Fiscal Multipliers in the Netherlands

A Structural VAR Approach*

Master Thesis in Policy Economics

Student: Nicolas J. Coudret[†]
Thesis Supervisor: dr. Lorenzo Pozzi[‡]
CPB Supervisor: dr. Adam Elbourne[§]

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Abstract

This study estimates average tax and spending multipliers for the Netherlands, for the last 16 years, using a structural VAR approach (SVAR). We identify exogenous tax and spending shocks by including external information and assumptions about the internal mechanisms of the Dutch tax and transfer system. We analyze both a three (taxes, spending, output) and five (incl. interest and inflation rates) variable model, thereby following Blanchard and Perotti (2002) and Perotti (2004). We also perform a battery of robustness checks, including a sign restriction approach (Mountford and Uhlig (2009)). The results show positive cumulative spending multipliers between 0.8 and 1.2, for a period of 4 years. Our estimates for the tax multipliers however do not indicate a consistent sign or magnitude. Robustness checks confirm this pattern. The reason for the inconsistency in tax multiplier results is believed to lie in occurences in the data that are not captured by the models.

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[†]Erasmus School of Economics; student number: 367657; nicolas@coudret.ch
[‡]Erasmus School of Economics
[§]Central Planbureau: Netherlands Bureau for Economic Policy Analysis

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1 Introduction

Knowing the size of fiscal multipliers[1] is important for governments. Basically, if fiscal multipliers are high, fiscal policy has large effects on the real economy; it not only means that expansionary spending is an efficient way to boost the economy, it also indicates that governments need to be careful when considering austerity measures. In that case, spending cuts or tax increases to balance government budgets may have devastating effects on the economy. This in turn might disincentivize governments to use contractionary instruments of fiscal policy. Conversely, if multipliers are very low or even negative, governments have less incentive to give in to demands for tax breaks or spending boosts because fiscal policies will not have a big effect on the economy, or even a counterproductive effect. In parallel, and since tax increases or spending cuts to balance government budgets later will have small harmful effects on the real economy, austerity measures may be an attractive, or in the case of negative multipliers even profitable, option for political leaders. For all these reasons, governments want to know how efficient their policies are in order to evaluate their effects. Oppositions on the other hand want to know how efficient, or inefficient, the policies of the acting government are in order to have a case against it. The recent global financial and economic crisis has led many countries to consider or implement stimulus packages and austerity measures (see Cwik and Wieland (2011) for an overview). Hence we see no shortage of discussions about the size of multipliers. One recent example are the debates about the multipliers used to evaluate the 2009 stimulus package of the first Obama administration[2], which were supposedly too high, leading to overoptimistic job numbers (see Matthews (2011) for an overview). The discussion about the probable size of fiscal multipliers has also reached the Dutch economic blogosphere, as can for instance be followed on the homepage of *Economisch Statistische Berichten*.[3]

With increased discussions and debates comes increased pressure to find precise values for fiscal multipliers. This is however subject to a number of problems. The biggest of them is the underlying endogeneity problem blurring the chain of causality of fiscal policy: On one hand, fiscal policy affects the real economy through a multitude of channels: governments increase government wages, which raises purchasing power and increases overall consumption; increased government spending in infrastructure projects can create jobs, etc. On the other hand, the real economy also influences fiscal policy: in good economic times, residents pay more taxes, therefore fueling government revenue. In bad economic times, more firms have to downsize or close altogether. As a consequence, more people lose their jobs and ask for unemployment benefits, thereby increasing government spending. In parallel, less income leads to less tax revenue for the government. It is therefore crucial to make a distinction between endogenous and exogenous fiscal policy. The first is the automatic reaction of government expenditures and revenue due to the business cycle. The second are the policy measures that are not a consequence of the current state of the economy. When estimating fiscal multipliers, policy makers are almost exclusively interested in the effects of exogenous policy measures. Without decomposing multipliers into endogenous and exogenous effects, it is impossible to identify the effect of a fiscal policy. Hence the necessity of a sound identification strategy to estimate fiscal multipliers (Blanchard and Perotti (2002)).

In order to identify exogenous changes in fiscal policy, one basically has two broad options. The first is to look empirically at all the policy measures and control for the effects of the automatic changes. The second option is to analyze the problem theoretically and make conclusions about the multipliers by calibrating economic models with reality, e.g., DSGE models (Chinn (2012)). Both techniques have been widely used in the last decades to estimate fiscal multipliers in major countries like the United States, Canada, Germany, or for panels of OECD (Organization for Economic Co-Operation and Development) countries. Comparisons have been made between monetary regimes, trade openness, degree of development or state of the economy. Unfortunately, no technique is perfect. The empirical approach focuses on the data, which typically leads to criticism about the lack of theoretical background. The second and theoretical approach concentrates on the assumptions about the

[1] In its most basic form, the fiscal multiplier corresponds to "the change in output for a change in a fiscal policy instrument such as government spending, transfers or taxes", Chinn (2012), page 1.

[2] American Recovery and Reinvestment Act (ARRA), approved February 17th 2009 by the United States Congress.

[3] `http://www.economie.nl/weblog/de-multiplier-buzz` (accessed 14.08.2013)

behavior of economic agents. One of the main consequences of these two frameworks is the degree to which each option can explain the chain of causality mentioned above. Theoretical models are able to explain the mechanisms perfectly, as each is constructed individually and functions are used to explain economic phenomena. On the downside, these models are restricted in their practicability, as they are bound to assumptions. Empirical models, however, need a sound identification strategy to separate exogenous from endogenous shocks and effects. On the plus side, empirical models give a bigger voice to the actual real data. Whereas theoretical predictions for single countries are multiple, empirical models usually need reliable and detailed data. As a consequence, estimates of fiscal multipliers for single countries have been rather scarce.[4]

This thesis is a first attempt to provide empirical estimates specifically for the Netherlands.[5] We will apply an identification strategy following the first group of strategies, that concentrate on the data. More specifically, this thesis uses a strategy developed by Blanchard and Perotti (2002). We make assumptions about the extent of automatic changes in fiscal policy and about the mechanisms of tax and spending behavior of the Dutch government. In other words, we look at data and *subtract* endogenous from exogenous changes, thereby refraining from qualitatively analyzing past fiscal policy measures or making assumptions about the behavior of economic agents. We estimate a vector autoregression (VAR) model, using quarterly data. Due to the endogeneity problem, we decompose the residual vector into unexpected and structural shocks. Unexpected shocks consist of the usual residuals, i.e., movements in the variables that are not explained by the model. Structural shocks include demand and supply shocks, technology shocks, monetary and fiscal policy shocks. All these shocks have in common that they are exogenous. In order to identify what is ultimately of interest, the structural shocks, we make assumptions about the mechanisms of fiscal policy: First, we assume that unexpected changes in output do not have an impact on government spending within a quarter, as policy measures take more time to be implemented. Second, the reaction of taxes to unexpected changes in output is calculated externally by using information about taxes and transfers. Third, the correlation between tax and spending policy is examined by implementing different orderings. We then calculate impulse response functions with the constructed structural shocks, using different specifications and covariates. The impulse responses are finally transformed into present value cumulative multipliers, which produce more understandable results.

We find a clear pattern in cumulative spending multipliers: they lie in the range of 0.8–1.2, depending on the specification. This corresponds to a closer match to New-Keynesian theories. Tax multipliers, however, reveal a more complicated sequence, where no consistent sign or magnitude is visible. Robustness checks confirm these patterns. A closer look at the data reveals that the scarcity of the data, the difficulty to find reliable numbers, and the presence of a very important and long-lasting outlier, the financial and economic crisis, are possible and probable reasons for these results: the models used in this study are not able to capture these incidents.

The next section provides an overview of existing academic literature and previous empirical studies. Section 3 provides an outline of the econometric techniques used to estimate the fiscal multipliers. The data used in this study is explained and summarized in section 4. Section 5 presents our parameter results, impulse responses and cumulative multipliers for the Dutch economy. Section 6 discusses limits of our approach and concludes.

[4]The exception being the United States.

[5]To the author's knowledge, no empirical estimations are yet available for the Netherlands.

2 Literature Review

As mentioned in the previous section, no technique for calculating or estimating multipliers is perfect. In fact, there exists a clear trade-off between theoretical and empirical models of fiscal multipliers. Theoretical models on the one hand have the advantage that they can simply select whether an endogenous or exogenous policy shock is to happen in the model. Consequently, the causality is crystal clear and the effect can be calculated for any policy shock requested. However, theoretical models come with the disadvantage consisting of restricting assumptions. These are made about most of the underlying mechanisms of theoretical models, thereby restricting the results to a series of conditions. Similarly, changes in conditions can be analyzed quickly as well, as only the parameters need to be changed.

Empirical models, on the other hand, do not restrict the results, as they base their estimates on data and basically let the observations tell the story. The downside of this approach is that the distinction between endogenous and exogenous variables is much more difficult to establish. The identification of this split is relying on assumptions, which, just as in theoretical models, attempt to be as few as possible. Nevertheless, a complete and perfect distinction between endogeneity and exogeneity is close to impossible. Therefore, the exact calculation of an effect of a certain policy is not possible either. The existing literature can be divided into these two groups of techniques that follow said trade-off. Each of those is again subdivided into several branches. This section roughly follows Chinn (2012) and Hebous (2011).

2.1 Theoretical mechanisms and predictions

Like in many other economic theories, the most important element are the assumptions about the behavior of the economic agent. One of the most crucial distinction is whether agents have the ability to look ahead and let their decisions in the present be influenced by rational expectations of other agents' past, present and future behavior.

2.1.1 Without expectations

Classical model In classical models, full price and wage flexibility is assumed, and the supply curve is a vertical line. This entails that any fiscal policy is completely absorbed by the economy through the price levels. Therefore, there is no effect on output, because output is demand-determined (Mankiw and Taylor (2008)).

Keynesian model In Keynesian models, prices are sticky and firms are in an oligopolistic or monopolistic environment. Without expectations, consumption depends only on the present period income. This setup enables fiscal policy to have an effect on output. The precise mechanism depends on the characteristics of the national economy. In a closed economy, the direct effect of a positive government spending shock is that it increases output directly through government purchases themselves. A spending shock also has indirect effects, as government expenditures are income for those economic agents who sell their products to the government. A spending shock is therefore also an income shock, which leads to higher expenditures of the recipients of this income. This in turn leads to higher income for again other agents, and so forth. The total effect on output is know as the multiplier. The increase in borrowing raises interest rates, which can lead to crowding out of private investment. The magnitude of the crowding out as well as of the multiplier depends on the speed of adjustment of nominal prices, in other words the price-stickiness. The stickier the prices, the lower the crowding out, the larger the multiplier. The effect of the tax multiplier has the same sign – negative for a tax increase, positive for a tax cut – but should be smaller than direct government expenditure, as parts of disposable income are saved (Mankiw and Taylor (2008)).

In a small economy with open borders and a floating exchange rate, spending increases raise the interest rate, which increases the demand for domestic currency, leading to a nominal appreciation. As prices are sticky and since capital moves internationally, the real exchange rate appreciates as well. This leads to a decline in exports, neutralizing the initial positive impulse on GDP. If the exchange rate is fixed or pegged, appreciation is prevented by increases in the money supply, and output is allowed to rise. In other words, the multiplier is positive. Keynesian models can be seen as a traditional Mundell-Fleming framework with price frictions (see e.g., Mankiw and Taylor (2008)).

Although the multiplier in a Keynesian framework is usually positive, there are situation in which in can lead to zero or negative multipliers. If we consider the simple equation $Y = C + I + G + NX$, and if G increases by 3 units, and if I decreases by 1 unit due to crowding out effects, NX decreases by 1 and C decrease by 1 due to a exchange rate appreciation, then the total effect on Y is null. Hence the importance of characteristics of the national economy and its links to the rest of the world (Mankiw and Taylor (2008); Spilimbergo et al. (2009)).

2.1.2 With expectations

If agents are allowed to look ahead, the situation changes considerably and also gains in complexity. Simple economic models like the Mundell-Fleming framework are less suited to account for expectations, which resulted in an increasing implementation of dynamic stochastic general equilibrium (DSGE) models. The models of the last two decades have almost always relied on neo-classical (real business cycle or RBC) specifications. In order to obtain a New-Keynesian setup (NK), nominal frictions and imperfect competition are added to the model.

Real Business Cycle models In RBC models, prices are fully flexible and competition is perfect. Forward looking agents are typically Ricardian: an increase in government spending yields expectations of future tax raises to (re-)balance the budget. Similarly, a tax-cut makes agents expect future spending cuts or tax raises. As agents internalize future behavior of governments, a negative wealth effect is created in the present period, i.e., consumption declines in favor of savings, interest rates rise and labor supply increases. Further notable is that the decrease in consumption is independent of the way the government spending is financed, as all expectations are rational. The risen interest rates and hours worked lead to a decrease in wages and an increase in investment and thereby output. *Summa summarum*, output rises whereas private consumption falls. A distinction has to be made between temporary and permanent shocks. Under a permanent shock, the fall in consumption completely balances out the increase in government spending, leading to a lower multiplier. Under a temporary shock, consumption falls less strongly and positive multipliers are possible (Barrell et al. (2012)).

Examples of RBC DSGE models can be found in Fatas and Mihov (2001) or Ramey and Shapiro (1998).

New-Keynesian models Contrary to the RBC framework, the NK framework assumes rigidity in nominal terms and monopolistic competition. The NK results differ from the previous framework in one elementary point: wages increase due to an increased demand of labor by government expenditure. Furthermore, this effect is higher than the downward pressure originating in the increase in hours worked. This leads to a positive consumption response. Positive responses imply that fiscal policy will have a more than proportional effect on output, which basically decreases the effort a government has to do to sustain output. Therefore, positive multipliers are generally seen as a desirable situation.[6]

In order to find a positive consumption response, there are several specification possibilities. All of these imply different further assumptions. As explained extensively in Hebous (2011), models can be adapted on the level of the individuals' utility function, by introducing *habit persistence*, by letting some consumers be *rule of thumb*, i.e., non-Ricardian consumers, or by allowing for spending reversals. The two questions then are whether all these assumptions are realistic, and in what degree they should be integrated in a model for it to be a close representation of reality.

Recent contributions of NK DSGE models have focused on specific situations, such as the zero lower bound (ZLB) during financial crises. Eggertsson (2011), following work by Eggertsson and Krugman (2012), shows that at the ZLB, output is not supply- but demand-determined. This means that short-run multiplier following demand-side oriented fiscal policy changes, such as labor tax cuts or

[6]Others might add that negative multipliers also have advantages: government austerity, through tax increases and/or spending cuts, would increase output, thereby making the government and the whole economy better off.

increased government spending, can be substantially higher. Similar results are found by Christiano et al. (2011) and Woodford (2011). Hall (2009) runs a variety of models under different specifications (NK, RBC, under ZLB regime, etc.). His multipliers are lower than unity in both business cycle specifications, but substantially higher when interest rates reach the ZLB. On the other hand, Farhi and Werning (2012) analytically show that in currency unions, multipliers remain below unity even when the interest rate reach the ZLB. Under a price-stabilizing monetary policy, nominal exchange rates are fixed, implying that price levels eventually return to their original level. In order for the multiplier to be above one, the economy needs other factors, e.g. credit-constrained costumers (see also Wren-Lewis (2013)).

An overview of DSGE estimations done in the QUEST model of the European Central Bank can be found in Henry et al. (2005). Recent Dutch contributions and applications in the field of DSGE models include Lafourcade and de Wind (2012), van der Kwaak and van Wijnbergen (2013). The Dutch Central Bank's (De Nederlandsche Bank, DNB) DELFI model measures a 0.75% (after 1 year) increase in GDP following a positive government consumption shock of 1% of GDP (DNB (2011)). The CPB's SAFFIER model calculates a 1-year multiplier of 0.9% of GDP and a 4-year value of 1.1% of GDP (CPB (2010)). The OECD also computes multipliers for the Netherlands, using their NiGEM[7], and finds cumulative, 1-year, tax multipliers of –0.07 to –0.53 (following a 1 unit spending cut/tax raise), depending on the spending types (Barrell et al. (2012)).

Cwik and Wieland (2011) compare the different DSGE models used in the Euro Area and analyze the probable effects of fiscal stimulus/consolidation.

2.1.3 Ceteris paribus conditions

Spilimbergo et al. (2009) lay out different conditions that can have an influence on the sign and magnitude of fiscal multipliers. Their results are summarized in table 5 in the appendix. Most conditions are rather straight-forward: a higher marginal propensity to consume, a lower propensity to import, non-Ricardian consumers or a higher spending component relative to tax cuts all increase the multipliers by acting on the link between fiscal policy and output. The more of the policy will be targeted on the national economy, the higher will be its effects. Similarly, the economic and monetary situation affects the way economic variables react to changes in policy: the current ZLB, for instance, renders a contrary response by the Central Bank impossible and therefore multipliers will be higher, all else equal. The downside of ceteris paribus conditions is that they, by definition, have more difficulty explaining simultaneous changes. If, e.g., the economy is in a financial and economic crisis and the nominal interest rates reach the ZLB, multipliers are assumed to be higher. Simultaneously, consumer and business confidence is probably very low, which again leads to higher propensities to save, leading to lower multipliers. In reality, there are likely to be even more phenomena happening at the same time.

2.2 Empirical results

When contemplating empirical strategies to calculate fiscal multipliers, the main question always comes down to how to split endogenous and exogenous shocks. This question is affected by several difficulties. First of all, fiscal policy and GDP influence each other. GDP can react to changes in fiscal policy, whereas fiscal policy can also expand or contract in response to changes in GDP. A second problem is the anticipation by economic agents. A change in fiscal policy is usually announced beforehand by government officials. If economic agents expect changes in fiscal policy, they are likely to change their economic behavior, thereby biasing the estimates of the multiplier. Both of these problems have been addressed using different methods for calculating the fiscal multiplier of exogenous changes in fiscal policy, all of them dependent on a credible identification strategy in order to measure and use said exogenous changes. The main strategies are addressed in the next subsections.

[7] National Institute Global Econometric Model

2.2.1 Instrumental variables

In order to solve the endogeneity problem underlying the estimation of fiscal multipliers, several authors have applied an instrumental variable (IV) approach. With this identification strategy, the correlation between output and spending policy is broken by using first stage regressions that explain the variation in fiscal policy variables with instruments. In order to be considered instruments, the variables need to be uncorrelated from the model's error terms, in other words they need to be uncorrelated from the dependent variable, in most cases GDP (Verbeek (2012)). Perotti (1999) studies the impact of fiscal consolidation and high government debt levels on private consumption by assuming exogenous government spending shocks and by constructing an economy behaving differently in times of slack than in times of expansion. Specifically, his model forces consumers to become *hand-to-mouth* consumers[8] when credit-constrained, e.g. in times of crisis. The author uses yearly data of a panel of 19 OECD countries to test the predictions of his constructed model. His results confirm his own model, i.e. that private consumption behaves consistently to New-Keynesian theory in times of expansion, but moves according to RBC theory in bad times. Perotti thereby proposes an explanation why private consumption seems to boom during times of economic expansion and bust when contraction hits. Nakamura and Steinsson (2011) use the financing channel of military spending on the US state level, using quarterly data. They argue that federal investment in military installations is typically highly dependent on geopolitical events, thereby exogenous from the national economy. Furthermore, the authors observe a disproportional effect of military expenditures across states, depending on the proportions of amounts states receive. This leads to the authors' assumption that states that receive disproportionate shares of the military spending chunk are less economically sound than the rest of the states. This enables the authors to calculate exogenous spending multipliers. They find local relative multipliers of 1.5. Acconcia et al. (2011) analyze the influence of spending shocks in Italian provinces when the central government cuts its support. This can happen when local government officials are expelled due to Mafia-related charges. By keeping the tax burden constant and only analyzing spending changes, the authors estimate the short-term multipliers on the provincial level. They find short-term multipliers of 1.2. The analysis of spending multipliers on the provincial level further permits important conclusions about the possible effect of exogenous spending changes in a monetary union, as Italian provinces typically do not have any power concerning monetary policy. Corsetti et al. (2012) also use a two-stage strategy. Exogenous spending shocks are identified by estimating differences between fiscal policy rules and their subsequent effects on the economy. The panel regression of 17 OECD countries is analyzed under different macroeconomic conditions, namely exchange rate regime, level of public debt and a dummy for financial crises. The authors find unconditional values between 0.5 and 1, but significantly higher values for financial crises. Shoag (2010) instrumentalizes windfalls in the US state-level pension system as a predictor for exogenous spending. Specifically, when governmental pension funds hold too many assets, they are required to sell parts of them, which enables positive government expenditure shocks. The author finds a total dollar increase of 2.1. He also analyzes the effects in times of slack and on neighboring states. The multiplier is higher in times of slack, and *spill-overs* or leakages to other states can be large if the payments benefit cities close to state borders.

Also using an IV approach, but analyzing the 1930's run-up of World War II, Almunia et al. (2010) use defense spending as an instrument for government spending and a gold standard dummy as an instrument for the interest rate. Their results are significantly higher than the other IV approaches (and all the empirical approaches in general): the authors find multipliers in the range of 1.1 to 2.2 and a median multiplier of 1.6. The authors argue that this enables important analogies about the spending multipliers in the current financial and economic crisis.

The main point of criticism of IV approaches is, as always with this estimation procedure, weak instrument bias, i.e., whether the variation is really made exogenous (Greene et al. (2005)).

[8] Agents with a propensity to consume of 1, i.e., they fully consume their income.

2.2.2 Vector Autoregression models

Vector autoregression (VAR) models have become increasingly popular both because of their prediction power and their simplicity.[9] Consequently, different identification strategies based on VARs have been developed.

Structural VARs This identification strategy usually uses quarterly data and assumes that changes in output cannot and do not lead to changes in policy in a within-quarter period. Previously used when evaluating the effects of monetary policy, Blanchard and Perotti (2002) (BP) are one of the first to apply this strategy to fiscal policy in the United States. The authors estimate a three-variable model (taxes, spending, output) and identify fiscal policy shocks by assuming different trends and using different covariates. In an extended specification, they also use anticipated shocks. The multipliers are close to unity in the basic specification; they reach values of up to 2, when anticipations are included. Perotti (2004) expands the BP model by endogenizing two additional variables, interest rates and prices, in order to control for the possible effects of monetary policy. He estimates a panel VAR of 5 OECD countries and proceeds to a GDP component analysis. He finds rather weak multipliers. In one of the first attempts to calculate the multiplier for a European country, he finds a one year cumulative multiplier of 0.4 for the case of West Germany. His results for the United States is even higher than BP's results: cumulative spending multipliers go up to 3.68 after 3 years. Still extending his own work, Perotti (2007) looks at 4 OECD countries and estimates a 7 variable model, where GDP components are also allowed to interact. By analyzing different types of spending shocks, the author finds very positive shocks when the government resorts to employment shocks.

More recently, Auerbach and Gorodnichenko (2012b) adapt the BP strategy and enhance it by using a model that is allowed to switch between recession and normal economic times.[10] Their findings can be summarized to very high multipliers in times of recession: 1.5 in year 1, 2.5 in year 5; and negative multipliers in times of expansion. They argue that their results are robust to other specifications, the crisis multipliers are however always higher. When the authors let the regression account for forecasts, the multipliers are very high and reach values up to 7 in some cases.

Chung and Leeper (2007) innovate in this field by including the type of financing of public debt in their analysis. Specifically, the authors add intertemporal governmental budget constraints and rational expectations of households. More interestingly, the authors analyze policy experiments: combinations of both tax and spending shocks. They find that primary surpluses following a tax shock, and taxes following a spending shock are stabilizing policies. Spending adjustments however are not. Bachmann and Sims (2011) include a previously unused variable: consumer confidence. They also estimate two different variance-covariance matrices (for recession and expansion times) to analyze the effect of confidence and spending shocks on output. Their impact multipliers range between 0.8 and 1. The authors argue that confidence is merely a proxy for future productivity, which entails that the latter is actually the driver of today's output.

In one of the few papers looking at the European Union, Beetsma et al. (2008) estimate a panel VAR of countries inside the Euro Area, focusing on the response of trade balance. Their peak multipliers on output reach 1.6, whereas the peak response on the trade balance is 0.8. The authors use the same strategy as BP, but apply it on yearly observations, due to the lack of usable data.

Ilzetzki et al. (2013) estimate a very substantial panel SVAR of 44 countries and analyze different country-specific characteristics (level of development, openness, exchange rate regime, public debt and government investment). Overall, they find very small multipliers on impact, but significant differences between regimes: flexible exchange rates lead to zero multipliers, multipliers are smaller in open economies, and multipliers are negative in high-debt countries. However, their SVAR only analyzes the effect of government spending shocks.

The structural VAR approach has been criticized severely by Ramey (2011a). Her argument is based on the fact that the timing of shocks and expectations is crucial. More specifically, the shocks that are calculated by the researchers can be anticipated by economic agents, even though the quarterly data should not allow that. Anticipations are still present as many changes in fiscal policy are

[9] See Elbourne and Teulings (2011); Sims (1980).

[10] Smooth transition VAR or STVAR

only exogenous in their announcement, not in their actual implementation. Ramey argues therefore that narrative strategies can better capture differences between announcement and implementation of policies. More recently, Leeper et al. (2013) has argued that news and foresight need to be taken into account when estimating the effect of especially tax policy. Others criticize that SVAR models do not account for changes in stock prices, that can have a considerable influence on tax revenue (Baum et al. (2012)).

Sign restriction VARs Another strategy is sign restriction, which has been used much less often. This strategy is even less dependent on *qualitative* assessment of exo- or endogeneity. Basically, the estimation relies on different business cycle assumptions and then scans the data on whether these restrictions apply. One of the first and most mentioned papers using this strategy is written by Mountford and Uhlig (2009). The authors analyze the United States and find clear negative effects of positive tax shocks. Furthermore, their strategy allows them to estimate policy multipliers. The authors find that a deficit-financed tax is the *best* way to stimulate an economy.[11] Pappa (2009) uses the same method to analyze four OECD countries and the Euro Area. She finds generally low multipliers below unity except in Canada and the US. Like Perotti (2007), government employment shocks have the biggest effect. Furthermore, fiscal shocks seem to crowd out investment in the Euro Area, Japan and the United Kingdom. Notable are also her results that response functions differ widely across countries. Cumulative 1-year values in the Euro Area, UK and Japan barely go above unity. Canadian and US responses reach values of 1 and 2.

Other VAR specifications Forecasts and predictions have been used repeatedly as a robustness test. However, Auerbach and Gorodnichenko (2012a) have made these measures their main identification strategy. By correcting for professional forecasts, the authors measure exogenous shocks, as by definition, they are not forecastable. By looking at a panel of OECD countries, they find cumulative multipliers of around 2.3, over a period of 3 years. They also observe higher multipliers in closed economies, economies with rigid labor markets or lower government debt, ceteris paribus. Born et al. (2013) include forecasts as well, but do not include taxation. Focusing on the effect of exchange rate regimes in OECD countries, the authors find a multiplier of 1.2 after 2 years in pegged exchange rate regimes; in a floating regime, the average cumulative multiplier is 0.75. Using forecasts has one clear disadvantage: as it is often unclear on which models they rely. As made clear by Blanchard and Leigh (2013), forecasts seem to be severely biased for measures in crisis years.

Using a threshold VAR to account for different regimes, Baum et al. (2012) estimate cumulative fiscal multipliers for 6 of the 7 G7 countries. Results differ widely across countries and regimes: Germany with a positive output gap, i.e. in expansion, shows spending multipliers of 0.2 for 4 quarters; 0.1 for 8 quarters. A negative output gap lets the spending multiplier increase to 1; 0.8 for 8 quarters. Tax multipliers lie in the range of –0.7 for expansions and –0.5 for recessions; –0.5 and –0.4 for 8 quarters respectively. Noteworthy are also the very low multipliers in the case of the United Kingdom. Spending multipliers do not exceed 0.2. The authors' results for France yield very low spending multipliers (–0.1 to 0.2) and positive tax multipliers: 0.5 in expansion, 0.7 in recessions, both for 4 quarters.

2.2.3 Narrative approach

Although the narrative approach usually also relies on a VAR, it differs to the previous subsection in the way of identifying exogenous and endogenous shocks. The strategy of all papers using the narrative approach is to analyze past changes in government spending and to argue qualitatively which spending shocks can be identified as exogenous. An ubiquitous candidate of exogenous changes is military spending, as it is often argued that military buildup is completely uncorrelated with other macroeconomic variables. One of the first papers to apply the narrative approach – and also the most cited item – is written by Ramey and Shapiro (1998). The authors use a new measure of military spending shocks and estimate the effect of major buildups, e.g., Korea, Vietnam and Iraq, on different

[11] The authors however stress the possible negative consequences for government finances.

variables. Their results show a clear negative wealth effect on consumption and GDP. Later estimates in other papers – namely those using SVARs – have yielded contradicting results, e.g., positive effects on output. Next to a SVAR analysis, the aforementioned paper by Perotti (2007) also resorts to a narrative analysis for comparison. Similar to the results of the structural analysis, he finds results that contradict those of Ramey and Shapiro (1998), namely a very positive effect on GDP, private consumption, private capital formation and different employment variables. Romer and Romer (2010) introduce new measures of exogenous fiscal policy shocks. They analyze all major speeches and economic reports of government officials[12] to assess exogeneity of tax changes. The authors find a clear negative effect of tax increases on GDP (cumulative multipliers of more than 2), unemployment rate and inflation rate. As expected, endogenous changes seem not to have any significant effect. In an effort to defend her previous results and methodology, Ramey (2011a) makes a case in representing her own results and those by BP in a new light, by introducing delays in the SVAR. She also uses new measures for the narrative analysis, namely professional forecasts as an instrument. Her results are again more consistent with neo-classical or RBC analysis, which the authors put down to the important influence of anticipation effects.

For more general discussions about the multipliers or authors treating several strategies at once, we refer the reader to Caldara and Kamps (2008); Favero and Giavazzi (2007); Hebous (2011); Suyker (2011) and Ramey (2011b).

Based on this discussion, we proceed to an empirical estimation of the Dutch fiscal multiplier, based on a SVAR and the sign restriction method. The empirical approach is chosen here for several reasons. First, DSGE models already exist for the Netherlands and can provide the public with calculations, estimations and predictions about the size of fiscal multipliers. They can also give information about the probable changes in the fiscal multipliers should some underlying conditions vary. Empirical estimates, that base their conclusions on data, are less available. The approach used by Blanchard and Perotti (2002) has, to the author's knowledge, never been used to estimate the Dutch fiscal multiplier. Its main advantage lies in the fact that it can be estimated based on a standard VAR model. It is therefore not dependent on instrumentalization, where a weak instrument bias can virtually never be excluded. Neither does it depend on a lot of qualitative research like the narrative approach, where considerable time has to be invested in order to identify exo- or endogeneity. A comparably simple SVAR model can therefore be used as a benchmark estimate, providing insight into the fiscal policy mechanisms of the Dutch economy. Furthermore, its *neutral* character also allows comparisons with other estimates, models or expected results.

[12] Namely reports by the office of the President of the United States.

3 Methodology

This paper proceeds in several estimation steps. First, and as a baseline specification, we estimate a three variable Structural Vector Autoregression (SVAR), using taxation, spending and output as endogenous variables. To control for monetary policy influence, we extend the model to allow for variation in interest and inflation rates. Both models are also enhanced by exogenous variables. The first model follows Blanchard and Perotti (2002), the extension is based on Perotti (2004). The third step consists of several robustness tests, one of them being an additional estimation model estimating the influence of these variables using a sign restriction model, developed by Mountford and Uhlig (2009). All these specifications are further discussed in the following subsections. For a closer look at the definitions of the variables, we refer the reader to section 4.

3.1 Structural Vector Autoregression models

3.1.1 The basic model

For the first VAR specification, we use the following specification (Greene et al. (2005)):

$$X_t = \Lambda(L)X_{t-1} + \Gamma D_t + U_t, \tag{1}$$

where $X_t \equiv [t_t, g_t, y_t]'$, i.e., a vector of three variables for quarter t, specifically the natural logs of real seasonally adjusted taxes, spending and output respectively. The matrix D_t includes trends and dummies. $\Lambda(L)$ is a lag polynomial describing the relationship between coefficients in each quarter. Γ defines the coefficient matrix of the dummy matrix and $U_t \equiv [u_t^t, u_t^g, u_t^y]'$ incorporates the reduced form residuals.

The coefficients for the different lags, trends, constants and dummies are estimated using OLS, the best linear and unbiased estimator in this case (Greene et al. (2005)). The standard errors are found calculating Monte Carlo bootstraps, due to the limited amount of observations. The OLS estimates yield a residual vector. In order to be able to make conclusions about causal chains of fiscal policy, and since the reduced form residuals do not account for causal relationships between variables, we need to recover structural shocks from the residuals. We do this by decomposing the reduced form residuals in the following way:

$$u_t^t = a_1 u_t^y + a_2 e_t^g + e_t^t \tag{2}$$
$$u_t^g = b_1 u_t^y + b_2 e_t^t + e_t^g \tag{3}$$
$$u_t^y = c_1 u_t^t + c_2 u_t^g + e_t^y, \tag{4}$$

where u_t^t, u_t^g and u_t^y are the unexpected movements in spending, taxes and output. Unexpected movements correspond to the usual residuals from the VAR estimates, i.e., the part of the data that is not explained by the model. e_t^t, e_t^g and e_t^y are the mutually uncorrelated structural shocks, our main point of interest: structural shocks include, among others, demand and supply shocks, technology shocks, or monetary and fiscal policy shocks. They capture the share of U_t that is due to exogenous factors, i.e. not dependent on policy and the *normal* evolution of the economy. Equations (2)–(4) can be rewritten as matrices:

$$\begin{pmatrix} 1 & 0 & -a_1 \\ 0 & 1 & -b_1 \\ -c_1 & -c_2 & 1 \end{pmatrix} U_t = \begin{pmatrix} 1 & a_2 & 0 \\ b_2 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix} E_t \tag{5}$$

$$\text{i.e. } AU_t = BE_t, \tag{6}$$

where $E_t \equiv [e_t^t, e_t^g, e_t^y]'$. This system of equations is not useful with that many unknown parameters.[13] Therefore, we rely on external information (for a_1 and b_1), on an instrumental approach (for b_2, c_1 and c_2) and on further assumptions about the within-quarter influence of these endogenous variables (for a_2).

[13] Although it can be solved, it yields an infinite amount of results. We are only interested in a unique answer

External information To obtain values for a_1 and b_1, we use external information about the tax and transfer system in the Netherlands. Due to the endogeneity of the underlying variables, these two parameters can contain two sets of information: endogenous changes in taxation and spending due to changes in GDP, and exogenous fiscal policy shocks as a response to extraordinary unexpected movements in output. Since we use quarterly data, we assume that the second channel is not possible within a given quarter, as a government is not able to react automatically nor quickly to the economic cycle. Furthermore, policy responses also take more than a quarter, as not only does it usually take more time to produce appropriate responses, but a new spending decision usually has to pass before the parliament and has to be accepted in order to be activated. The assumption is also supported by the so-called *Zalmnorm*, valid specifically for the Netherlands: During the first Kok cabinet (1994–1998), finance minister Gerrit Zalm installed the political principle that government expenditures are institutionally and decisionally detached from government income movements; and that spending limits are voted ex-ante. This last point implies that $b_1 = 0$. For a_1, or the automatic responses of taxes to changes in output, we use different values of output elasticities of taxes.[14] The computations of elasticities are explained in section 4. a_1 is assumed to be constant over the sample period.[15]

Further assumptions Typically, when a government implements its fiscal policy, it will change both tax and spending policy. As a consequence, either a_2 or b_2 needs to be non-zero to capture the correlation between the two variables. $a_2 = 0$ implies that the government may change tax policy only, but changes in spending policy will always lead to changes in tax policy. When $b_2 = 0$, unilateral spending policy changes are allowed, but not the opposite. As explained in Blanchard and Perotti (2002), there is no credible way to identify whether taxes are responding to increases in spending or the reverse, when both variables are increased. Therefore, we first estimate the parameters setting $a_2 = 0$ and estimating b_2 and vice-versa.

Instruments Having obtained values for a_1 and b_1 (a_2 and b_2), we can calculate the cyclically adjusted residuals of taxes and spending: $\tilde{u}_t^t = u_t^t - (-a_1)u_t^y$ and $\tilde{u}_t^g = u_t^g - b_1 u_t^y = u_t^g$. Although $\tilde{u}_t^t$ and $\tilde{u}_t^g$ are still correlated with each other, they are not anymore with e_t^t and e_t^g. Therefore, we can use $\tilde{u}_t^t$ and $\tilde{u}_t^g$ as instruments for u_t^y and u_t^g and estimate c_1 and c_2.[16]

3.1.2 The basic model with additional variables

Besides endogenous variables, a small extension of the model allows us to account for exogenous variables. Our model therefore has the following form (Greene et al. (2005)):

$$X_t = \Lambda(L)X_{t-1} + \Phi(L)Z_{t-1} + \Gamma D_t + U_t, \tag{7}$$

where Φ is the lag polynomial of the exogenous variable vector Z. Once the coefficients and the standard errors are calculated from the VAR, the rest of the estimation procedure stays identical to the previous model.

3.1.3 The extended model

For the second main estimation procedure, we follow the paper of Perotti (2004) by including other explanatory variables in our VAR model. We do this to prevent omitted variable bias that can occur when ignoring other influences on GDP. Dutch GDP is highly correlated to the German GDP for instance, which has a big influence on Euro Area wide interest rates.[17] Specifically, we include inflation (p_t) and interest rates (i_t) to our dependent variable vector. Contrary to the inclusion of oil prices, which can be assumed to be completely exogenous, the case of interest and inflation rates is a

[14] This is possible as all the aforementioned variables are expressed in logs.

[15] Implications are discussed in section 6.1.

[16] In vector form: $\hat{b}_2 = \frac{\tilde{u}_t^{t\prime} u_t^g}{\tilde{u}_t^{t\prime} u_t^t}$; $\hat{c}_1 = \frac{\tilde{u}_t^{t\prime} u_t^y}{\tilde{u}_t^{t\prime} u_t^t}$; $\hat{c}_2 = \frac{\tilde{u}_t^{g\prime} u_t^y}{\tilde{u}_t^{g\prime} u_t^g}$

[17] Correlation of Dutch to German GDP: 0.97. Source: Eurostat

bit more complicated. In 1999, the Netherlands relinquished their monetary autonomy and thereby also their direct influence on interest and inflation rates. One could therefore consider them to be exogenous. However, we can treat them as endogenous throughout both monetary regimes, as Dutch and European-wide interest rates have been highly correlated for several decades. In a small VAR with many omitted variables, exogenous variables can appear as endogenous. Nevertheless, this leads to a loss of efficiency.[18]

In addition to these considerations, and as done previously for the other endogenous variables, we can write down the decomposition of the reduced-form residuals:

$$u_t^t = \alpha_1 u_t^y + \alpha_2 u_t^p + \alpha_3 u_t^i + \alpha_4 e_t^g + e_t^t \quad (8)$$
$$u_t^g = \beta_1 u_t^y + \beta_2 u_t^p + \beta_3 u_t^i + \beta_4 e_t^t + e_t^g \quad (9)$$
$$u_t^y = \gamma_1 u_t^t + \gamma_2 u_t^g + \gamma_3 u_t^p + \gamma_4 u_t^p + e_t^y \quad (10)$$
$$u_t^p = \delta_1 u_t^t + \delta_2 u_t^g + \delta_3 u_t^y + \delta_4 u_t^i + e_t^p \quad (11)$$
$$u_t^i = \lambda_1 u_t^t + \lambda_2 u_t^g + \lambda_3 u_t^y + \lambda_4 u_t^p + e_t^i. \quad (12)$$

As in the previous model, this equation system shows the mechanisms between unexpected and structural shocks. For instance, the first equation of the system states that unexpected shocks in tax revenue u_t^t are influenced by unexpected shocks in output u_t^y, unexpected shocks in inflation u_t^p, unexpected shocks in interest rates u_t^i, structural shocks in spending e_t^g and structural shocks in tax revenue e_t^t. The coefficients α_1, α_2 and α_3 indicate the direction and magnitude of the effects of automatic shocks. α_4 captures the sign and size of the effects of structural shocks. This yields the following matrix:

$$\begin{pmatrix} 1 & 0 & -\alpha_1 & -\alpha_2 & -\alpha_3 \\ 0 & 1 & -\beta_1 & -\beta_2 & -\beta_3 \\ -\gamma_1 & -\gamma_2 & 1 & 0 & 0 \\ -\delta_1 & -\delta_2 & -\delta_3 & 1 & 0 \\ -\lambda_1 & -\lambda_2 & -\lambda_3 & -\lambda_4 & 1 \end{pmatrix} U_t = \begin{pmatrix} 1 & \alpha_4 & 0 & 0 & 0 \\ \beta_4 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 \end{pmatrix} E_t \quad (13)$$

Again, we rely on external information, assumptions and instrumentalization.

External information As explained above, several of the parameters can be seen as elasticities. α_1 is the output elasticity of tax revenue, as in previous sections. Again, the output elasticity to government spending (β_1) is set to zero. α_2 and β_2 are the price elasticities of taxation and government spending. α_3 and β_3 also take a null value, since taxes and spending are not assumed not to be affected by interest rates within a quarter. Further remain the interest rate elasticities of taxation (α_3) spending (β_3), which are also determined externally. γ_3 (price elasticity of output), γ_4 (interest elasticity of output) and δ_4 (price elasticity of interest rates) all equal zero. Output being deflated (see section 4), it doesn't act on the inflation rate directly. Neither is output affected by interest rates within a quarter. Finally, interest rates are assumed not to be affected by inflation within a quarter period.[19]

Further assumptions As with Blanchard and Perotti (2002), the parameter α_4 is set to zero. The alternative ordering, where $\beta_4 = 0$, is examined as well.

Instruments We calculate cyclically adjusted residuals of taxes and spending, using the stated assumptions. We thereby subtract all automatic changes from the policy variables:

$$\tilde{u}_t^t = u_t^t - ((-\alpha_1)u_t^y + (-\alpha_2)u_t^p) = e_t^t \quad (14)$$
$$\tilde{u}_t^g = u_t^g - ((-\beta_1)u_t^y + (-\beta_2)u_t^p) + \hat{\beta}_4 e_t^t = e_t^g + \hat{\beta}_4 e_t^t, \quad (15)$$

where $\hat{\beta}_4$ has been estimated using $\tilde{u}_t^t$ as an instrument for u_t^t.[20] This allows the estimation of γ_1 and γ_2, using $\tilde{u}_t^t$ and $\tilde{u}_t^g$. To estimate δ_1, δ_2 and δ_3, we construct $\tilde{u}_t^y$, using $\hat{\gamma}_1$ and $\hat{\gamma}_2$ as an instrument for

[18] Imposing the restriction of exogeneity can also lead to a misspecification bias.
[19] These last two assumptions are admittedly rather restrictive. They are however needed for the identification process.
[20] See footnote 16

u_t^y. The same technique is used for $\hat{\lambda}_i$. As we are only interested in the tax and spending shocks, the ordering of the fourth and fifth row is of less importance.
As explained previously, the parameters are used to calculate impulse response functions, using Monte-Carlo draws for the confidence bands.

The extended model with additional variables

Again, we can include oil prices as exogenous and confidence as endogenous variables, using the same technique as explained above (see section 3.1.2).

3.2 Sign restriction

The last step consists of robustness tests, and among others, a sign restriction analysis. This estimation method will be analyzed in less detail as its main purpose is to provide measures to check our two SVAR models. We assume identifying assumptions about the probable evolution of the variables in our VAR model. In other words, instead of estimating and using the parameter matrices of our shocks, our A and B matrices describing the unexpected and structural shocks, we take a sample of all possible orthogonalization of the covariance matrix. Of all these matrices, we pick those that match with our assumptions about the sign of the variables. For fiscal policy, we typically expect that if tax revenue is raised, output falls. Similarly, if government spending is raised, output is expected to rise as well. In other words, we impose our ex-ante beliefs about the effects of fiscal policy on the dataset.

For this method, we estimate a traditional VAR model (see equation (1)), with three endogenous variables and with or without exogenous variables. The estimated coefficients are plugged into a companion matrix, which is then used to calculate all possible impulse responses of the model. The orthogonalization matrices are computed using Cholesky decomposition of the covariance matrix of the VAR residuals. Finally, the impulse responses with the correct signs are extracted, sorted and plotted over a given number of impulse periods.

Compared with the first two models, this third identification strategy relies on no assumptions on any elasticities, within quarter reactions, etc. Consequently, the results are all the more dependent on the data set.

4 Data

4.1 Variables

Net taxes are defined as income and property tax receipts, corporate tax receipts, indirect tax revenues and social security premia. Government spending contains government consumption, government investments transfer payments to individuals (*uitkeringen*), tax subsidies (tax expenditures), minus expenditure subsidies. Taxes and spending are corrected for the new Dutch health care system introduced in 2006.[21] As a consequence, important amounts were shifted between private and public insurance companies. In order to correct for this shift, the time series are nominally corrected by an amount of €1.95bn[22] in 2006Q1. Output is defined as the sum of all products and services produced in a given period on the national territory (GDP). Interest rates are defined as the 10-year Dutch government bond rate and inflation rates are measured by the consumer price index of the Netherlands. Taxes, spending and output are deflated and seasonally adjusted.

Net taxes and government spending for our baseline period (2001Q1–2013Q1) are collected from sector statistics by Statistics Netherlands (Centraal Bureau voor de Statistiek, CBS).[23] For the extended sample (including 1996Q1–2000Q4), we make use of data produced by the *Saffier* model (for government consumption, government investment, subsidies, social security premiums) and other internal sources (for tax income) of the Netherlands Bureau for Economic Policy Analysis (Centraal Planbureau, CPB).[24] Quarterly data for Dutch output is taken from Eurostat. Bond rates are retrieved from Eurostat. Measures of the inflation rates are available at the CBS. Quarterly oil prices are computed by calculating the three-month average of monthly oil prices, available at the CBS.

4.2 Properties

The time series for taxes, spending and GDP are plotted in figure 1. Interest and inflation rates are plotted in figure 2. We see that until the beginning of the financial crisis, net taxes and government spending move more or less on the same path. Net tax revenue plateaus slightly in 2001 but takes off again after 2003. The recent financial and economic crisis is clearly visible in all graphs. Net taxes peak in the middle of 2008, right before GDP declines substantially. Spending, however, stays on an upward track only to plateau in the middle of 2009. We also observe a clear decline in interest rates right after the bankruptcy of Lehman Brothers in August of 2008. Inflation has a clear downward trend these last two decades. We observe that inflation rates slightly improved in the run-up to the crises, dot.com in the beginning of the year 2000s and global crisis starting in 2007/08. They eventually declined during the financial crisis and ever since, with the exception of 2011, where a small spike is visible.

The model is analyzed with a crisis dummy for 2008Q3, the start of decline of output in the recent financial and economic crisis. Unit-root tests (Augmented Dickey-Fuller tests) for all endogenous variables (taxes, spending, output) cannot reject the unit-root hypothesis. Due to the limited power of Dickey-Fuller tests (Verbeek (2012)), we calculate the models both with a deterministic and a stochastic trend. The former takes the form of a linear trend with an intercept, whereas the latter specifies the model without trend nor intercept variables.

Table 1 shows summary statistics for the main explanatory variables in the model. The statistics show a clear difference between the two sub-samples (1996Q1–2000Q4 and 2001Q1–2013Q1) for most of the variables.[25] A more appropriate way of comparing the two sub-samples would be to estimate multipliers for both the long and the short sample. However, this is rendered difficult if not impossible by the scarcity of data. Figure 3 shows the share of GDP of net taxes and government spending over the whole sample. We see that taxes have generally been lower than government spending.[26]

[21] ZVW, Zorgverzekeringswet

[22] Bn (billions) equal 10^9.

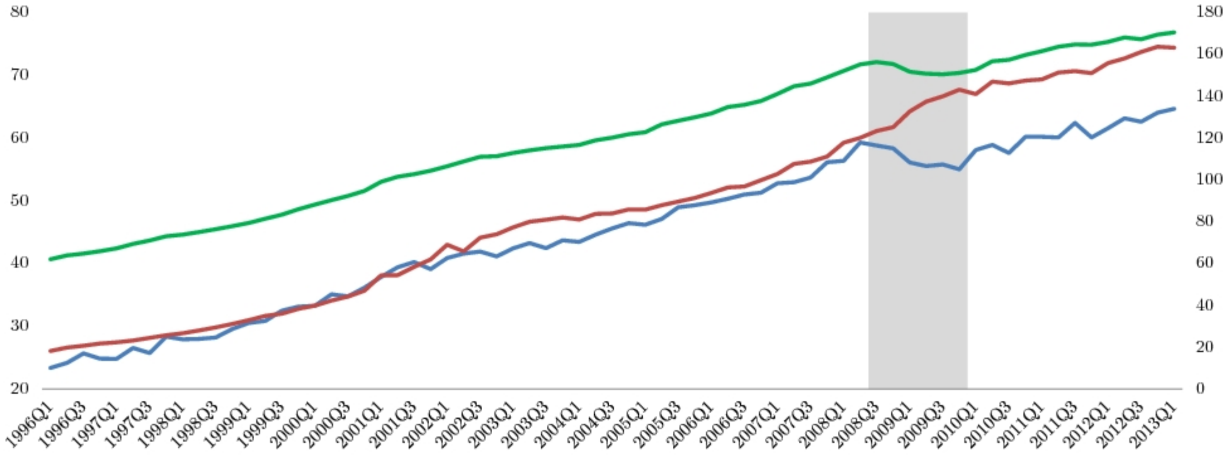
[23] For other definitions, see section 5.4.

[24] Saffier data is composed of splined time series. Implications are discussed in section 6.1.

[25] Difference between the two subsamples are partly due to the different data sources. It remains however interesting to make a distinction between samples and analyze them separately.

[26] Note that the difference of the two measures is not the EMU-Saldo.

Figure 1: Net taxes, government spending and GDP, in €bn, seasonnally adjusted and deflated.

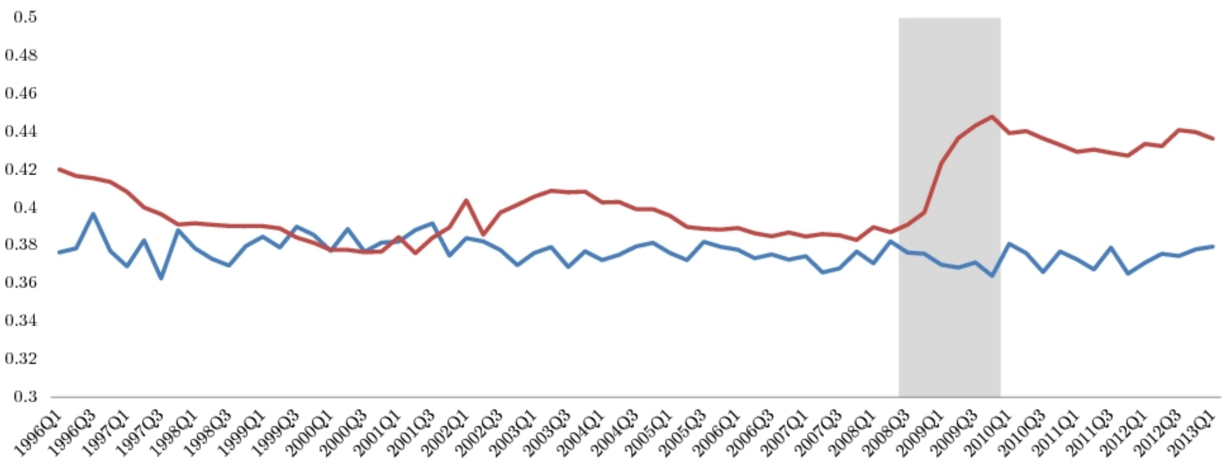


(Blue line: net taxes; red line: government spending (both on left axis); green line: GDP (right axis); shaded areas indicate recessions)

Figure 2: Long term government interest rates and inflation, in percentage points

(Blue line: inflation; red line: long term government interest rates in green; shaded areas indicate recessions)

Figure 3: Percentage share of GDP



(Blue line: net taxes; red line: government spending; shaded areas indicate recessions)

Table 1: Summary statistics, policy variables.

	Sample	Taxes (€bn)	Spending (€bn)	GDP (€bn)	Int. rates (%)	Inflation (%)
Statistical mean	(1)	45.16	48.84	120.14	4.18	2.57
	*	37.66%	40.36%			
	(2)	29.18	30.13	76.80	4.16	2.79
	*	37.98%	39.39%			
	(3)	51.68	56.47	137.83	2.47	2.48
	*	37.54%	40.43%			
Standard deviation	(1)	12.46	15.38	33.90	1.13	1.03
	(2)	3.94	2.91	9.95	0.80	0.71
	(3)	7.37	10.19	20.57	1.41	1.15

Notes: Sample (1): 1996Q1-2013Q1; sample (2): 1996Q1-2000Q4; sample (3): 2001Q1-2013Q1; *: average share of GDP in %.

This figure also shows more clearly that the variance of net taxes and government spending differ substantially, with the exception of the crisis, where the share of government spending skyrockets due to the decline in GDP. We see that tax revenue reacts more strongly to the current economy than spending. Government expenditures are usually budgeted at the beginning of a cabinet period and/or for the yearly budget in August. Both these observations confirm our assumptions from our model.

4.3 Elasticities

Basic model a_1[27], the output elasticity of taxes, is computed by relying on external information. We follow Blanchard and Perotti (2002) and compute a weighted average elasticity using data from Girouard and Andre (2005). We use tax and social security premium elasticities to calculate the average elasticity. The different elasticities are weighted by the share of different taxes to the total amount of tax revenue:

$$a_{1,t} = \sum_i \eta_i \frac{\tilde{R}_{i,t}}{\tilde{R}_t} \tag{16}$$

$$a_1 = \frac{1}{T} \sum a_{1,t}, \tag{17}$$

where η_i is the tax elasticity to output of tax i (i = income tax, corporate tax, indirect tax, social security premium), $\tilde{R}_{i,t}$ is the revenue level of tax i in quarter t and $\tilde{R}_t$ is the total amount of tax revenue in quarter t. T indicates the total number of observations. The values of η_i are shown in table 2. Using these values for the short sample, we obtain an elasticity of 1.38. As mentioned, a_1 can be seen as an average tax elasticity to output. Consequently, multipliers calculated with this value are also *average* multipliers.[28]

Extended model For α_1[29], we use a_1. The value for α_2 is computed taking a weighted average of revenue elasticities, following Perotti (2004). For this value, the procedure is almost identical to the calculation method for a_1. We use the values of elasticity of income tax relative to earnings (resp. social security contributions relative to earnings) from Girouard and Andre (2005), from which we subtract 1 to obtain price elasticities ν_i (see table 2).[30] This gives us a value of $\alpha_2 = 0.46$. β_2 is the price elasticity of government spending. Government spending consisting of wages is typically

[27] See equation 2

[28] Alternative values for a_1 are analyzed as robustness checks, see section 5.4.

[29] See equation 8

[30] Constructing an appropriate value for the price elasticity of corporate taxes is practically impossible, because of many complex effects. It is therefore set to 0. The price elasticity for indirect tax revenue is 0, as the revenue variable is in real terms (Perotti (2004))

not affected by price changes in the same quarter as the indexing of government wages is lagged by several quarters. Furthermore, keeping government wages nominally fixed has been used several times as a measure to cut down on spending. This leads to the conclusion that real government spending on wages a price elasticity of -1 within a quarter (Perotti (2004)). For other expenditures, spending might be more indexed to the current price level. With these points in mind, we use a benchmark value of $\beta_2 = -0.5$.[31]

Table 2: Values for η_i and ν_i

i	η_i	ν_i
income tax	1.7	1.4
corporate tax	1.5	0
indirect tax	1.0	0
premiums	1.0	-0.2

Source: Girouard and Andre (2005)

The interest rate elasticities (α_3 and β_3) of government revenue and spending are set to zero as well. A look at the composition of government revenue and spending shows that the items depending on interest rates the most (taxes on dividends, property, etc.) represent only a small fraction of total government revenue.[32] In other words, the bulk of revenue is generated by income taxes and indirect taxes, which are not directly affected by the interest rates.[33] Furthermore, we assume that the effect of interest rates on government spending via government debt is not present within a quarter.

4.4 Programs

We use Matlab to estimate the base VAR (with OLS) and to calculate the impulse response functions. The code is adapted from Fabio Canova and Evi Pappa, made available by the CPB. Seasonal adjustment is obtained using the X-12-ARIMA method developed by the U.S. Census Bureau, implemented within Eviews 7. Summary statistics and cumulative multipliers are calculated using Microsoft Excel 2007.

[31]In order to account for different levels of price adaptation, we use alternative values of the price elasticity of government spending as a robustness test, see section 5.4.

[32]Taxes on dividends and property range between 3 and 6%.

[33]Income tax, VAT and corporate tax represent about two thirds of tax revenue.

5 Results

This section addresses the estimation results and calculations based on the models described in section 3. We first look at the basic model, which we also enhance with additional exogenous variables. Since the results are not very satisfactory, we then estimate an extended model. Robustness tests examine several assumptions taken in the model. Among others, and using the sign restriction method, we take more drastic steps and impose our expectations directly on the data and observe the reactions. As we are confronted with data from two different samples from two different sources, we show the results for both the short (2001Q1–2011Q4) and the long sample (1996Q1–2011Q4). Furthermore, and based on the Schwarz Criterion (SIC) (see Schwarz (1978)), all results correspond to VARs estimated with two quarterly lags.

5.1 Basic model

5.1.1 Baseline estimates

We first look at the basic, three variable model. Table 6 in the appendix shows the parameters of the A and B matrices, which describe the tax (c_1) and spending (c_2) elasticity of output and the automatic response of spending to taxes (b_2) or vice-versa (a_2). For the benchmark results, we use a output elasticity of taxes (a_1) of 1.38.[34] Following New-Keynesian analysis (see Mankiw and Taylor (2008)), we would expect c_1 to be positive and c_2 to be negative. A positive c_1 implies a negative[35] effect of unexpected movements in taxes on unexpected movements in output: First, an unexpected increase in taxes is assumed to lead to an unexpected decrease in the spendable income of households, thereby unexpectedly decreasing consumption and overall GDP. Second, the unexpected increase in government revenue, which increases output directly, is assumed to be less than the previous effect, not being able to offset the unexpected decrease in output. Conversely, a negative c_2 stands for a positive relationship between unexpected movements in spending and unexpected movements in output, through different channels: First, unexpected increases in government spending are assumed to lead to unexpected increases in output directly. Second, contractors that profit from unexpectedly increasing government expenditures have more income and will therefore also spend more, thereby fueling output. The expected signs of a_2 and b_2 are less clear. Governments can typically increase both taxes and government spending, thereby implying a positive parameter. On the other hand, on can also observe governments that increase taxes and decrease spending, which would lead to a negative sign of the correlation parameter.

Looking at the parameters, we note that the parameters a_2 and b_2 show no clear pattern in their signs, although it is usually negative, pointing towards simultaneous opposite changes in policy. We further note that the signs of c_1 and c_2 are always met in the specification with deterministic trend with our original ordering – except for the model with oil prices and crisis dummies for the short sample. This leads us to mainly consider this specification and leaving the specification without the stochastic trend aside. The model with stochastic trend is driven by the absence of the deterministic trend and mostly displays explosive responses. The alternative ordering indicates no remarkable difference from the original ordering. Representative impulse response functions for the specification with a stochastic trend and the alternative ordering are displayed in the appendix (figures 8 and 9).[36]

We further see that standard errors are always bigger than the coefficients. Whereas this indicates statistical insignificance, it however is difficult to interpret due to the restricted sample, as statistical significance is a measure of the sample size. Similarly, the confidence bands of the impulse response functions are very large. This is common in VARs and is to be even more expected with that a short sample period. Even if the parameters are not significantly different from zero, this gives us a message about the probable sign of the parameters (Kennedy (2002)).

Figures 4a and 4b show tax and spending shocks for the period of 2001Q1 until 2013Q1 without and with crisis dummies respectively. The impulse response figures depict a positive one standard

[34] Alternative values of a_1 are discussed in section 5.4

[35] Note that the signs are reversed in the decomposition matrices, as they come from equation 2.

[36] All impulse response functions for both the stochastic trend and the alternative ordering for all specifications are available on request.

deviation shock of taxes, i.e., a tax increase, or spending. The blue lines delimit the confidence bands with 68% certainty. For all four specifications, we see revenue shocks (upper row) and spending shocks (lower row) and their effect on the other variables. All figures show that a positive revenue shock leads to a negative impact response of spending, after which the response reaches either positive level (without the crisis dummies) or stays approximatively around the 0 level (with crisis dummies).

Even though examining the impact of tax and spending shocks on themselves is important to check for the reliability of the results, our main focus lies in the output responses. The output response to tax shocks is negative for both specifications, which matches NK expectations. The shape of the reaction is negatively hump-shaped when we do not include crisis dummies and consistently negative when including said dummies. Without dummies, the function peaks at around –0.5 standard deviations after approximatively a year, before continuously heading for zero values. The response stays significantly different from zero for several periods. With crisis dummies, the response is not as strong, the function peaks at –0.1, also after 4 quarters. The confidence bands however show that these values are not significantly different from zero. When concentrating on spending shocks on output, a different picture emerges. The specification without crisis dummies displays negative spending multipliers. This does not match with the theoretical predictions of NK models, as these suggest a spending shock should lead to a positive output response. First of all, the response should be positive for an algebraic reason: an increase in government spending increases the standard definition of output.[37] Second, the response should be multiplied due to the chain effect on, e.g., consumption, such as the response should be higher than 0. The spending multipliers of the model accounting for the crisis are positive, with an initial multiplier of 0.15 and a second peak at around 0.125 after two years. It then declines back to 0, revealing a hump shape.

5.1.2 Including exogenous variables

Given that the results shown in the previous paragraph show rather unsatisfactory traits and do not match NK expectations, and in order to attempt to improve the underlying VAR, we include exogenous variables.

Oil prices Following the analysis of Sims (1980), we add a variable describing oil prices in the VAR model. According to Sims, oil prices have both indirect and direct influence on the evolution of macroeconomic variables. Furthermore, the SIC show that from a specification point of view, the inclusion of oil prices seem like a reasonable choice. Table 6 displays the estimated parameters for the structural residuals and responses for specifications with a deterministic trend are shown in figures 4c and 4d.[38] The signs of the reaction without crisis dummies are identical whether we include the new variable or not. Tax multipliers are slightly less negative, peaking at approximatively –0.4 after 2 years. Spending multipliers are more negative and reach values of –0.6 after 2 years. When including crisis dummies, the responses are again showing more controversial multipliers, i.e. positive tax multipliers, although very small and the zero line lies inside the confidence bands, and basically zero spending multipliers. These occurrences, already met in the previous section, might be due to *special* structural shocks during this time period.[39] Crisis dummies do add quality to the specification, based on the SIC. On a more intuitive level, the presence of a crisis is likely to have an important influence on the development of all variables. Therefore, we keep the dummies in our model.

5.1.3 Alternative time samples

We also have a look at the extended sample period, by including data from 1996Q1 to 2000Q4. Figures 5a and 5b show the impulse response functions without and with crisis dummies. The signs are now according to NK predictions: responses to tax shocks are negative or insignificantly different from zero, responses to spending are positive. In the basic specification, the tax multiplier peaks

[37] See section 2.1.1

[38] C.f. the appendix for representative impulse response functions of other specifications.

[39] An analysis of structural shocks do however not show any large outliers except the financial crisis. The possibility of several small special shocks cannot be excluded.

at around –0.175 after 2 years. With crisis dummies, the response is practically zero. Spending multipliers show impact responses of 0.1 and 0.25 for the model without and with crisis dummies respectively. In the latter case, this response is significantly different from zero. When including oil prices, the responses stay more or less the same, with one exception: output responses to tax shocks, when allowing for crisis dummies, again reach positive values, like in the short sample.

5.1.4 Cumulative multipliers

Impulse response functions measure the period-by-period effect of the shock variable on the policy variables. This measure is useful when one wants to analyze the evolution of the responses. For a clear visualization, cumulative multipliers are much more helpful, as they show the additive effect of policy variables on output and are expressed in money or percentage terms. In this study, we follow the following formula, also used by Mountford and Uhlig (2009):

$$\text{Present value cumulative multiplier after } j \text{ periods} = \frac{\sum_{j=0}^{N}(1+i)^{-j}\Delta y_j}{\sum_{j=0}^{N}(1+i)^{-j}\Delta v_j}\frac{1}{v/y}, \tag{18}$$

where j are the impulse periods over an horizon N, i is the average interest rate over the sample, Δy_j is the output reaction in period j and Δv_j is the policy variable (taxes or spending) reaction in period j and p/y is the sample average share of the fiscal variable of GDP. Table 3 shows the cumulative multipliers in percentage terms[40] for both taxes and spending for horizons of 1 to 4 years for different specifications and sample lengths. For comparison purposes, we also calculate cumulative multipliers up and until the crisis, as shown in the two bottom row groups.

Table 3: Present value cumulative multipliers, basic model.

	4 periods		8 periods		12 periods		16 periods	
Specification	Tax	Spending	Tax	Spending	Tax	Spending	Tax	Spending
	2001Q1-2013Q1							
(1)	7.63	-0.44	4.15	-1.01	3.88	-1.50	3.85	-1.87
(2)	50.02§	-1.13	4.82	-3.38	4.08	-6.60	3.87	-10.98
(3)	-2.05*	0.5*	-6.38*	0.75*	-13.43*	0.91*	-23.2*	0.99*
(4)	0.40	0.23*	0.73	0.15*	0.86	0.11*	0.91	0.10*
	1996Q1-2013Q1							
(1)	-2.19*	0.22*	27.23	-0.04	6.56	-0.30	5.01	-0.57
(2)	-1.19*	0.21*	-7.94*	-0.30	15.69	-0.93	7.13	-1.70
(3)	-0.29*	0.74*	-0.43*	0.73*	-0.53*	0.70*	-0.59*	0.68*
(4)	0.00	0.72*	0.15	0.61*	0.20	0.48*	0.19	0.38*

Notes: (1): Deterministic trend; (2): Deterministic trend including oil prices; (3): Deterministic trend and crisis dummies; (4): Deterministic trend, crisis dummies and including oil prices. Asterisks indicate the multiplier has the expected sign.

§Very big values can be the consequence of the policy response (in the numerator) being very close to zero whereas the output response is not. If the policy variable response crosses the null-line, the sign of the multiplier can also change.

We note several patterns: First, the signs of specifications (3) and (4), i.e., including crisis dummies, match NK expectations to a greater extent than specification (1) and (2). Second, there seems to be a big difference in volatility between tax and spending multipliers in our results: tax multipliers not only take very large values in some cases, they also vary more between positive and negative values. Spending multipliers on the other hand, do not exceed 1.5 and are usually below 1.[41] Third, where

[40] 1% change in the policy variable: fot instance, for the period 2001–2013, with the specification including crisis dummies, we see that after 4 periods, a spending shock of 1% of GDP leads to an increase in GDP of 0.5%.

[41] Although some outliers take negative values, but for more representative specifications, i.e., (3) and (4), this is never the case.

tax multipliers take credible values, they are lower than spending multipliers, which again matches theoretical expectations. Fourth, spending multipliers seem to decrease over time, except for specification (3), which means that there are negative effects after several periods. This can be due both to negative spending responses and negative output responses to spending shocks, as both variables come into play when calculating cumulative values.

The basic model does not yield very consistent results, especially considering the tax multipliers. It is probable that more complicated mechanisms are going on in the data that are not captured by the three variable model. In order to try to elucidate this matter, we estimate the extended model (section 3.1.3), where interest and inflation rates are included.

5.2 Extended model

5.2.1 Baseline estimates

Our extended model includes inflation and interest rates as endogenous variables. In this model, all 5 variables are allowed to influence each other. The parameters used to calculate the structural residuals and the subsequent A and B matrices are shown in table 7. Given that we allow for monetary policy, the expectations for the signs of the parameters become ambiguous. According to the standard IS-LM, the reaction of the economy to tax or spending shocks is depending on the reaction of the central bank (Mankiw and Taylor (2008)). Assuming that the central bank holds the money supply constant, c_1 and c_2 are expected to have the same signs as in the previous specification. The rationale of these two parameters stays the same as in the previous explanations. We note that the signs of c_1 and c_2 again always match our expectations. These two parameters are of primary concerns, as they express the endogenous reactions of output to tax and spending shocks.[42] Even though the specifications with a stochastic trend seem to give the expected sign to the parameters, plotting the impulse response functions again yields explosive responses. The signs and magnitudes do not really vary in the alternative ordering either. Therefore, we again show two exemplary figures in the appendix (figures 10 and 11).

Figures 6a and 6b show the impulse response functions for the short sample, without and with crisis dummies respectively. The rationale of the figures is identical to the previously discussed graphs, but policy shocks also impact inflation and interest rates. Our main interest lies again in the reaction to output. Due to the increased numbers of variables, the degrees of freedom come close to critical values, implying that interpretation of these results are to be taken with a grain of salt.

We observe that both tax and spending multipliers always show the expected impact sign. We also note that again, the specification with crisis dummies lead to results that match our expectations not only in the impact sign, but also the further evolution of the responses. Without said dummies, the responses of output to both tax and spending shocks display a rather cyclical pattern. This might be explained by the crisis that is not accounted for. The cyclical pattern disappears partly in the model including crisis dummies. Again, most responses peak after approximately 4 periods. The response to taxes peaks at –0.3 when not including dummies, and at approximately –0.12 when including dummies. Responses of inflation and interest rates lie in reasonable ranges, and also show the expected impact signs. Furthermore, they more or less converge to zero, which is according to expectations about the watering out of shocks.

5.2.2 Including exogenous variables

For the same reasons as explained above, we add oil prices to the extended model. The responses are displayed in figures 6c and 6d. We still see a cyclical pattern when the crisis dummies are not

[42]Under the same assumption of fixed money supply, the adaptation rate of prices to tax (δ_1) and to spending shocks (δ_2), should be zero. We observe that this is not the case in our results, although the parameters are approximately 10 times smaller than the rest. δ_3, the rate of adaptation of prices to output shocks is expected to be positive, i.e. negative in our table. This again is the case for all specifications. The elasticities of interest rates λ_i are more ambiguous as again they depend strongly on the reaction of the central bank. We note however that almost all of the parameters show a negative sign, indicating positive elasticities to shocks in taxes, spending, output and inflation.

included. And once more, this pattern dissipates partly when dummies are included. Furthermore, the same sign pattern emerges. We recall that in the basic model, tax responses were negative for all specifications except the fourth, with dummies and with oil prices. This pattern repeats itself in the extended model, although the responses are never significantly different from zero.[43]

Both the baseline estimates and the results including oil prices for the short sample have a limited amount of degrees of freedom. In order to gain more insight in the present mechanisms, we now examine the longer sample.

5.2.3 Alternative time samples

Table 7 shows the parameters for the long sample period.[44] Again, most of the parameters c_1 and c_2 have the signs expected by theoretical predictions. Exceptions are values for c_1 for the specifications including crisis dummies, both without and with oil prices. We also note that the parameters have mostly become smaller for c_1 and larger for c_2.[45]

Figure 7 illustrates the responses for the longer sample period. We observe that the cyclical patterns, present in the results of the short sample, have further faded away and are only there for the deterministic trend without additional variables or dummies. The signs of the impact responses match our expectations when we consider output responses to spending. However, when looking at output responses to tax shocks, the crisis dummies make the sign flip and we now see positive impact responses. In the case of included oil prices, the response even quickly rises to 0.15 and is significantly different from 0. We also note that responses peak at approximately the same time as previously observed. Furthermore, responses to spending shocks are significantly higher than in the previous models, reaching values of up to 0.5.

The inflation and interest rate responses preserve their shape and signs, but become slightly larger. Larger responses of output to spending, and larger responses of interest rates and inflation in general, might simply indicate that the included data does show new patterns that are interpreted as higher spending multipliers. However, since these are period-to-period responses, a closer examination of the cumulative values can lead to more compelling conclusions.

Table 4: Present value cumulative multipliers, extended model.

	4 periods		8 periods		12 periods		16 periods	
Specification	Tax	Spending	Tax	Spending	Tax	Spending	Tax	Spending
				2001Q1-2013Q1				
(1)	27.17	0.11*	6.41	-0.55	5.98	-1.08	5.76	-1.45
(2)	-13.14*	-0.18	6.56	-1.81	5.12	-4.55	4.87	-8.04
(3)	-2.47*	0.95*	-9.55*	0.91*	-28.62*	0.93*	184.59	1.02*
(4)	0.28	0.9*	0.34	0.71*	0.19	0.54*	0.13	0.54*
				1997Q1-2013Q1				
(1)	-0.58*	1.10*	-1.76*	0.65*	-6.32*	0.35*	-70.01*	0.23*
(2)	-0.62*	1.08*	-2.24*	0.57*	-10.21*	0.23*	44.06	0.05*
(3)	0.48	1.63*	0.84	1.31*	0.95	1.13*	0.97	1.11*
(4)	0.71	1.47*	1.28	1.20*	1.41	1.02*	1.41	0.94*

Notes: (1): Deterministic trend; (2): Deterministic trend including oil prices; (3): Deterministic trend and crisis dummies; (4): Deterministic trend, crisis dummies and including oil prices. Asterisks indicate the multiplier has the expected sign.

[43]With 68% certainty.

[44]Due to restrictions in the data, observations for inflation start in the first quarter of 1997.

[45]The signs of the other parameters stay very similar to the baseline estimates.

5.2.4 Cumulative multipliers

As in the basic model, we present present value cumulative multipliers for different specifications and samples in table 4. When only looking at the signs, we observe that the extended model lets the multipliers match our expectations to a greater extent, however slightly. Values become also more realistic for the restricted sample (until 2008Q1). In general, spending multiplier now are a bit larger, taking values up to 1.63, even though they usually lie in the range of 0.8–1.5, whereas tax multipliers display a lot more volatility and are mostly positive. This pattern that we already observed in the basic model reappears here.

5.3 Main results

Our main results can be summarized in three points:

First, we observe clear differences in specifications. We recall that we used four different main specifications for our samples including the crisis. (1) and (2) do not include crisis dummies, whereas (3) and (4) do. In general, we note a sign reversal between these two groups of specifications in the basic model.[46] When crisis dummies are not included, tax multipliers are mostly positive, and spending multipliers are mostly negative. The opposite is visible if crisis dummies are included. When looking at the extended model, this sign reversal is less present and spending multipliers stay positive for almost all specifications. Given that it seems reasonable that the crisis needs to be accounted for by the model and the SICs indicate that specifications (3) and (4) are better, our results are a closer match to New-Keynesian predictions, where spending multipliers are positive and tax multipliers are negative. The volatility of our results across specifications however lead us to consider these results with a grain of salt.

Second, we note that responses to tax shocks are in general negative, although this pattern is broken by the specification which includes both oil prices as exogenous variables and crisis dummies. When transformed into cumulative tax multipliers, this pattern disappears and the signs become fuzzier. We are not able to draw any consistent conclusions from the tables, as the values are very volatile, switch signs and take magnitudes that are beyond credibility. This is the case for both the basic and the extended model. Furthermore, tax shocks yield higher multipliers in the longer time sample (starting in 1996Q1). The fact that the extended model does not seem to bring more light into the inconsistent results of the basic model indicates that there are indeed workings that are difficult to capture with our model.[47]

Third, the effects of spending shocks are mostly positive, both in impulse responses and cumulative values. The majority of the calculated multipliers lie in the range of 0.8–1.2 for the basic model and between 0.6 and 1.5 in the extended model. The observed signs of spending multipliers confirms the greater match with NK models than with RBC models. Spending multipliers seem to be decreasing over time, indicating negative effects of spending shocks after a couple of years that are more important than the positive effects.[48]

5.4 Robustness tests

Our third step consists of robustness tests. The results of our two previous models bring up some concerns about the consistency of the fiscal multipliers. First, we check for the influence of the recent crisis, by excluding those observations since its beginning in 2008. In order to check whether this could be due to definitions of policy variables or other assumptions, we then reestimate our models under different circumstances. We first compare our results to other definitions of policy variables. Third, we try out different values for a_1, α_1, α_2 and β_2. Last but not least, we impose our prior beliefs on the data and estimate a sign restriction model.

Excluding the crisis In order to check whether the recent financial and economic crisis does bias our results, we calculate cumulative multipliers for shortened samples: 2001Q1–2008Q1 and

[46]Sign reversals are also present in Perotti (2004).

[47]See also section 6.1.

[48]It could also be due to negative spending responses to spending shocks, see again notes table 3.

1996Q1/1997Q1–2008Q1. The results are displayed in table 8 in the appendix. Results for the sample 2001Q1–2008Q1 reach very low degrees of freedom, especially for the extended model. We observe more frequent sign reversals over time. This indicates again that after initial shocks, cumulative multipliers are influenced by contrary movements in spending and/or output responses. For cumulative values for the first two years, the sign pattern is still more or less consistent with NK theory, i.e. spending multipliers are mostly positive, tax multipliers are mostly negative. Especially when looking at the longer sample (1996Q1/1997Q1–2008Q1), we note that tax multipliers are *calming down* to some extent. Tax multipliers are now mostly between –2 and 0. Spending multipliers stay in the same range as in previous samples. The decreasing shape is yet again present.

All in all, we do not observe a striking change in signs, shapes or magnitudes when we exclude the crisis. Especially when compared with specifications (3) and (4) for the original samples, the inclusion of crisis dummies seems to account rather well for the happenings during the crisis, thereby affirming our choice to treat these two specifications as more credible. The values for tax multipliers do however not seem to indicate a pattern that would yield consistent conclusions.

Different definitions for the policy variables In order to test the robustness of our results, we estimate the fiscal multipliers using a variety of definitions for the fiscal policy variables, i.e. taxes and spending. The definitions range from very restrictive to more complicated measures, which are all shown in table 9 in the appendix. We plotted the reactions of output to policy shocks for the different definitions for the basic model in figure 12. The signs of the fiscal multipliers stay mostly the same, i.e., within the confidence bands of our original definition. The magnitude and shapes can however vary across the different measures. One possible explanations is the value of a_1, i.e. the different influences of different components of the variable. The output elasticity of taxes, which is held constant here, is likely to vary depending on the policy measure, as different components have different magnitudes of impact in their automatic responses. Therefore, the impulse response functions are also likely to be rather different. Unfortunately, the framework of this thesis does not allow for a component analysis (neither of output, nor of policy measures). Future research will need to be conducted to provide a more thorough analysis of different effects of individual components. All in all, although the magnitudes vary, they don't vary too much, and are usually not significantly different from each other. Therefore, we conclude that our results are generally robust when it comes to the different definitions of policy measures.

Different values for a_1 One of the most important assumptions of the SVAR model lies in the determination of an appropriate value for the output elasticity of taxes, i.e. the percentage reaction of output to a percentage reaction in tax. Not surprisingly, different values for a_1 yield very different tax multipliers, whereas the spending multiplier is less or even marginally affected. Results for benchmark values of this elasticity can be found in the appendix (figure 13). Ceteris paribus, a higher value of a_1, i.e. a higher automatic responsiveness of output to changes in taxes will lead to a lower multiplier. If output doesn't react at all to automatic innovations in taxation, spikes in output are not allowed to be explained by spikes in automatic tax revenue changes, which leads to very high tax multipliers. From the figures, we see that tax multipliers depend substantially on the value of the output elasticity of taxes. In some cases, the value can also be determinant for the sign of the initial response of tax multipliers. Compared with our number for a_1, we notice that both values of 1 and 1.5 mostly lie in the confidence area around the benchmark value of 1.38. This shows that also our value for a_1 is rather robust. As explained previously, finding an appropriate value of a_1 is rather tricky and very dependent on the definition of tax revenue. The pictures show that our results lie approximately in the middle range of averages of tax elasticities to output.[49]

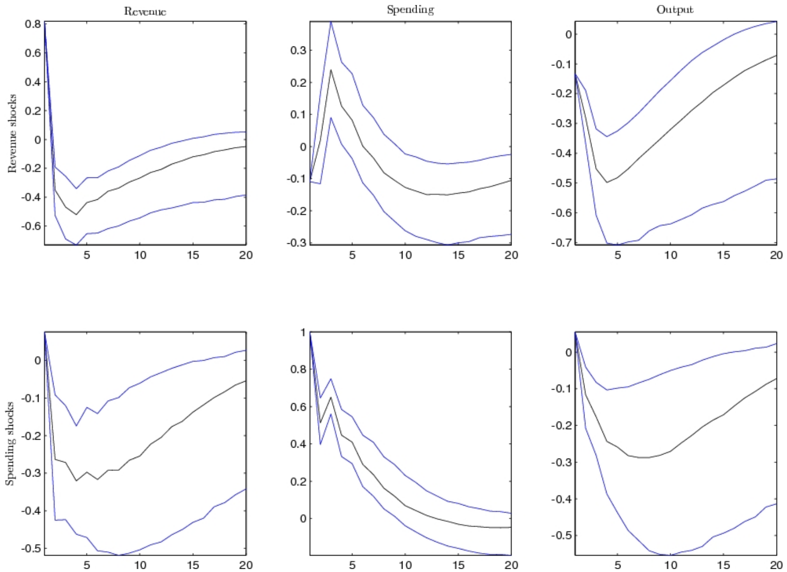
[49]Finding weighted averages of tax base elasticities to output for comparison purposes are difficult to find, as most works do not calculate them. However, comparing numbers from Girouard and Andre (2005) with other papers that discuss long-term elasticities, e.g., Henry et al. (2005); Koester and Priesmeier (2012); Wolswijk (2007) do not show very large differences. According to conversations with members of the CPB, the average long-term elasticity is likely to be around unity.

Different values for α_2 and β_2 The extended model uses two additional assumptions about the mechanisms of fiscal policy. Figure 14 and 15 show alternative values for α_2, the price elasticity of taxes, and β_2, the price elasticity of government spending, respectively. For α_2, we use the same benchmark values as with a_1. For β_2, we use values from –1 to 0.5. Values below –1 would imply that a price shock in any given quarter has a more than proportional influence on government spending. Values above 0.5 do not seem realistic, as this would mean that government spending adapts quite fast within a given quarter. As expected, a change in α_2 has almost no influence on the output responses to spending. A lower value of α_2 implies a larger response to tax shocks, ceteris paribus, as more of the observed shocks need to be explained by the structural component. Similarly, smaller values of β_2 imply a higher output response to spending shocks. A small value for this coefficient forces the model to explain unexpected movements in spending less by the adaptation rate to inflation, and more by other components. Hence, the structural component, and consequently the impulse responses. In passing, the difference to other values is minute, so is the influence of β_2 on the output responses to tax shocks. β_2 clearly is not the most decisive assumption of this model.

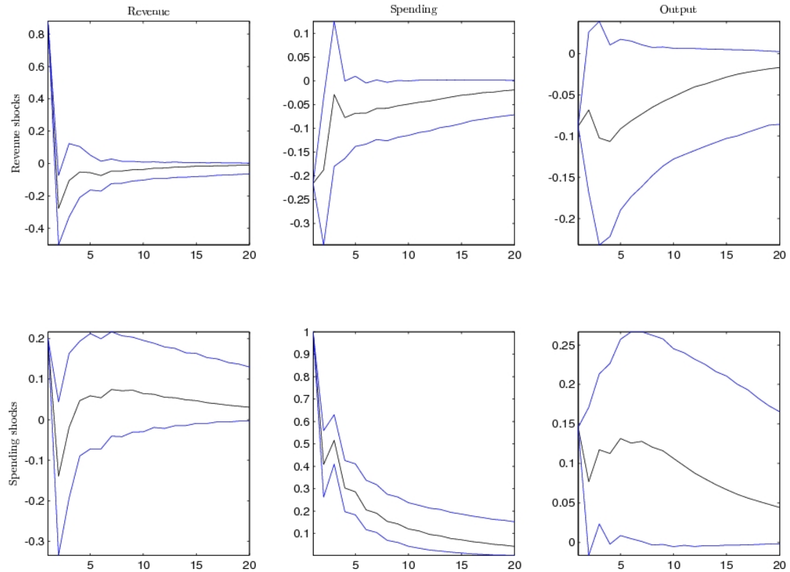
All in all, we observe that alternatives for both parameters lie widely in the 68% area of confidence of the value used in our model. We further note that in the specification with crisis dummies, the value of 0.46 for α_2 and –0.5 for β_2 are in the more optimistic range of responses. This implies that multipliers are not likely to vary much when the value of α_2 or β_2 is changed, and certainly the size should not be adjusted upwards.

Sign restriction A last robustness test consists of a sign restriction analysis. This purely computational strategy has practically no assumptions at all and is therefore well suited to check for the basic validness of our results. Since there are no assumptions, it can be considered as a *neutral* examination of our results. In order to compare our results, we compute sign restriction multipliers with the following restrictions: positive revenue shocks and negative GDP shocks; positive spending shocks and positive GDP shocks. Restrictions are examined over horizons of 2 to 4 quarters. The resulting sign restriction are shown in figure 16 in the appendix. For the very basic specification, without crisis dummies, the signs and shapes of the sign restriction impulse responses of the specifications without crisis dummies match our extended model. The responses for the specification including crisis dummies matches more with our previous results from the basic model. Other specifications are not computed as we couldn't find enough structural tax shocks, i.e., more than one consecutive period of positive tax shocks and negative output shocks. We also note that although the sign restriction results do coincide with our results under the same said specification, the responses are extremely close to zero. The sign restriction approach seems to restrict the data and shocks in a manner that renders higher responses impossible. This could on the one hand be due to the complicated pattern in the data, which would confirm our previous statements that we are confronted with incidents that cannot easily be captured by the models. On the other hand, it is also conceivable that the restrictions are simply too strong. Compared with the sign restriction approach, the SVAR technique does leave some room for the model to observe the data and let the structural shocks tell the story, even if they don't match prior beliefs. This is not possible in the sign restriction approach, where the prior beliefs are *forced* on the residuals. Either way, a closer examination of fiscal multiplier using this approach is worthy of consideration. Due to time constraints and since the sign restriction approach is not the main focus of this study, we leave this question open for future research.

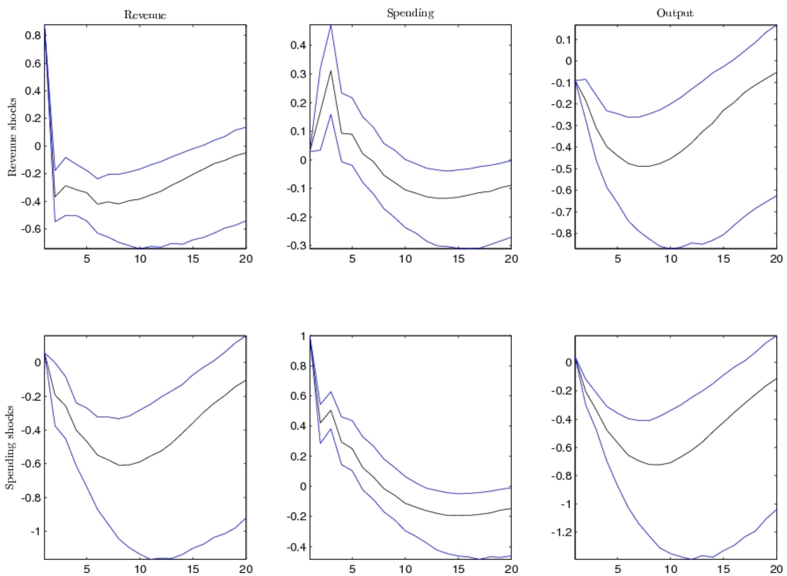
Figure 4: Impulse response functions of the basic model, short sample (2001Q1-2013Q1).



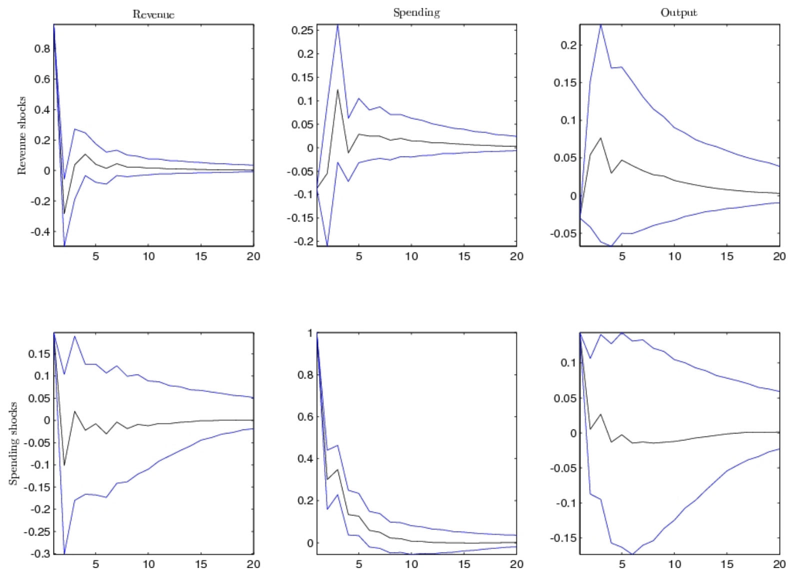
(a) Deterministic trend



(b) Deterministic trend, with crisis dummies

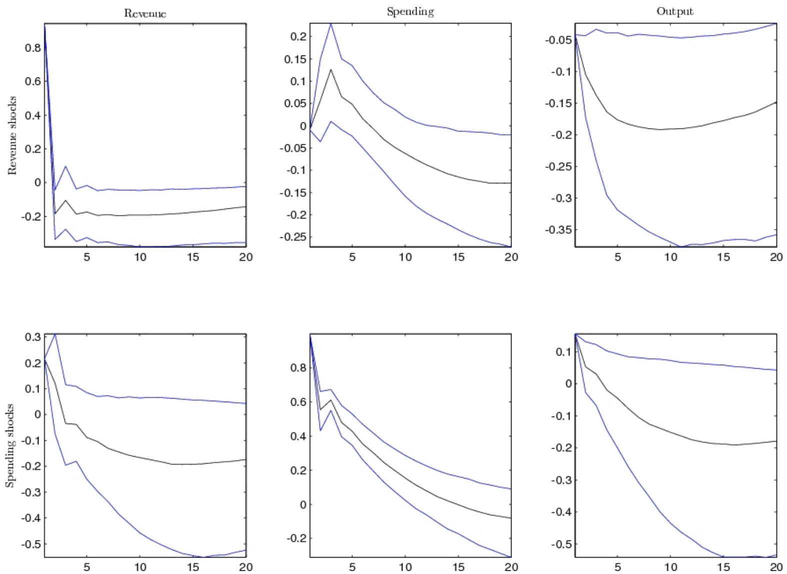


(c) Deterministic trend, with oil prices

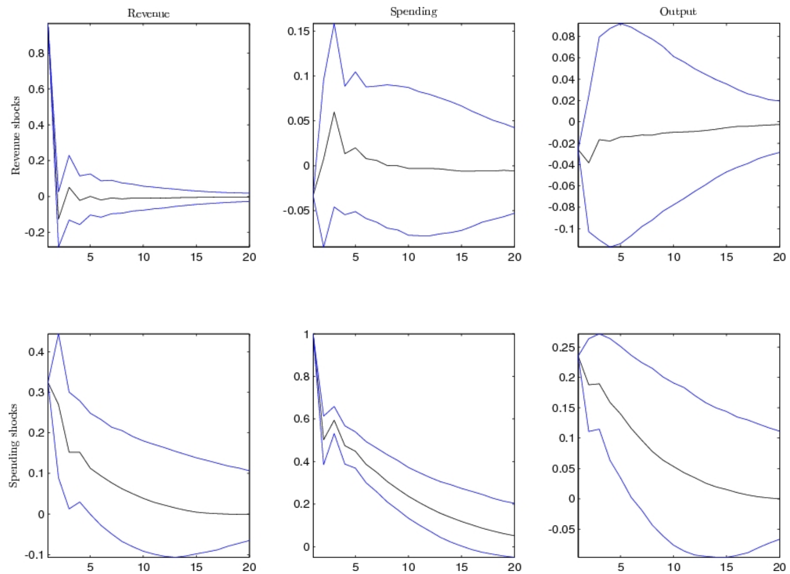


(d) Deterministic trend, with oil prices and crisis dummies

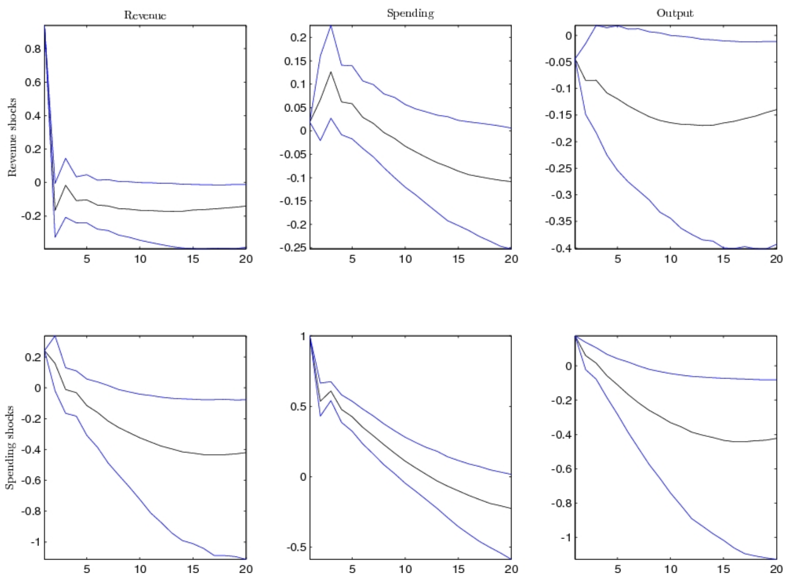
Figure 5: Impulse response functions of the basic model, long sample (1996Q1-2013Q1).



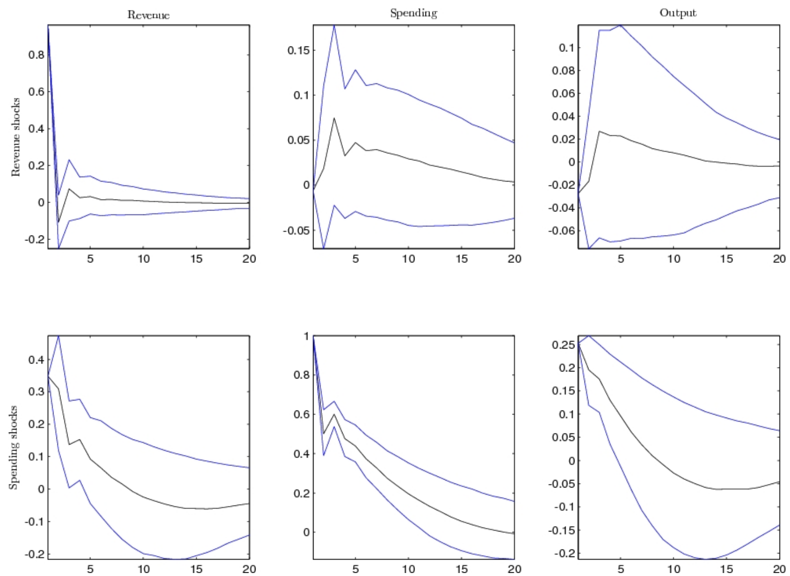
(a) Deterministic trend



(b) Deterministic trend with crisis dummies

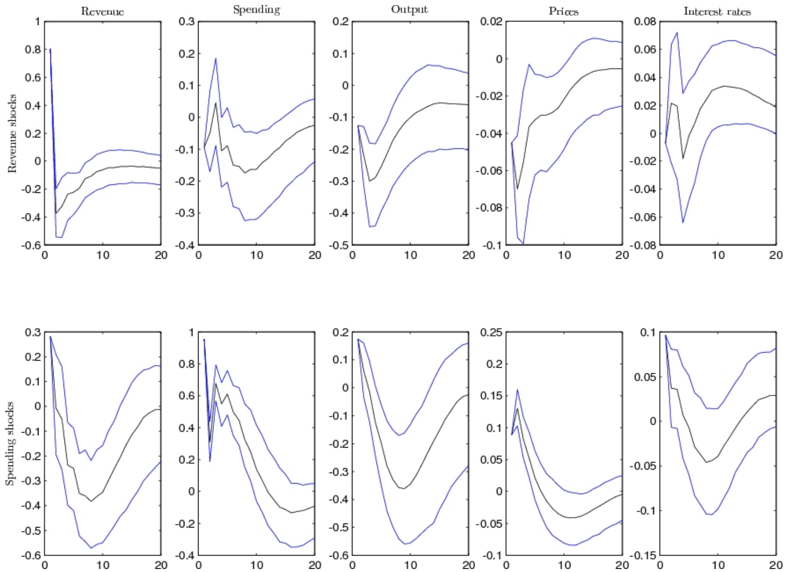


(c) Deterministic trend, with oil prices

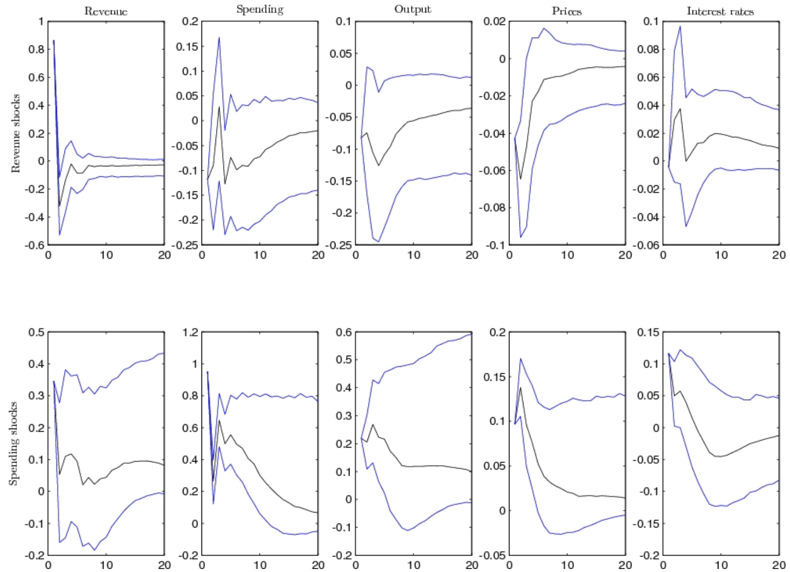


(d) Deterministic trend, with oil prices and crisis dummies

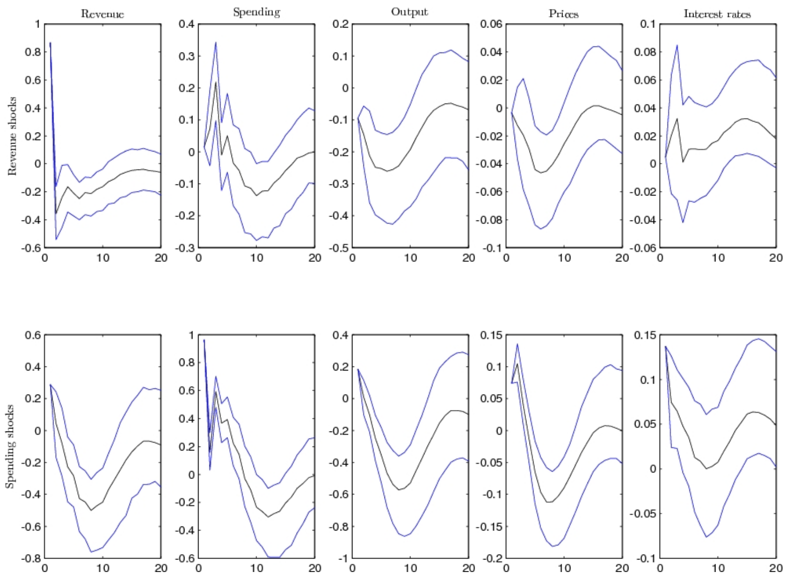
Figure 6: Impulse response functions of the extended model, short sample (2001Q1-2013Q1).



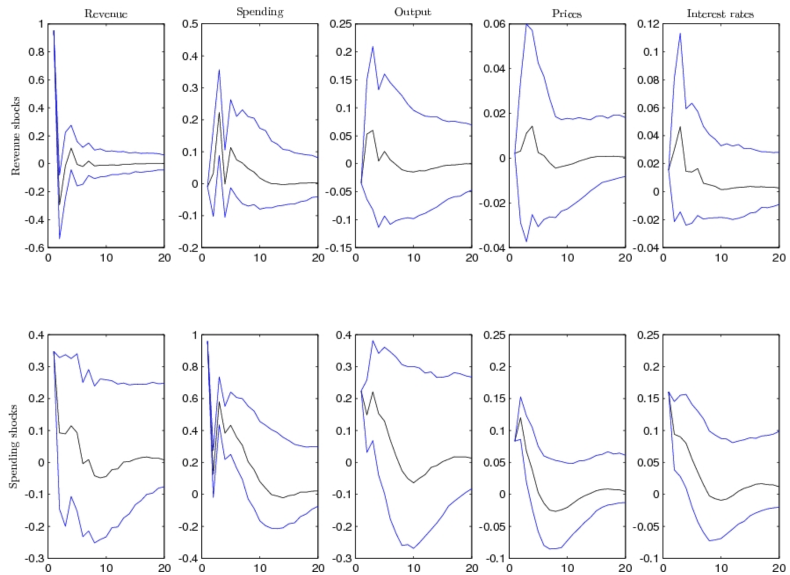
(a) Deterministic trend



(b) Deterministic trend, with crisis dummies

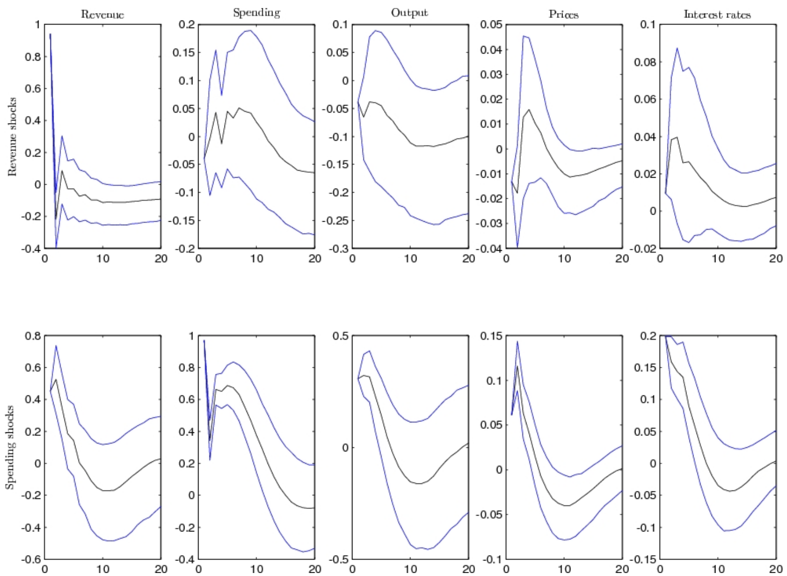


(c) Deterministic trend, with oil prices

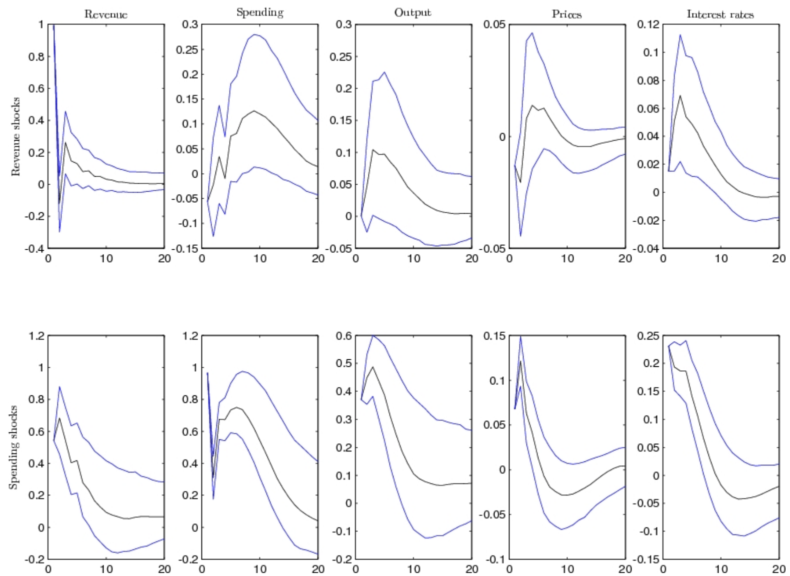


(d) Deterministic trend, with oil prices and crisis dummies

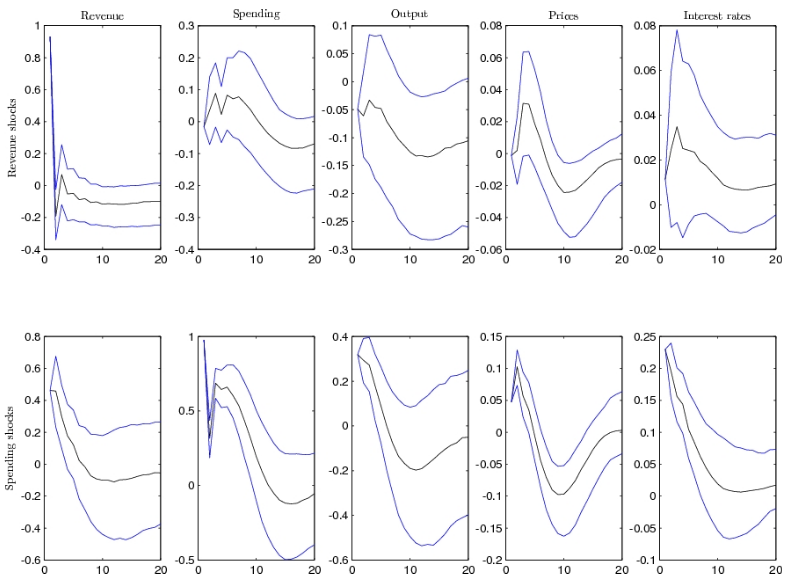
Figure 7: Impulse response functions of the extended model, long sample (1997Q1-2013Q1).



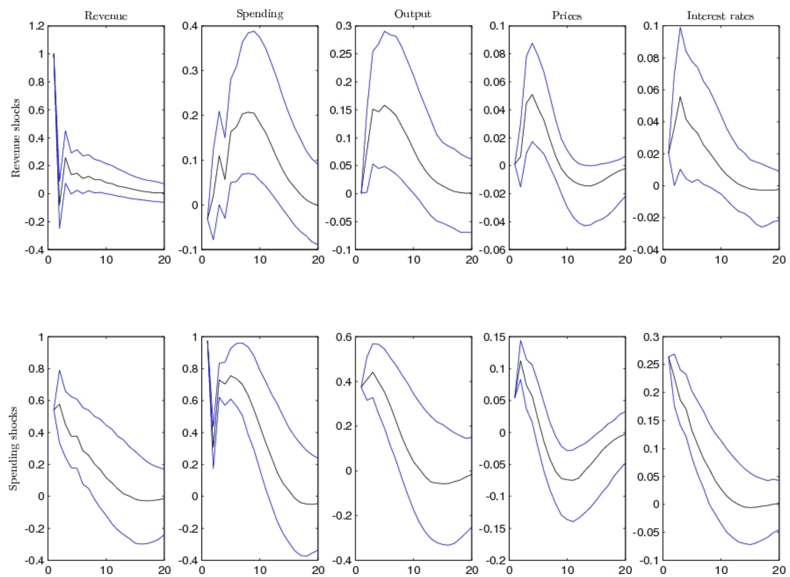
(a) Deterministic trend



(b) Deterministic trend with crisis dummies



(c) Deterministic trend, with oil prices



(d) Deterministic trend, with oil prices and crisis dummies

6 Conclusions

In this last section, we first take a closer look at the limits of our method and results. The second subsection concludes by putting the results in perspective with previous research and proposing some policy recommendations based on the findings.

6.1 Caveats

Several problems and limits are worth addressing in the context of this thesis, method and results. The main problems can be summarized into two categories: the data and the method.

Data First of all, the availability and reliability of the data used in this thesis are of primordial importance. For this identification strategy, quarterly data is necessary. This kind of data however is rather scarce and subject to many conditions in order to be used. On the one hand, a SVAR model is dependent on shocks *as they really happened*, in order to make good conclusions. For data points before 2001, we used a combination of different sources for tax revenue, social security premia, transfers and government spending, some of which are splined data. In order to construct high-frequency data points from a low-frequency time series, a high-frequency series, which is correlated with our target series is needed, the disaggregated series will therefore also contain the shocks from the correlated high-frequency series. In other words, the disaggregated data points will show shocks that are not their own, but rather from another series. This implies that we have to be cautious with interpretations (see also Baum et al. (2012); Perotti (2004)). In the calculation and estimation of our results, we were careful by not changing both the sample period and the specification at once, which would have rendered comparisons difficult. Therefore, all samples are calculated for all time samples. As observed, the results do not change considerably.

On the other hand, quarterly data needs to be collected appropriately, which also presents several problems on its own. It is clear the statistical offices collect much of the data with lags, which can sometimes be very long, especially when it concerns policy variables like spending and taxes. Furthermore, it can be difficult to allocate values in policy variables to a certain quarter. For example, individuals and firms can sometimes choose, when they would like to pay their taxes, or whether they would like to pay them all at once or in rates. This makes it complicated to allocate structural shocks to a certain quarter, as the shock could have actually happened in the previous quarter but was only orchestrated later on. The same is valid for spending shocks. The user of a SVAR model is interested in the actual shock in money terms in the economy. Different ways of accounting for expenditures in the government can water down possible structural shocks of government spending, they can also be concentrated in a certain quarter due to accounting reasons. These two reasons are the origin that we concentrate on CBS data from 2001 until 2013Q1.

Second, the data used in this thesis consists of 49 data points for the short sample and 69 for the long sample. Further pressure was put on the degrees of freedom by including dummies, lags and exogenous variables. Although all specifications were computable, we observed cyclical patterns and somewhat explosive responses in some cases with very low degrees of freedom, notably the extended model with crisis dummies and oil prices, for the short sample. Compared with other studies, like the original paper by Blanchard and Perotti (2002) or panel estimations like Perotti (2004) or Beetsma et al. (2008), we are therefore confronted with higher standard errors and larger confidence bands. On the plus side, we are sure to be able to make conclusions about the current fiscal multipliers of a single country. Whether the trade-off between amount of data and practicability leans one or the other way is however not the focus of this study.

Another third important problem of the data is its content. The last decade has seen the eruption of a financial and economic crisis of long unseen scope and duration, which affected the Dutch economy in many ways, some of which are not yet fully captured and/or analyzed. As a consequence, almost half the data point in our data stem from an environment during an economic crisis, which surely puts a lot of pressure on the results. In other words, the impulse responses are highly influenced by the structural shocks happening during the financial crisis. It is however questionable whether the structural shocks happening during a financial crisis are *normal* structural shocks for an economy. Even when using dummy variables for the state of a crisis, this can hardly account for all the changes in the economic system that happened in the last few years. Similarly, since almost half of the observations come from an economic crisis, there are not enough remaining data points to *water* down the unusual happenings during a crisis in order to estimate the effects of policy shocks on the economy. To cite one striking example: as can be seen in figure 1, government spending continued during the economic crisis, whereas GDP was falling for approximately a year. This means that positive structural shocks in government spending, constructed for this period, are likely to be followed by negative structural shocks in GDP. The SVAR model will interpret this as a causal relation and display impulse responses accordingly. The shocks during the financial crisis are also very large, which, as mentioned, are not watered down by *usual* structural shocks from the period before that. This example shows the limits of a VAR model with a short sample period. All in all, our results show the reaction of output to fiscal policy from the last 17 years. Whether the last 2 decades have been an example of *normal* economic times is another question. The combination of the entrance into a monetary union, a dot.com crisis and a housing bubble and finally a global financial crisis might be a desertion for this statement. The evaluation of all these events is however not possible with our identification strategy and will have to be covered by future research.

On a related matter, it needs to be noted that all our three endogenous variables are highly correlated, and especially Dutch GDP and our measure of tax revenue. Using cyclically adjusted measures of taxes and spending in our analysis should have taken care of the correlation. It is however difficult to assess this based on the unexpected and structural shocks we are dealing with.

Method Using a SVAR analysis has both advantages and disadvantages, some of which have already been addressed in section 2. One of the main advantages is the absence of extensive assumptions about the functioning of the economy, e.g., whether the economy works according to a RBC or a New-Keynesian framework. Similarly, we do not need to assume Ricardian or non-Ricardian consumers. We only use three main assumptions. However, as with most assumptions, they have their limits. The strongest assumption in our model is the stability of the elasticity over the whole sample. Indeed, it is very simplifying to assume that elasticities do not change after the change of policy. Similarly, a change in monetary regime, or a financial crisis, are also rather likely to change the way taxes and output interact directly. With a more extended data set, it would be possible to compare different samples separately and allow for changes in the variance-covariance matrix across observations.[50] This however exceeds our possibilities, both because of limits in the data and because of the scope of this thesis. We are however able to use these average elasticities to compute average multipliers. In that sense, the Lucas (1976) critique is also valid for our thesis.

A SVAR model is an almost purely statistical way of analyzing mechanisms in the economy. Consequently, it is not possible to interpret specific policy measures. A SVAR model is therefore not the right tool to examine whether a certain policy measure has been effective, but rather to see whether *in general*, fiscal policy is working like it is expected to be and how big the effects are likely to be in general circumstances. These circumstances are important when interpreting the results presented in this paper and also influences the policy recommendations extensively.

Another major point of criticism of the SVAR method is that it ignores expectations of economic actors (Ramey (2011a)). This is especially problematic in the case of taxes (Leeper et al. (2013)). It is in the nature of fiscal policy that it usually needs to pass in front of several institutional steps before being implemented by the government. As a consequence, and even though a fiscal policy measure can be considered exogenous as in not directly dependent on the state of the economy, individuals and firms are likely to hear or read about the proposed fiscal measure before it is actually implemented. It follows that if actors hear of a planned fiscal measure that they are likely to change their behavior, which renders the computation of the effect of exogenous measures rather complicated. Furthermore, the economic actor actually has more information than the economist trying to estimate the effect,

[50] Threshold VAR

which yields problems: As stated by Leeper et al. (2013), the estimation technique then identifies tax shocks, even though the actual shocks are the effects of other independent incidents. This is also related with the third point in the limits of the data, here above. Even if we include measures of anticipations in the SVAR, as done for instance by Beetsma et al. (2008), questions remain on the representativeness of these anticipations. Ramey (2011a) shows how difficult and disputed it is to use certain measures of anticipations and how complicated it is to capture the wanted mechanisms. In this thesis, we limit ourselves to the more uncontroversial assumptions.

6.2 Conclusions

We have seen that our results cannot be put into a single drawer. In general, we can conclude that cumulative spending multipliers display a clear pattern across specifications and time samples and we conclude that they mostly lie in the range of 0.8–1.2. If we compare these values to other studies, we note that they lie in the same range as other studies for European countries.[51] Compared with Germany, the European country with the most empirical estimates in the literature, our results are slightly higher: Baum et al. (2012) find spending multipliers of 0.1–1, depending on the state of the economy; Perotti (2004) finds a one year multiplier of 0.4. In general, our numbers indicate a structure which is best described by a New-Keynesian framework, where spending multipliers are positive. The size also matches expectations about relative country size and monetary and exchange rate regimes: as the Netherlands are a small country in a monetary union, its fiscal multipliers are likely to be smaller than for instance the United States. This is due to simple macroeconomic facts like proximity to other countries, institutional circumstances leading to a lot of trade in the European Economic Area and bigger dependence on neighboring countries, enabling higher specialization across Europe. All of these lead to higher leakages than in big countries (Barrell et al. (2012)). Nevertheless, our results are higher than multipliers modeled by the OECD's NiGEM model (Barrell et al. (2012)). When compared to the models of the DNB (2011) or the CPB (2010), we see that the spending multipliers lie in the same range.

Due to our limited dataset, it is not possible to perform a component analysis. Such an analysis would be able to show more detailed mechanisms about fiscal policy, as for instance how private consumption, private saving reacts to changes in fiscal policy, or, on the other hand, which policy measure (government wage increases, infrastructure, etc.) has the strongest effect on output. Research in the U.S. suggests that multipliers might vary considerably across types of spending (see for instance Feyrer and Sacerdote (2011)).

In order to find more consistent results, future research should concentrate on larger, alternative and more detailed data sources. It may also be worthwhile to try different identification strategies in order to bring some clarity in the tax measures. One might also consider different robustness check methods, as for instance the local projection method introduced by Óscar Jordá (2005). A narrative approach, as implemented by Romer and Romer (2010) may bring additional insight into the working and causal effect of fiscal policy. Furthermore, introducing anticipations and their influence on the fiscal multiplier, an aspect that has not been covered by this study, will shed more light on the issue.

Concerning economic and fiscal policy, we emphasize the following points:

First of all, both in the basic and the extended model, most cumulative spending multipliers lie in the range of 0.8–1.2. This means that in general, positive spending shocks have a positive effect on output, although there might not be a big boosting effect. Consequently, cutting spending is not likely to have a devastating effect on output either, but in general, there will be an effect. According to our numbers, cutting spending by 1% of GDP will lead to a quasi-proportional decline in GDP. Most of our results lie below unity, which indicates that the effect is most likely to be less than proportional.

On a side-note, the presented results do not exclude other mechanisms from happening in current economic times. In other words, the ceteris paribus conditions presented in section 2 are still valid and the results of this thesis should be seen in that way. When it comes to the influence of the ZLB and the financial crisis, and since our results are highly influenced by the last few years, we can carefully

[51] C.f. Acconcia et al. (2011); Baum et al. (2012); Beetsma et al. (2008); Perotti (2004)

state the following: either the normal multipliers has indeed increased the multiplier, but the fact that it is quite low nonetheless shows that the multiplier must be even lower in normal times; or the multipliers found in this study correspond to the average multiplier and the recent crisis didn't have a very big effect on it. The same can be stated for other ceteris paribus conditions.

Second, results for tax multipliers show more complicated mechanisms going on in our dataset. Unfortunately, our model is not able to capture those phenomena. The signs of the tax multipliers are less reason for concern than the absence of a pattern. Indeed, positive tax multipliers are perfectly imaginable.[52] As explained above, there are several possible reasons for this *non-pattern.* Given the signs and magnitudes, it is difficult to put a mark of either NK or RBC framework on it. In any case, policy makers are advised to be careful when doing predictions about the expected effects of their tax policy propositions. If tax policies are only meant to bring the government budget back in order, then this might be of less concern. If tax policy changes are however expected to bring some changes in output, more diligence is in order.

Third, the circumstances of this thesis can bring some new light on fiscal multipliers of small, developed countries in a monetary union. Estimates have been really scarce for European countries and especially for small countries. Most studies have concentrated on the United states or panel data sets, with a few notable exceptions that leaned on Germany. In this context, our results suggest that multipliers are indeed smaller than in big countries, but they are not that small to render fiscal policy without effect on the economy. This also signifies that leakages to neighboring countries, namely government spending that is used in imports of goods and services, might not be as high as expected.

[52] Section 2 laid out some conditions under which this can happen.

7 References

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8 Appendix

Table 5: Ceteris paribus conditions for higher multipliers.

Determinants	**Conditions**	**Mechanism**
Leakages	Increase in spending higher than tax cuts	Spending has a direct effect on output, whereas wealth effects on income can partly be saved
	Higher marginal propensity to consume	The higher the part of income that is consume, the higher the multiplier
	Liquidity constrained consumers are targeted	Liquidity constrained consumers have less access to financial markets; they save less
	More targeted towards non-Ricardian consumers	Non-Ricardian consumers do not account for future tax increases if the government spends more in the current period. Hence, they do not save more in the current period.
	Lower propensity to import	Imports transfer the wealth effect to trading partners.
	Smaller automatic stabilizers	Smaller stabilizers limit the transfer of wealth, thereby increasing the effect of (exogenous) government spending.
	Larger output gap	The larger the output gap, the better can the Central Bank increase the money supply to increase demand, without having to increase interest rates.
Monetary conditions	Nominal interest rate does not adapt	A more rigid nominal interest rate lowers crowding out.
	Fixed exchange rates	Under fixed exchange rates, a spending shock to an appreciation of the real exchange rate, which leads to a response of the Central Bank (increase of the money supply). This raises output.
Fiscal sustainability	Stable public finances	Stable public finances reduce the pressures of higher debt on interest rates.
Financial markets	*Lower degree of financial integration*	Less developed financial markets decrease consumers' access to financial markets, they become more borrowing-constraint and are not allowed to save.
	Better government access to international financial markets	Countries without access to international lending markets have to finance their debt internally, which leads to higher interest rates on bonds and thus more crowding out.
	Lower government access to international financial markets	Countries without access to international lending markets are able to attract domestic savers, which lowers the cost of financing.
Economic situation	Lower degree of uncertainty	Lower uncertainty about the future raises the precautionary saving rate.
	Higher levels of deleveraging	Higher levels of deleveraging decreases access to financial markets and increases multipliers.
	Zero lower bound	The zero lower bound of nominal interest rates prevents an offsetting response by the Central Bank, thereby keeping multipliers high.
Other determinants	Consumers' and investors' confidence	Consumers' and investors' confidence is intrinsically linked to the marginal propensity to consume/save (cf. above).
Timeframe	*Permanent measures, if interventions on income level*	On the income level, permanent changes in relative intertemporal prices affect behavior more strongly, due to a shift in intertemporal consumption behavior.
	Temporary measures, if interventions on price level	On the price level, temporary changes in relative intertemporal prices act more strongly, due to powerful short-term changes in consumption behavior.
	Temporary measures	Temporary measures reduce fears of unsustainability

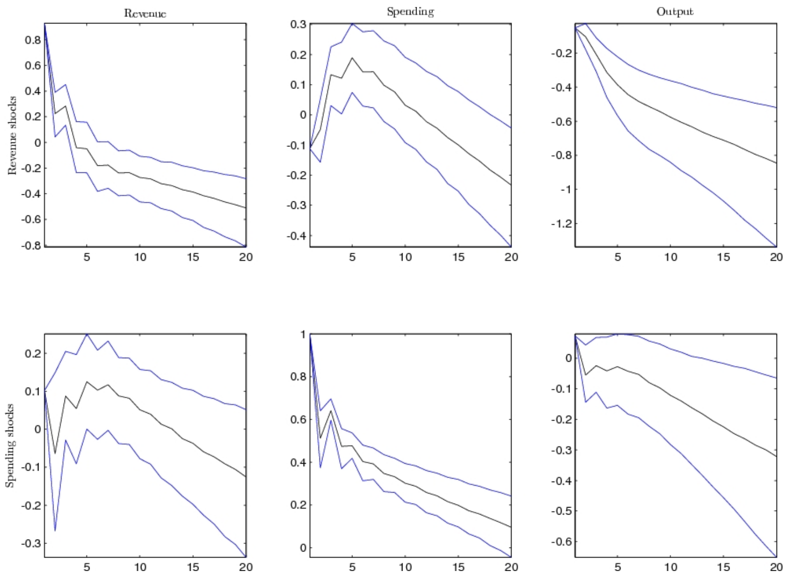
Source: Spilimbergo et al. (2009); conditions in italic indicate contradicting conditions.

Table 6: Parameters of the basic model.

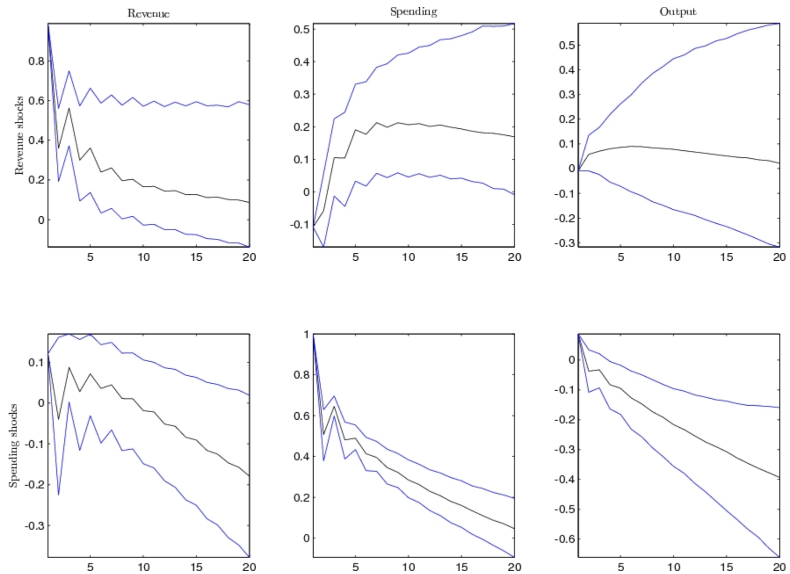
2001Q1-2013Q1				1996Q1-2013Q1			
c_1	c_2	b_2	a_2	c_1	c_2	b_2	a_2
Basic model							
DT							
0.1532*	-0.0667*	-0.1091		0.0428*	-0.1655*	-0.0095	
(3.3112)	(3.4636)	(3.3112)		(0.9513)	(1.6695)	(0.9513)	
0.4715*	0.0831		0.0020	0.3692*	0.1662		0.2127
(1.4662)	(3.4211)		(1.6808)	(0.4948)	(1.6692)		(7.8472)
ST							
0.0477*	-0.0786*	-0.1120		0.0263*	-0.1714*	-0.0137	
(2.1542)	(3.4334)	(2.1542)		(0.6660)	(1.6495)	(0.6660)	
0.4024*	0.0853		-0.0572	0.3044*	0.1722		0.2038
(1.0325)	(3.3662)		(-5.8866)	(0.3997)	(1.6487)		(8.0901)
Including crisis dummies							
DT							
0.0615*	-0.1581*	-0.2158		0.0187*	-0.2410*	-0.0332	
(3.3645)	(3.9043)	(3.3645)		(0.9363)	(1.7834)	(0.9363)	
0.4379*	0.1646		-0.0104	0.3361*	0.2417		0.2705
(1.4582)	(3.7042)		(-3.5737)	(0.5106)	(1.7796)		(6.5801)
ST							
-0.0015	-0.0877*	-0.1081		0.0090*	-0.1879*	-0.0161	
(2.0740)	(3.4309)	(2.074)		(0.6552)	(1.6538)	(0.6552)	
0.3397*	0.0858		-0.0570	0.2602*	0.1882		0.2192
(1.1065)	(3.3658)		(-5.9018)	(0.4237)	(1.6527)		(7.5408
Including oil prices as an exogenous variable							
DT							
0.1051*	-0.0483*	0.0278		0.0511*	-0.1869*	0.0186	
(3.7860)	(3.7511)	(3.7860)		(1.0233)	(1.7125)	(1.0233)	
0.4731*	0.0454		0.0901	0.3719*	0.1852		0.2868
(1.5417)	(3.7482)		(4.1580)	(0.5389)	(1.7115)		(5.9681)
ST							
0.0770*	-0.0908*	-0.0943		0.0445*	-0.1969*	0.0077	
(2.3721)	(3.4759)	(2.3721)		(0.7164)	(1.6891)	(0.7164)	
0.4143*	0.1001		0.0017	0.3073*	0.1961		0.2887
(1.1364)	(3.4311)		(1.9707)	(0.4406)	(1.6888)		(5.8487)
Including oil prices and crisis dummies							
DT							
0.0179*	-0.1470*	-0.0873		0.0270*	-0.2616*	-0.0062	
(3.7708)	(4.2625)	(3.7708)		(1.0070)	(1.8274)	(1.0070)	
0.4323*	0.1475		0.1058	0.3367*	0.2619		0.3501
(1.5451)	(4.2261)		(3.9961)	(0.5587)	(1.8273)		(5.2186)
ST							
-0.0080	-0.0840*	-0.0802		0.0197*	-0.2065*	0.0052	
(2.2653)	(3.4719)	(2.2653)		(0.7027)	(1.6906)	(0.7027)	
0.3369*	0.0822		-0.0082	0.2621*	0.2062		0.2972
(1.1998)	(3.4381)		(-4.1909)	(0.4618)	(1.6905)		(5.6876)

Notes: Numbers between brackets are standard errors; asterisks indicate the parameter has the expected sign.

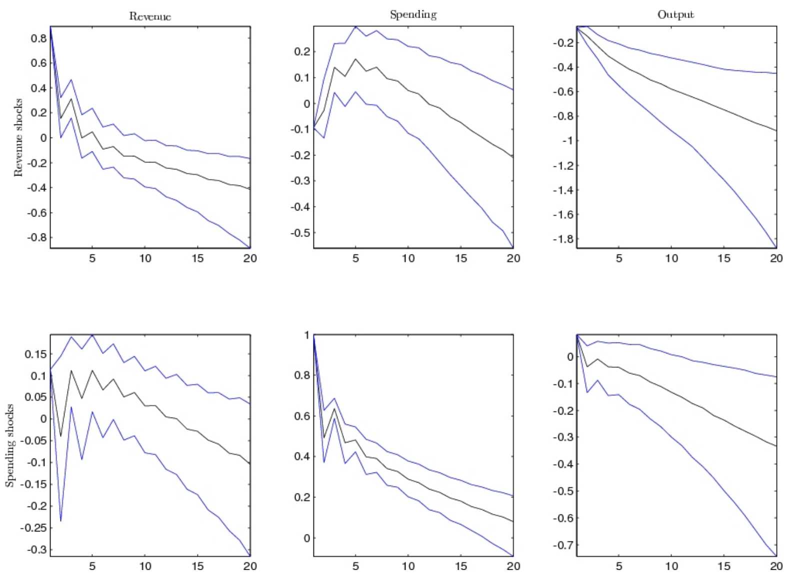
Figure 8: Impulse response functions of the basic model, 2001Q1-2013Q1, with stochastic trend.



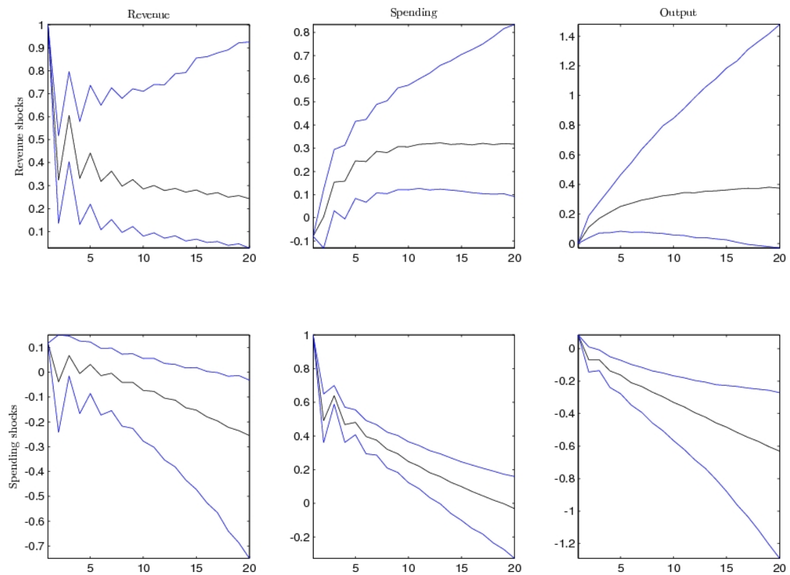
(a) Basic model



(b) With crisis dummies

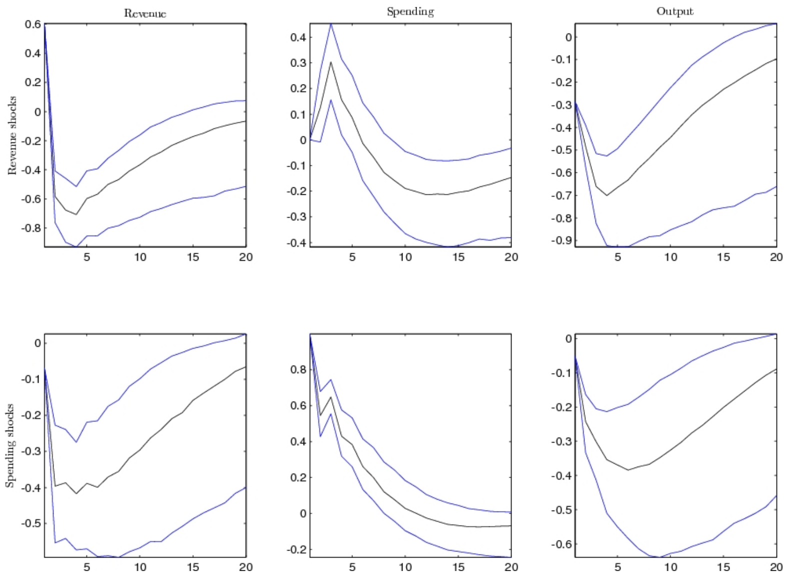


(c) With oil prices

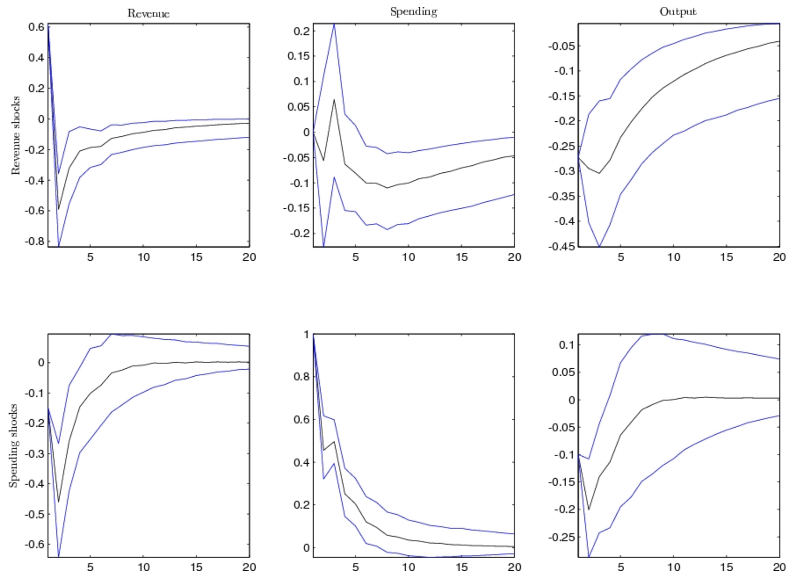


(d) With oil prices and crisis dummies

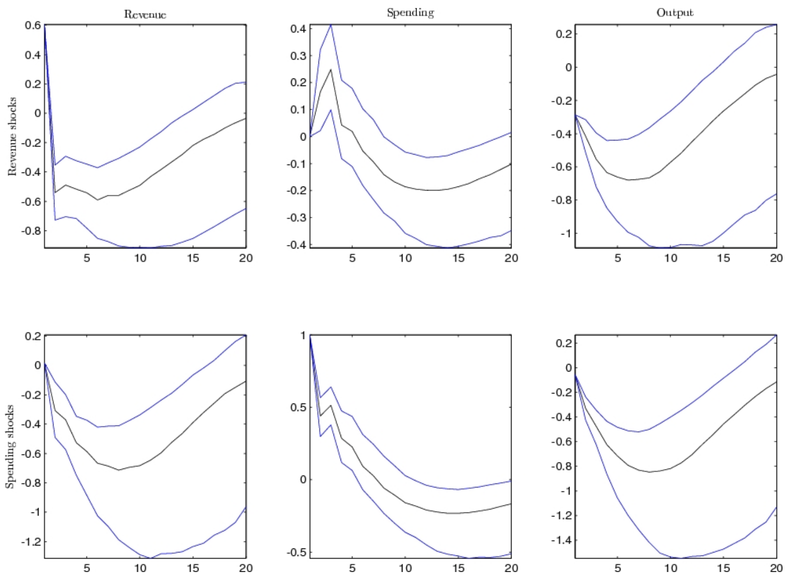
Figure 9: Impulse response functions of the basic model, 2001Q1-2013Q1, alternative ordering



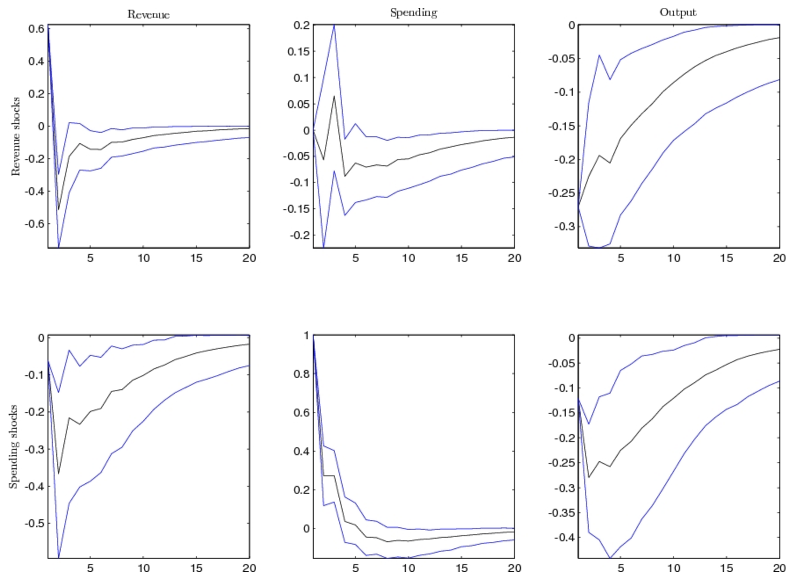
(a) Basic model



(b) With crisis dummies



(c) With oil prices



(d) With oil prices and crisis dummies

Table 7: Parameters of the extended model, 2001Q1-2013Q1.

γ_1	γ_2	δ_1	δ_2	δ_3	λ_1	λ_2	λ_3	λ_4	β_2	α_2
Extended model										
DT										
0.131*	-0.221*	0.027	-0.078	-0.124	-0.038	-0.028	-0.130	-0.407	-0.117	
(3.682)	(4.875)	(3.682)	(4.875)	(9.139)	(3.682)	(4.875)	(9.139)	(77.006)	(3.682)	
0.165*	-0.237*	0.036	-0.081	-0.125	-0.037	-0.022	-0.123	-0.386		0.194
(3.77)	(4.788)	(3.77)	(4.788)	(9.475)	(3.77)	(4.788)	(9.475)	(77.569)		(3.77)
ST										
0.102*	-0.264*	0.018	-0.070	-0.084	-0.015	-0.031	-0.156	-0.363	-0.023	
(2.478)	(4.585)	(2.478)	(4.585)	(7.386)	(2.478)	(4.585)	(7.386)	(78.839)	(2.478)	
0.156*	-0.268*	0.028	-0.070	-0.084	-0.012	-0.030	-0.148	-0.336		0.342
(2.631)	(4.58)	(2.631)	(4.58)	(7.855)	(2.631)	(4.58)	(7.855)	(79.479)		(2.631)
Including crisis dummies										
DT										
0.060*	-0.252*	0.025	-0.080	-0.136	-0.035	-0.029	-0.161	-0.430	-0.140	
(3.704)	(4.941)	(3.704)	(4.941)	(9.26)	(3.704)	(4.941)	(9.26)	(76.171)	(3.704)	
0.096*	-0.256*	0.035	-0.082	-0.137	-0.034	-0.021	-0.155	-0.409		0.193
(4.422)	(5.879)	(4.422)	(5.879)	(10.319)	(4.422)	(5.879)	(10.319)	(96.799)		(3.791)
ST										
0.057*	-0.272*	0.018	-0.070	-0.099	-0.016	-0.031	-0.181	-0.382	-0.026	
(2.427)	(4.587)	(2.427)	(4.587)	(8.086)	(2.427)	(4.587)	(8.086)	(77.842)	(2.427)	
0.109*	-0.274*	0.028	-0.070	-0.100	-0.012	-0.030	-0.175	-0.357		0.345
(2.576)	(4.581)	(2.576)	(4.581)	(8.594)	(2.576)	(4.581)	(8.594)	(78.428)		(2.576)
Including oil prices as an exogenous variable										
DT										
0.113*	-0.225*	-0.006	-0.056	-0.101	-0.025	-0.051	-0.163	-0.678	0.013	
(4.102)	(5.880)	(4.102)	(5.880)	(9.535)	(4.102)	(5.880)	(9.535)	(94.712)	(4.102)	
0.172*	-0.223*	0.001	-0.056	-0.096	-0.017	-0.052	-0.155	-0.657		0.356
(4.422)	(5.879)	(4.422)	(5.879)	(10.319)	(4.422)	(5.879)	(10.319)	(96.799)		(4.422)
ST										
0.126*	-0.307*	0.003	-0.047	-0.082	-0.007	-0.063	-0.162	-0.678	-0.002	
(2.639)	(5.127)	(2.639)	(5.127)	(7.538)	(2.639)	(5.127)	(7.538)	(98.765)	(2.639)	
0.207*	-0.308*	0.009	-0.047	-0.077	0.005	-0.063	-0.153	-0.656		0.440
(2.895)	(5.127)	(2.895)	(5.127)	(8.257)	(2.895)	(5.127)	(8.257)	(100.608)		(2.895)
Including oil prices and crisis dummies										
DT										
0.034*	-0.246*	-0.007	-0.057	-0.119	-0.022	-0.052	-0.198	-0.706	-0.009	
(4.104)	(5.915)	(4.104)	(5.915)	(9.699)	(4.104)	(5.915)	(9.699)	(92.782)	(4.104)	
0.093*	-0.246*	0.000	-0.056	-0.115	-0.014	-0.051	-0.193	-0.687		0.358
(4.426)	(5.915)	(4.426)	(5.915)	(10.505)	(4.426)	(5.915)	(10.505)	(94.639)		(4.426)
ST										
0.076*	-0.304*	0.002	-0.047	-0.099	-0.007	-0.063	-0.194	-0.702	0.000	
(2.578)	(5.128)	(2.578)	(5.128)	(8.354)	(2.578)	(5.128)	(8.354)	(96.9)	(2.578)	
0.148*	-0.304*	0.008	-0.047	-0.094	0.005	-0.063	-0.187	-0.683		0.438
(2.819)	(5.128)	(2.819)	(5.128)	(9.089)	(2.819)	(5.128)	(9.089)	(98.51)		(2.819)

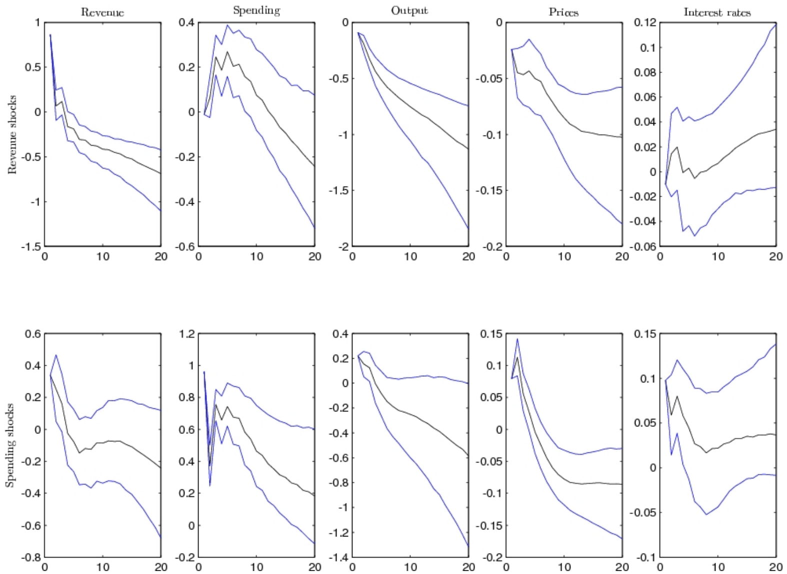
Notes: Numbers between brackets are standard errors; asterisks indicate the parameter has the expected sign.

Parameters of the extended model, 1997Q1-2013Q1.

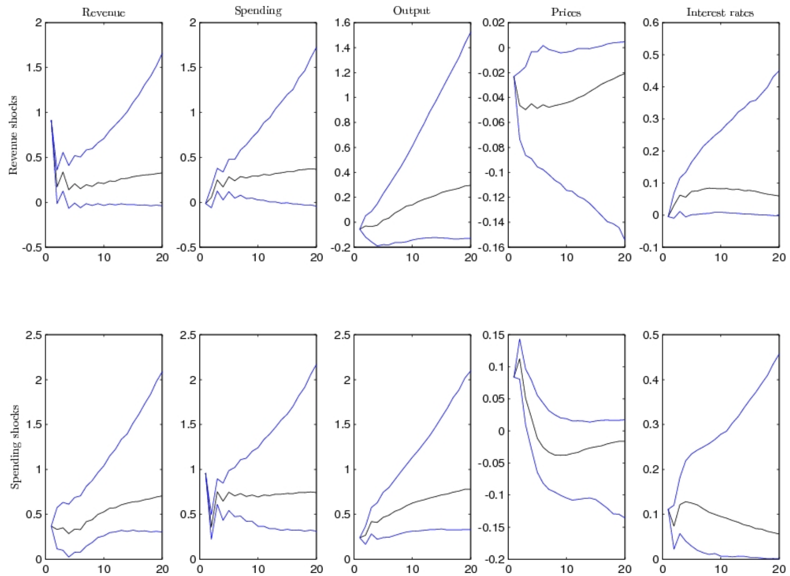
γ_1	γ_2	δ_1	δ_2	δ_3	λ_1	λ_2	λ_3	λ_4	β_2	α_2
Extended model										
DT										
0.027*	-0.329*	0.009	-0.047	-0.065	-0.029	-0.098	-0.212	-0.418	-0.046	
(1.430)	(2.284)	(1.430)	(2.284)	(3.483)	(1.430)	(2.284)	(3.483)	(46.269)	(1.430)	
0.114*	-0.329*	0.017	-0.047	-0.064	-0.007	-0.096	-0.205	-0.388		0.395
(1.574)	(2.277)	(1.574)	(2.277)	(3.878)	(1.574)	(2.277)	(3.878)	(46.694)		(1.574)
ST										
0.051*	-0.302*	0.018	-0.031	-0.061	-0.003	-0.113	-0.230	-0.310	-0.018	
(1.025)	(2.089)	(1.025)	(2.089)	(3.573)	(1.025)	(2.089)	(3.573)	(44.774)	(1.025)	
0.111*	-0.304*	0.021	-0.031	-0.062	0.019	-0.113	-0.229	-0.303		0.378
(1.099)	(2.087)	(1.099)	(2.087)	(3.826)	(1.099)	(2.087)	(3.826)	(44.841)		(1.099)
Including crisis dummies										
DT										
-0.022	-0.371*	0.011	-0.046	-0.078	-0.026	-0.099	-0.247	-0.437	-0.063	
(1.399)	(2.319)	(1.399)	(2.319)	(3.626)	(1.399)	(2.319)	(3.626)	(45.891)	(1.399)	
0.073*	-0.366*	0.018	-0.047	-0.077	-0.004	-0.096	-0.242	-0.409		0.415
(1.783)	(2.478)	(1.783)	(2.478)	(4.186)	(1.783)	(2.478)	(4.186)	(52.657)		(1.549)
ST										
0.059*	-0.364*	0.018	-0.036	-0.060	-0.007	-0.099	-0.245	-0.330	-0.007	
(1.041)	(2.224)	(1.041)	(2.224)	(3.544)	(1.041)	(2.224)	(3.544)	(44.857)	(1.041)	
0.155*	-0.365*	0.024	-0.037	-0.061	0.016	-0.099	-0.237	-0.313		0.487
(1.166)	(2.224)	(1.166)	(2.224)	(3.922)	(1.166)	(2.224)	(3.922)	(44.969)		(1.166)
Including oil prices as an exogenous variable										
DT										
0.047*	-0.349*	-0.002	-0.029	-0.056	-0.027	-0.121	-0.229	-0.548	-0.017	
(1.556)	(2.479)	(1.556)	(2.479)	(3.623)	(1.556)	(2.479)	(3.623)	(52.175)	(1.556)	
0.165*	-0.350*	0.000	-0.029	-0.049	0.007	-0.120	-0.219	-0.525		0.471
(1.783)	(2.478)	(1.783)	(2.478)	(4.186)	(1.783)	(2.478)	(4.186)	(52.657)		(1.783)
ST										
0.071*	-0.306*	0.021	-0.032	-0.071	-0.017	-0.109	-0.225	-0.470	-0.01	
(1.124)	(2.093)	(1.124)	(2.093)	(3.704)	(1.124)	(2.093)	(3.704)	(48.176)	(1.124)	
0.145*	-0.308*	0.026	-0.032	-0.072	0.005	-0.109	-0.217	-0.455		0.401
(1.226)	(2.093)	(1.226)	(2.093)	(4.019)	(1.226)	(2.093)	(4.019)	(48.287)		(1.226)
Including oil prices and crisis dummies										
DT										
-0.013	-0.378*	-0.002	-0.029	-0.067	-0.023	-0.121	-0.272	-0.578	-0.032	
(1.521)	(2.499)	(1.521)	(2.499)	(3.795)	(1.521)	(2.499)	(3.795)	(51.729)	(1.521)	
0.106*	-0.377*	0.000	-0.029	-0.061	0.011	-0.120	-0.267	-0.555		0.483
(1.749)	(2.495)	(1.749)	(2.495)	(4.391)	(1.749)	(2.495)	(4.391)	(52.168)		(1.749)
ST										
0.067*	-0.387*	0.021	-0.028	-0.075	-0.017	-0.111	-0.240	-0.461	-0.015	
(1.119)	(2.253)	(1.119)	(2.253)	(3.643)	(1.119)	(2.253)	(3.643)	(48.565)	(1.119)	
0.178*	-0.389*	0.026	-0.028	-0.076	0.010	-0.110	-0.227	-0.445		0.497
(1.268)	(2.252)	(1.268)	(2.252)	(4.079)	(1.268)	(2.252)	(4.079)	(48.729)		(1.268)

Notes: Numbers between brackets are standard errors; asterisks indicate the parameter has the expected sign.

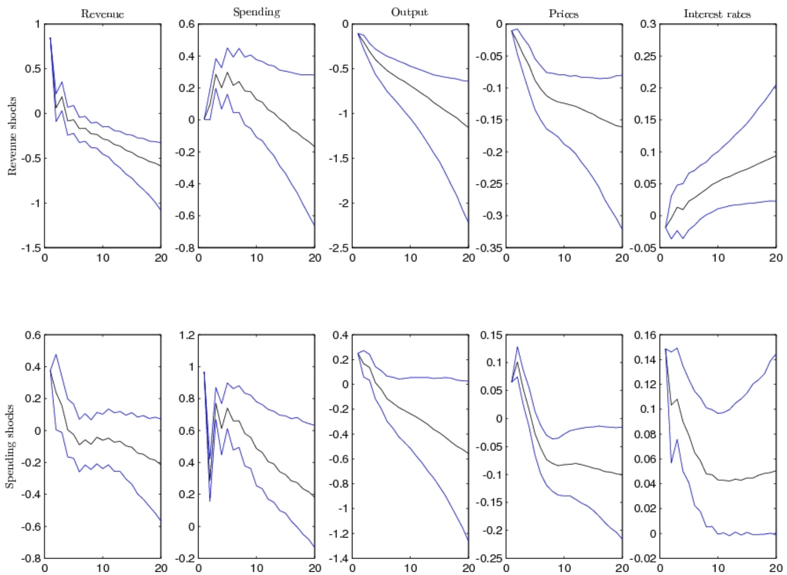
Figure 10: Impulse response functions of the extended model, 2001Q1-2013Q1, with stochastic trend.



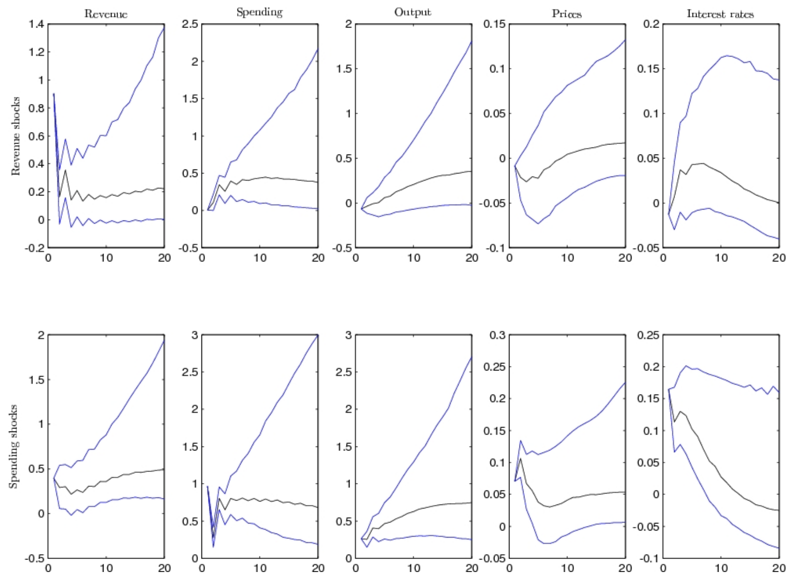
(a) Basic model



(b) With crisis dummies

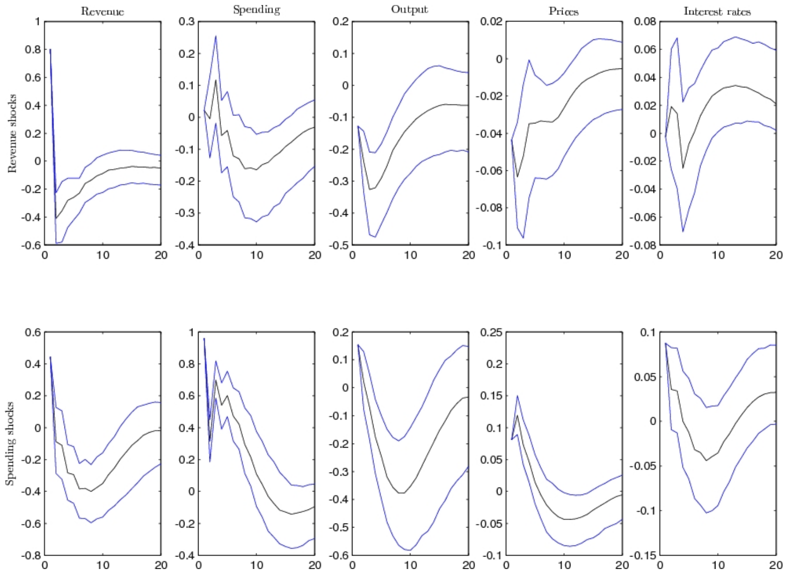


(c) With oil prices

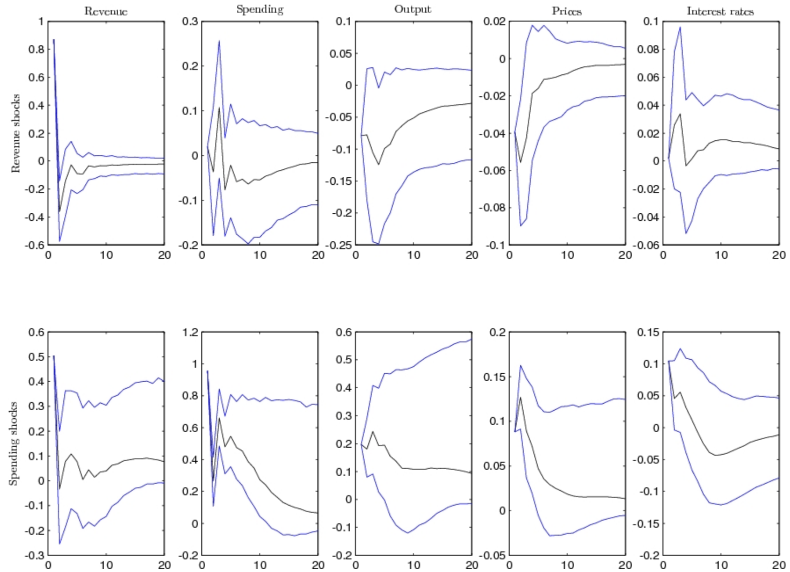


(d) With oil prices and crisis dummies

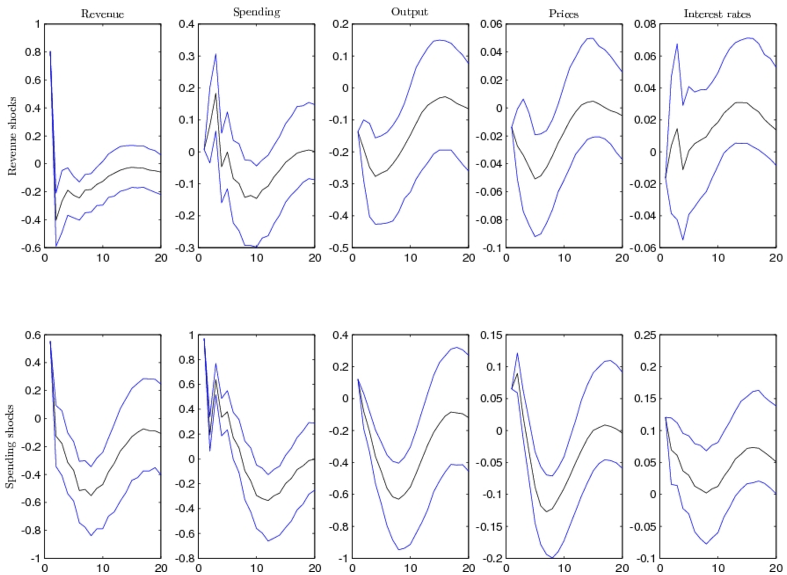
Figure 11: Impulse response functions of the extended model, 2001Q1-2013Q1, alternative ordering



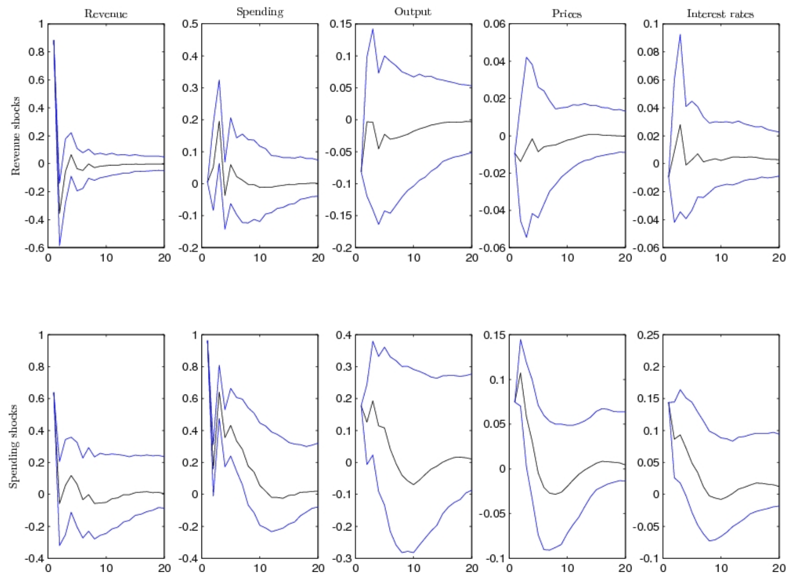
(a) Basic model



(b) With crisis dummies



(c) With oil prices



(d) With oil prices and crisis dummies

Table 8: Present value cumulative multipliers, shortened sample.

	4 periods		8 periods		12 periods		16 periods	
Specification	Tax	Spending	Tax	Spending	Tax	Spending	Tax	Spending
	Basic model							
	2001Q1-2008Q1							
(1)	-0.65*	1.52*	-0.76*	1.18*	-0.62*	0.92*	-0.46*	0.73*
(2)	-0.26*	0.49*	-0.09*	-0.08	0.12	-0.84	0.26	-1.87
	1996Q1-2008Q1							
(1)	-2.15*	0.22*	33.38	-0.03	6.85	-0.29	5.18	-0.54
(2)	-1.18*	0.21*	-7.39*	-0.29	18.25	-0.90	7.60	-1.63
	Extended model							
	2001Q1-2008Q1							
(1)	-120.31	1.08*	17.83	0.95*	43.83	0.78*	-79.16*	0.68*
(2)	1.14	-0.04	1.68	-1.09	1.36	-4.35	1.00	-5.20
	1997Q1-2008Q1							
(1)	-2.02*	1.17*	-1.04*	0.75*	-0.01*	0.29*	0.41	-0.17
(2)	-0.38*	1.21*	0.75	0.63*	1.23	-0.24	1.34	-1.70

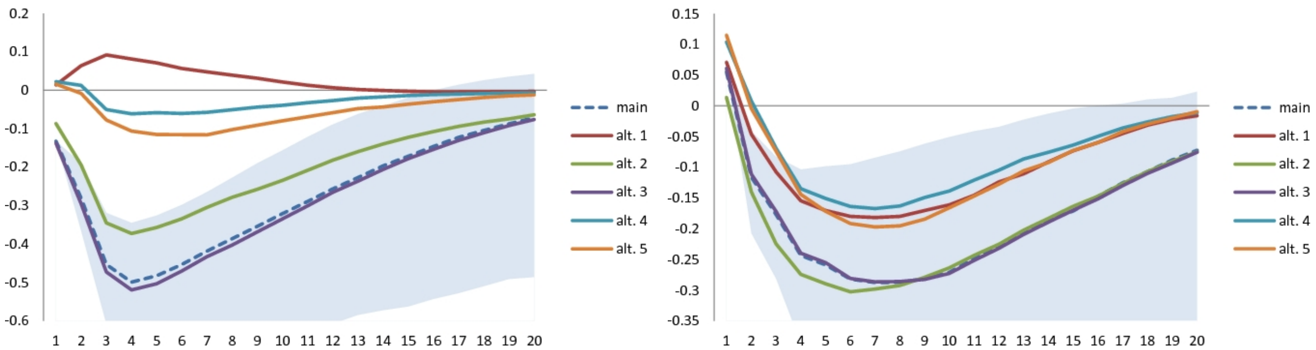
Notes: (1): Deterministic trend; (2): Deterministic trend including oil prices. Asterisks indicate the multiplier has the expected sign.

Table 9: Alternative definitions of policy variables

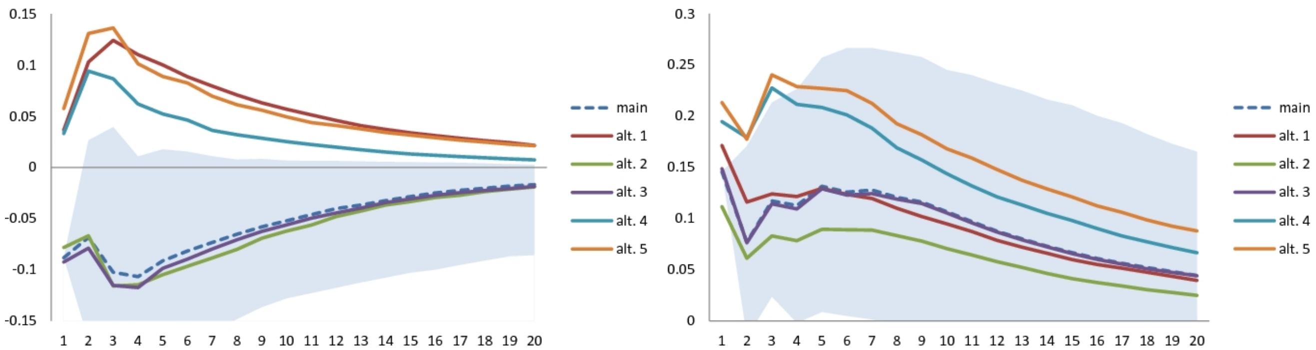
	Main definition		
	Taxes		*Spending*
	Income and property taxes[1]		Government consumption[4]
+	Indirect and corporate taxes[2]	+	Government investment[5]
+	Social security premiums[3]	+	Payments to persons[6]
		+	Tax subsidies[7]
		−	Spending subsidies[8]
	Alternative 1		
	Taxes		*Spending*
	Income and property taxes		Government consumption
+	Indirect and corporate taxes	+	Government investment
	Alternative 2		
	Taxes		*Spending*
	Income and property taxes		Government consumption
+	Indirect and corporate taxes	+	Government investment
+	Social security premiums	+	Payments to persons
−	Tax subsidies	−	Spending subsidies
	Alternative 3		
	Taxes		*Spending*
	Income and property taxes		Government consumption
+	Indirect and corporate taxes	+	Government investment
+	Social security premiums	+	Payments to persons
+	Spending subsidies	+	Tax subsidies
	Alternative 4		
	Taxes		*Spending*
	Income and property taxes		Government consumption
+	Indirect and corporate taxes	+	Government investment
+	Social security premiums	−	Spending subsidies
−	Tax subsidies		
−	Payments to persons		
	Alternative 5		
	Taxes		*Spending*
	Income and property taxes		Government consumption
+	Indirect and corporate taxes	+	Government investment
+	Social security premiums	+	Tax subsidies
+	Spending subsidies		
−	Payments to persons		

Notes: CBS vocabulary: [1]Belastingen op inkomen en vermogen; [2]Belasting op productie en invoer; [3]Sociale premies; [4]Consumptieve bestedingen; [5]Investeringen; [6]Sociale Uitkeringen; [7]Subsidies (middelen kant); [8]Subsidies (bestedingen kant)

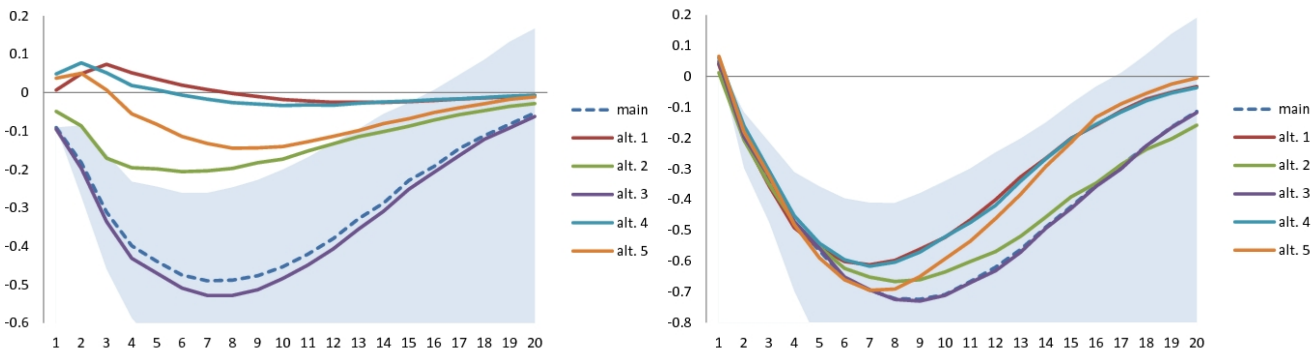
Figure 12: Responses of output to fiscal policy shocks using different definitions of policy variables.



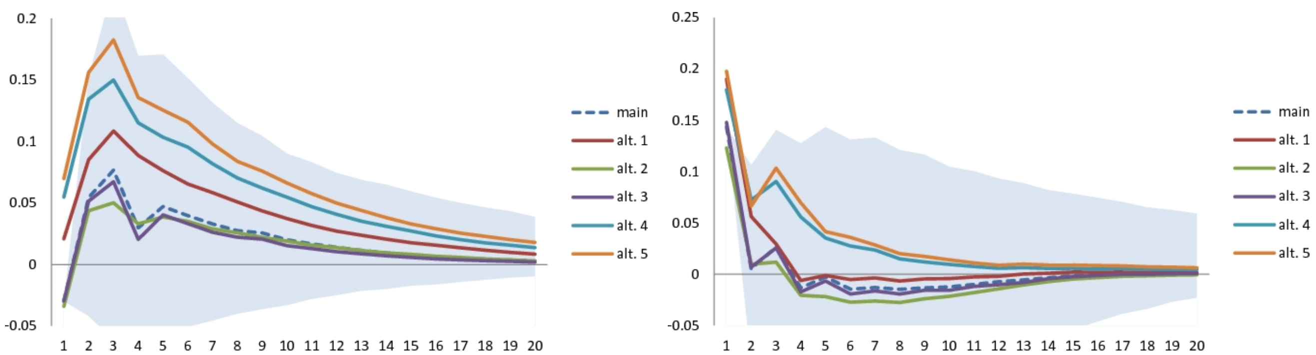
Basic model



Basic model, with crisis dummies



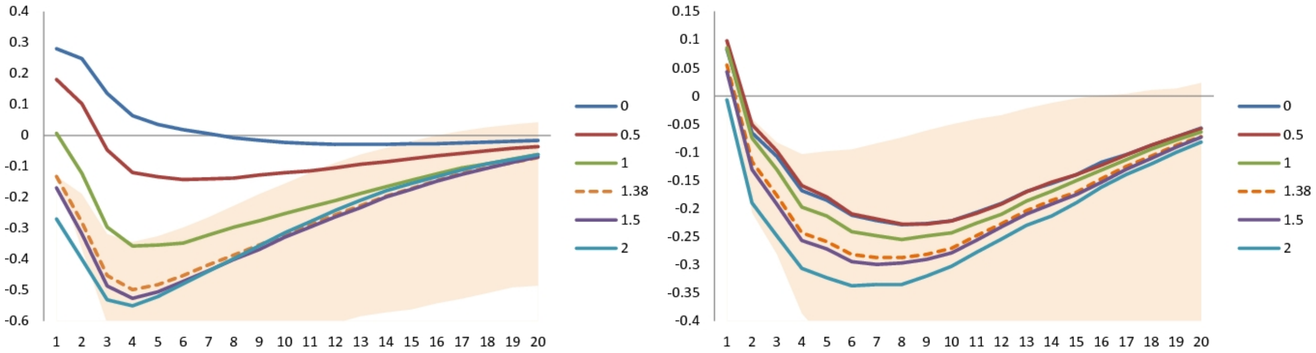
Including oil prices



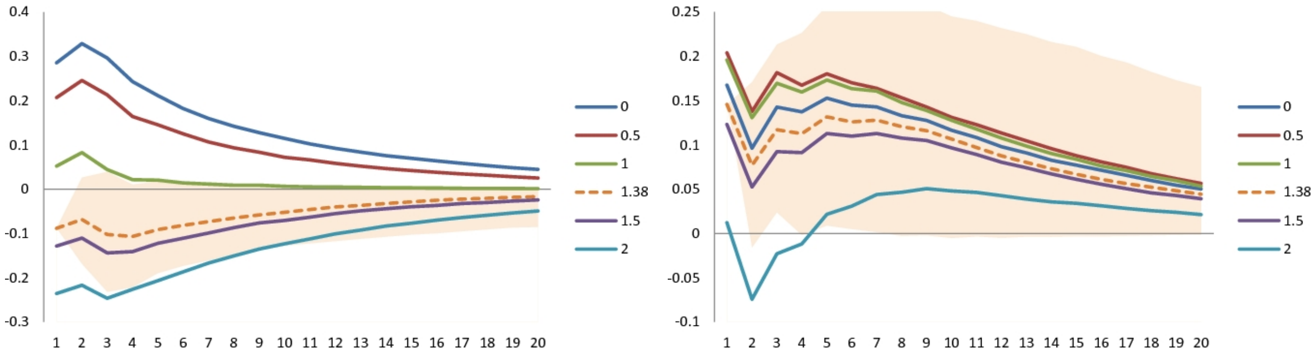
Including oil prices, with crisis dummies

The definition used in the remainder of the thesis is marked as the striped blue line. Light blue areas indicate the 68% confidence bands for the main definition. Revenue shocks are in the left, spending shocks in the right column.

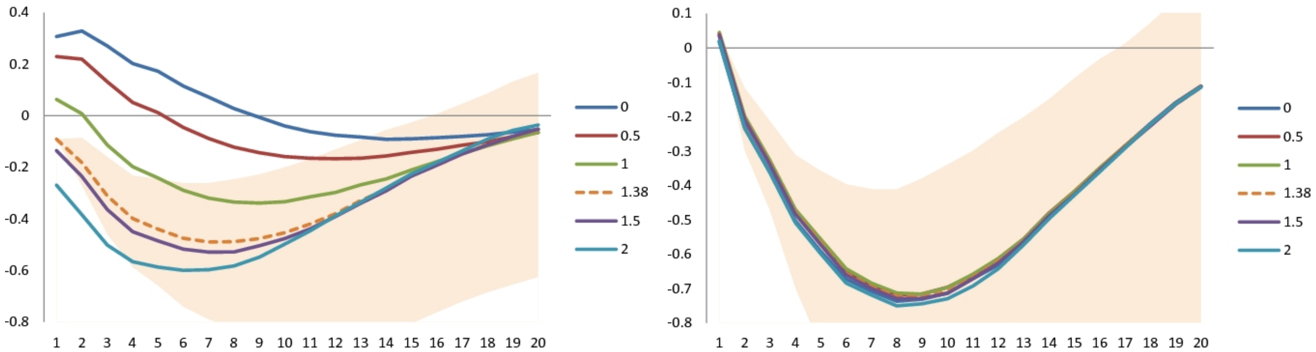
Figure 13: Responses of output to fiscal policy shocks using alternative values for a_1.



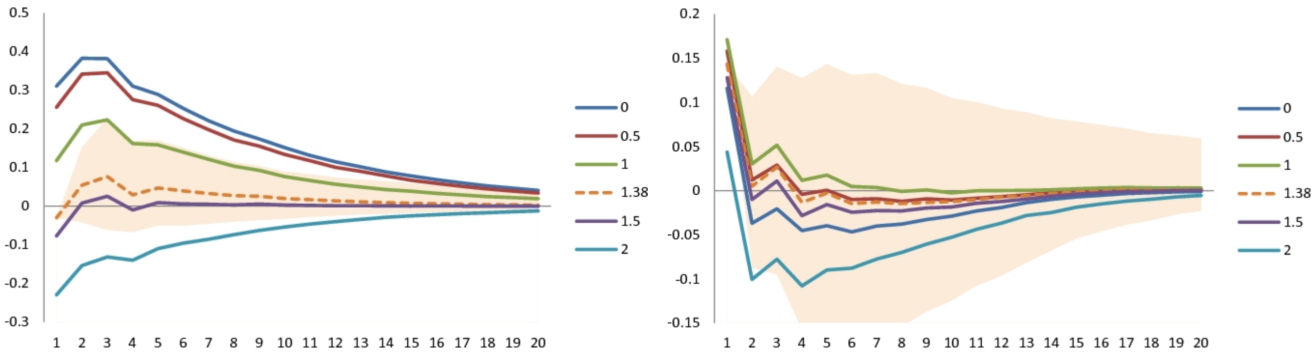
Deterministic trend



Deterministic trend, with crisis dummies



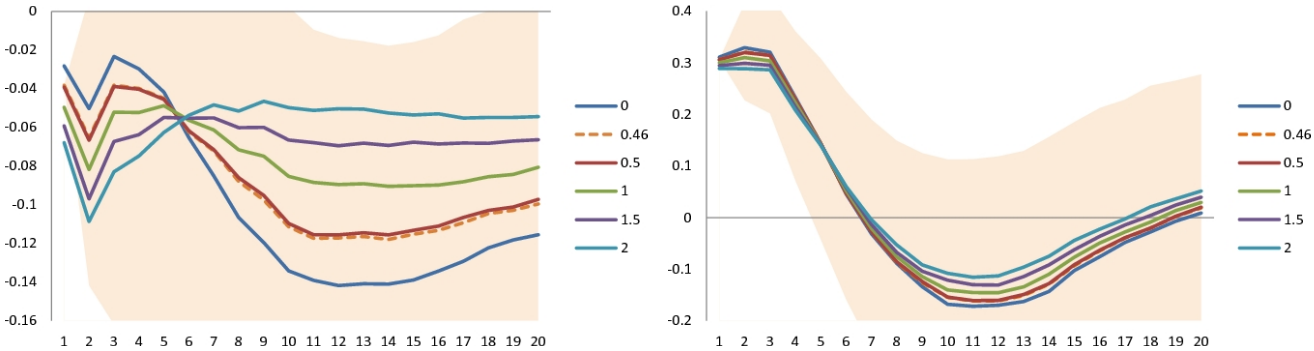
Deterministic trend, including oil prices



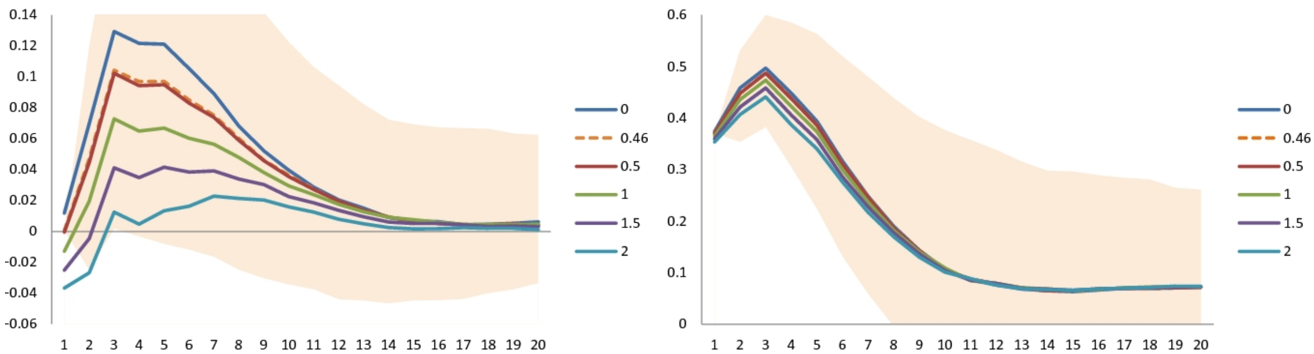
Deterministic trend, including oil prices and crisis dummies

The value of a_1 used in the remainder of this thesis is marked as the striped orange line. Light orange areas indicate the 68% confidence bands for $a_1 = 1.38$. Revenue shocks are in the left, spending shocks in the right column.

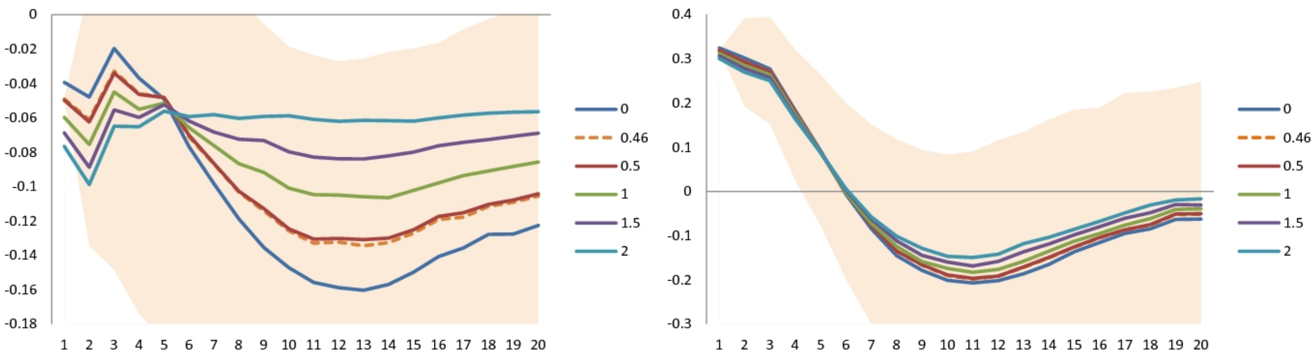
Figure 14: Responses of output to fiscal policy shocks using alternative values for α_2.



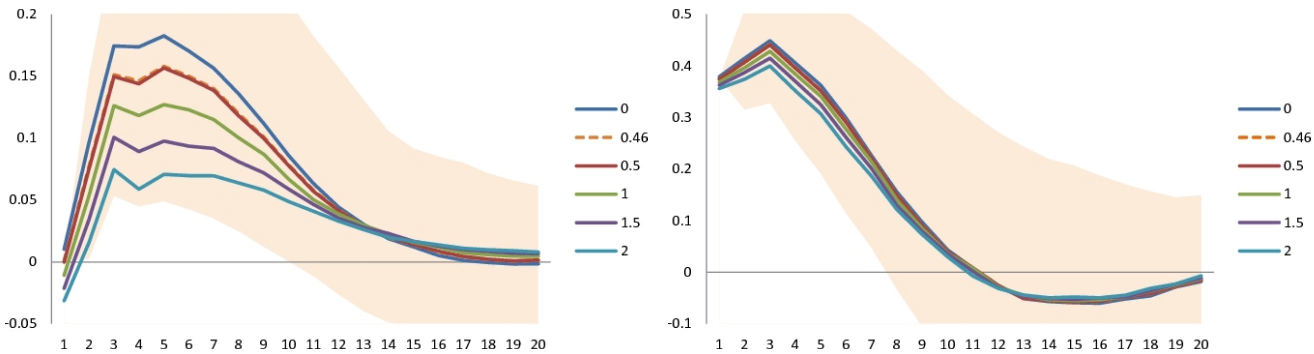
Deterministic trend



Deterministic trend, with crisis dummies



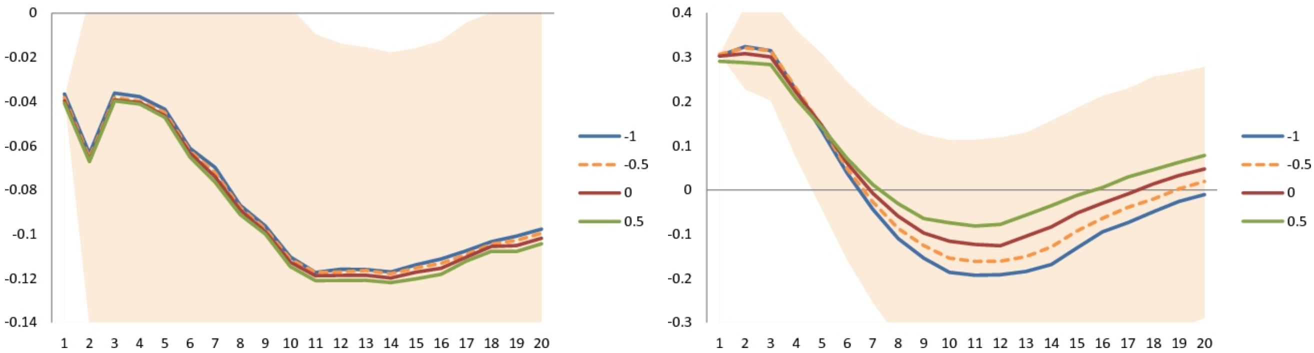
Deterministic trend, including oil prices



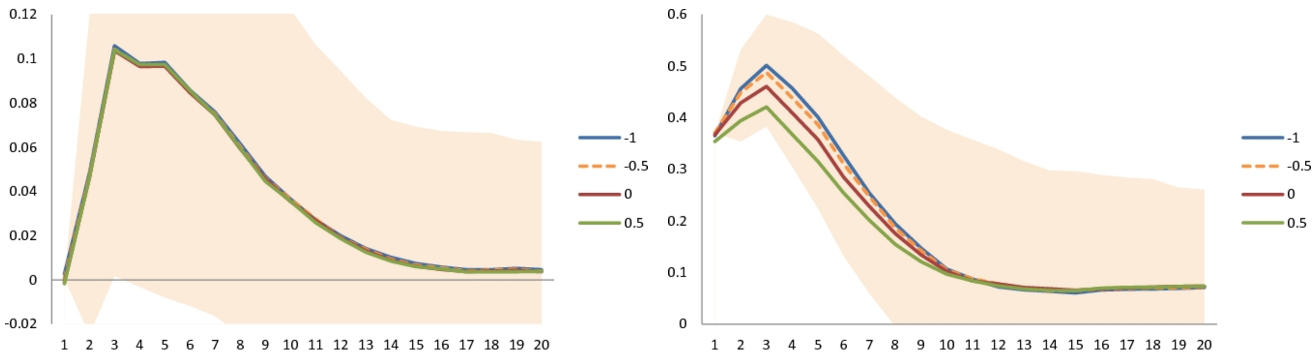
Deterministic trend, including oil prices and crisis dummies

The value of a_1 used in the remainder of this thesis is marked as the striped orange line. Light orange areas indicate the 68% confidence bands for $\alpha_2 = 0.46$. Revenue shocks are in the left, spending shocks in the right column.

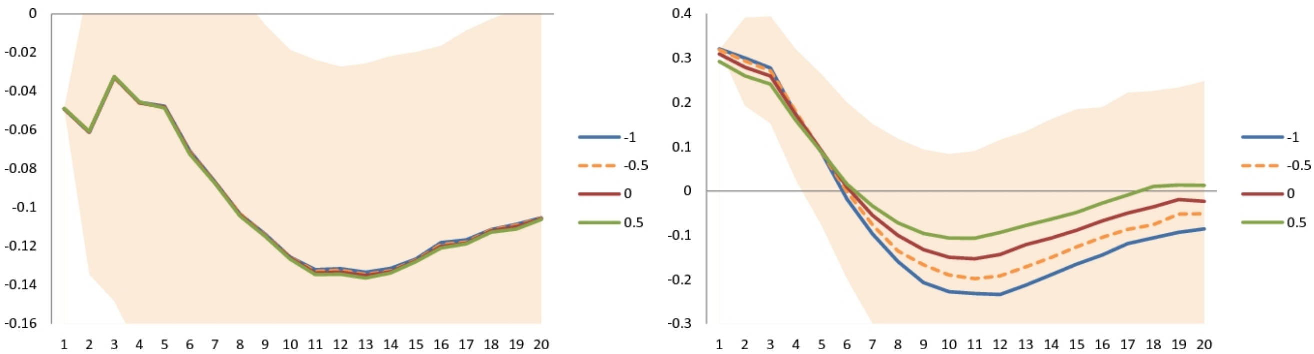
Figure 15: Responses of output to fiscal policy shocks using alternative values for β_2.



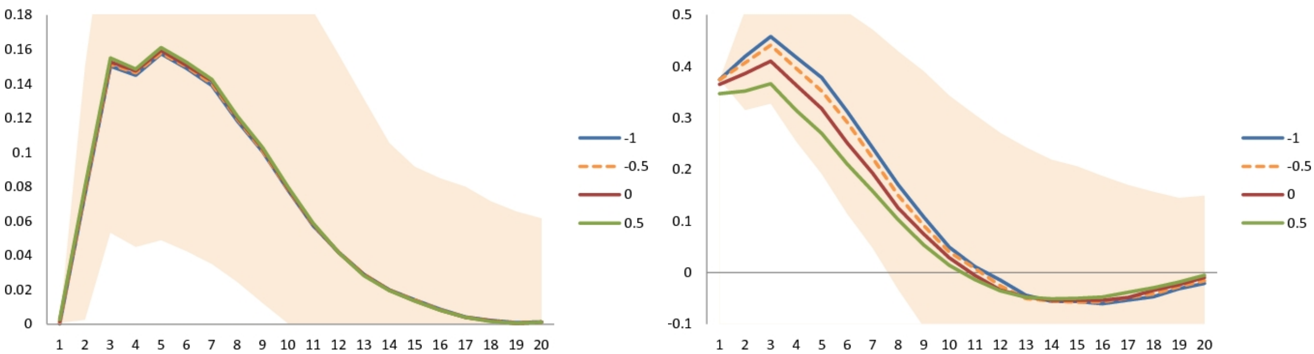
Deterministic trend



Deterministic trend, with crisis dummies



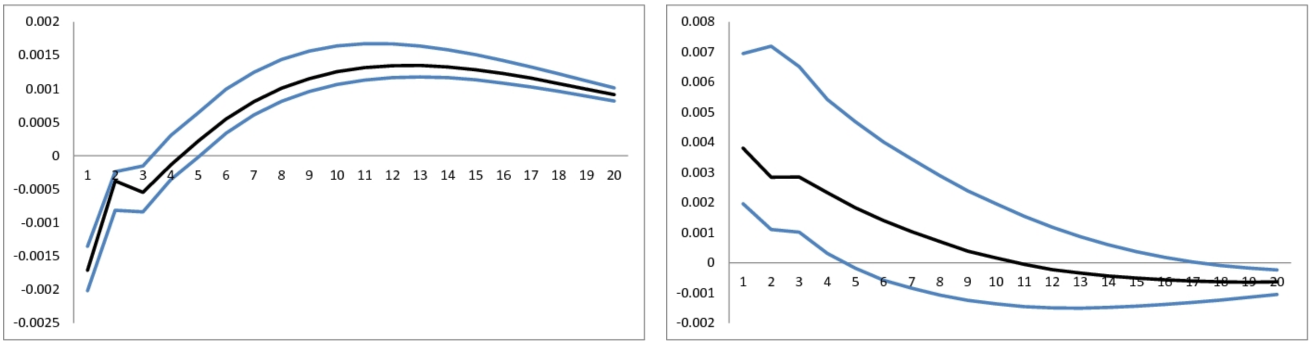
Deterministic trend, including oil prices



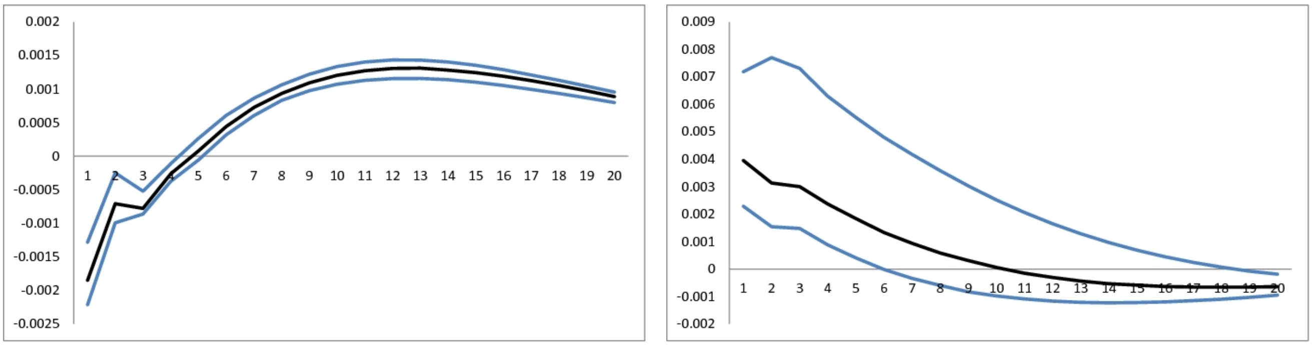
Deterministic trend, including oil prices and crisis dummies

The value of a_1 used in the remainder of this thesis is marked as the striped orange line. Light orange areas indicate the 68% confidence bands for $\beta_2 = -0.5$. Revenue shocks are in the left, spending shocks in the right column.

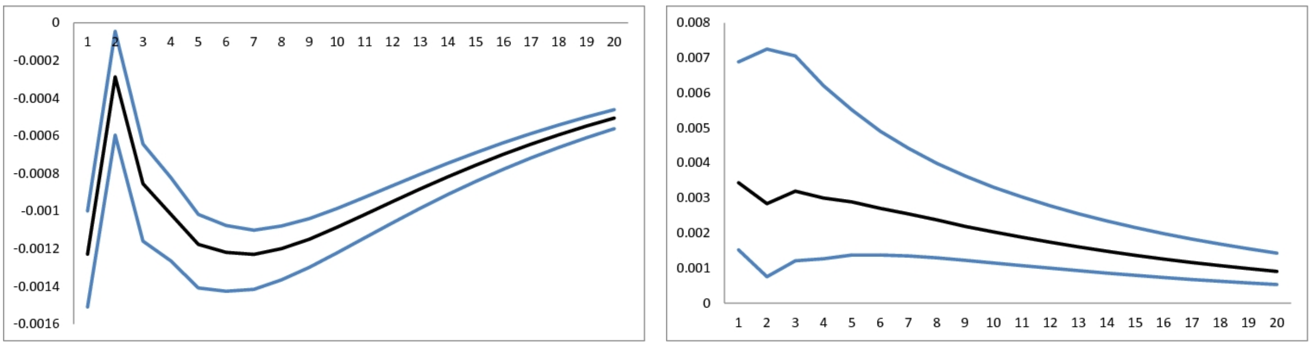
Figure 16: Output responses with a sign restriction identification strategy.



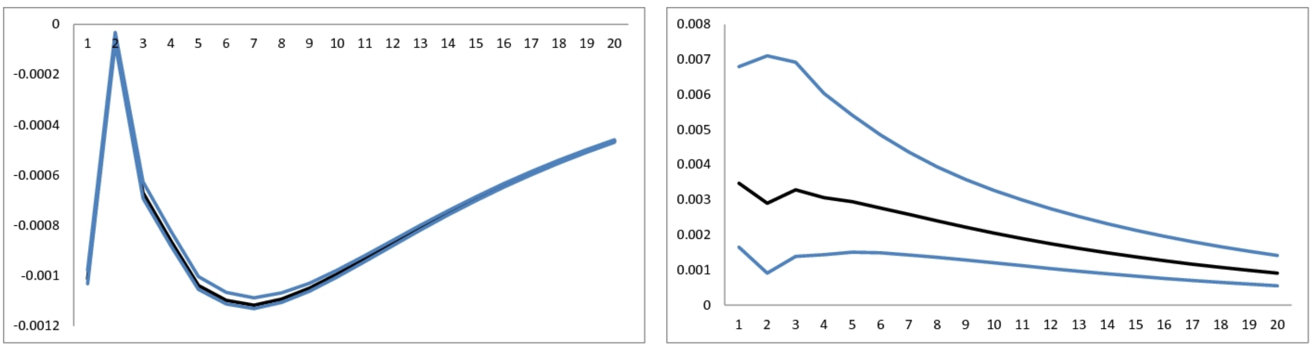
Output responses to tax shocks (left) and spending shocks (right) with restrictions over 3 horizons. Deterministic trend.



Output responses to tax shocks (left) and spending shocks (right) with restrictions over 4 horizons. Deterministic trend..



Output responses to tax shocks (left) and spending shocks (right) with restrictions over 3 horizons. Deterministic trend, including crisis dummies



Output responses to tax shocks (left) and spending shocks (right) with restrictions over 4 horizons. Deterministic trend, including crisis dummies.

Blue lines delimit the 68% confidence bands.