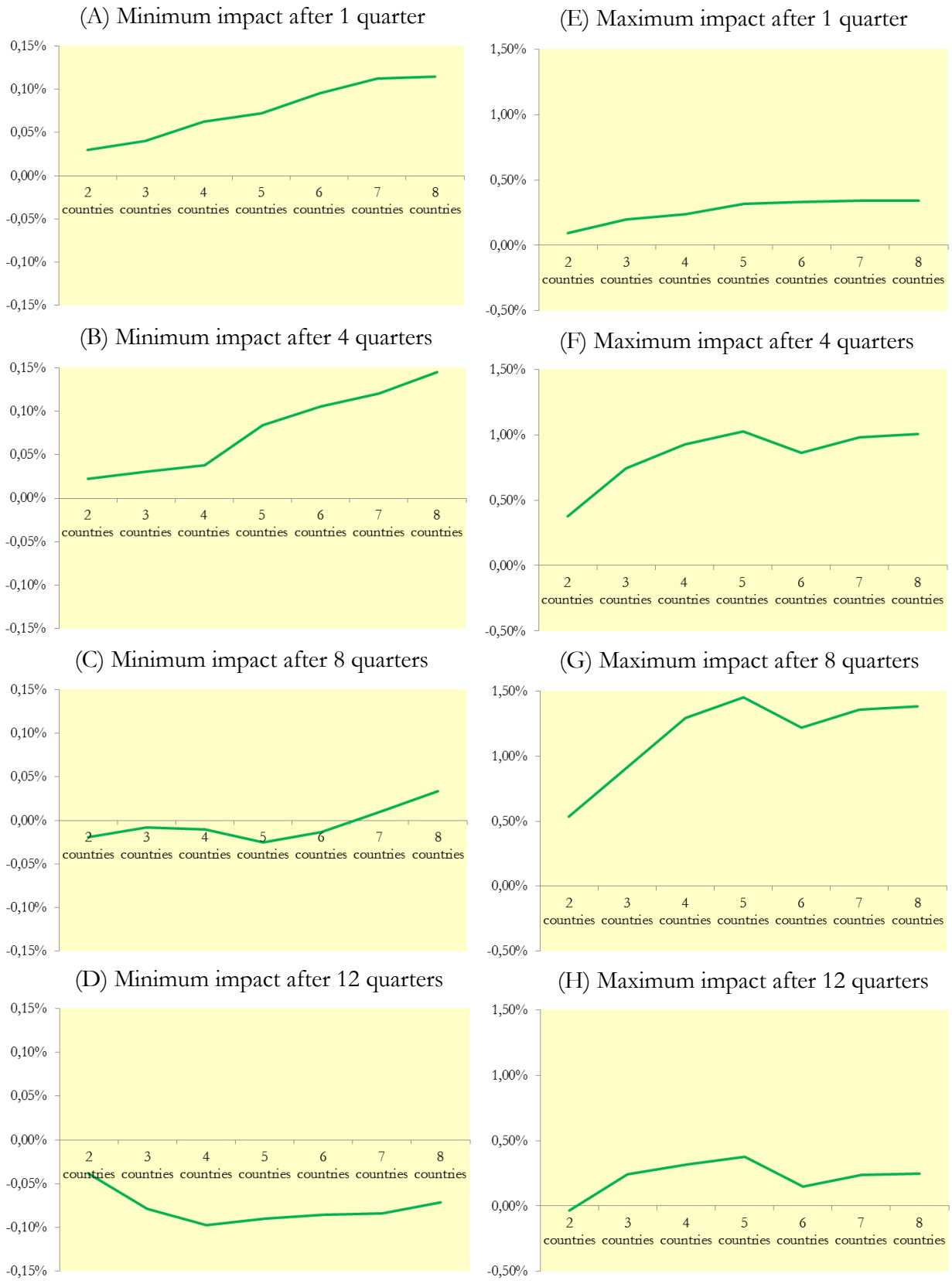
First, I determined the scope of the experiment. Potentially, the vast amount of spillover coefficients that I uncovered in Table 3 allows for an extensive analysis, covering lots of possible combinations. For example, using combinatorics we can calculate that in a sample of 15 countries there are $\binom{15}{3} = 455$ possible ways to create a group of 3 countries experiencing simultaneous fiscal shocks. Thus it is hardly possible to create a useful overview of the effects of simultaneous fiscal shocks when we have to take into account all possible combinations.

Therefore, I decided to calculate for each country the *average* impact that a fiscal shock has on the other 14 countries in the sample. This is equivalent to adding the spillovers from each column of Table 3 and then calculating the average spillovers. Using the same column-wise approach, I also calculated the standard deviation of the average spillovers. These standard deviations are useful as a proxy of the variation in spillover magnitudes, so that we can still grasp some of the complexity without having to calculate all possible combinations.

After that, I ranked the spillovers according to their average size, from small to large. The rank orders enabled me to calculate the minimum (average) impact a group of k countries has on a partner country when simultaneous shocks of 1 per cent of GDP occurs in this group of countries. Similarly, I calculated the maximum (average) impact a group of k countries has on a partner country. Since I only used average spillovers, the measurement unit of both the impulse (the fiscal shock) and the response (real bilateral exports) remain unchanged. The results of the experiment can be found in Figure 14 below. I present the minimum and the maximum impact of simultaneous fiscal shocks in 2 to 8 countries, after 1, 4, 8 and 12 quarters.

The results of the experiment give an interesting overview of the implications of simultaneous fiscal shocks: the impact ranges from a few tenths of a per cent of GDP to nearly 2 per cent of GDP. This means that the impact of simultaneous fiscal spillovers is quite substantial, especially when one realises that fiscal shocks are sometimes larger than 1 per cent of GDP, which implies that the impact of simultaneous fiscal shocks can be even larger than Figure 14 shows.

FIGURE 14 — Average impact of simultaneous fiscal shocks on a partner country



Notes: the graphs depict the average impact of simultaneous fiscal shocks of 1 per cent of GDP on real bilateral exports of a partner country, measured as a percentage of partner country GDP. The number of countries experiencing a fiscal shock is depicted on the horizontal axis.

Calculations and lay-out made by author.

We should realise that a drop in exports of a few per cent of GDP does not have to mean direct economic calamity for a country. In general, international trade is more volatile than output, so even in normal times there can be large upswings and downswings in exports. On the other hand, when a country is in the midst of a fiscal consolidation a drop in exports can exacerbate the economic downturn, especially because in times of fiscal consolidation domestic demand is already depressed and cannot easily replace withering foreign demand.

There are also other observations that can be made about Figure 14. First of all, we can see the familiar pattern that the impact of simultaneous fiscal shocks is small at first, then rises to reach its peak after 4 quarters and then slowly declines. Furthermore, we see that the average minimum impact rises as the number of countries involved in the shock rises, while the average maximum impact declines as the number of countries involved in the shock rises. The reason for this is the ranking of spillovers from small to large.

Though the results of the policy experiment are interesting, there is a caveat. The policy experiment was conducted ceteris paribus. For small experiments this is not a problem. However, the more countries that are included in the experiment, the less realistic this assumption becomes. For example, in case of a big, multi-country shock it is probable that exchange rates will adjust, partly cancelling out the effects of the shock. The same applies to monetary policy, which could change as well as a result of a simultaneous fiscal shock. Therefore, we should be careful when we interpret the results of the experiments or derive policy recommendations from them.

6.4 Policy recommendations

At the end of the empirical part of this study I assess some policy recommendations. The policy objectives that I deal with are threefold. A first objective could be to smooth the business cycle. A second objective could be to guarantee the availability of important public services over time. A third objective could be to avoid economic harm in other places or in other times, for example for other countries or future generations. With sound economic reasoning — and a sense of responsibility — fiscal policy can meet all three objectives.

My first recommendation is about anticyclical fiscal policy. My model shows that fiscal multipliers are mostly around 1, which implies that anticyclical government spending is able to smooth the business cycle to some extent. However, as Girouard and André (2012) observe, the importance of automatic stabilisers has declined over the past decades. Due to the European Stability and Growth Pact (SGP), Eurozone governments are not allowed to run large deficits. Thus many

governments have chosen to smooth fiscal policy itself rather than the business cycle. Furthermore, many economists have advocated less generous welfare systems in order to make labour markets more flexible and economies more competitive. Contrarily, I would recommend diminishing the role of automatic stabilisers *not too far*. Anticyclical fiscal policy does not only prevent temporary damage to the economy, it can also prevent structural damage. For example, when a group of people becomes structurally unemployed because the government did nothing to stabilise an economic downturn, it is generally hard to get this group of people back to work.

The second recommendation that concerns the effectiveness of fiscal policy is, paradoxically, monetary policy. Both the theoretical and the empirical results of this study clearly show that monetary policy plays a crucial role in shaping the effects of fiscal policy. A logical but controversial deduction that I make here is that the harmonised and centralised monetary policy that we have in the European Union is not very favourable for effective fiscal policy. My empirical results confirm this: countries that control their own monetary policy, such as Denmark and Sweden, have larger multipliers. Though the scope of this study is too limited to draw conclusions about the EMU, I would at least suggest that policymakers take a closer look at the trade-offs involved: yes, harmonised monetary policy and tight fiscal rules for member states are good for the stability of the common currency but they can also lead to more extreme paths of the business cycle in individual countries, because domestic governments can neither fully employ fiscal nor monetary policy to smooth the business cycle.

The third recommendation is about fiscal spillovers. Is fiscal coordination desirable from an international point of view? My empirical analysis shows that fiscal spillovers are significant, statistically as well as economically: when countries neglect fiscal spillovers, they tend to implement fiscal policies that are too expansive (contractive) for raising (reducing) output in response to a common shock (Beetsma et al., 2006). Thus fiscal coordination can reduce the risk of overheating or recession, as well as the risk of contamination. Possible disadvantages of fiscal coordination are that it restricts the freedom of national policymakers and that peripheral countries tend to benefit less from fiscal coordination than core countries (Barell et al., 2007). Overall, I think that the benefits of fiscal coordination are greater than its costs. This is especially true if we take into account simultaneous fiscal shocks and the big impact these shocks have.

Concluding remarks

At the end of this study I will summarise the main conclusions. I will make some remarks about the theory and the empirical analysis, and I will also show their interrelatedness. Furthermore, I will make some suggestions for future research. Though there is ample room for debate with regard to the precise mechanisms through which fiscal policy affects the economy, all the evidence from this study points towards the conclusion that the impact of fiscal policy, both at home and abroad, is substantial.

The theory suggests that at a domestic level the effects of fiscal policy are mainly transmitted through the demand channel, the supply channel, the price channel and the interest rate channel. Despite several theoretical indications that the role of the demand channel and the traditional Keynesian multiplier has become smaller — for example due to financial liberalisation or the fact that economies have become more open — my up-to-date dataset clearly shows that the demand channel is still relevant, yielding multiplier values between 1 and 2 for all countries included in the dataset. We should also realise that in the current economic crisis firms, banks and households are deleveraging their balance sheets, which enhances the risk of Fisher debt deflation, the liquidity trap and the paradox of thrift, so that the effectiveness of monetary policy *decreases* while the effectiveness of fiscal policy *increases*.

Though the demand channel remains important, I also find robust theoretical and empirical support for the other transmission channels of fiscal policy, especially the price channel and the interest rate channel. Interestingly, the price channel and the interest rate channel have an impact in two directions: the data show that in some countries the price index rises as a result of a fiscal expansion, while in other countries the price index remains flat or even declines after a fiscal expansion. The price effect is not immediate — proving that prices are sticky in the short run — but the effect is statistically significant. This implies that in some cases the crowding-out hypothesis can be empirically verified: aggregate supply is fixed in the short run, so when the output gap is around zero or positive at the moment of a fiscal expansion, the extra public sector activity crowds out extra private sector activity, causing inflationary pressure and overheating of the economy. Two intermediate factors that play small but crucial roles in this process are wage

negotiations and expectations formation. When employees have much bargaining power and expect higher inflation in the future, a wage-price spiral can arise. The scope of this study is too limited to explain why in some countries a fiscal shock leads to a wage-price spiral more often than in other countries, so I recommend further empirical research about that issue.

The difference in the response of prices to fiscal changes is mirrored in the response of interest rates to fiscal changes. My model shows that in some countries short-term interest rates increase as a result of a fiscal expansion while in some countries short-term interest rates decrease as a result of a fiscal expansion. This means that — apart from the neoclassical wealth effect, which could induce changes in the labour supply, private investment and hence short-term interest rates — the reaction of monetary authorities to a fiscal shock is an important determinant of the effectiveness of fiscal policy. Naturally, the reaction of monetary policy is in turn shaped by the inflationary pressure created by a fiscal shock. My research therefore suggests that the influence of the interaction between fiscal and monetary policy should not underestimated: it is an important factor that determines whether the strong demand channel effects of fiscal policy are reinforced, yielding multipliers that rise over time and peak at a value of 2, or mitigated, yielding multipliers that decrease over time and quickly fall below zero.

A practical implication of this conclusion that is often neglected in academic and policy-making circles is the fact that within the context of a monetary union, fiscal policy and monetary policy are separately decided upon. It is well-known that within monetary unions large deviations in economic performance between countries can arise; deviations that are difficult to compensate for, because countries do not control their own monetary policy. Paradoxically and dangerously, widening economic deviations or economic instability within a monetary union — of which the current European currency crisis and sovereign debt crisis are the acute symptoms — call for a strong monetary response and stricter, harmonised rules for fiscal policy, which makes economic deviations between countries even larger in the short run and diminishes national control over economic policy in the long run. I therefore sincerely doubt whether and how the EMU can survive, economically as well as politically. Unfortunately, there are very few empirical studies about the interaction of fiscal and monetary policy within a monetary union, so I strongly recommend that economists put in more effort to understand these important issues.

The theory suggests that at an international level the most important channel through which the effects of fiscal policy are transmitted is the trade channel. The price channel and the interest channel have less explanatory power at the international level; instead, the real exchange rate plays an important intermediary role. I find strong empirical evidence for fiscal spillovers through the trade channel. Fiscal spillovers for individual countries are significant and moderately

sized; on average their magnitude amounts to a few tenths of a per cent of GDP. Over time, fiscal spillovers follow a U-shaped pattern.

With regard to the determinants of the magnitude of fiscal spillovers, a few observations stand out. Country size, economic openness and distance — in short: economic gravity — explain much of the differences in spillover magnitudes. Economic openness influences the magnitude of spillovers in two distinct manners. On the one hand, open economies have a higher import penetration, which usually leads to smaller fiscal multipliers, and thus smaller spillovers. On the other hand, open economies have a larger export sector, which makes their economies more susceptible to fiscal spillovers from other countries. Therefore, we would expect spillovers from open economies to be relatively small and spillovers to open economies to be relatively large.

There is one final observation that has to be made that is especially relevant in the current time of crisis. Though international spillovers of fiscal shocks originating in individual countries are quite small, the international impact of simultaneous fiscal shocks is quite large, cumulating to 1 to 3 per cent of GDP. This means that it is probable that the simultaneous fiscal consolidation plans that are currently carried out in the EU exacerbate the economic downturn through lower export revenues. It also means that the macroeconomic imbalances within the EU and the rest of the world will become more difficult to solve. Therefore, I conclude that fiscal coordination can be useful and beneficial. Hopefully, policymakers are able to gather enough knowledge and muster enough political will to be able to solve our economic woes.

Bibliography

Alesina, A. & R. Perotti (1996), 'Fiscal Adjustments in OECD Countries: Composition and Macroeconomic Effects', NBER Working Paper 5730.

Alesina, A. (2010), 'Fiscal Adjustments: Lessons from Recent History', EcoFin meeting, April 15, 2010.

Alesina, A., Ardagna, A., Perotti, R. & F. Schiantarelli (2002), 'Fiscal Policy, Profits and Investment', *The American Economic Review*, Vol. 92 (3), pp. 571-589.

Ardagna, S. (2004), 'Fiscal Stabilisations: When Do They Work and Why?', *European Economic Review*, 48, 1047-1074.

Barell, R., Holland, D., Liadze, I. & O. Pomerantz (2007), 'Fiscal Spillovers and Trade Relations in Europe', Working Paper on Global Modelling, Trinity College, Cambridge.

Barro, R.J. (1979), 'On the Determination of the Public Debt', *Journal of Political Economy*, 87 (5), 940-971.

Baumol, W.J. (1967), 'Macroeconomics of Unbalanced Growth: The Anatomy of Urban Crisis', *The American Economic Review*, Vol. 57 (3), pp. 415-426.

Baxter, M. & R.G. King (1993), 'Fiscal Policy in General Equilibrium', *The American Economic Review*, Vol. 83 (3), pp. 315-334.

Beetsma, R.M.W.J., Giuliodori, M. & F.J.G.M. Klaassen (2008), 'The Effects of Public Spending Shocks on Trade Balances and Budget Deficits in the European Union', *Journal of the European Economic Association*, Vol. 6 (2-3), pp. 414-423.

Beetsma, R.M.W.J., Giuliodori, M. & F.J.G.M. Klaassen (2006), 'Trade Spill-overs of Fiscal Policy in the European Union: A Panel Analysis', *Economic Policy*, pp. 639-687.

Bénassy-Quéré, A. (2006), 'Short-term fiscal spillovers in a monetary union', CEPII, Working Paper No 2006-13.

Berthelon, M. & C. Freund (2008), 'On the Conservation of Distance in International Trade', *Journal of International Economics*, Vol. 75, pp. 310-320.

Blanchard, O.J. & R. Perotti (2002), 'An Empirical Characterisation of the Dynamic Effects of Changes in Government Spending and Taxes on Output', *The Quarterly Journal of Economics*, Vol. 117 (4), pp. 1329-1368.

Blanchard, O.J. (1990), 'Comment on [Can Severe Fiscal Contractions Be Expansionary? Tales of Two Small European Countries]', NBER Macroeconomics Annual, Vol. 5, 111-116.

Bun, M.J.G. & F.J.G.M. Klaassen (2007), 'The Euro Effect on Trade is not as Large as Commonly Thought', *Oxford Bulletin of Economics and Statistics*, Vol. 69 (4), pp. 473-496.

Burda, M. & C. Wyplosz (2005), 'Macroeconomics: a European Text', Oxford: Oxford University Press.

Case, A. & H.S. Rosen (1992), 'Budget Spillovers and Fiscal Policy Interdependence', *Journal of Public Economics*, Vol. 52, pp. 285-307.

Chafuen, A.A. (2003), 'Faith and Liberty: The Economic Thought of the Late Scholastics', New York: Lexington Books.

Cooper, R., Kempf, H. & D. Peled (2010), 'Insulation Impossible: Fiscal Spillovers in a Monetary Union', Documents de Travail du Centre d'Economie de la Sorbonne, No. 2010.45.

Corsetti, G. & G.J. Müller (2011), 'Multilateral Economic Cooperation and the International Transmission of Fiscal Policy', National Bureau of Economic Research, Working Paper No. 17708.

Corsetti, G., Meier, A. & G.J. Müller (2010), 'Cross-Border Spillovers from Fiscal Stimulus', *International Journal of Central Banking*, Vol. 6 (1), pp. 5-37.

Dixit, A. & L. Lambertini (2001), 'Monetary-fiscal Policy Interactions and Commitment versus Discretion in a Monetary Union', *European Economic Review*, Vol. 45, pp. 977-987.

Eggertsson, G. & P. Krugman (2011), 'Debt, Deleveraging and the Liquidity Trap: A Fisher-Minsky-Koo approach', presentation for the Federal Reserve, Washington, DC.

Eggertsson, G.B. (2009), 'What Fiscal Policy Is Effective at Zero Interest Rates?', Federal Reserve Bank of New York Staff Reports, No. 402.

Fisher, I. (1933), 'The Debt-Deflation Theory of Great Depressions', *Econometrica*, Vol. 1 (4), pp. 337-357.

Giavazzi, F. & M. Pagano (1990), 'Can Severe Fiscal Contractions Be Expansionary? Tales of Two Small European Countries', NBER Macroeconomics Annual 1990, volume 5, pp. 75-122.

Girouard, N. & C. André (2012), 'Measuring Cyclically-Adjusted Budget Balances for OECD Countries', OECD: General Economic Analysis Division.

Gros, D. & A. Hobza (2001), 'Fiscal Policy Spillovers in the Euro Area: Where are they?', Centre for European Policy Studies, Working Paper No. 176.

Guajardo, J., Leigh, D. & A. Pescatori (2011), 'Expansionary Austerity: New International Evidence', IMF Working Paper 158.

Hebous, S. & T. Zimmermann (2010), 'Budget Deficit Spillover Effects in the Euro Area', Working Paper.

Hollmayr, J. (2011), 'Fiscal Spillovers and Monetary Policy Transmission in the Euro Area', preliminary version.

Hummels, D. (2007), 'Transportation Costs and International Trade in the Second Era of Globalisation', *Journal of Economic Perspectives*, Vol. 21 (3), pp. 131-154.

Ivanova, A. & S. Weber (2011), 'Do Fiscal Spillovers Matter?', IMF Working Paper, No. 211.

Keynes, J.M. (1936), 'The General Theory of Employment, Interest and Money', London: MacMillan and Company, Ltd.

Kim, S. & N. Roubini (2008), 'Twin Deficit or Twin Divergence? Fiscal Policy, Current Account, and Real Exchange Rate in the US', *Journal of International Economics*, Vol. 74, pp. 362-383.

Koo, R. (2009), 'The Age of Balance Sheet Recessions - What Post-2008 United States, Europe and China Can Learn from Japan 1990-2005', Tokyo: Nomura Research Institute.

Lane, P. (2012), 'The European Sovereign Debt Crisis', *Journal of Economic Perspectives*, Vol. 26 (3), pp. 49-68.

Lane, P.R., & R. Perotti (1998), 'The Trade Balance and Fiscal Policy in the OECD', *European Economic Review*, Vol. 42, pp. 887-895.

Laxton, D., Isard, P., Faruqee, H., Prasad, E. & B. Turtelboom (1998), 'Multimod Mark III: The Core Dynamic and Steady-State Models', IMF Occasional Paper, No. 164.

Lewis, M.K. & P.D. Mizen (2000), 'Monetary Economics', Oxford: Oxford University Press.

Mankiw, N.G. (1992), 'Macroeconomics', New York: Worth Publishers.

Marcellino, M. (2002), 'Some Stylized Facts on Non-systematic Fiscal Policy in the Euro Area', CEPR, NBER and Università Bocconi, Working Paper 225.

McDermott, C & R.F. Wescott (1996), 'An Empirical Analysis of Fiscal Adjustments', IMF Staff Papers, 43 (4), 725-753.

McKibbin, W.J. (1997), 'Empirical evidence on international economic policy coordination', in: M.U. Fratianni, D. Salvatore & J. von Hagen (eds.), *Macroeconomic Policy in Open Economies*, Chapter 6, Greenwood Publishing, Westport, CT, 148–76.

Minsky, H.P. (1992), 'The Financial Instability Hypothesis', Prepared for the Handbook of Radical Political Economy, edited by Philip Arestis and Malcolm Sawyer, Edward Elgar: Aldershot, 1993.

Müller, G.J. (2008), 'Understanding the Dynamic Effects of Government Spending on Foreign Trade', *Journal of International Money and Finance*, Vol. 27, pp. 345-371.

Perotti, R. (2004), 'Estimating the Effects of Fiscal Policy in OECD Countries', CEPR, NBER and Università Bocconi Working Paper No. 276.

Pindyck, R.S. & D.L. Rubinfeld (1998), 'Econometric Models and Economic Forecasting', New York: McGraw-Hill.

Ramey, V.A. & M.D. Shapiro (1998), 'Costly Capital Reallocation and the Effects of Government Spending', Carnegie-Rochester Conference Series on Public Policy 48, pp. 145-194.

Ravn, M.O. & H. Uhlig (2002), 'On Adjusting the Hodrick-Prescott Filter for the Frequency of Observations', *The Review of Economics and Statistics*, Vol. 82 (2), pp. 371-380.

Romer, C.D. & D.H. Romer (2010), 'The Macroeconomic Effects of Tax Changes: Estimates Based on a New Measure of Fiscal Shocks', *The American Economic Review*, Vol. 100 (3), pp. 763-801.

Romer, D. (2006), 'Advanced Macroeconomics', New York: McGraw-Hill, Chapter 11, pp. 559-617.

Sims, C.A. (1980), 'Macroeconomics and reality', *Econometrica*, Vol. 48 (1), pp. 1-48.

Spilimbergo, A. Symansky, S. Blanchard, O. & C. Cottarelli (2008), 'Fiscal Policy for the Crisis', IMF Staff Position Note.

Stevans, L.K. & D.N. Sessions (2010), 'Calculating and Interpreting Multipliers in the Presence of Non-Stationary Time Series', *American Journal of Social and Management Sciences*, Vol. 1 (1), pp. 24-38.

Stiglitz, J. (1986), 'Economics of the Public Sector', New York: W.W. Norton and Company, Inc.

Sydsaeter, K. & P. Hammond (1995), 'Essential Mathematics for Economic Analysis', Upper Saddle River, New Jersey: Prentice-Hall, Inc.

Tinbergen, J. (1956), 'Economic Policy: Principles and Design', Amsterdam: North-Holland Publishing Company.

Ueda, K. (2012), 'Deleveraging and Monetary Policy: Japan since the 1990s and the United States since 2007', *Journal of Economic Perspectives*, Vol. 26 (3), pp. 177-202.

Van den Noord, P. (2000), 'The Size and Role of Automatic Fiscal Stabilizers in the 1990s and Beyond', OECD Economics Department Working Papers, No. 230.

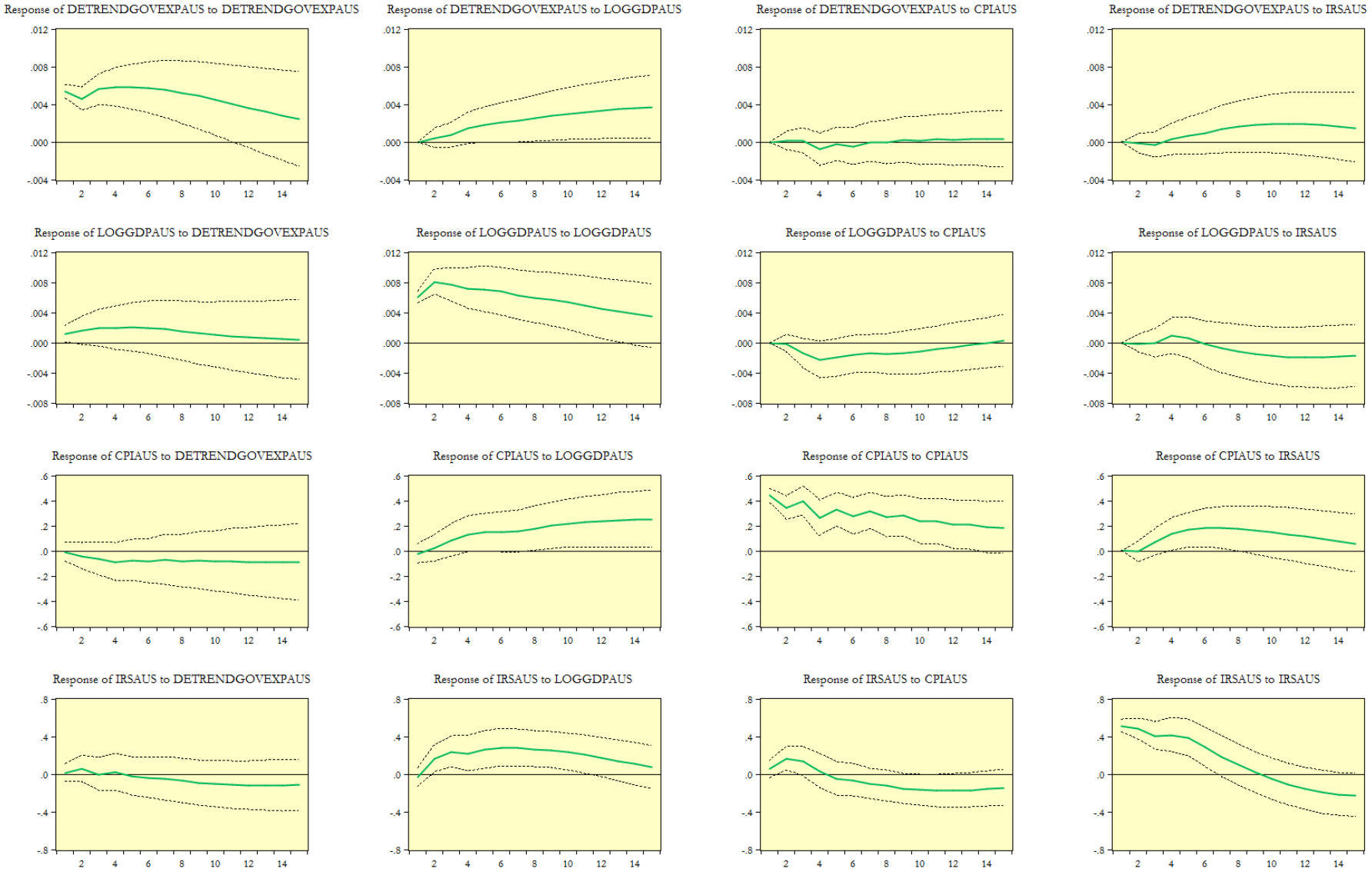
Werning, I. (2007), 'Optimal Fiscal Policy with Redistribution', *Quarterly Journal of Economics*, August 2007.

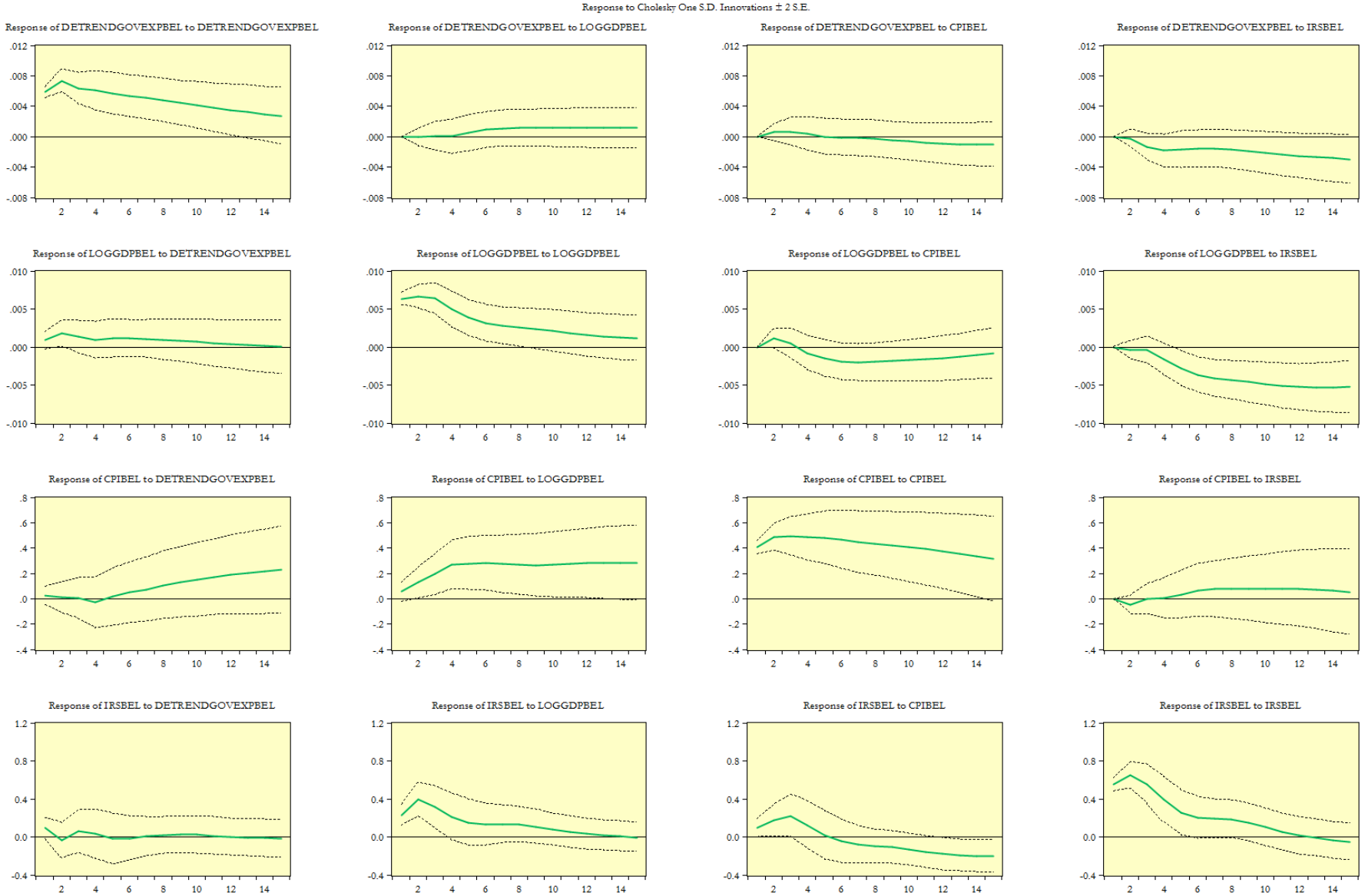
Weyerstrass, K., Jaenicke, J., Neck, R., Haber, G., Van Aarle, B. Schoors, K. Gobbin, N. & P. Claeys (2006), 'Economic Spillover and Policy Coordination in the Euro Area', Staff Paper of the Directorate-General for Economic and Financial Affairs of the European Commission.

Appendix

On the next pages I present the impulse response functions of all variables in the fiscal block. The graphs depict the response of the specified response variable to a Cholesky one standard deviation innovation in the impulse variable. The dotted lines depict the 95 per cent confidence interval, based on a Monte Carlo simulation with 1000 replications. Calculations and lay-out made by author.

Response to Cholesky One S.D. Innovations ± 2 S.E.

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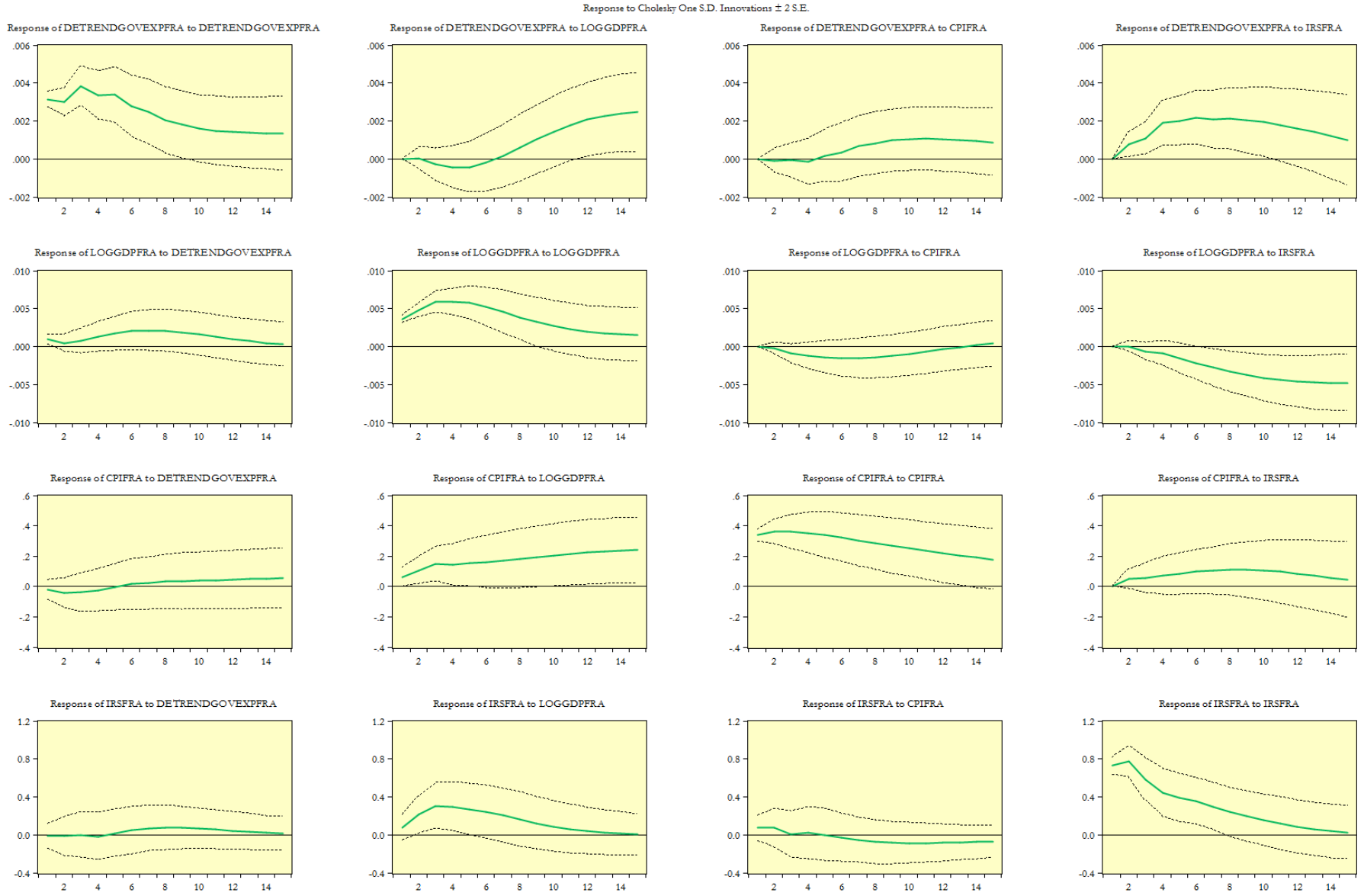
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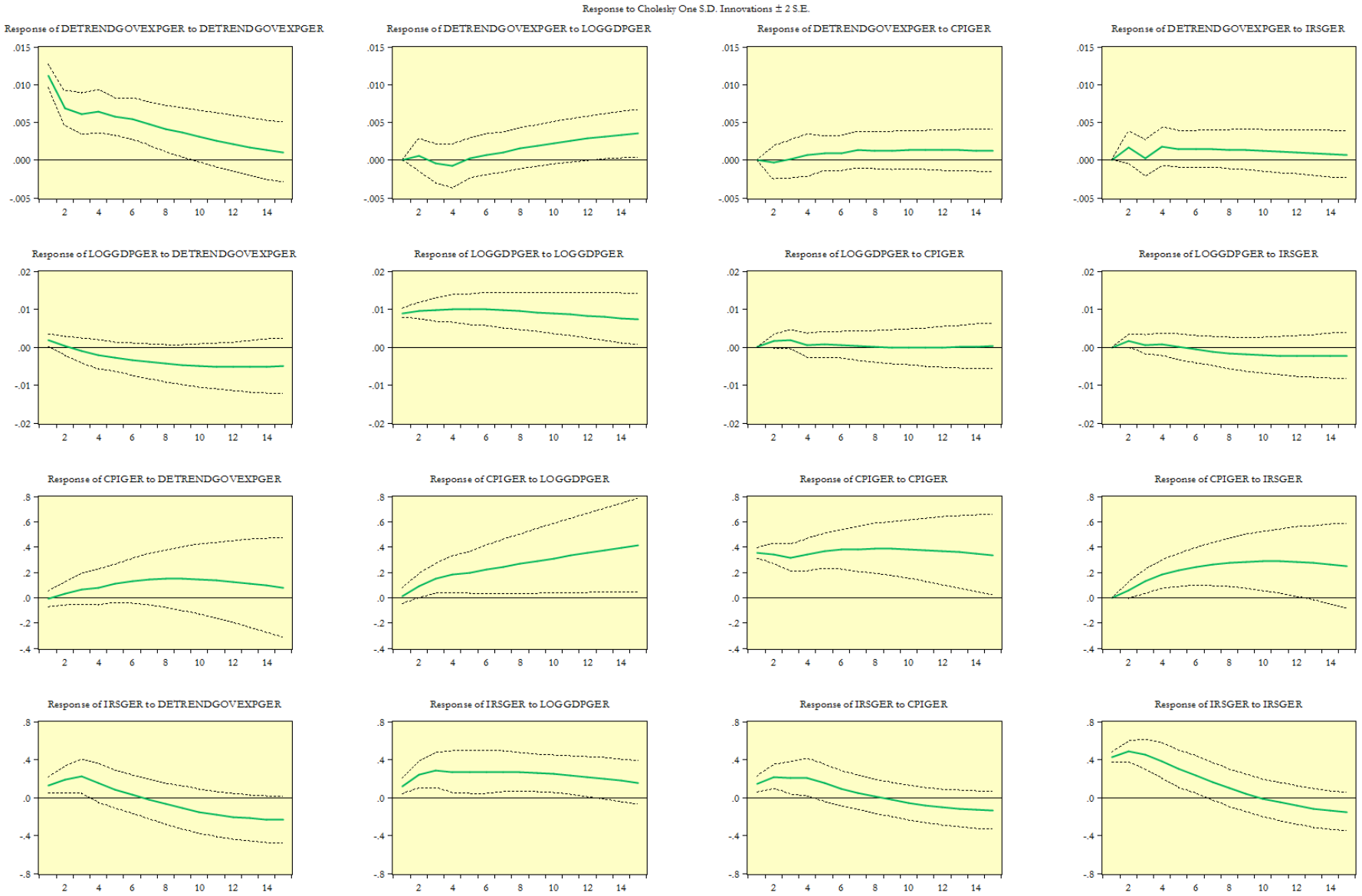
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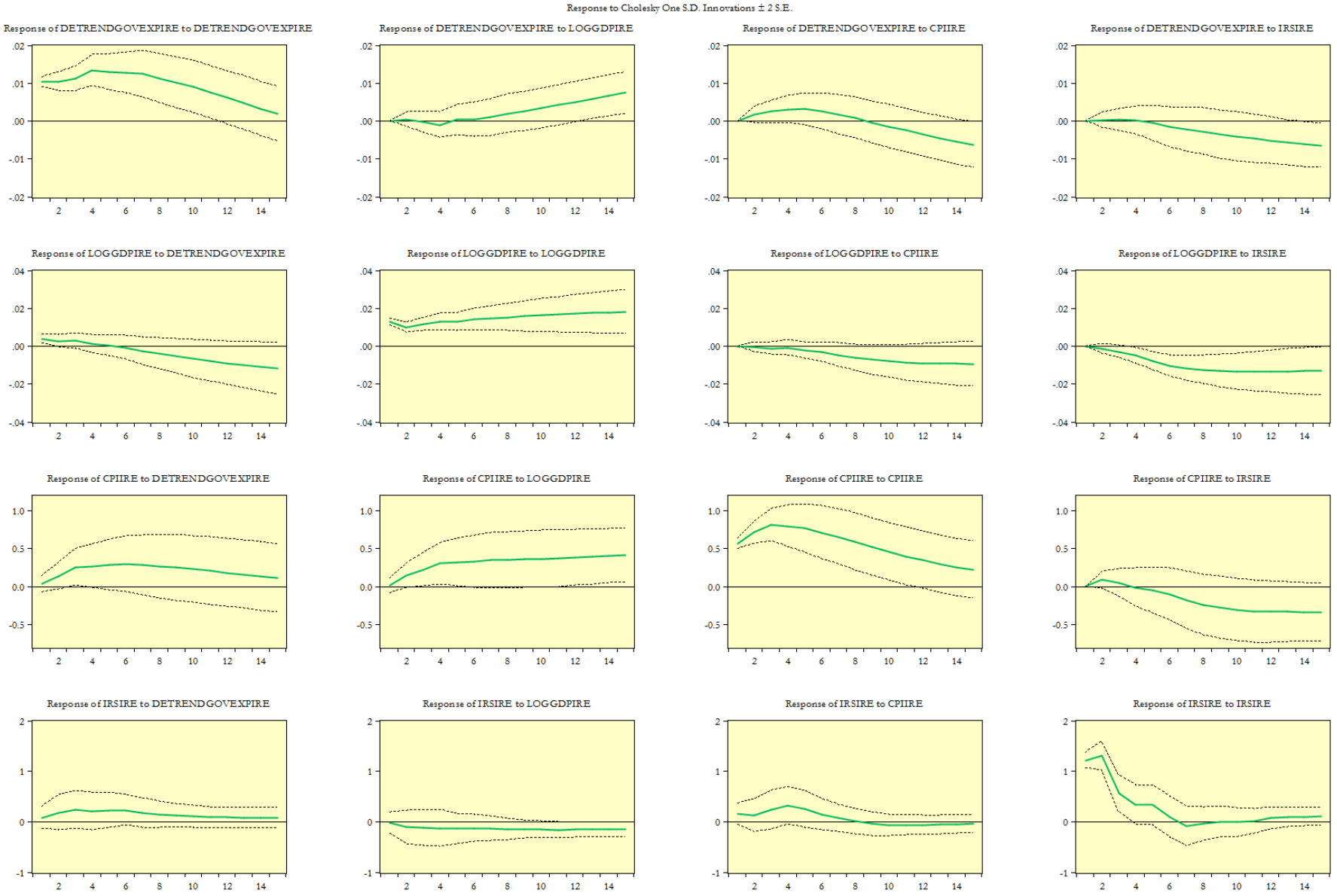
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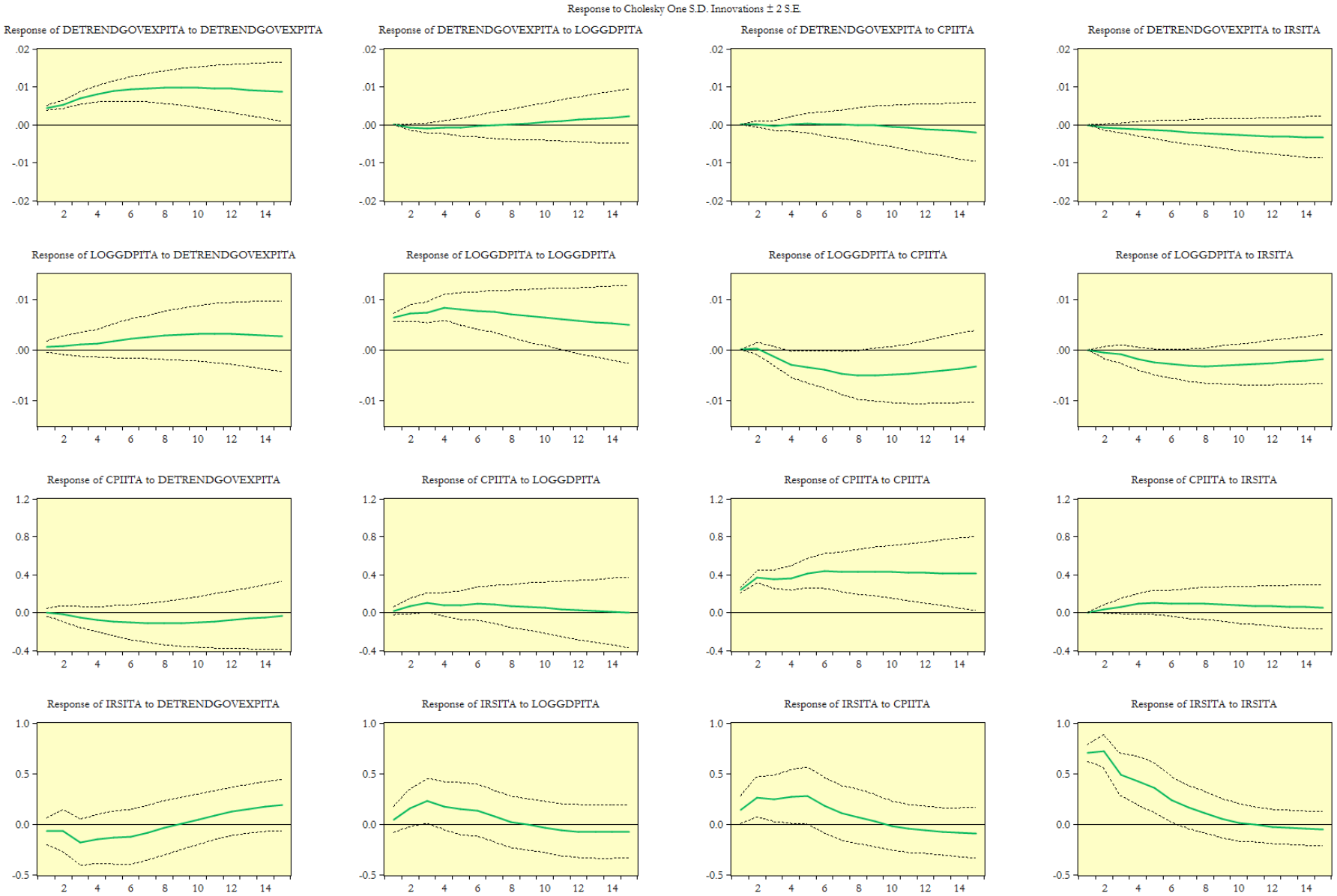
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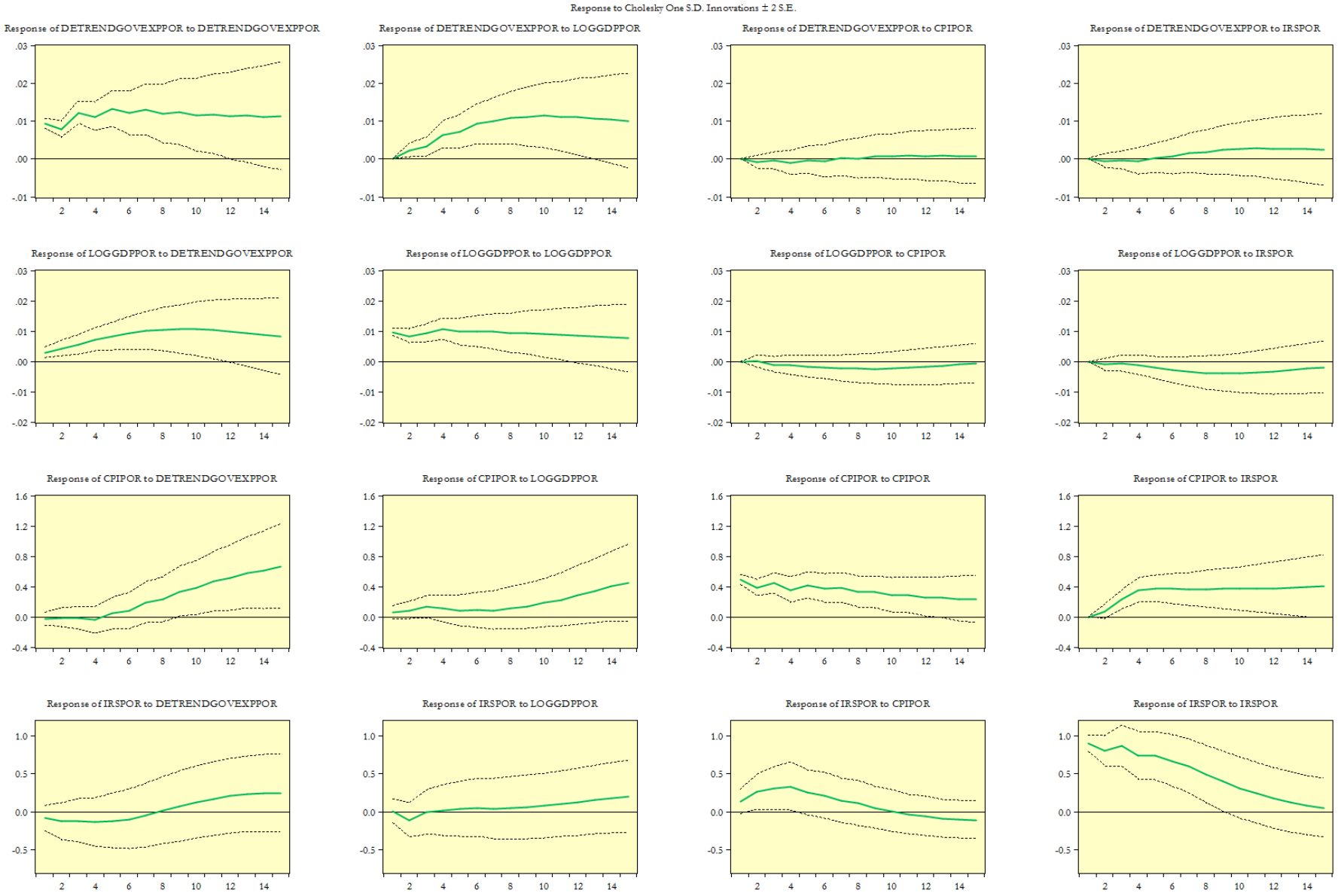
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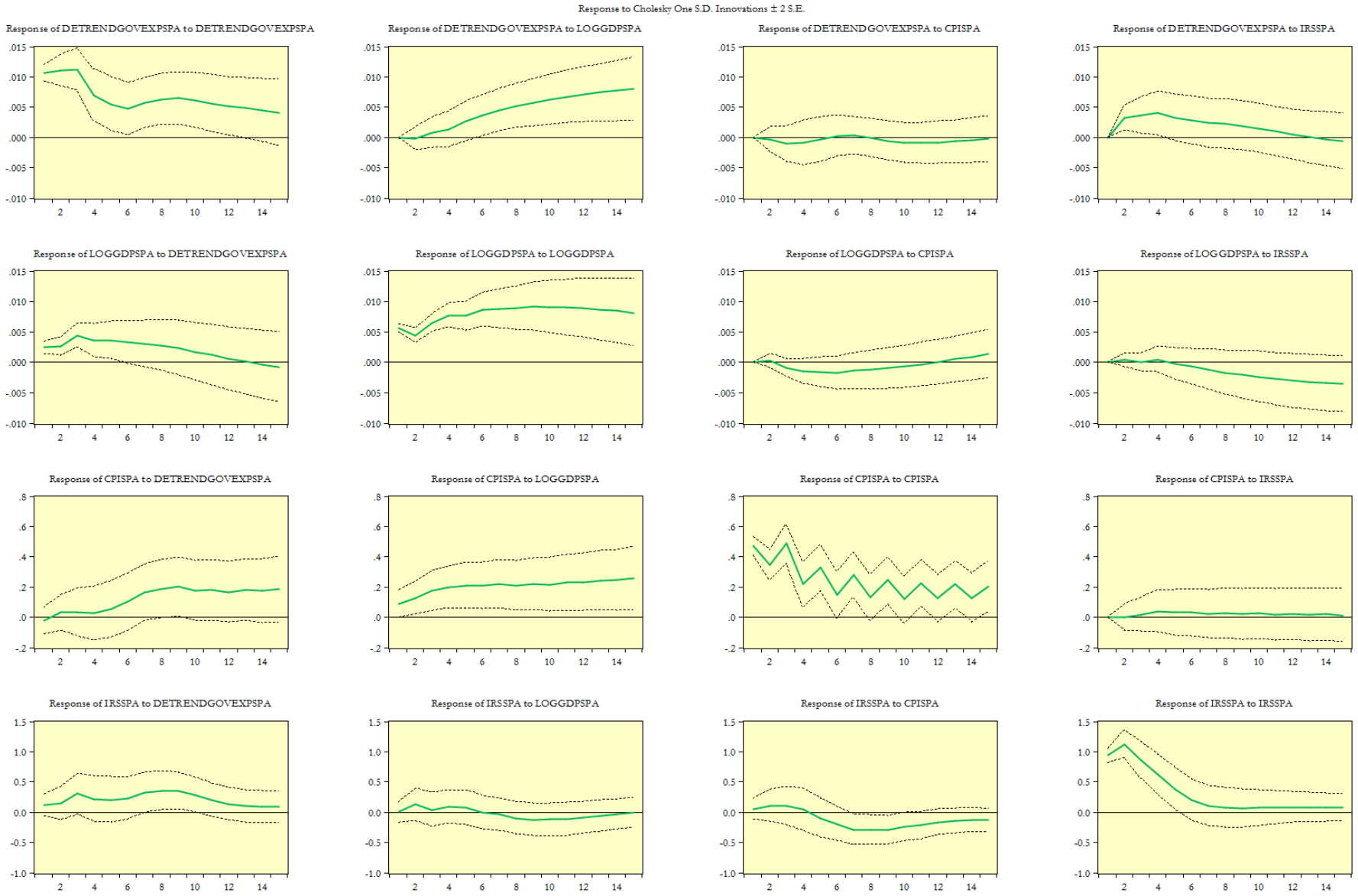
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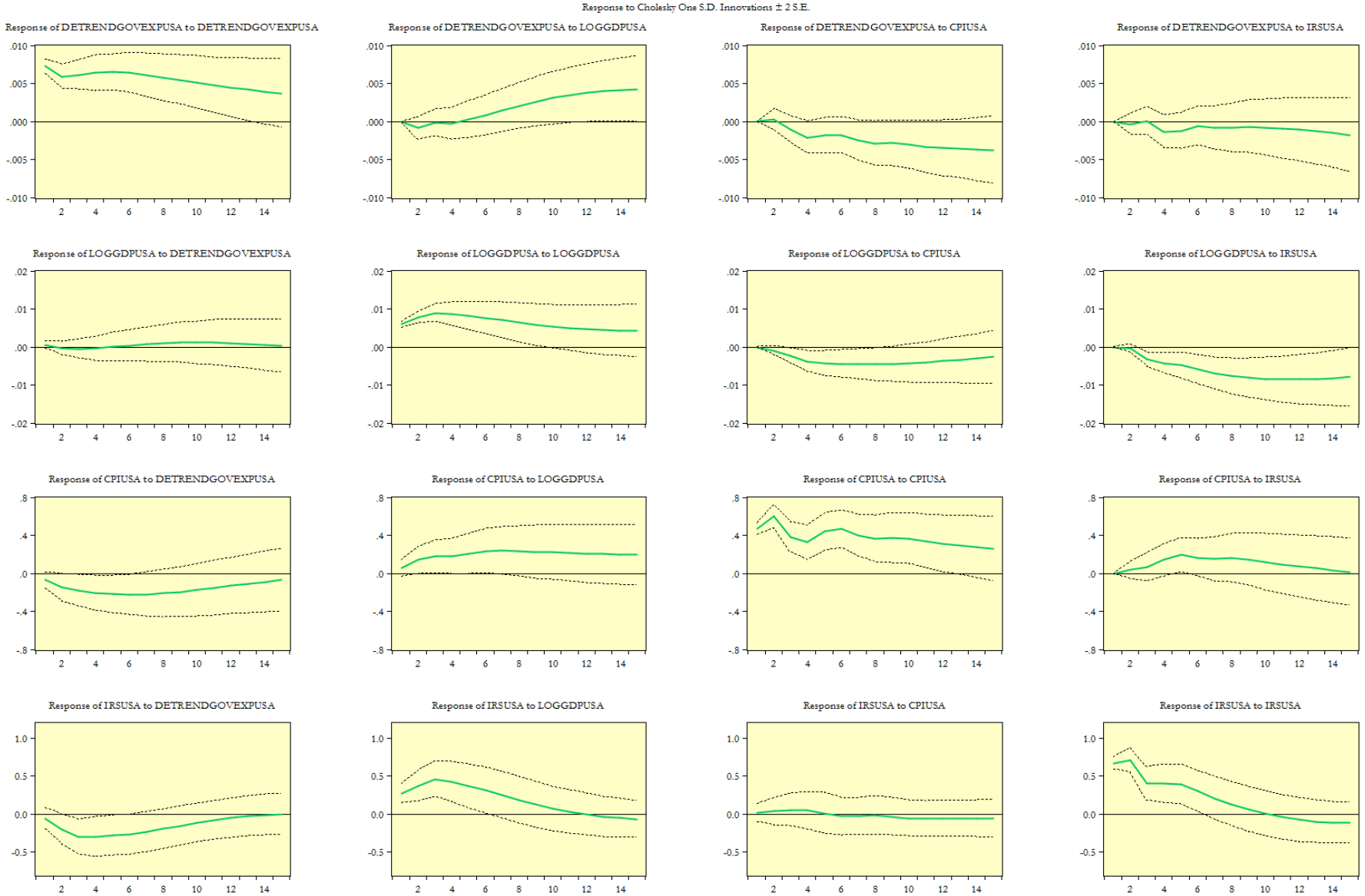
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