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Master Thesis

The Effects of Fiscal Policy on the Norwegian Economy

What are the impacts of fiscal policy on output and other macroeconomic variables in the Norwegian economy?

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Abstract

This master thesis examines the effect of fiscal policy on various macroeconomic variables in the Norwegian economy, using the recursive approach within a Structural Vector Autoregressive (SVAR) model. The main point of focus is on the size and direction of the fiscal multipliers, i.e., the government spending multiplier and the tax multiplier. Additionally, we investigate the effect of fiscal policy on private consumption, private investment, and inflation.

In the baseline model, we observe a small positive government spending multiplier and a small positive tax multiplier. Our findings are broadly consistent with previous literature and economic theory, except for one notable exception regarding the tax multiplier, which theory and literature suggest is negative. The effect remains largely unchanged when controlling for private investment, private consumption, inflation, and interest rate.

Our results find that private consumption falls in response to the positive government spending shock and rises in response to a positive tax shock. The response to investment is more ambiguous and mostly statistically insignificant. The effect on inflation is negative following a tax shock and positive following a government spending shock.

Overall, this research contributes to understanding the relationship between fiscal policy and macroeconomic variables in the Norwegian economy. However, the unexpected results of the tax multiplier highlight the complexities involved in accurately modeling and identifying the effects of fiscal policy shocks. Also, our findings highlight the limitations of the recursive approach and using Cholesky ordering when analyzing fiscal policy.

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1. Introduction

1.1 Motivation and Purpose

This thesis examines fiscal policy's impact on the Norwegian economy by studying how government spending and taxes affect output (GDP). The field of fiscal policy has been extensively studied, particularly following the financial crisis of 2008. However, there remains a lack of consensus among economists regarding the magnitude of these effects (Boug et al., 2017). In line with previous literature, we apply a methodology commonly used in studies and analyze how fiscal shocks in Norway impact the economy.

Fiscal policy is a tool that governments can utilize to affect the economy. The financial crisis and the following zero interest rate policy in many countries have caused decision-makers to turn to a range of fiscal policy programs in an attempt to avoid an extended economic recession. Resulting in an increased interest among academic researchers in assessing the macroeconomic effects of fiscal interventions in different economies. Although fiscal policy might be a more important tool when monetary policy is restricted by the zero lower bound, it is also necessary in normal times to promote sustainable growth and reduce poverty (*IMF*, 2023).

How much GDP changes in response to a change in government spending or taxes is referred to as the fiscal multiplier. In general, estimates of the multipliers are calculated using a specific theoretical or empirical model. These estimates exhibit considerable variation and are contingent upon methodology, assumptions, and the dataset (Boug et. al., 2017). Previous empirical studies like Blanchard and Perotti (2002), Caldara and Kamps (2008), Mountford and Uhlig (2009), and Romer and Romer (2010) all use different identification approaches and find similar results. A positive government spending shock typically leads to an increase in output, while a positive tax shock generally results in a decrease in output. However, findings considering the response of other macroeconomic variables like private consumption and private investment following a fiscal policy shock are less conclusive.

The discussion on fiscal multipliers is also a political issue. Following the financial crisis in 2008, President Barack Obama launched a substantial fiscal stimulus on the grounds that the fiscal multiplier was believed to be close to 1.5. Barro (2009) made the point that this seems like magic, and if this is the case, why would you ever stop increasing fiscal policy? He argued that the empirical studies do not support the Obama view, nor that fiscal policy in itself is a quick fix to a more deep-rooted problem which was the financial crisis. Ten years later, Ramey (2019) summarized what was learned in the aftermath of the financial crisis. This study presents the case that empirical evidence cannot reject a fiscal multiplier in the range of 0.5 - 2, suggesting that the literature after 2008 does not agree on the size of the multiplier.

The financial crisis of 2008 did not impact the Norwegian economy to the same degree as other countries (Norges Bank, n.d.), similar to what was observed during the Covid-19 pandemic (SSB, 2022). Many allude this to the government's ability to counteract the economic downturn by increasing government spending. However, we are currently experiencing the highest rise in inflation in many years, which has initiated a debate on to what degree fiscal policy affects inflation. The government has stated that government spending should be stricter now to prevent even higher inflation. As a response, some economists argued that government spending has little to no effect on inflation. Thus, political opponents deem it unfair not to provide a stimulus for those falling behind due to the high price level (*DN*, 2023). The debate has proven that the Norwegian academia in economics does not agree on how fiscal policy affects inflation or to what degree.

1.2 Research Question

Given the ambiguous results in the existing literature regarding the impact of fiscal policy on the economy, we want to investigate this further, specifically for the Norwegian economy. Hence, our research question is: *What are the impacts of fiscal policy on output and other macroeconomic variables in the Norwegian economy?* To answer this question, we utilize Cholesky identification within a Structural Vector Autoregression (SVAR) model to identify fiscal shocks and analyze their impact on the economy.

1.3 Outline

The thesis is structured in the following sections: Section 2 introduces the theoretical framework of fiscal policy in general and specifically for Norway. Section 3 provides an overview of previous empirical studies that have studied the effects of fiscal policy. Our data and methodology are introduced in section 4. Section 5 presents and illustrates our final results, followed by a discussion of the result in section 6, where we go into the depths of the results. We provide a selection of robustness tests in section 7 and finally conclude in section 8.

2. Theoretical Framework

2.1 Characteristics of Fiscal Policy

Fiscal policy is used to influence the economy through government spending and taxation. A classic definition of fiscal policy is that it encompasses the choices that impact the net assets of the public sector. Meaning all the public sector receipts and payments from the general government that does not apply to the purchase or sale of receivables (Johansen, 1965 referred to in Torvik, 2016). In general, fiscal policy aims to balance long-term fiscal stability and short-term economic development (Juel & Nicolaisen, 2022). Through investment in infrastructure, health care, and education, fiscal policy can benefit the economy in the long term. Furthermore, the tax and transfer system and the provision of public services play a crucial role in promoting a fair distribution of incomes and opportunities (Adrian & Gaspar, 2022).

Fiscal policy can be used to supplement monetary policy and as a tool for stabilizing economic fluctuations, thus reducing costs by mitigating these fluctuations. The government can use fiscal policy through active decisions by increasing or decreasing public revenues and expenses to influence economic activity. Also functioning as automatic stabilizers, where the tax revenues and certain expenses are allowed to fluctuate along the business cycles (Vik, 2008). The overall fiscal balance affects the demand for goods and services and inflationary pressures (Adrian & Gaspar, 2022). In times of low or negative economic growth, fiscal policy can be utilized as a countercyclical tool. The government can implement expansionary fiscal policies by increasing expenditures in the national budget or reducing taxes and fees. These measures aim to stimulate private consumption, production, and investment, leading to increased employment and inflation. Conversely, fiscal policy can be tightened when there is high economic growth and low unemployment, resulting in high wage demands and inflation. Budgetary constraints can then be employed to reduce employment and the overall level of inflation (Civita, 2018).

Several aspects influence inflation, one being supply shocks, typically caused by external factors like geopolitical conflicts or natural disasters, which could cause a supply shortage that drives prices up. Considering the increased interconnection between countries, this price effect could spread and thus drive-up inflation. On the other side, demand shock could also drive inflation as prices increase if more people are willing to buy. One final aspect is people's expectations about prices in the future, which is believed to have a substantial effect on inflation. Although, to what degree these aspects affect inflation is not given (IMF, n.d.).

2.3 Characteristics of Norwegian Fiscal Policy

The public sector in Norway is large and has a comprehensive welfare offer where the state delivers services and finances activities in many areas of society. A high proportion of the National Budget is spent on social welfare programs, healthcare, and education. This has contributed to maintaining high social unity and quality of life in Norway. More importantly, Norway is in a unique situation due to oil and gas extraction, which is an activity that contributes a lot to GDP. However, it is common to look at Mainland Norway when analyzing fiscal policy because it separates out the effect of the oil business and looks at the value creation in the rest of the economy (Riekeles, 2017).

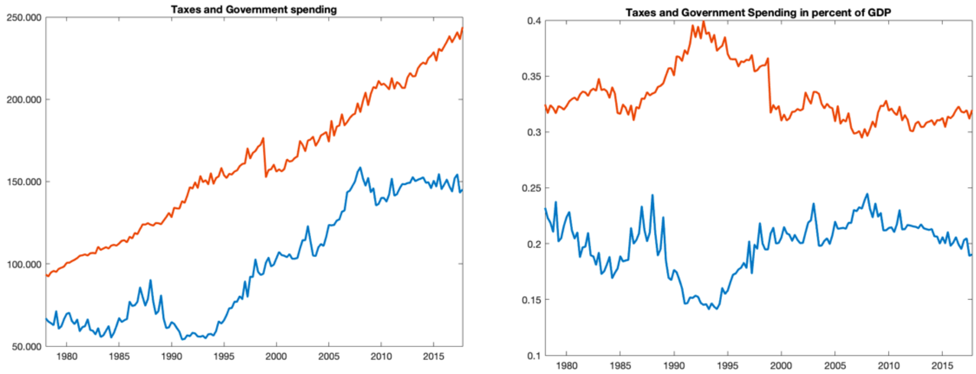


Figure 2.1 *- Net Taxes (Blue) and Government Spending (Orange) in millions NOK and as a share of GDP, quarterly data from 1978 – 2017.*

Figure 2.1 shows how net taxes and government spending have increased over time and how these variables fluctuate as a share of GDP. GDP changes without a correspondingly large change in public sector expenditures during an economic downturn. In the long run, the public sector will therefore appear larger than it is. Additionally, increased unemployment and countercyclical policies will temporarily increase public expenditures. There will also be temporary increases in public expenditures due to increased unemployment and the implementation of countercyclical policies. We observe that government spending tends to increase during economic downturns. This can be attributed to countercyclical policies leading to higher public expenditures. Notably, one of the most significant increases in government spending occurred in the early 1990s during the banking crisis (Riekeles, 2017). During that period, the taxes also accounted for a smaller share of GDP, which can also be explained by the combination of decreased taxes as a countercyclical policy and a decrease in GDP during recessions. After the 1990s, we see that there is a more stable relationship between government spending and government revenue as a share of GDP.

The Norwegian tax system plays a significant role in shaping labor supply, consumption, savings, and investments. The design of the tax system is therefore based on fundamental principles to ensure the efficient allocation of resources within the economy. This was also the focus of the tax reforms of 1992 and 2006, moving towards a tax system that does not change the overall level of taxes but rather the structure. Moreover, following principles of broad tax bases with low rates and systematic treatment of income and expenses. At the same time, it should limit high administrative costs for taxpayers and authorities.

(Regjeringen.no, 2014). Fiscal policy has an automatic stabilizing effect on the economy. Meaning that in economic booms, taxes will increase due to higher disposable income and private consumption, thereby having a dampening effect on GDP. The same applies to government spending, where unemployment benefit programs will decrease because they depend on unemployment, which in turn depends on the business cycles (Regjeringen.no, 2023).

2.3.1 The Government Pension Fund Global and The Fiscal Rule

To shield the Norwegian economy from fluctuations in oil revenues, all petroleum-related government revenues since 1992 have been transferred to the Government Pension Fund Global (GPFG), also known as the Sovereign Wealth Fund. The Fund functions as a financial reserve and generational fund so that future generations can benefit from it. Most of the fund is earned through investments in shares, interest, property, and infrastructure for renewable energy (nbim.no, 2019).

The introduction of the Fiscal Rule in 2001 aimed to manage Norway's oil revenues for the long-term sustainability of the government's finances. Transfers from the Fund to the government budget follow the expected real return on the Fund, which was adjusted to 3% in 2017. The focus is stabilizing the budget against short-term petroleum revenue fluctuations, benefiting future generations, and allowing fiscal policy to counteract economic downturns. However, given the fund's significant growth since its implementation and its financing of a substantial portion of budget expenditures. Therefore, fiscal policy should be designed to prevent significant cuts to budget expenditures or tax increases, particularly during periods of economic recessions. Spending from the fund should generally remain below 3% to mitigate risks associated with potential declines in its value (Regjeringen.no, 2021, 2022).

2.4 Fiscal Multipliers

According to Spilimbergo et al. (2009), "*the fiscal multiplier is the ratio of a change in output to an exogenous change in the fiscal deficit with respect to their respective baselines.*" In other words, what is the NOK-change in GDP when increasing fiscal policy by one NOK. The magnitude of the fiscal multiplier effect can vary depending on the type of action and the specific circumstances in which it is implemented. A fiscal multiplier greater than zero indicates a positive impact on GDP. Conversely, negative values suggest a contraction in GDP. A multiplier exceeding one implies that GDP responds more than one-to-one. Consequently, the value of the multiplier will significantly influence whether objectives, such as GDP growth and proportional debt reduction, are more likely to be achieved through an increase in government spending (Gechert, 2020). The most common fiscal multipliers are described in Table 2.1.

Fiscal Multiplier	**Formula**
The Impact multiplier	$\frac{\Delta Y(t)}{\Delta G(t)}$
The multiplier at some horizon N	$\frac{\Delta Y(t+N)}{\Delta G(t)}$
The peak multiplier	$\max_{N} \frac{\Delta Y(t+N)}{\Delta G(t)}$
The cumulative multiplier	$\frac{\sum_{j=0}^{N} \Delta Y(t+j)}{\sum_{j=0}^{N} \Delta G(t+j)}$

Table 2.1 *- Fiscal Multipliers – Source: Spilimbergo et al. (2009)*

These multipliers are the same for net taxes. The *impact multiplier* measures the the change in output to a change in government expenditure or government revenue when the shock to fiscal policy occurs. The *peak multipliers* are defined as the maximum value over the time horizon of the fiscal shock and are widely used to compare results following Blanchard and Perotti (2002). The *cumulative multiplier* measures the overall impact of fiscal policy action on the economy over time. It represents the total change in output resulting from fiscal policy shock. The cumulative multiplier considers that fiscal policy actions can have both short-term and long-term effects on the economy (Ilzetzki et al., 2011).

2.5 The Importance of Fiscal Foresight

Since many changes in government spending and taxes are announced in advance, Ramey (2011) finds that the timing of government purchases matters for the effectiveness in stimulating the economy. Several studies highlight the importance of differentiating between immediate and phased-in tax changes when analyzing their effects on the economy. House and Shapiro (2006) and Mertens and Ravn (2012) specifically emphasize the distinction between tax cuts implemented shortly after legislation and those implemented gradually or with a delay. Their findings reveal that while unanticipated immediate tax cuts have an expansionary effect on output, phased-in taxes cuts can initially depress output as firms and consumers postpone their economic activity until tax rates are lower. However, when considering the anticipation effect following a government spending shock, Mertens and Ravn (2010) do not find any evidence to overrule the existing findings in SVAR literature. Leeper et al. (2013) further examined the econometric biases that arise due to this type of fiscal foresight, leading to the literature addressing the issue concerning anticipation of fiscal policy. Researchers approach the challenge by incorporating different factors into the analysis to mitigate the problem and improve the accuracy of the findings regarding the effect of fiscal policy changes on the economy (Ramey, 2019).

2.6 Theoretical Models

Economic theory has different predictions regarding fiscal policy's effect and the fiscal multiplier's size. Predictions differ not only with respect to the size of the effect but also, in some cases, with respect to the direction of the effect. The predictions differ depending on the characteristics of the economy under consideration, whether the world is “Neo-classical” or “Keynesian”, if the economy is open or closed, and if the consumers are “Ricardian” or “non-Ricardian” (Hebous, 2010). Ricardian consumers are characterized by the fact that they will not increase consumption when fiscal policy is increased, but rather increase savings. On the other side, non-Ricardian consumers are liquidity constrained, i.e., in the face of a fiscal policy increase, they will increase their consumption[1].

[1] Lecture 8 (03.03.23), GRA 6631 Macroeconomic Policy, by Francesco Furlanetto,

One of the first theoretical models in macroeconomics is The Standard Keynesian Model, which John Maynard Keynes developed in the 1930s in response to The Great Recession. Since then, many other macroeconomic models have been developed, including The Neoclassical and New Keynesian models. Each of these models makes different assumptions about the behavior of households, firms, and policymakers, and both have been used to analyze the effect of monetary policy and fiscal policy (Hebous, 2010).

2.6.1 The Standard Keynesian Model

The Standard Keynesian model emphasizes the role of aggregate demand. The theory is illustrated by the IS-LM model, where prices are sticky and current consumption depends on current income with no role for expected future income (Hebous, 2010). The model is a macroeconomic framework that helps to explain the relationship between the real economy and financial markets. Meaning the interaction between the goods market and the money market and how changes in these markets affect the overall level of economic activity. Since output is demand-determined, the level of GDP is largely determined by the level of consumption, government spending, investment, and net exports (Ramey, 2019). The impact of an expansionary fiscal policy on an economy can vary depending on multiple factors, such as the degree of openness and the exchange rate regime adopted by the economy (Hebous, 2010).

By looking at the equations in Appendix (A2.1), we observe that The Standard Keynesian model predicts that increasing government spending will increase aggregate demand, thus, stimulating economic activity and increasing output. As output rises, households experience an increase in disposable income, prompting higher consumption. Generating an additional demand for goods and services, and thus, businesses are motivated to expand their operations and increase their investment. A multiplier effect comes into play as additional income generated by government spending circulates through the economy, stimulating consumer spending. This will stimulate demand, motivating businesses to invest to meet the rising consumer demand. Due to the higher demand for money, the increase in demand could increase the interest rate. Investments are crowded out, and the magnitude of the crowding out is determined by the sensitivity of private investment to changes in income and interest rate. This effect can offset the spending multiplier effect (Hebous, 2010).

In the case of tax cuts, the effects are the same as with an increase in government spending. When households receive a tax cut, their disposable income increases through the income effect, resulting in more money available to spend on private consumption. Private consumption is boosted, leading to a rise in aggregate demand and output. The increase in consumption can have an additional multiplier effect, creating additional rounds of spending and stimulating overall economic growth. However, the impact of tax cuts on private consumption depends on households' marginal propensity to consume (MPC). The MPC represents the proportion of additional income that households choose to spend. High MPC indicates a greater propensity to consume, resulting in a stronger impact of tax cuts on private consumption. The overall higher demand results in an increase in investment, which again puts pressure on the interest rate. The resulting increase in the interest rate will partially crowd out investment. Thus, the tax multiplier is negative but generally yields a smaller effect than the government spending multiplier (Hebous, 2010).

2.6.2 The Neoclassical Model

The prediction in neoclassical models is a positive spending multiplier and a negative (distortionary) tax multiplier. However, the model has different underlying mechanisms than the Keynesian theory and operates under different assumptions (Ramey, 2019). In the Neoclassical framework, an increase in government spending implies a larger demand for labor, resulting in an expansion in labor supply. The magnitude of the expansion in labor supply is dependent on the labor supply elasticity. This increase in labor supply will subsequently drive down wages. Lower wages will dampen consumption, as households have less disposable income available for spending. The increase in hours worked will increase production and output, but since the marginal product of labor decrease, output will not increase one-to-one to government spending. Implying a multiplier lower than one[2]. In consequence, expansionary fiscal

[2] Slides Fiscal Policy 3 (2022), GRA6639 Business Cycles, Karin Kinnerud

policies result in a decrease in private consumption but increase investment and output according to the Neoclassical theory. Distortionary tax rate affects labor through the supply channels by influencing individuals or businesses to engage in certain economic activities. This can potentially have large effects in these models (Ramey, 2019).

2.6.3 The New Keynesian Theory

The New Keynesian framework has a similar structure to the neoclassical model, but it introduces two additional features by adding nominal rigidities and monopolistic competitive firms in the goods market. Following the increase in government spending, the firms will produce additional output by raising labor demand as long as the marginal cost does not exceed the given price level. Consequently, the aggregate demand for labor shifts, and real wages rise. (Fontana, 2009).

One additional assumption to the New Keynesian model, which was introduced by Galí et al. (2007), is a distinction between “Ricardian” consumers and “rule-of-thumb” consumers. The “rule-of-thumb” consumers are individuals who face credit constraints and cannot freely borrow or save. Thereby consuming all their wages in each period. Also, in this version of the model, the firms will raise labor demand and, in turn, real wages. The implication in this version is that introducing credit-constrained consumers will increase consumption. The model now predicts that an increase in government spending raises output, similar to the Neoclassical model. However, it also predicts that the real wage and private consumption will increase as long as there are sufficient numbers of “rule-of-thumbs” consumers (Fontana, 2009).

Theory	**Fiscal multiplier**
The Standard Keynesian	$\frac{dY}{dG} > 1$
Neoclassical	$\frac{dY}{dG} < 1$
New Keynesian	$\frac{dY}{dG} \gtrless 1$

Table 2.2 *- Summary of theoretical predictions*

3. Empirical Studies

Empirical studies play a crucial role in addressing key issues left by economic theory, particularly concerning the magnitude of effects on output and the response of other macroeconomic variables. The discussion around the size of the fiscal multiplier revolves around the central issue of which approach one should use when identifying fiscal shocks. Due to different methodologies and a wide range of estimates, there is a lack of consensus within the field regarding the credibility of the multipliers. The empirical literature on the fiscal multiplier has grown significantly since 2007 (Hebous, 2010). This section provides an overview of the different identification approaches that have been used in recent empirical studies.

3.1 The VAR Framework

In recent years, Vector Autoregressive (VAR) models have become the primary econometric tool for analyzing the impacts of fiscal policy shocks. However, the empirical literature has faced challenges in establishing robust stylized facts regarding the effects of fiscal policy shocks (Caldara & Kamps, 2008). Various specifications of the VAR model differ in terms of the sample period, selection of variables, including deterministic terms, and lag length. Most recent research on the effects of fiscal policy shocks relies on Structural Vector Autoregressive (SVAR) models (Fernández & de Cos, 2006). When identifying fiscal policy shocks in vector autoregressions, there are often three main difficulties that should be considered. Firstly, distinguishing fiscal policy shocks from automatic responses of fiscal variables to other shocks, such as business cycles or monetary policy shocks, is challenging. Secondly, there are different opinions on the definition of a fiscal policy shock. Finally, one must account for the time lag between the announcement and the implementation of fiscal policy and the possibility of anticipation effect on macroeconomic variables before any fiscal changes take effect (Mountford and Uhlig, 2009).

3.2 Identification Approaches

Apart from differences in the specification within the VAR framework, previous empirical studies differentiate themselves by the approach chosen to identify fiscal policy shocks. Four main identification approaches have been used to identify structural fiscal shocks. Firstly, Sims (1980) introduced the recursive approach, which was later applied as an identification approach to fiscal policy analysis by Fatas and Mihov (2001). Secondly, Blanchard and Perotti (2002)[3] proposed their Structural VAR approach, which was later extended by Perotti (2004 & 2007). The sign restriction was the third approach, which dates back to Faust (1998) and later developed by Uhlig (2005). The approach was applied to fiscal policy analysis by Mountford and Uhlig (2009). Fourth, we have the narrative approach, introduced by Ramey and Shapiro (1998), to study the effect of large, unexpected changes in government defense spending (Caldara & Kamps, 2008).

3.2.1 The Recursive Approach

The Recursive approach utilizes Cholesky ordering to identify fiscal shocks. The approach implies a causal ordering of the model variables, which means that the ordering of the variables defines the direction of the causal relationship. Each variable only reacts to its own initial shock and the shocks of preceding variables in the system (Hebous, 2010).

Fatas and Mihov (2001) analyze data from the US using a semi-structural VAR model. Their findings indicate that a positive shock in government spending increases private consumption. They also find that a persistent rise in output generates a multiplier greater than one, meaning that output increases more than one-to-one. A large and significant increase in consumption mainly drives this increase. However, they observe that investment does not significantly respond to an increase in government spending (Fatas & Mihov, 2001).

Caldara and Kamps (2008) use quarterly data from the U.S. in their study. They find that the recursive approach has similar results to when using the B&P approach. The pure government spending shock leads to a persistent increase in GDP and private consumption, followed by a hump-shaped pattern. The spending multiplier peak after three to four periods, reaching a value of around two. Inflation and short-term interest rates increase with a lag of about two years

[3] The Blanchard and Perotti approach will be referred to as the B&P approach.

after the spending shock. The results of a pure tax shock lead to a persistent decrease in GDP and private consumption. The tax multiplier peaks after three to four years, reaching a value of around one. Inflation and short-term interest rates decrease with a lag of about two years after the tax shock (Caldara & Kamps, 2008).

Arin and Koray (2006) investigate the response of macroeconomic variables to four different series of tax revenues in Canada within a VAR framework. They investigate whether some taxes have different impacts than others using Cholesky decomposition. They find that the fiscal multipliers associated with different types of taxes vary significantly. They find that multipliers associated with personal income taxes and corporate income taxes are negative. Indicating that these types of taxes have a contractionary effect on the economy. On the other hand, the multiplier associated with consumption taxes is positive, having an expansionary effect on the economy. Overall, their studies suggest that changing different tax categories may have different implications on the economy (Hebous, 2010).

3.2.2 Blanchard and Perotti Approach

Blanchard and Perotti`s (2002) identification approach depends on utilizing institutional data relating to tax and transfer systems and information regarding the timing of tax collections. They assume that three separate channels influence unexpected changes in fiscal variables. The first is the automatic stabilizers, and the second is the discretionary response to economic conditions and the business cycle. The third is the exogenous shocks unaffected by business cycles, which is the channel of interest. They use institutional data to estimate the tax elasticity of output, i.e., the first channel. Further, they argue that using quarterly data will make the second channel irrelevant since it takes more than one quarter for policymakers to identify the unexpected event and implement the right response. Thus, all they are left with is the third channel containing only the true exogenous shocks to fiscal policy. Blanchard & Perotti (2002) obtained a positive spending multiplier of around 0.84 and a negative tax multiplier of 0.7 (Hebous, 2010).

In a working paper for the Ministry of Finance, Asche and Kristjánsson (2019) used the B&P approach on the Norwegian economy. According to them, the precision of the B&P approach is vulnerable to the estimates of the tax elasticity of output. Their estimation of the tax elasticity of output following the B&P approach on the Norwegian economy was in the range of 0.9 to 1.8, depending on the chosen specification, which aligns with results from other studies. On the other hand, when they estimate the tax elasticity inside the SVAR, they obtain an elasticity of 2.9. The consequences of having a tax elasticity of output of 0.9 versus 2.9 gives very different results on the tax multiplier. If it is 0.9, the tax multiplier is -0.4; if it is 2.9, the tax multiplier is 0.3. This demonstrates one of the weaknesses of the B&P approach. The spending multiplier is unaffected by this problem, and their findings of a spending multiplier in the range between 0.3 - 0.5 are robust (Asche & Kristjánsson, 2019).

Other studies like Fernández and de Cos (2006) study the economic effect of exogenous fiscal shocks in Spain using the B&P approach. They find that an increase in government spending resulted in a positive effect on output. The fiscal expansion also caused an increase in inflation and the interest rate. Consumption also increases but becomes significantly negative after 14-15 periods. The output response to the tax shock (increase) is positive due to the parallel increase in government expenditure. However, output becomes negative after 12 periods, the same for consumption (Fernández & de Cos, 2006).

3.2.4 Sign Restriction

The sign restriction approach requires restrictions on the sign of the impulse responses of the fiscal variables. Meaning that the method restricts the shape of the impulse response functions using economic theory (Hebous, 2010).

Mountford and Uhlig (2009) identify government revenue shock and government spending shock by imposing sign restrictions on the fiscal variables themselves and imposing orthogonality to a generic business cycle and a monetary policy shock. They use US quarterly data and the same definitions of government expenditure and revenue as Blanchard and Perotti (2002). They find that following an increase in basic government revenue, GDP, consumption, and investment falls with a lag. The interest rates and prices increase, indicating less intuitive responses following the shock. However, given an anticipated rise in revenues, they find an immediate negative response in output and consumption. The basic government spending shock has a weak increase in output in the first four periods and has a weak effect on consumption. Investment falls, but not due to higher interest rates. However, the delayed shock in government spending resulted in an immediate positive effect on output and interest rates. The shocks appear more persistent and stronger than the basic spending shock (Mountford & Uhlig, 2009).

Dungey and Fry (2009) study the effects of fiscal policy shock in New Zealand and find a positive effect on output and a negative effect on consumption following an increase in government spending (Hebous, 2010). Inflation falls, and the interest rise due to higher GDP quickly becomes negative. In contrast to other studies, they find that a temporary taxation shock increases GDP, while inflation and the interest rate fall (Dungey & Fry, 2009).

3.2.5 Narrative Approach

The narrative approach seeks to identify exogenous fiscal shocks directly, examining historical records, speeches, and news articles to identify periods when fiscal policy changed. Thereby using econometric methods to estimate the effect of the changes on the economy (Hebous, 2010).

Ramey and Shapiro (1998) introduced the narrative identification approach to identify exogenous changes in government spending and examine their effects on the economy. The method involves searching for and identifying historical events or news stories that are widely recognized as exogenous shocks to government spending. They identify 12 historical events in their study that led to changes in government spending, such as World War II and the Korean War. These events were used to study the effects of changes in government spending on the economy. In the short run, the resulting multiplier for government spending shocks is around 1.4, while the long-run multiplier is 0.7. Ramey

(2011) extended and refined their approach and find a multiplier close to one using richer narrative data on news of military buildups (Ramey, 2019).

Romer and Romer (2010) examine the impact of changes in the level of taxation on economic activity. Using narrative records, they identify the size, timing, and principal motivation for all major postwar tax policy actions between 1947 and 2006. Looking at the behavior of output and the exogenous changes in taxes, the resulting estimates indicate that tax increases are highly contractionary. Meaning that the tax increases appear to have a very large significant negative impact on output. Since most of their exogenous tax changes are reductions, they express their results as if the tax cuts have very large and persistent positive output effects. The strong negative response of investment in response to exogenous tax increases may explain the large increase in output. The tax increase also leads to a negative effect on consumption (Romer & Romer, 2010).

3.3 Summary and key findings in Empirical Evidence

Previous studies and theories show that the size of fiscal policy depends on multiple factors. Regardless of the chosen identification approach, a majority of the studies find an increase in output following a positive government spending shock. However, studies show that the size of the impact and peak multiplier can vary due to differences in model specification and sample period. Most empirical studies following a tax increase find a negative effect on output (Hebous, 2010).

The findings considering the response of consumption following a fiscal policy shock are inconclusive. Most studies show that a positive government spending shock positively affects consumption when using the recursive and B&P approach. On the other hand, Mountford and Uhlig (2009) find no effect on consumption using sign restriction. The narrative approach yields negative effects on consumption (Hebous, 2010). Overall, the majority of studies show that in the case of a tax cut, consumption seems to increase, which is seen in Blanchard and Perotti (2002) and Romer and Romer (2010). On the other hand, Ramey and Shapiro (1998), and Ramey (2009), which capture anticipation effects, find a negative effect on consumption (Hebous, 2010).

Linking the empirical results to theory, one can argue that the recursive and B&P approach is consistent with the Keynesian and modified DSGE models. Because of the positive response of consumption following fiscal expansion (Hebous, 2010). On the other hand, the narrative approach is more in line with the Neoclassical theory due to a negative response in consumption[4].

Study	**Country & Sample**	**Identification strategy**	**Multiplier**	**Other effects**
Blanchard and Perotti (2002)	USA Quarterly, 1957-1997	B&P Approach	0.84	(+) Consumption
Caldara and Kamps (2008)	USA Quarterly, 1955-2006	Recursive B&P Approach Sign Restriction Narrative Approach	1 1 ca. 0.5 0	(+) Consumption (+) Consumption (+) Consumption
Dungey and Fry (2009)	New Zealand Quarterly, 1983-2006	Sign Restriction	(+) Positive effect on output	(-) Consumption (+) Interest Rate
Fatas and Mihov (2001)	USA - Quarterly, 1960-1996	Recursive	0.3	(+) Consumption, Employment and Interest Rate
Fernández & de Cos (2006)	Spain	B&P Approach	1.31-1.33	
Galí et al. (2007)	USA - Quarterly, 1954-2003	B&P Approach	0.78	(+) Consumption and Employment
Mountford and Uhlig (2009)	USA - Quarterly, 1955-2000	Sign Restriction	0.44	Insignificant and zero effect on consumption
Pappa (2009b)	Canada, Japan, UK, US: 1970-2007 EU aggregate: 1991-2007	Sign Restriction	0.13 – 0.74 0.16	(+) Consumption and Employment

[4] Lecture 9 GRA 6631 Macroeconomic Policy, by Francesco Furlanetto

Ramey (2009)	USA - 1947-2003	Narrative	0.6 – 1.1	(-) Consumption (+) Employment (+) Interest rate
Ramey and Shapiro (1998)	USA - 1947-1996	Narrative	0.7 – 1.4	(-) Negative effect on consumption (+) Interest rate
Ramey (2011)		Narrative	1.1 – 1.2	

Table 3.3 *- Government Spending Multiplier from Empirical Studies*

Study	**Country & Sample**	**Identification strategy**	**Multiplier**	**Other effects**
Arin and Koray (2006)	Canada, 1960-1999	Recursive (Increase)	(-)	Shock to income tax revenues
Blanchard and Perotti (2002)	USA, 1960-1997	Blanchard and Perotti (Increase)	-0.69	(-) Consumption
Caldara and Kamps (2008)	USA, 1955-2006	Blanchard and Perotti Sign Restriction Recursive (Increase)	0 -0.8 0	No effect on consumption or employment
Dungey and Fry (2009)	New Zealand, 1983-2006	Sign restriction - Increase in taxes	+	(-) Consumption
Mountford and Uhlig (2009)	USA, 1955-2000	Sign restriction (Decrease)	0.19	(+) Consumption
Mertens and Ravn (2009)	USA, 1947-2006	Narrative Unanticipated- tax cut Anticipated - tax cut	Peak 2.17 in 10 quarters nadir of -1.16 three quarters before implementation	(+) Consumption and Employment
Romer and Romer (2010)	USA, 1950-2007	Narrative - Increase in taxes	-3% of GDP - peak response over 3 years	(-) Consumption

Table 3.4 *- Tax Multipliers from Empirical studies*

4 Methodology

In this section, we present our chosen methodology and dataset that consists of relevant macroeconomic variables that are used in our analysis. We use a Structural Vector Autoregression (SVAR) model to analyze the dynamic interactions between fiscal policy and output. Moreover, we apply the Cholesky decomposition to identify the fiscal shocks. The technical presentation of our methodology and the identification approach will be based on lecture notes[5] combined with Bjørnland and Thorsrud (2015) page 190 to 223.

4.1 Vector Autoregressive Model (VAR)

We employ a Structural Vector Autoregressive (SVAR) model in our analysis, which aligns with previous empirical studies. Firstly, we present our baseline three-variable VAR model:

$$(1) \qquad \begin{bmatrix} G_t \\ T_t \\ GDP_t \end{bmatrix} = \begin{bmatrix} A_{11} & A_{12} & A_{13} \\ A_{21} & A_{22} & A_{23} \\ A_{31} & A_{32} & A_{33} \end{bmatrix} \begin{bmatrix} G_{t-1} \\ T_{t-1} \\ GDP_{t-1} \end{bmatrix} + \begin{bmatrix} e_{G,t} \\ e_{T,t} \\ e_{GDP,t} \end{bmatrix}$$

A Vector Autoregressive (VAR) model is a univariate model that extends the univariate Autoregressive (AR) model, combining the variables of interest. The VAR explains how a variable is dependent not only on its own lagged values but also lagged values of other variables. In economic theory, it is reasonable to assume that macroeconomic variables depend on their own lagged values and other lagged macroeconomic variables. The VAR(p) model can further be illustrated as:

$$(2) \qquad y_t = \mu + A_1 y_{t-1} + A_2 y_{t-2} + \cdots + A_p y_{t-p} + e_t$$

This is the reduced form representation where y_t is an $K \times 1$ vector containing the endogenous variables of interest, which in our baseline model are government spending, net taxes, and output (GDP). A_i is a $K \times K$ coefficient

[5] Lecture notes by Jamie Cross - Lecture 8 in GRA6648 (2022).

matrix, μ is a $K \times 1$ vector of intercepted terms, and e_t is a $K \times 1$ vector of error terms.

We can write the general VAR(p) model using the companion form representation:

$$Z_t = \Gamma_0 + \Gamma_1 Z_{t-1} + v_t \quad (3)$$

Where the Γ_1 is the companion form matrix which is useful because it simplifies notation and derivation of key theoretical properties, including stability, forecasts, and impulse response functions (see Appendix A4.1). We can check whether the VAR(p) is covariance stationary by looking at the eigenvalues in the companion form matrix. To ensure covariance-stationarity in our VAR model, it is necessary for the effects of shocks to diminish over time. This condition is satisfied when the absolute values of the eigenvalues of the companion form matrix are less than one. An eigenvalue that is close to one suggests that the associated eigenvector has a slow decay or damping effect over time, potentially leading to long-lasting or persistent dynamics in the system. Before doing our analysis, we control that our VAR model is stable by checking the maximum eigenvalue of our models (See Table A.11).

4.1.1 A Structural VAR Model

To accurately estimate the independent effects of government spending and net tax shocks, it is necessary to create a structural representation of the VAR model. The difference between the reduced form VAR and the Structural VAR is that all contemporaneous terms, i.e., terms in time t, are on the left side of the equation in the SVAR. This allows for variables to affect each other contemporaneously. The general SVAR(p) model, with K variables and p lags, can be illustrated as:

$$B_0 y_t = b + \sum_{j=1}^{p} B_j y_{t-1} + \epsilon_t \quad (4)$$

y_t is still a vector of the variables of interest, and b is a $K \times 1$ vector of constants. B_0 is the impact matrix that describes the contemporaneous relationship among the variables in y_t and how these respond to shock at current time t. B_j is a $K \times K$ coefficient matrix of the autoregressive coefficients that capture the shock´s direct and indirect effects on the variables. The coefficient matrix helps to identify the structural relationships and causal effects between the variables in the SVAR model. ϵ_t represents the independent structural shocks. Illustration (4) of the general form, using a SVAR (1) model with three variables, no constant, and one lag:

(5)

$$\begin{bmatrix} B_{11,0} & B_{12,0} & B_{13,0} \\ B_{21,0} & B_{22,0} & B_{23,0} \\ B_{31,0} & B_{32,0} & B_{33,0} \end{bmatrix} \begin{bmatrix} G_t \\ T_t \\ GDP_t \end{bmatrix} = \begin{bmatrix} B_{11,1} & B_{12,1} & B_{13,1} \\ B_{21,1} & B_{22,1} & B_{23,1} \\ B_{31,1} & B_{32,1} & B_{33,1} \end{bmatrix} \begin{bmatrix} G_{t-1} \\ T_{t-1} \\ GDP_{t-1} \end{bmatrix} + \begin{bmatrix} \epsilon_{G,t} \\ \epsilon_{T,t} \\ \epsilon_{GDP,t} \end{bmatrix}$$

Where the covariance matrix of the structural shocks (ϵ_t) is assumed to be an identity matrix. Thus, the structural shocks are uncorrelated and have a unit variance, $\Omega = I$:

(6)
$$\begin{pmatrix} \epsilon_{G,t} \\ \epsilon_{T,t} \\ \epsilon_{GDP,t} \end{pmatrix} \sim i.i.d.N \left(\begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix} \right)$$

or,

$$\epsilon_t \sim i.i.d.N(0, \Omega)$$

In the structural model, all variables are endogenous, and the contemporaneous values of variable y_t are used as explanatory variables. The Simultaneity problem arises from the fact that a change in one variable affects the other variables contemporaneously. Due to this, we cannot use Ordinary Least Square (OLS) to estimate and identify the model's parameters. If we attempt to do so, the estimates would be inconsistent. To overcome this problem, we illustrate the SVAR as reduced form VAR, as shown in equation (7).

4.1.3 From Structural to Reduced Form VAR

The reduced form VAR can be estimated using OLS, allowing us to recover the SVAR for analysis. We demonstrate the process using a SVAR(1) and then multiplying all terms with the inverse of the impact matrix (B_0^{-1}) to obtain a reduced form VAR.

(7)
$$B_0 y_t = b + B_1 y_{t-1} + \epsilon_t \qquad | \times B_0^{-1}$$

$$B_0^{-1} B_0 y_t = B_0^{-1} b + B_0^{-1} B_1 y_{t-1} + B_0^{-1} \epsilon_t$$

(8) $$y_t = \alpha + A_1 y_{t-1} + e_t, \quad e_t \sim \mathcal{N}(0, \Sigma)$$

Where $A_0 = I,\ \alpha = B_0^{-1}b,\ A_1 = B_0^{-1}B_1$, and importantly, $e_t = B_0^{-1}\epsilon_t$
Writing out the VAR(1) representation of equation (8), is found in Appendix A4.3. The reduced form errors, e_t, are linear combinations of the structural shocks, ϵ_t, with the covariance matrix:

(9) $$E[e_t, e_t'] = \beta_0^{-1}[\epsilon_t, \epsilon_t'](\beta_0^{-1})' = \beta_0^{-1}\Omega(\beta_0^{-1})' = \textstyle\sum_e$$

(10) $$e_t \sim i.i.d.N\left(\begin{pmatrix}0\\0\\0\end{pmatrix}, \begin{pmatrix}\sigma_1^2 & \sigma_{12} & \sigma_{13}\\ \sigma_{21} & \sigma_2^2 & \sigma_{23}\\ \sigma_{31} & \sigma_{32} & \sigma_3^2\end{pmatrix}\right)$$

Where Ω is the covariance of the structural errors, and $\sum_e$ is the covariance matrix of the reduced form errors. All the parameters of the reduced form model can be estimated by OLS. To estimate the elements in A_1 we can simply run a series of regressions and then compute the covariance matrix $\sum_e$. However, without restrictions, the reduced form errors are typically correlated.

4.1.4 The Identification Problem

The SVAR has more parameters than the estimated reduced form VAR, resulting in an under-identified system of equations. From the general SVAR representation equation (4), B_0 has n^2 contemporaneous parameters. While the reduced form VAR has $\frac{n(n+1)}{2}$ unique parameters in the covariance matrix. To achieve exact identification, following Sims (1980) by specifying a recursive system and restricting all elements of B_0 above the main diagonal to be zero: $n^2 - \frac{n(n+1)}{2} = \frac{n(n-1)}{2}$ known as the order condition. However, this condition does not state which elements in the SVAR need to be restricted. Thereby, we can make use of Cholesky decomposition.

4.1.5 Identification Approach - Cholesky Decomposition

The Cholesky decomposition states that every positive definite symmetric matrix, Ω, can be factorized as $\Omega = PP'$, where P is the lower triangular matrix called the Cholesky factor of Ω. While P' is its conjugate transpose. Since Σ_e is a positive definite symmetric matrix, combining $\Omega = PP'$ and the covariance matrix of the reduced form residuals (Σ_e) identification can be achieved by restricting $B_0^{-1} = P$. We can use the reduced form residuals to recover the structural shocks since P is always invertible:

$$(11) \qquad e_t = B_0^{-1}\epsilon_t = P\epsilon_t \;\rightarrow\; \epsilon_t = P^{-1}e_t$$

In the Appendix A4.4 we make use of the MA representation of the reduced form VAR. We obtain the MA representation of our three-variable SVAR model using Cholesky as illustrated in equation (12):

$$(12) \qquad \begin{bmatrix} G_t \\ T_t \\ GDP_t \end{bmatrix} = \begin{bmatrix} P_{11} & 0 & 0 \\ P_{21} & P_{22} & 0 \\ P_{31} & P_{32} & P_{23} \end{bmatrix} \begin{bmatrix} \epsilon_{G,t} \\ \epsilon_{T,t} \\ \epsilon_{GDP,t} \end{bmatrix} + \Theta_1\epsilon_{t-1} + \Theta_2\epsilon_{t-2} + \cdots$$

Given that P is a lower triangular matrix, the components in ϵ_t will not correlate. From (12), we see that the shock in $\epsilon_{T,t}$ will not affect government spending in time t. However, both shocks $\epsilon_{G,t}$ and $\epsilon_{T,t}$ will affect GDP in period t. There are no restrictions after the first period, and the shocks can feely affect each other.

When we have estimated and identified the model, the next step in the SVAR modeling is to form the impulse responses. The impulse responses demonstrate how a given shock affects the variables in the y_t vector over time. We can investigate the effects of such shocks on the variables within our SVAR model. These are presented in section 5.

4.2 Data

Our analysis is based on data covering the period from 1978Q1 to 2017Q4[6]. In line with previous literature on fiscal policy, we use quarterly data. Most of the variables are collected from Statistics Norway, including Mainland GDP, Government Spending, Private Consumption, Private Investment, and Inflation.

[6] Due to limited available data, we were unable to obtain net tax data for the period from 2018Q1 to 2022Q4.

The data for Net Taxes is originally from the KVARTS database from Statistics Norway. The data were obtained in million NOK at fixed 2020-prices. They are also seasonally adjusted, except for net taxes. To match previous studies, we express the variables in per capita terms and take the log. The interest rate was available on Federal Reserve Economic Data (FRED) on a quarterly frequency[7].

Government Spending

In line with Blanchard and Perotti (2002), government expenditure is the sum of government consumption plus government investment.

Government Revenue - Net-taxes

Following Blanchard and Perotti (2002), the net taxes variable was constructed by taking total government revenues at current prices and deducting social transfers, other transfers, capital income, and oil revenues. Since we are looking at Norway, excluding oil revenues is important because revenues from the oil sector go directly into the sovereign wealth fund. Transfers include cash transfers to households, subsidies, and other transfers (e.g. foreign aid). Net taxes are deflated by our constructed GDP deflator to obtain real values. The variable is seasonally adjusted using Holt-Winters seasonal smoothing method[8].

Gross Domestic Product (GDP)

The output variable represents the Gross Domestic Product of Mainland Norway. The variable excludes petroleum production and international shipping, thereby capturing the market value of Mainland GDP. Meaning that it focuses on the non-oil sectors that play a crucial role in driving the overall economy (SSB, 2014).

[7] The available data on interest rates limited the time period to 1979Q1 to 2017Q4.

[8] The Holt-Winters method includes the estimation of the seasonal pattern in the data and its subsequent removal to obtain seasonally adjusted data. This process eliminates the systematic patterns that occur at specific time points within a given season. The seasonal component is modeled based on historical seasonal values and is utilized to adjust the observed data accordingly (STATA, n.d.).

Private Consumption

Private consumption measures the money consumers spend in a country to buy goods and services. The variable consists of consumption in households and ideal organizations.

Private Investments

Following definitions of previous empirical literature, private investments include gross real investment of Mainland Norway, less government investment, and residential investment.

Price level (Inflation) - GDP Deflator

The Consumer Price Index (CPI) is often used to measure inflation and track the prices of goods and services typically purchased by households (SSB, 2023). Increased CPI over time indicates that the general price rises. CPI is a good measure of inflation because it reflects the cost of living experienced by households. However, the GDP deflator is typically used in previous studies. The GDP deflator considers both the final goods and services produced for consumption and the intermediate goods and services used in production. The GDP deflator is constructed by taking the nominal Mainland GDP (current) and dividing it by real Mainland GDP (fixed 2020 prices) and multiplying by 100.

Interest Rate

We use the 3-month interbank rate in Norway as the interest rate. This rate represents the cost at which banks lend and borrow funds from each other on a short-term basis. When determining the overall interest rate environment in the country, the interbank rates play a crucial role. They are used as reference rates for various financial transactions (FinansNorge, n.d.).

Population

To compute the variables in per capita terms to match previous studies, we retrieved data on the Norwegian population from Statistics Norway. However, the quarterly data were only available from 1998:Q1 and in annual figures from 1978 to 1997. We used linear interpolation to fill in the quarterly data to obtain quarterly data from the annual. Linear interpolation is a method for curve fitting using linear polynomials to construct new data points within the range of a discrete set of known data points (Cuemath, n.d.). This method is consistent with the literature (Asche & Kristjánsson, 2019). We did this by using the linear forecast function in Microsoft Excel.

4.2.1. Stationarity

When doing time series analysis, working with a stationary series is often desirable. Meaning that the time series includes characteristics such that the mean, variance, and autocovariance remain constant over time. Such time series will return to its trend following a shock. Macroeconomic time series are often non-stationary and include trends and drift upwards. Such non-stationary data often contain a unit root, indicating a lack of mean reversion. Transforming time series with a deterministic trend or unit root involves removing the trend or differencing the data (Bjørnland & Thorsrud, 2015, p. 111-117).

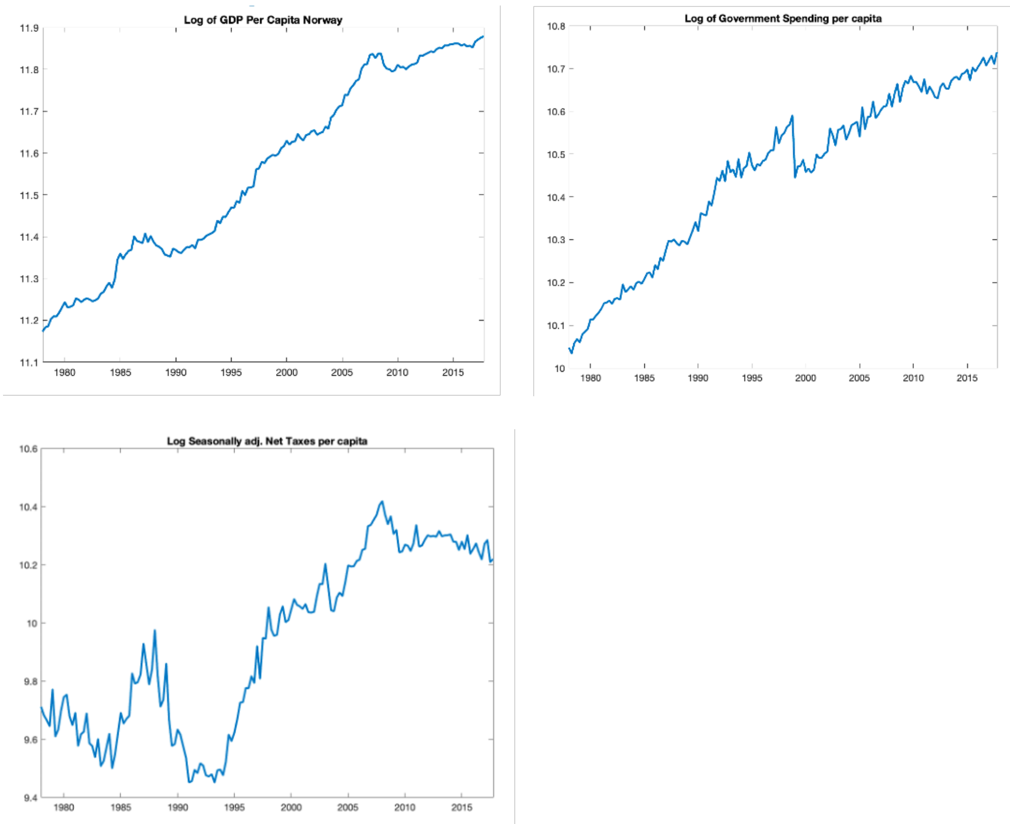


Figure 4.2 *- Log of GDP, Government Spending and Net taxes,*

We observe that the variables government spending and GDP have a very clear linear trend, and there are large fluctuations around the banking crisis and some fluctuations around the financial crisis in 2008-2009. Net taxes are different without a clear trend and seem stochastic, with large fluctuations around the banking and financial crises (Asche & Kristjánsson, 2019). From these figures and those in Appendix A4.5, we see that all variables, except for net taxes, investment, and the interest rate, are clearly drifting upwards over time. These time series seem to have a deterministic time trend, indicating non-stationarity (Bjørnland & Thorsrud, 2015, p. 113).

Relying solely on graphical analysis to determine the stationarity of the data series is not sufficient to conclude. To address this, we performed an Augmented Dickey-Fuller test on each of the log-transformed data series in our baseline model, as presented in Appendix A4.6. Since we cannot reject the null hypothesis at any significance level, all the log-transformed data series are non-stationary. Taking the first difference of our data series and removing the underlying trend or pattern result in stationary data. However, previous literature keeps the log-transformed data, and we choose the same to ensure comparability in our analysis. Moreover, log-transformed data allows for a clearer interpretation because we can directly relate the estimated coefficients to percentage changes in the original variables. By taking the first difference of the data, we may lose the underlying trend, which could be important for the relationship between variables. To address the potential issues with the non-stationary data, in line with previous studies, we include a time trend in our VAR model[9] (Asche & Kristjánsson, 2019).

4.3 VAR Model Specification

The specification of our VAR model can become heavily parameterized, which means that the model has many parameters relative to the available data. Therefore, it is important to balance the complexity of the VAR model and the available data (Bjørnland & Thorsrud, 2015, p. 200). Due to the relatively small number of observations in our data set, we must consider the number of lags and variables to include in our model.

[9] Excluding the trend from the model results in an unstable VAR model (obtaining a maximum eigenvalue bigger than 1).

4.3.1 Lag selection

As previously mentioned, the number of data observations is limited to the period from 1978 to 2017 on a quarterly basis. We need to determine the appropriate lag length based on the number of observations. Including too few lags might lead to omitting valuable information and may prevent us from fully capturing the dynamic relationships and patterns in the data. In this case, the residuals might become correlated with its lagged value. Indicating that there is still systematic information in the residuals that the model does not capture. Each variable's lagged value is considered a separate independent variable in the model. Therefore, if we include many lags, we introduce more variables into the model. Thereby potentially estimating too many coefficients compared with the number of observations in the dataset.

One common way of determining lag length is by using an information criterion function. Information criterion functions evaluate the trade-off between model fit and parameter uncertainty. Two of the most common information criteria are Bayesian Information Criterion (BIC) and Akaike Information Criterion (AIC). It is worth noting that the BIC is more conservative as it penalizes the model size more than the AIC. Thus, BIC generally suggests fewer lags than AIC (Bjørnland og Thorsrud, 2015, p 68-69). The BIC- and AIC-test results on our baseline VAR model can be found in Appendix A4.6. From the BIC test, we find that the optimal lag selection is two lags, while the results from the AIC implied that the optimal lag selection is four. The AIC test aligns more with previous literature like Blanchard and Perotti (2002) and Asche and Kristjánsson (2019).

Considering the conflicting results from BIC- and AIC-test, we need to rely our decision on the specific context for our analysis. To avoid overfitting the model the BIC is better to rely on. Therefore, based on the two tests and previous empirical studies, we will do our analysis with both two and four lags, whereas the version with two lags will be the main point of reference.

4.3.1 Choice of Variables

In our baseline VAR model, we include Government Spending, Net Taxes, and GDP as the main variables of interest. These variables are considered endogenous, meaning they are influenced by the dynamics within the system. However, we acknowledge that other important variables could impact the relationships we are investigating. Therefore, we extend our baseline VAR with two additional models to capture a more comprehensive picture of the dynamics. Additionally, we conduct a robustness test with all variables in a seven-variable VAR. These extended models incorporate additional variables that are relevant to our analysis. This helps us assess the influence of these variables on the results and may improve the model´s explanatory power and accuracy. Moreover, it enables us to account for potential omitted variable bias and better understand the complex dynamics of the economic system under investigation.

4.3.2 Baseline Model Ordering

The assumptions regarding the variable ordering are nontrivial, and no clear theoretical guideline exists. Therefore, the specific ordering can significantly affect the results (Hebous, 2010). When doing Cholesky decomposition, the order becomes crucial as it imposes restrictions on how the variables affect each other. The variable assumed to be the most endogenous variable should be placed last. When variables are ordered in a particular way, the shocks in the model are assumed to propagate through the system in that specific order. And may result in different dynamics and responses of the variables to the shocks (Bjørnland & Thorsrud, 2015, p. 215-216). The existing literature offers varying perspectives on the optimal ordering of fiscal variables, creating uncertainty regarding the correct approach.

Looking at previous studies and theory, our suggested ordering for our three variable VAR model is government spending, net taxes, and GDP. With this ordering, shocks in government spending and net taxes will affect GDP contemporaneously when the shock hits. Government spending is ordered first because it is considered a policy choice independent of the current state of the economy. Shocks originating in the private sector are assumed to have no immediate contemporaneous effect on government spending (Caldara & Kamps, 2008).

The ordering of net taxes is more uncertain. Blanchard and Perotti (2002) and Arin and Koray (2006) placed the fiscal variables first. This ordering suggests that policymakers require more than a quarter to implement discretionary fiscal responses to unforeseen shocks in GDP. Also, the ordering aims to smooth out any abrupt or discrete changes in fiscal variables that may result from unexpected fluctuations in GDP. Consequently, the analysis focuses on capturing more sustained adjustments in fiscal policy rather than immediate and drastic responses to unexpected changes in economic conditions (Bjørnland, 2013). Recognizing that the order of variables in the Cholesky decomposition can influence the model´s results, we perform robustness tests using different ordering to ensure the consistency and reliability of our findings.

4.4 Limitations of the Methodology and Identification Approach

The VAR approach has a limitation in that it is typically suitable for estimating models with a relatively low number of variables and lags. Indicating that the model may not perform well when applied to complex systems with many variables and high-order lags. The effects of any omitted variables are captured within the residuals. Consequently, this can result in significant distortions in the impulse responses, making them less valuable for structural interpretations. Moreover, any measurement errors or misspecifications in the model can lead to unexplained information remaining in the disturbance terms, making interpreting the impulse responses challenging. The construction of the impulse responses emphasizes that careful empirical analysis should be applied when specifying the VAR (Bjørnland & Thorsrud, 2015, p. 245).

Cooley and LeRoy (1985) offered a critique of the Cholesky decomposition method, labeling it as "atheoretical". They argued that this approach lacked a strong theoretical foundation, making it difficult to interpret the impulse responses as representative of structural relationships. Moreover, the Cholesky decomposition assumes a specific ordering and does not capture all possible causal relationships between the variables. They also pointed out that altering the ordering of variables in the model would lead to different structural estimates, thereby undermining the reliability and consistency of the results (Bjørnland & Thorsrud, 2015, p. 234).

5. Results

In this section, we present the results of our analysis of fiscal shocks using MATLAB. We examine how a one percent shock in government spending and net taxes at time zero affects the other variables in the model. We present three different models: a baseline model and two extended models. We utilize impulse response functions to illustrate the impact of the shocks over a horizon of 20 quarters and use confidence bands of 16% and 84% to evaluate the uncertainty of the estimates[10]. The choice of horizon and the confidence bands are in accordance with previous literature.

Given the transformation of variables into log form when doing our analysis, the resulting impulse responses illustrate elasticity rather than the direct one-krone change necessary for calculating the fiscal multiplier. Consequently, the multipliers cannot be directly inferred from the graphs (Ramey, 2019). Following the approach outlined in Asche and Kristjánsson (2019), we modify the original impulse functions. This transformation involves multiplying the elasticities obtained from the log-based IRFs with: $\frac{\sum \exp(GDP_t)}{\sum \exp(G_t)}$ for spending, and $\frac{\sum \exp(GDP_t)}{\sum \exp(T_t)}$ for taxes, to transform elasticities into multipliers. However, it has been argued in previous empirical literature that significant trends in the share of spending and taxes in relation to GDP can introduce bias (Ramey (2016 and 2019) referred to in Asche & Kristjánsson (2019)).

5.1 Baseline Model Results

The impulse response functions below present how a one percent shock to government spending and net taxes affects the Norwegian GDP in our baseline model. First, we present the impulse response functions and then the different fiscal multipliers.

[10] Changing to a longer horizon on the IRFs does not change the results.

Impulse Response Functions from a Government Spending Shock

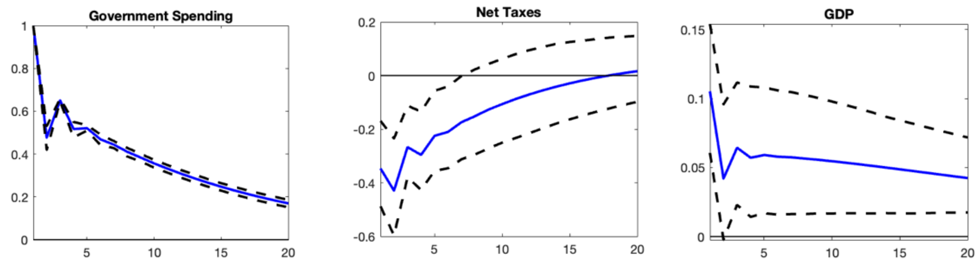


***Figure 5.3** - Impulse Response of Government Spending Shock (Baseline Model)*

Government spending raises on impact before it decreases steadily back to its initial trend, implying that the shock is persistent. The response of net taxes initially shows a statistically significant negative effect for the first seven periods, after which it gradually moves towards the initial trend and eventually becomes positive. In Figure 2.1 we observed a consistent relationship between high levels of government spending and low levels of net taxes in our dataset, especially during recessions. This finding provides an explanation for the negative immediate response observed in net taxes following a government spending shock. However, studies like Caldara and Kamps (2008) and Fatas and Mihov (2001) find that a positive government spending shock leads to a positive response in net taxes when using the recursive approach.

The impulse response function reveals a positive response in output, with an approximate increase of 0.1 percent. The response is also statistically significant for all periods and has a persistent rise in output. The positive effect on GDP aligns with previous findings (Fatas & Mihov, 2001; Blanchard & Perotti, 2002; Romer & Romer, 2010; Mountford & Uhlig, 2009; Dungey & Fry, 2009).

	1st quarter	4th quarter	8th quarter	12th quarter	20th quarter	Peak
GDP	0.32*	0.17	0.17	0.16	0.13	0.32 (1)
Cumulative	0.32	0.31	0.34	0.37	0.43	

***Table 5.5** – Government Spending Multiplier (Baseline Model)*

Our results in Table 5.5 reveals an impact multiplier of 0.32, which suggests that a one NOK increase in government spending corresponds to a 0.32 NOK increase in output. These findings fall in the lower range compared to the range

0.5-0.9 typically observed in the SVAR literature (Mineshima et al. (2014) referred to in Asche & Kristjánsson (2019)). Fatas and Mihov (2001) report a multiplier larger than one, while Caldara and Kamps (2008) find a multiplier of one using both the recursive and B&P approaches. Moreover, the peak multiplier in both studies is reached after two to three years, while our analysis suggests a peak multiplier in the first period.

However, these multipliers are mostly estimated on larger economies, and the Norwegian economy has some characteristics that must be considered when interpreting our results. Thus, it makes sense to compare our results with studies like Asche and Kristjánsson (2019). They find a spending multiplier between 0.3 - 0.5, which is in the same range as our results. This is in line with Spilimbergo et al. (2009), who propose that the spending multiplier in small open economies is typically 0.5 or less. Asche and Kristjánsson (2019) find a cumulative multiplier that increases steadily over time, reaching 1.10 over the course of the analysis period. In contrast, our multiplier remains relatively stable throughout the entire period, exhibiting minimal increases.

Impulse Response Functions to a Shock in Net Taxes:

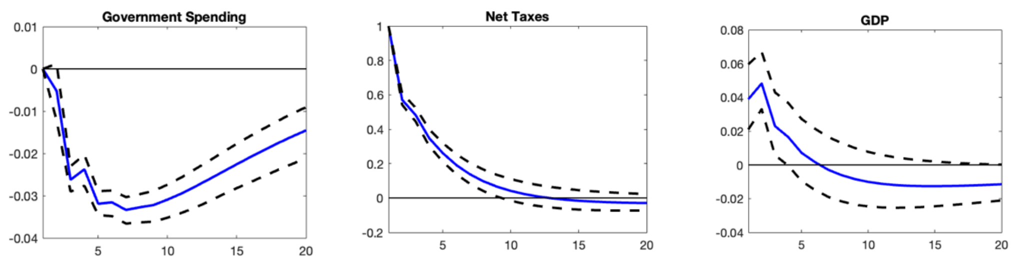


Figure 5.4 *- Impulse Response of Shock in Net Taxes (Baseline Model)*

Figure 5.5 presents the impulse response of our baseline model in response to a one percent shock in net taxes. The graph called Net Taxes represents the shock. The shock steadily declines and dies out after about 12 periods. Government spending is affected negatively by the tax shock and the effect is significant from impact until it reverts to zero. The same reasoning as discussed in the government spending shock applies here, i.e., that in times where taxes increase, government spending is usually decreased.

GDP is positive on impact but falls below zero after 7 periods, but the effect is not significant after the fourth period. Although some studies find a positive or insignificant tax multiplier, the overall view in the literature is that the multiplier is negative, i.e., a negative response on GDP, following a tax increase. The positive response in GDP on impact is similar to what Dungey and Fry (2009) find in their analysis of New Zealand, which has some of the same characteristics as Norway. Asche and Kristjánsson (2019) find similar results when estimating the tax elasticity of output endogenously. However, their results are not statistically significant. Also, Arin and Koray (2006) find a positive effect on GDP from a corporate tax increase in Canada, but still a negative effect on GDP following an increase in income tax. Caldara and Kamps (2008) do not find a result that is significantly different from zero.

	1st quarter	4th quarter	8th quarter	12th quarter	20th quarter	Peak
GDP	0.19*	0.08	-0.03	-0.06	-0.06	0.24 (2)
Cumulative	0.19	0.26	0.20	0.13	-0.02	

Table 5.6 *- Tax Multiplier (Baseline Model)*

Table 5.6 presents the tax multipliers corresponding to a one-krone shock on GDP, i.e., if tax is raised by one krone, GDP will rise by 0.19 kroner on impact. The cumulative effect after 5 years is a negative effect of -0.02 kroner on GDP, i.e., the cumulative effect is not significantly different from zero. This is consistent with Asche and Kristjánsson (2019) and Caldara and Camps (2008). Still, our results differ from most studies. Blanchard and Perotti (2002) find a negative impact multiplier of about 0.7 in the USA following increased taxes. The sign restriction and the narrative approach confirm this negative multiplier, like Mountford and Uhlig (2009) and Romer and Romer (2010) (Hebous, 2010). A negative tax multiplier is also in line with both the Keynesian and Neoclassical model suggests (Ramey, 2019).

It is worth noting that in the robust test, we check the same model with 4 and 6 lags and find similar results. However, GDP remained positive for a longer period, and the effect is more volatile (see Figure A.19 and A.21). Also, when controlling for different ordering, we observe that GDP becomes negative in response to a tax increase, which is more in line with the overall finding in the literature. This model also shows that the overall results become more significant (see Figure A.27).

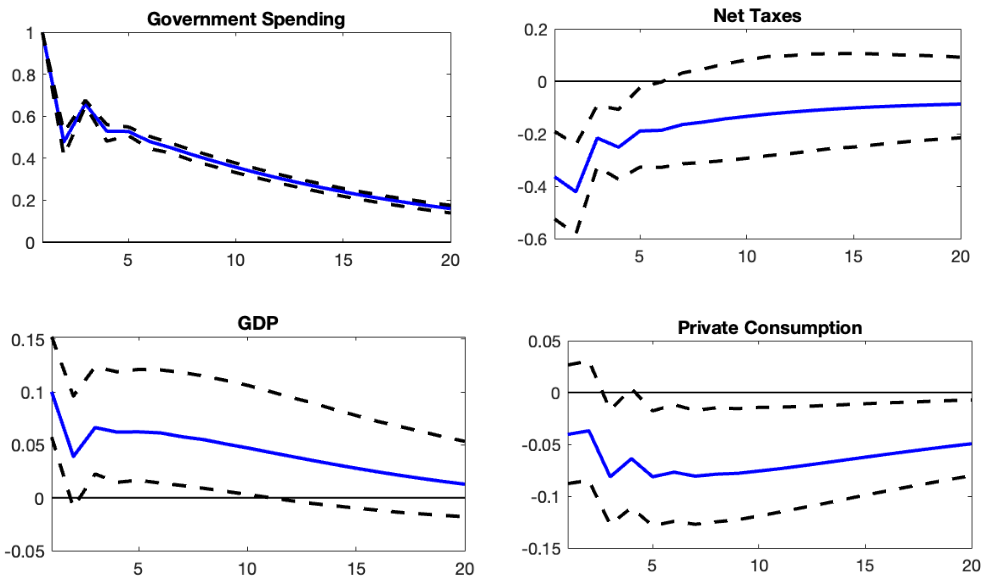
5.2 Results Extended Model I & II

This section introduces private investment, private consumption, inflation, and interest rate to our baseline model. We use two lags, including a constant and linear trend, similar to our baseline VAR model.

5.2.1 Five-Variable VAR with Investment and Consumption

We expand our baseline model by introducing a five-variable VAR model. This extension incorporates two significant components of GDP: private investment and consumption. Previous studies have also included the same variables when studying the effects of fiscal policy. The objective is to examine whether the effects on GDP differ when these relevant variables are included, compared with our baseline results. Furthermore, we aim to explore the impacts of fiscal policy on these variables and compare them with previous literature and theory.

Impulse Response Functions Following a Government Spending shock:



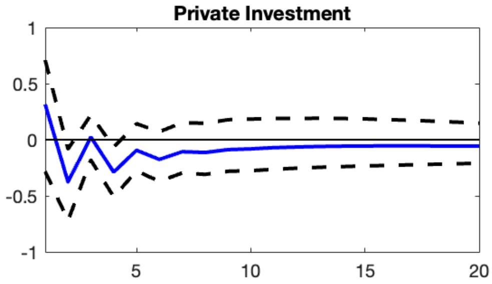


Figure 5.5 *- Extended model I: Impulse Response Following a Government Spending shock*

When private consumption and private investment are included in our model, the response of GDP remains unchanged. We observe an insignificant negative response on impact in consumption following a government spending shock. The response remains negative in the following time periods and is statistically significant after the third quarter. Indicating that the response in consumption has delayed negative effects. The negative response in private consumption is in line with theoretical predictions like The Neoclassical model. However, the negative response of consumption is not in line with previous literature like Fatas and Mihov (2001), which finds a large significant increase in consumption. Also, studies employing the recursive or B&P identification approach find that a positive government spending shock has a positive impact on consumption. In contrast, studies employing sign restriction approach like Mountford and Uhlig (2009), find an insignificant response on consumption. Ramey (2009) finds a negative effect on consumption using the narrative approach (Hebous, 2010).

Studies like Ramey (2011) find that government spending shocks have a positive impact on investment. Similarly, Auerbach and Gorodnichenko (2012), which examined the effects of fiscal policy shocks on investment, find that expansionary fiscal policy stimulates investment. These findings are similar to what we observe on impact. However, the response of investment is never statistically significant in our case.

	1st quarter	4th quarter	8th quarter	12th quarter	20th quarter	Peak
GDP	0.30*	0.19	0.17	0.11	0.03	0.30 (1)
Cumulative	0.30	0.10	0.11	0.12	0.11	

Table 5.7 *- Extended model I: Government Spending Multiplier*

Impulse Response Functions to a Shock in Net Taxes:

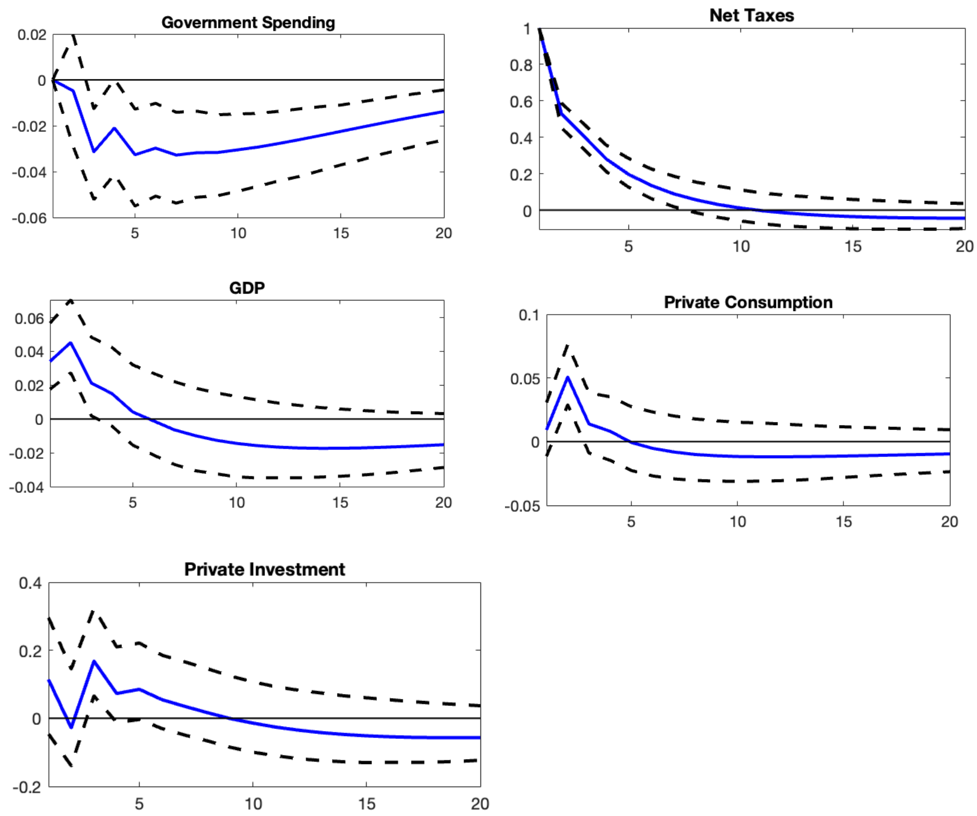


***Figure 5.6**: Extended model I: Impulse Response following a shock in Net Taxes*

Looking at the impulse response functions, output does not change significantly compared to our baseline model. It raises on impact and is statistically significant in the first four periods before it becomes negative and insignificant.

In contrast to previous literature, our findings reveal that private consumption does not exhibit a significant response on impact but rather responds with a lag, reaching its peak in the third quarter. However, the positive effect is only observed in the first 5-6 quarters and is negative for the remainder of the horizon, although never significant. The negative effect aligns more with previous literature like Blanchard and Perotti (2002) and Romer and Romer (2010). Investment has a small positive response on impact and peaks in the third period at 0.17 percent. However, the response is only statically significant in the following periods after the peak before it moves back to its trend and becomes insignificant around the 5-6 quarter. This is an unexpected response compared to most other studies and theoretical frameworks, which finds a negative response in private investment following a tax increase. Studies like Romer and

Romer (2010) find a strong negative response of investment in response to an exogenous tax increase. Mountford and Uhlig (2009) also find a negative response in investment, although with a lag.

	1st quarter	4th quarter	8th quarter	12th quarter	20th quarter	Peak
GDP	0.17*	0.07	-0.05	-0.08	-0.08	0.23 (2)
Cumulative	0.17	0.05	0.04	0.02	-0.06	

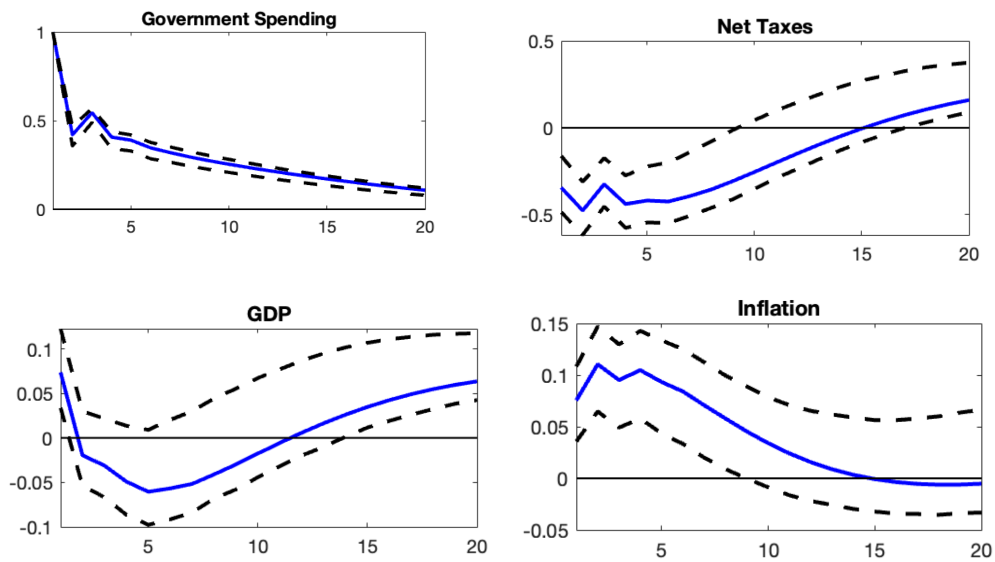
Table 5.8 *- Extended model I: Tax multiplier.*

The results from Table 5.7 and 5.8 indicate that adding more variables to our baseline model, the impact on output becomes slightly smaller. The subsequent period shows similar results to the baseline model, but the cumulative multiplier in the extended model is reduced. The peak multiplier is almost the same as in the baseline model in the second period.

5.2.2 Five-Variable VAR with Inflation and Interest Rate

In this section we focus on what happens to our model when we include inflation and interest rate. Again, we incorporate significant components of GDP. This section aims to examine if inflation is affected by fiscal policy and, if so, to what degree.

Impulse Response Following a Shock in Government Spending



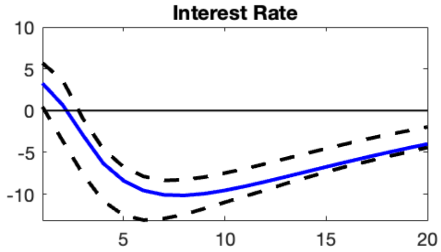


Figure 5.7 - Extended model II: Impulse Response Following a Shock in Government Spending

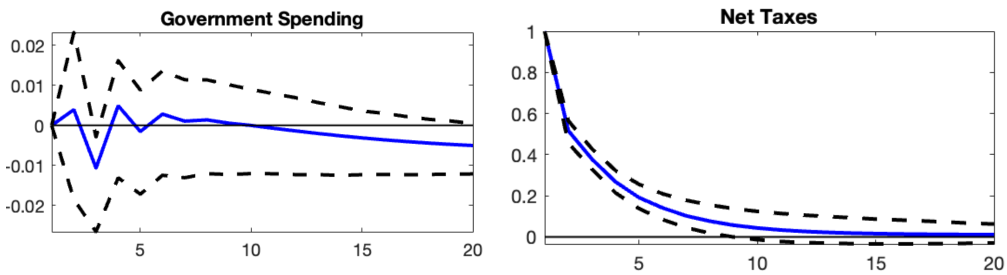
When controlling for inflation and interest rate, the impact effect of a spending shock on GDP is positive on impact, similar to what is seen in previous models. Surprisingly, the effect becomes negative after two periods before it becomes positive again after 11 periods. It is worth noting that the negative effect is never significant.

The effect on inflation is significantly positive on impact until the 9th period when the effect is no longer significant. The effect goes to zero in the 15th period. The spending shock increased inflation by 0.06% on impact. Interest rate and monetary policy are outside the scope of this thesis, but as it has an important effect on the economy, it was added to our SVAR.

	1st quarter	4th quarter	8th quarter	12th quarter	20th quarter	Peak
GDP	0.28*	0.12	0.10	0.13	0.16	0.28 (1)
Cumulative	0.28	0.25	0.26	0.30	0.45	

Table 5.9 *- Extended model II: Government Spending Multiplier*

Impulse Response Following a Shock in Net Taxes



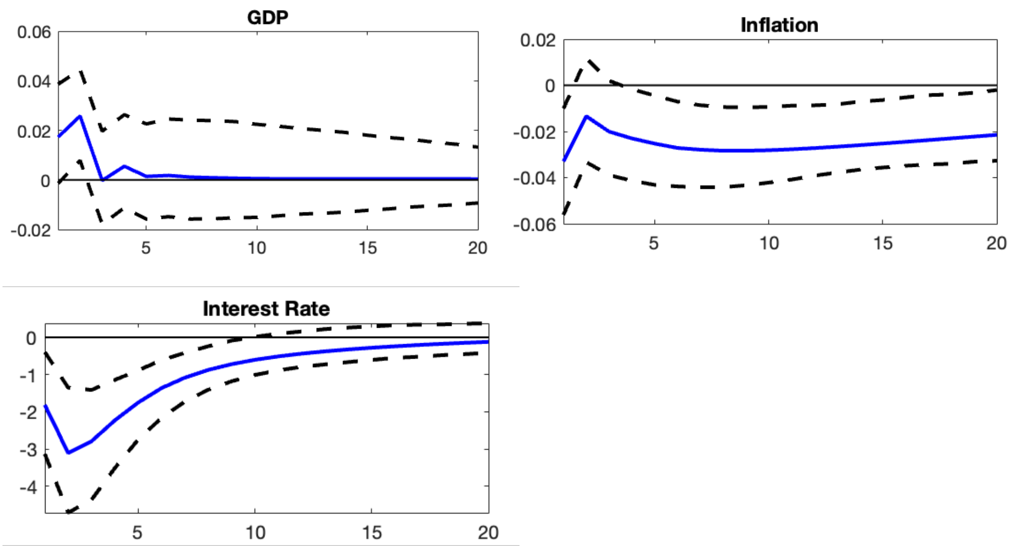


Figure 5.8 *- Extended model II: Impulse Response Following a Shock in Net Taxes*

As before, Net Taxes represent the shock to net taxes which affect the other variables. Again, the shock is persistent and dies out after about three years. We observe that GDP is positive on impact and peaks in the second period, which is quantitatively observable in Table 5.10. The effect is only significant in the second period, and the effect is zero after the fourth period for the remainder of the horizon. Inflation falls on impact and stabilizes at a negative value, and the effect is significant in all periods except in the second period. The impact effect of a one percent increase in net taxes implies a drop in inflation by 0.04%. The effect on inflation is persistent throughout the horizon.

	1st quarter	4th quarter	8th quarter	12th quarter	20th quarter	Peak
GDP	0.1*	0.07	-0.04	-0.05	-0.04	0.26 (2)
Cumulative	0.1	0.11	0.04	-0.02	-0.16	

Table 5.10 *- Extended model II: Tax Multiplier*

6. Discussion of Results

This section will discuss our results in light of previous empirical studies and economic theories. While there have been limited studies on the fiscal multiplier specifically for Norway, other previous empirical research has enabled us to compare and draw insight from these findings. Our results are discussed in line with the Norwegian economy's characteristics.

6.1 Discussion Baseline model

One potential explanation for our analysis's small impact on GDP could be that the Norwegian economy is small and open. Hence, the effects of fiscal policy measures, such as government spending, can be influenced by external factors and international trade dynamics. The openness of the economy implies that a significant portion of the increased government spending may leak out through imports. Limiting the direct impact on domestic production and GDP, as a portion of the spending is directed towards purchasing goods and services from other countries. Also, given that the Norwegian economy is relatively small, the openness makes it more affected by external shocks and global economic conditions. Different factors, such as global economic trends, trade relationships, and exchange rate fluctuations, can shape the transmission mechanism through which fiscal policies impact the Norwegian economy. These mechanisms might explain the relatively low impact on GDP following fiscal policy shocks.

Our counterintuitive results regarding the effects on GDP following a positive tax shock could be related to the characteristics of the Norwegian tax system. In our study, we have considered the total level of taxes without distinguishing between specific components of the tax base. Since the tax reform in 1992, the focus has been on changing the composition of taxes rather than the overall level of taxes, which might make it harder to identify the tax shocks. This explanation is supported by our findings in the robustness test, where we split the sample before and after the 1992 tax reform. We observe a negative tax multiplier before 1992 and a positive one after 1992. Since a negative multiplier is more in line with literature, it suggests that the model is more able to identify tax shock in the pre-1992 sample. Also, it is worth noting that the sample pre-1992 contains most of the bank crisis. The results are ambiguous as to which of the two aspects makes it easier to identify the shocks in the pre-1992 sample or if it is a combination.

The Norwegian tax system is designed to promote high output and efficient resource allocation. As fiscal policy is a heterogeneous instrument, we could achieve an efficient resource allocation by increasing taxes since the effect of fiscal policy can vary across different sectors, regions, or groups (Asche & Kristjánsson, 2019). Consequently, this improved reallocation from increasing taxes could be the potential reason for the positive impact on GDP. This reasoning might indicate that the SVAR framework is not ideal for analyzing tax shocks (Auerbach & Gorodnichenko, 2012).

The presence of the reversed causality relationship between taxes and GDP in the model may influence the observed increase in GDP following an increase in taxes. This suggests that our model captures that instead of taxes causing changes in GDP, the changes in GDP influence the level of taxes. Moreover, the negative lagged effect on GDP might be attributed to the function of automatic stabilizers. As net taxes increase, it reduces disposable income and can potentially decrease private consumption and investment. Leading to a dampening effect on GDP after the initial positive impact. However, the function of automatic stabilizers seems to disappear when including more lags since GDP become positive throughout the horizon. Suggesting that our model is not able to capture the true dynamics between the variables.

One challenge the SVAR framework faces in analyzing fiscal policy is the anticipation effect. Fiscal policy is typically announced a few months before implementation such that households, firms, and institutions can anticipate the impact of fiscal policy measures. In the case of the Norwegian economy, the national budget is usually presented to the Parliament in October and implemented in January (Regjeringen, 2023). This anticipation period can potentially lead to adjustments in behavior and expectations, which may diminish the effects of fiscal policy shocks that we are interested in studying.

The Norwegian economy is characterized by a substantial and extensive public sector, with a significant portion of the national budget allocated to welfare programs. The Government Pension Fund Global allows the Norwegian government to allocate more money, particularly during periods of economic downturns. One could therefore expect to observe more variation in government spending. However, Figure 2.1 shows a consistent upward trend in government spending over the analyzed period. Furthermore, following the bank crisis in the late 1980s and early 1990s, the Norwegian economy has experienced a prolonged period of growth, which poses a challenge in extracting and identifying shocks from the data. Consequently, the identification of the specific shocks becomes more uncertain and can affect the reliability and interpretation of our results. Hence, we cannot determine the exact cause of the observed changes in the variables and not draw any definitive conclusions regarding the effects of the shocks.

6.2 Discussion Extended Model I

The response in GDP does not change following the same fiscal shocks when adding private consumption and private investment. This indicates that the additional variables included in the model do not significantly impact the relationship between fiscal policy and GDP when using this specific ordering. Moreover, the additional variables may be highly correlated with existing variables in the model. In this case, when including these variables it will not provide new information beyond what is already captured by the existing variables, resulting in little change in the estimated relationships.

The observed negative response in private consumption following a government spending shock aligns with insights from neoclassical theory. According to this theory, increased government spending leads to a higher labor supply and downward pressure on wages, resulting in reduced consumption. However, following an increase in taxes, we observe a small significant increase in consumption, implying that we consume more in the first two periods. This could be because the increased taxes have effectively redistributed the income and increased the disposable income of certain groups of individuals with a higher propensity to consume. The increase in disposable income resulting from the redistribution makes these individuals spend more of their additional income on consumption.

A potential reason for not obtaining a significant response in investment following either of the fiscal shocks could be due to the composition of the fiscal variables. This means that the specific areas where the government allocates its spending may not directly align with private investment opportunities. Thereby, the fiscal variables may not directly stimulate private investment.

6.3 Discussion Extended Model II

An increase in government spending could lead to a positive demand shock, which drives inflation up. On the other hand, an increase in net taxes would suggest the opposite. Thus, our findings seem plausible. It is also logical to assume that the expectations of future inflation would be influenced upon announcement. However, most of this effect is not seen in our results as we consider the time at which the shock is implemented. Considering that increased taxes give households less money and some cannot maintain their level of consumption, it is sensible to interpret a tax increase as a negative demand shock. Thereby, the New Keynesian model would suggest a decrease in inflation, as also seen in our results. Decreased consumption will under rigid prices in a New Keynesian model has a negative effect on inflation[11].

Our results indicate that fiscal policy does impact inflation, implying a tradeoff between changes in fiscal policy and their effects on inflation. These findings provide some insight into the ongoing discussion on how fiscal policy affects inflation which was presented in the motivation section. Although the effect is relatively small, our findings do not consider the effect upon announcement, which may influence our results.

6.4 Discussion of Chosen Identification Approach

From what we observe in Appendix A7.2, changing the ordering in our model is important to better understand the relationship between taxes and GDP. Also, giving a broader insight into the dynamic interactions between the two variables. The fact that our results become more significant in our baseline and Extended I model when ordering GDP before taxes implies that we have reversed causality in our model. The sensitivity of the results to the ordering of variables does not

[11] Lecture two supplementary (18.01.23), GRA 6631 Macroeconomic Policy, by Francesco Furlanetto,

necessarily mean that our initial ordering was incorrect but can rather be seen as a weakness of the method.

7. Robustness

In this section, we perform different robustness tests to assess the reliability of our empirical results. The tests include checking for different lags for our baseline and two extended models. We also try ordering output (GDP) before net taxes, leaving the other variables unchanged to see if this impacts the results. Lastly, we split our sample into two subsamples using the same methodology.

7.1 Changing Lags

The results we obtain from using more lags are found in Appendix A7.1. These indicate that the effects of shocks in our data are unpredictable compared to when we only use two lags. Suggesting that the responses of variables to shocks are inconsistent and vary over time, making it difficult to draw reliable conclusions about the effects of shocks based on the observed data. Therefore, caution and further analysis are needed to understand the system's underlying dynamics and sources of variability.

7.2 Changing the ordering of GDP and Net taxes

There are different opinions on identifying fiscal shocks due to the presence of two possible causal directions. It is uncertain whether taxes influence GDP or if GDP affects taxes. Ordering taxes before GDP can be justified because shocks to GDP have an immediate impact on the tax base and, thus, a contemporaneous effect on tax receipts. However, the specific order in which variables are arranged allows us to capture the impact of automatic stabilizers on government revenue. Simultaneously, it excludes the potentially significant effect of discretionary tax changes on output in the short term (Caldara & Kamps, 2008).

We observe that rearranging the ordering of variables results in a more significant response on GDP following a tax shock in both the baseline and the Extended I model. The revised ordering in the baseline model shows a small positive effect on GDP in the second period. However, we see a significant negative effect on GDP after three periods and throughout the horizon. This finding aligns with previous studies and supports our earlier results, namely that tax increases have a lagged negative effect on GDP. Additionally, the included variables in the Extended I model become more significant, but the direction of the impulse response remains unchanged. Similar to our original model, we observe a positive response in consumption in the second quarter, which aligns with our previous discussion. However, using this ordering, the following negative response after the second period is significant.

These findings highlight the substantial impact of causal ordering and emphasize the method´s sensitivity to different ordering. Furthermore, the revised ordering indicated that GDP contemporaneously affects taxes, challenging our initial assumption that taxes contemporaneously affect GDP.

7.3 Splitting the Sample

By splitting our sample in two, we investigate whether the results changes. To investigate the period before and after the tax reform separately, we split the sample in 1992. We may not obtain reliable and valid results in the pre-1992 sample, with the limited sample size of only 56 observations. In the post-1992 sample, we have 104 observations which is a more sufficient sample size. The impact on GDP in the pre-sample is positive and insignificant on impact, but the cumulative effect is negative and significant following both of the fiscal shock. We observe opposite effects on GDP in the post-sample, which amplifies our discussion in section 6.1.

7.4 Seven-Variable VAR Model

The main takeaway from this model is that we get more or less the same results as before, only less significant (see Appendix A7.5).

8. Concluding Remarks

This thesis contributes to the empirical literature on fiscal policy's effect on a small and open economy. We utilize a Structural Vector Autoregressive (SVAR) model and a recursive approach with Cholesky decomposition to identify the fiscal shocks. We introduce a baseline model with government spending, taxes, and GDP. Further, we extend our analysis with two additional models. The first includes private consumption and private investment, while the second includes inflation and interest rate.

Our baseline model finds a government spending multiplier of 0.32 on impact and a cumulative multiplier of 0.43, which aligns with other studies when considering small and open economies. The effect is persistent and significant, although not robust when adding more lags as the results become less significant, but still positive on impact. Our results have a few possible explanations. The characteristics of the Norwegian economy make it harder to identify the spending shocks, given the steady rise in government spending. Also, the fact that the Norwegian economy is both small and open will make the effect of a spending shock less significant as external factors influence the economy, and some of the effects of the shock may leak out through imports.

We find a positive tax multiplier of 0.19 on impact, which does not align with most literature. The positive effect on impact is also robust when adding more lags. The cumulative multiplier is slightly negative, but the negative effect is never significant. One possible explanation for our results is that the structure of the Norwegian tax system is about changing the composition of the taxes rather than changing the overall tax level, which implies identification problems. Also, the tax system should promote effective resource allocation, which could explain the observed positive effect on impact. We also assume to have a problem of reversed causality between GDP and net taxes. When changing the order of net taxes and GDP, we obtain a significant negative tax multiplier, which amplifies the argument of reversed causality in our model. Notably, we find a negative tax multiplier when analyzing the data before the tax reform of 1992 and a positive multiplier after.

When incorporating consumption and investment into our model, we observe that the results do not change. Thereby, the additional variables do not contribute substantially to explaining the dynamics or causal relationships among the variables in the model. The negative response in private consumption following the spending shock aligns with the mechanisms seen in the Neoclassical model.

On the other hand, a shock in net taxes increases consumption in the first two periods, which the effect of effective income redistribution could explain. Our results show no significant response in investment.

By including inflation and interest rate into our model, we observe a different response of GDP following both fiscal shocks. The effect on GDP also becomes insignificant. The impact of government spending and net taxes on GDP is not robust or other factors, beyond the variables considered in the model, are driving the changes in GDP. We observe that inflation is positively affected by increased government spending and negatively affected by increased net taxes. These results align with the mechanisms in the New Keynesian model, where a positive demand shock increases inflation and vice versa. Our model does not consider the announcement effect, which could affect our results.

Our results and the following discussion highlight the problems of the recursive approach when considering fiscal policy in Norway. It is potentially problematic to identify fiscal shocks. We observe more volatile results when including more lags, indicating that our model is not robust. Additionally, we have a problem with reverse causality. When changing the ordering of GDP and net taxes, we observe more significant results, which suggest a weakness of the model and the identification approach.

This thesis contributes to the important understanding of the effects of fiscal policy and the underlying mechanisms. It also highlights some of the problems of using the recursive approach when analyzing the effects of fiscal policy in Norway. For further research, we suggest differentiating between specific tax bases to analyze the individual effect on output could be an interesting approach which could also be done for government spending. Additionally, it would be interesting to compare the results using different identification approaches.

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Appendix

Appendix Section 2 – Theoretical Framework

A2.1 The Standard Keynesian Model - IS-LM Model

(A1) IS curve:

- $Y = C + I + G + NX$
- $C = c_0 + c_1(Y - T)$
- $I = i_0 - i_1 R$
- $T_t = t_t Y$
- $NX = m_0 + m_1(Y^* - Y)$

(A2) LM – curve

- $R = r_0 + r_1 Y$

Y = Aggregate output, C = aggregate consumption, I = aggregate investment, G = government spending, NX = net export, c_0= consumption independent of income, c_1 = marginal propensity to consume (MPC), $(Y - T)$ = disposable income, i_0= exogenous level of private investment, i_1= how sensitive investment are to changes in the interest rate, T_t= lump sum taxes, t_1= income tax rate, m_0= exogenous level of import, m_1= how sensitive import are to changes in output, Y^*= total output, Y = output from a small open economy, r_0= exogenous level of interest rate, r_1= endogenous response of monetary policy.

Appendix Section 4 – Methodology

A4.1 Comapnion Form Matrix

(A3)
$$\Gamma_1 = \begin{pmatrix} A_1 & A_2 & \cdots & A_{p-1} & A_p \\ I & 0 & \cdots & 0 & 0 \\ \vdots & & \ddots & & \vdots \\ 0 & & \cdots & I & 0 \end{pmatrix}$$

A4.2 Stability of the VAR model

Model	Lags	Max Eigenvalue
Baseline	2	0.946882
Extended I:	2	0.958065
Extended II	2	0.980926
Baseline	4	0.957212
Baseline	6	0.924843
Extended I	4	0.95536

Extended II	4	0.958862
Baseline w/different ordering	2	0.946882
Baseline w/different ordering	4	0.957212
Extended I w/different ordering	2	0.958065
Extended II w/different ordering	2	0.980926
Subsample pre-1992	2	0.976197
Subsample post-1992	2	0.986165
Seven variable model	2	0.978492

***Table A.11** - Maximum Eigenvalues - VAR model*

A4.3 From Structural to Reduced Form VAR

Writing out the representation of the reduced form:

(A4)

$$\begin{bmatrix} G_t \\ T_t \\ GDP_t \end{bmatrix} = \begin{bmatrix} A_{11} & A_{12} & A_{13} \\ A_{21} & A_{22} & A_{23} \\ A_{31} & A_{32} & A_{33} \end{bmatrix} \begin{bmatrix} G_{t-1} \\ T_{t-1} \\ GDP_{t-1} \end{bmatrix} + \begin{bmatrix} e_{1,t} \\ e_{2,t} \\ e_{3,t} \end{bmatrix}$$

With,

$$e_t \sim i.i.d.N\left(\begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix}, \quad \begin{pmatrix} \sigma_1^2 & \sigma_{12} & \sigma_{13} \\ \sigma_{21} & \sigma_2^2 & \sigma_{23} \\ \sigma_{31} & \sigma_{32} & \sigma_3^2 \end{pmatrix}\right)$$

A4.4 Cholesky Decomposition:

We can use the MA(∞) representation to investigate how the structural shocks have impact the variables in the model. The reduced form VAR can be written as:

$$A(L)y_t = e_t$$

Where $A(L)$ is the lag polynomial. If the VAR(p) is stable, then $A(L)$ is invertible and the MA representation of the reduced form VAR is given by:

(A5)

$$\begin{aligned} y_t &= C(L)e_t \\ &= \sum_{j=0}^{\infty} C_j e_{t-j} \\ &= e_t + C_1 e_{t-1} + C_2 e_{t-2} + \cdots \end{aligned}$$

Where, $C(L) = A(L)^{-1}$ and $C_0 = I$. Applying Cholesky and the fact that $I = PP^{-1}$ to get:

(A6)

$$y_t = \sum_{j=0}^{\infty} C_j P P^{-1} e_{t-j}$$
$$= \sum_{j=0}^{\infty} \Theta_j \epsilon_{t-j}$$
$$= P\epsilon_t + \Theta_1 \epsilon_{t-1} + \Theta_2 \epsilon_{t-2} + \cdots$$

where $\epsilon_t = P^{-1} e_t$ and $\Theta_j = C_j P$.

A4.5 Data Collection

Government Spending: Retrieved from - Statistics Norway: Table 09190: Final expenditure and gross domestic product, by macroeconomic indicator, quarter and contents. Government spending consists of the variables General Government Investments plus Final Consumption Expenditure of General Government.

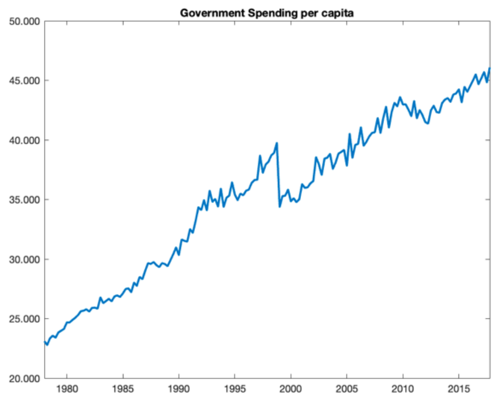


Figure A.9 - *Government Spending Per Capita*

Net Taxes: The net taxes variable is collected from another master thesis, which received its data from The Ministry of Finance. Originally these data are from the KVARTS database. Statistics Norway has annual data available on tax variables for the period 1978 to 2001 and quarterly data from 2002:1 to 2023:1. Therefore, The Ministry of Finance constructed the quarterly data on net taxes from the annual data for the missing period by using relevant tax bases and a quarterly pattern. The quarterly pattern for the relevant tax bases was created by regressing log variables on a constant, a linear trend, and quarterly dummies in the different variables for the available quarterly data 2002:1-2017:1. Then, using the quarterly dummies to construct the quarterly observations from the annual data for 1978:1-2001:4. Assuming that the quarterly pattern is the same in 1978-2001. The data on net taxes are approximations (Asche & Kristjánsson, 2019).

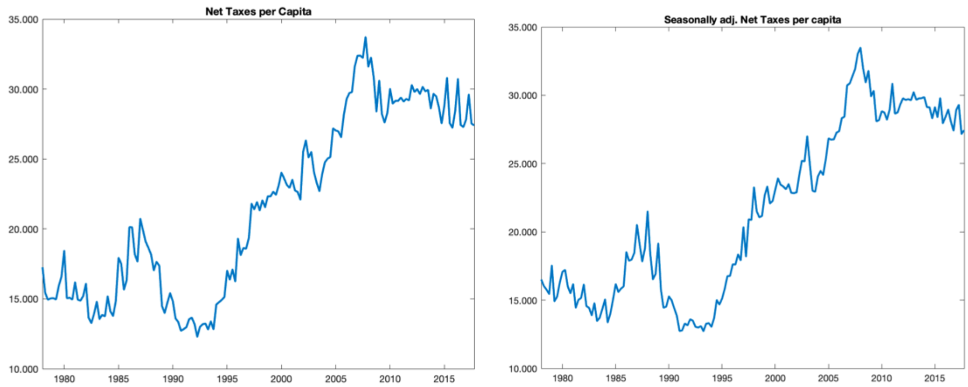


Figure A.10 *- Net Taxes Per Capita & Seasonally Adjusted Net Taxes*

Output (GDP): Retrieved from - Statistics Norway: Table 09190: Final expenditure and gross domestic product, by macroeconomic indicator, quarter, and contents. The variable is called Gross domestic product Mainland Norway, market values.

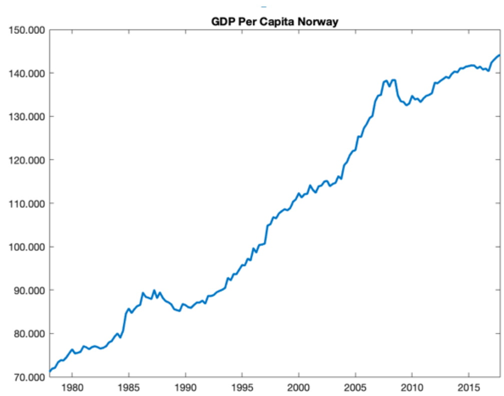


Figure A.11 *– Output (GDP) Per Capita*

Private Consumption: Retrieved from table: 09190 - Final expenditure and gross domestic product, by macroeconomic indicator, quarter and contents. National accounts Norway. The variable consists of final consumption expenditure of households and non-profit institutions serving households.

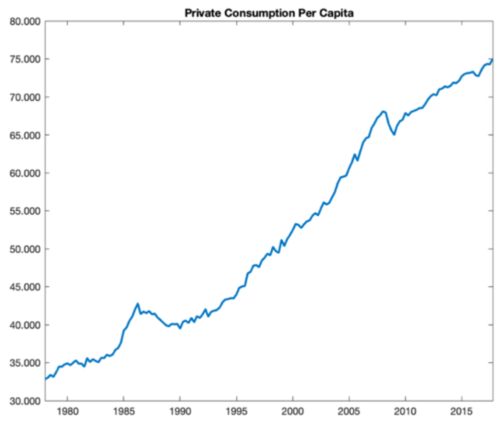


Figure A.12 *- Private Consumption Per Capita*

Private Investment: Retrieved from table: 09190: Final expenditure and gross domestic product, by macroeconomic indicator, quarter and contents. National accounts Norway. The variable private investment consists of Mainland Norway (GFCF) minus Dwelling service (households) (GFCF) and general government (GFCF).

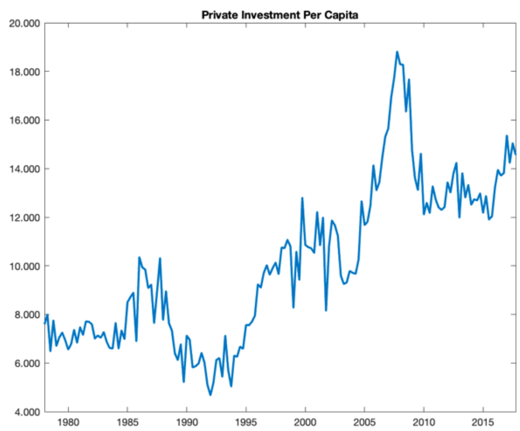


Figure A.13 *- Private Investment Per Capita*

GDP-deflator (Inflation): Retrieved from table: 09190 - National accounts Norway. Consist of Mainland GDP, market value in fixed 2020-prices and current prices.

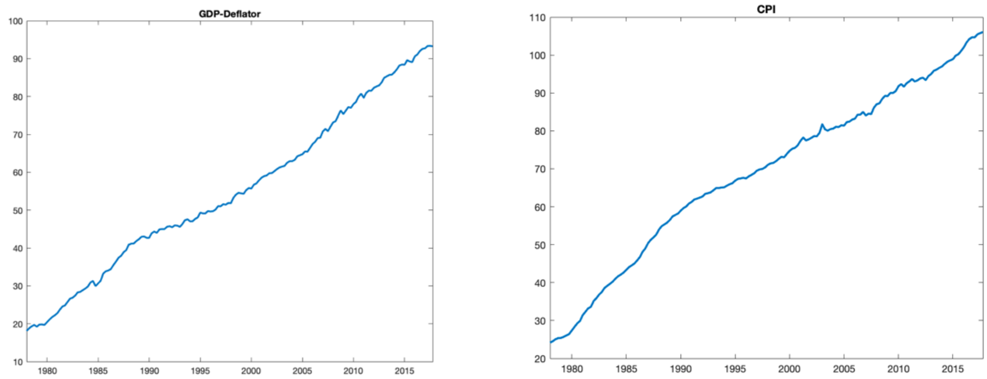


Figure A.14 *- GDP-deflator & CPI*

Interest Rate: As Norges Bank has only published its interest rate data from 1986 and onwards, we collected our data from FRED. The data were only available from 1979. Therefore, when including this variable, which we do in the second extended model, the sample period is 1979Q1 to 2017Q4.

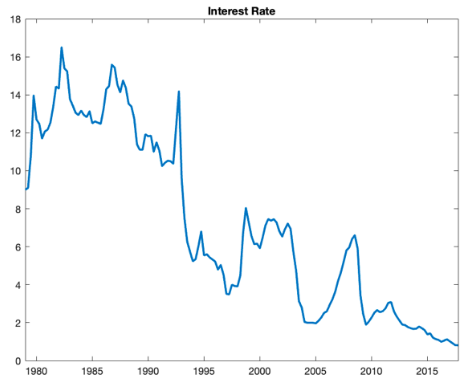


Figure A.15 *- Interest Rate*

Population: Retrieved from Table: 01222: Population and changes during the quarter (M) 1997K4 - 2022K4

A4.6 Test Statistics

Lags	Real, per capita terms		Log-form	
	AIC	*BIC*	*AIC*	*BIC*
1	49,95	50,18	-14,07	-13,82
2	49,75	50,16*	-14,25	-13,85*
3	49,71	50,30	-14,23	-13,64
4	49,59*	50,35	-14,31*	-13,56

Table A.12 - *AIC & BIC test Baseline Model. * indicates optimal number of lags. The highest number in the AIC test represents the optimal number of lags, while the lowest number in the BIC test represent the optimal number.*

Lags	Real, per capita terms		Log-form	
	AIC	*BIC*	*AIC*	*BIC*
1	81,67	82,26*	-22,26	-21,66*
2	81,46	82,54	-22,39	-21,31
3	81,29	82,86	-22,51	-20,95
4	81,19*	83,25	-22,55*	-20,50

Table A.13 - *AIC & BIC test Extended Model I. * indicates optimal number of lags. The highest number in the AIC test represents the optimal number of lags, while the lowest number in the BIC test represent the optimal number.*

	Log		Log-Difference	
	T-statistic	P-value	T-statistic	P-value
	-1.485	0.5407	-20.622	0,000**
Test Critical Values:				
1% level	-3.490		-3.491	
5% level	-2.886		-2.886	
10% level	-2.576		-2.576	

Table A.14 *- Argumented Dickey-Fuller Test Government Spending*

	Log		Log-Difference	
	T-statistic	P-value	T-statistic	P-value
	-1.099	0.7156	-15.299	0,000**
Test Critical Values:				
1% level	-3.490		-3.491	
5% level	-2.886		-2.886	
10% level	-2.576		-2.576	

***Table A.15** - Argumented Dickey-Fuller Test Net Taxes*

	Log		Log-Difference	
	T-statistic	P-value	T-statistic	P-value
	-1.048	0.7355	-14.181	0,000**
Test Critical Values:				
1% level	-3.490		-3.491	
5% level	-2.886		-2.886	
10% level	-2.576		-2.576	

***Table A.16** - Argumented Dickey-Fuller Test Output (GDP)*

	Log		Log-Difference	
	T-statistic	P-value	T-statistic	P-value
	-0.475	0.8968	-13.831	0,000**
Test Critical Values:				
1% level	-3.490		-3.491	
5% level	-2.886		-2.886	
10% level	-2.576		-2.576	

***Table A.17** - Argumented Dickey-Fuller Test Private Consumption*

	Log		Log-Difference	
	T-statistic	P-value	T-statistic	P-value
	-2.173	0.2162	- 20.202	0,000**
Test Critical Values:				
1% level	-3.490		-3.491	
5% level	-2.886		-2.886	
10% level	-2.576		-2.576	

***Table A.18** - Argumented Dickey-Fuller Test Private Investment*

	Normal form	
	T-statistic	P-value
	-5.519	0,000**
Test Critical Values:		
1% level	-3.490	
5% level	-2.886	
10% level	-2.576	

Table A.19 *- Argumented Dickey-Fuller Test GDP-deflator (Inflation)*

	Normal form		Log-Difference	
	T-statistic	P-value	T-statistic	P-value
	-0.691	0.8490	-7.464	0,000**
Test Critical Values:				
1% level	-3.490		-3.491	
5% level	-2.886		-2.886	
10% level	-2.576		-2.576	

Table A.20 *- Argumented Dickey-Fuller Test Interest Rate*

Appendix Section 7 – Robustness Tests

A7.1 Changing Lags

In our baseline model we used two lags when doing our analysis based on the results we got from our BIC test. Investigating whether the results change when adding more lags to our SVAR model is therefore interesting. Firstly, we test for a lag length of 4, which is what most previous empirical studies have used in their studies and what our AIC test suggested. Secondly, we will test with 6 lags and see if this has any different impact. And we do the same for our extended model.

The figures below shows that when increasing the number of lags to 4 in our baseline model we obtain a more volatile response of GDP in response to a shock in net taxes. The response is also positive throughout the whole time period and statistically significant up to the 11-12th quarter. Indicating that the response is persistent and leads to a small significant positive response to GDP. Considering the response of GDP and net taxes following an increase in government spending we observe that the impulse response functions are only statistically significant on impact. This result is different from what we obtain when using only two lags, where the response of GDP is positive and significant throughout the whole time period.

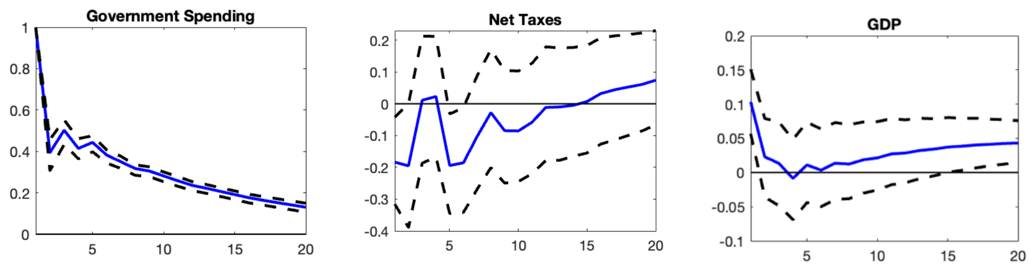


Figure A.16 *- Shock to government spending with 4 lags (Baseline Model)*

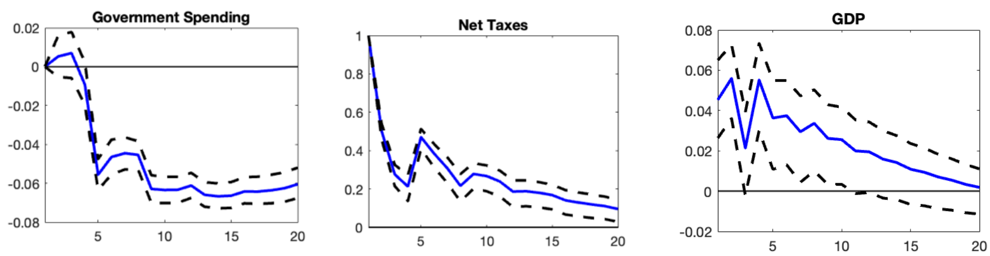


Figure A.17 *- Shock to net taxes with 4 lags (Baseline Model)*

Figure A.20 and A.21 show the impulse response functions following a lag length of six. The results we obtain from a shock in net taxes, shows a more volatile, positive response of GDP. However, the positive response increases over time and peaks in the 9th quarter. While the response following a shock in government spending are similar to when we are using 4 lags, the response is more insignificant and volatile.

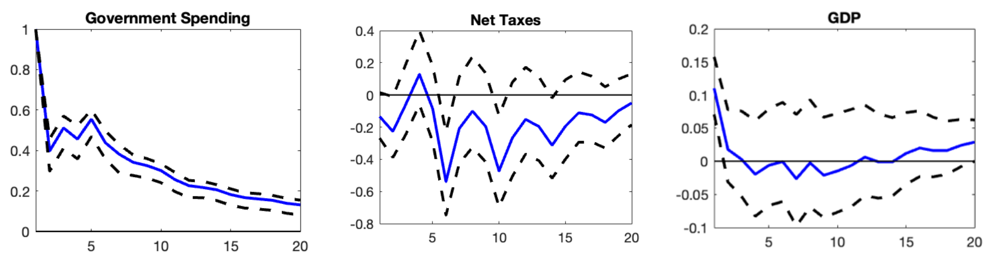


Figure A.18 *- Shock to government spending with 6 lags (Baseline Model)*

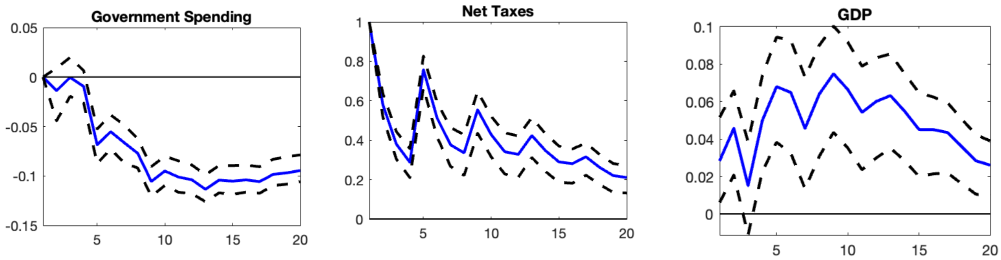
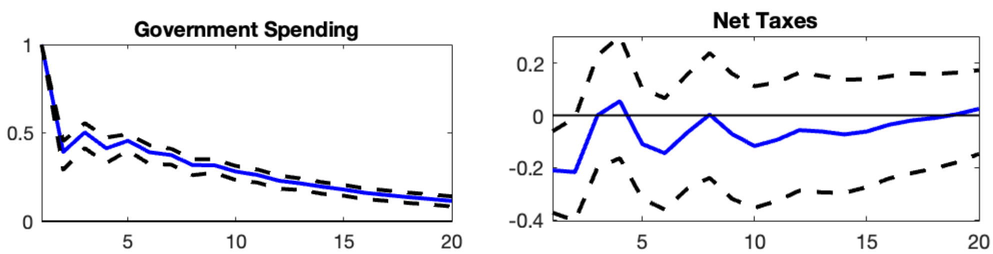


Figure A.19 *- Shock to net taxes with 6 lags (Baseline Model)*

The results we obtain from increasing the number of lags in our baseline model indicates that when adding more lags to our model, we obtain results that are less statistically significant following a shock in government spending. While for net taxes, the response becomes statistically significant, but much more volatile. These results could indicate that the relationship between government spending and GDP is not consistently significant over a longer lagged period. However, it could also be that the estimates are less precise by introducing more lags to the model and that the model could potentially be not well specified. Therefore, we apply the same robustness test to our extended models.

From Figure A.22 and A.23 we see that by increasing the lag length to 4 we obtain similar results to what we get from doing the same in our baseline model. The variables following the shock respond the same on impact, but the IRFs are more volatile and not as stable compared to when we only use 2 lags. This implies that the additional variables that are added to our baseline model, do not give us any more robust results. The model is still sensitive to shocks and therefore not well specified. Our model may suffer from an endogeneity problem, meaning that the variables in our model are simultaneously determined with each other. Leading to biased estimates and volatile impulse response functions.



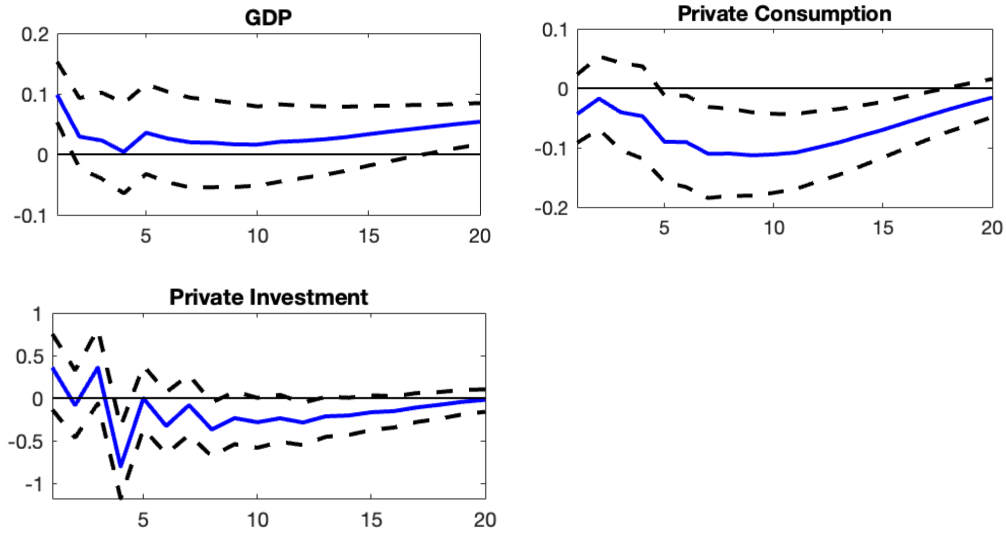


Figure A.20 *- Shock to government spending with 4 lags (Extended model I)*

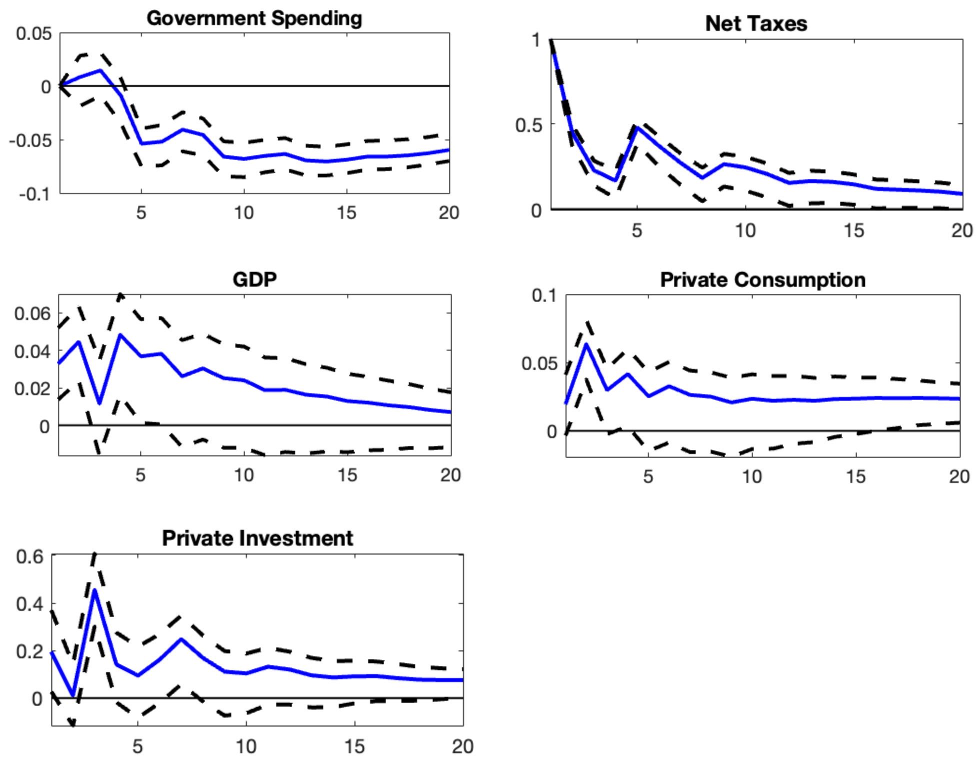


Figure A.21 *- Shock to net taxes with 4 lags (Extended model I)*

Looking at Figure A.24 and A.25 we observe that some of our results become less significant. The impact effect in this version does not change in direction, but change in magnitude as well as the lagged effect, which does suggest that our results are not robust. The results we obtain from using more lags in our baseline model becomes more volatile. Indicating that the effects of shocks in our data are unpredictable compared to when we only use two lags. This also suggests that the responses of variables to shocks are inconsistent and vary significantly over time, making it difficult to draw reliable conclusions about the effects of shocks based on the observed data. Therefore, the need for caution and further analysis to understand the underlying dynamics and sources of variability in the system.

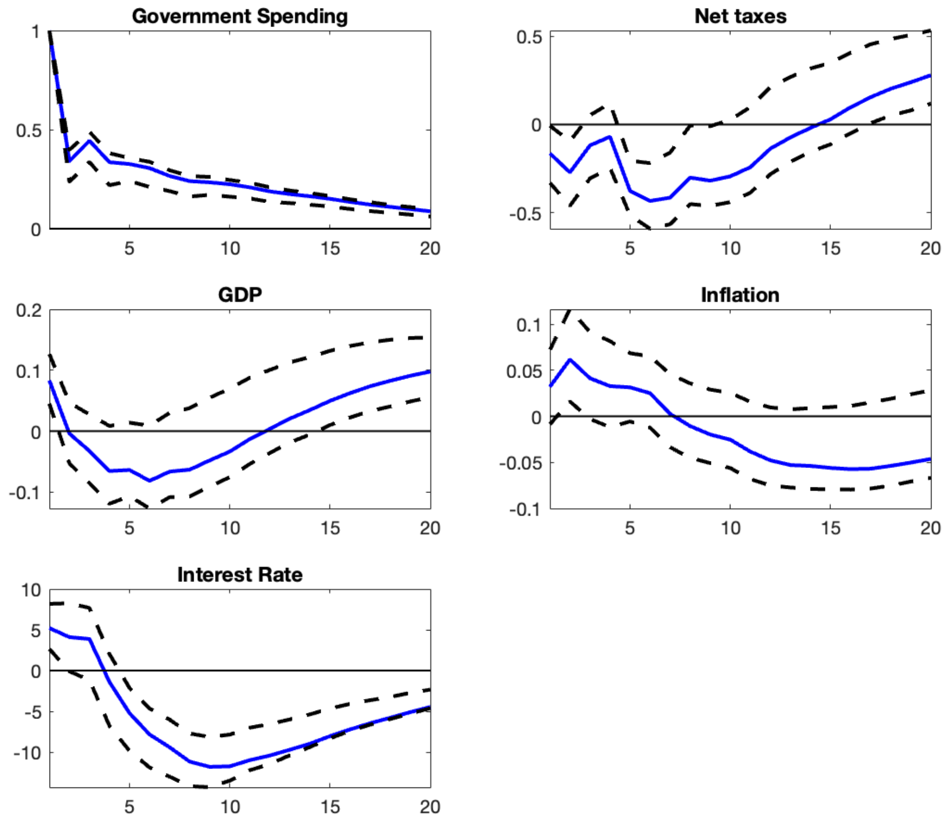


Figure A.22 - *Shock to government spending with 4 lags (Extended model II)*

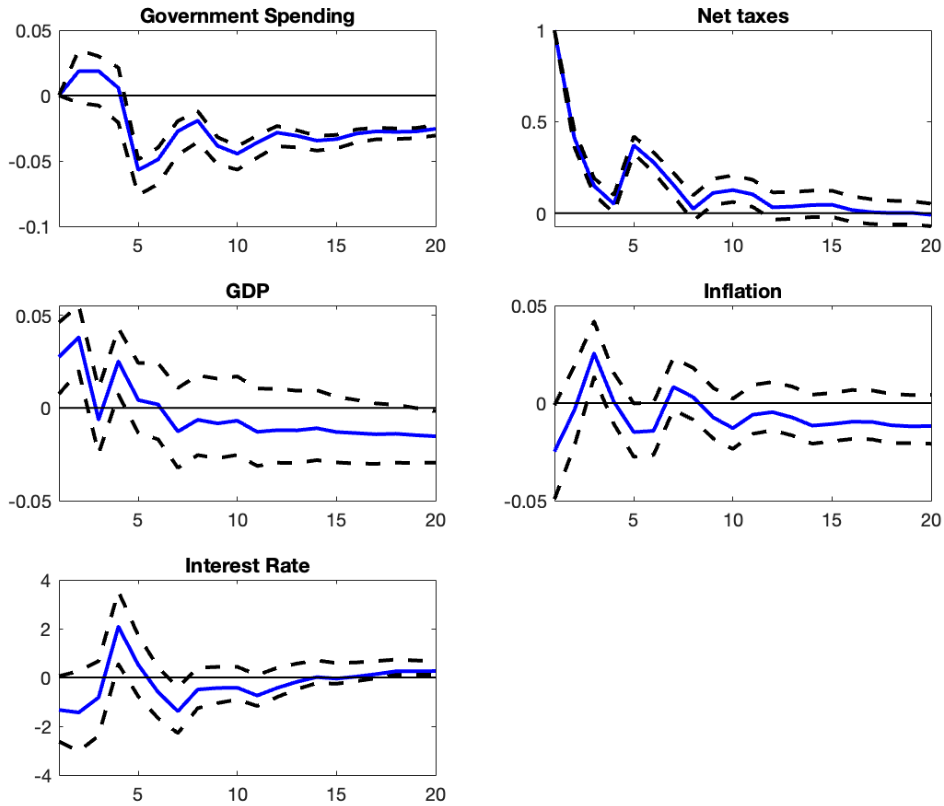


Figure A.23 *- Shock to net taxes 4 lags (Extended model II)*

A7.2 Changing the Ordering (Baseline Model)

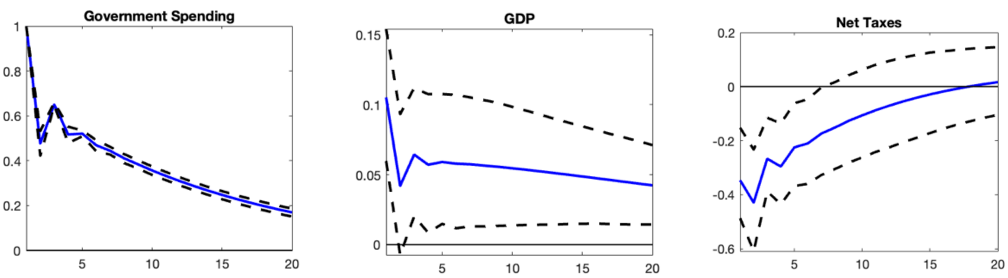


Figure A.24 *- Different ordering: Shock to government spending 2 lags (Baseline Model)*

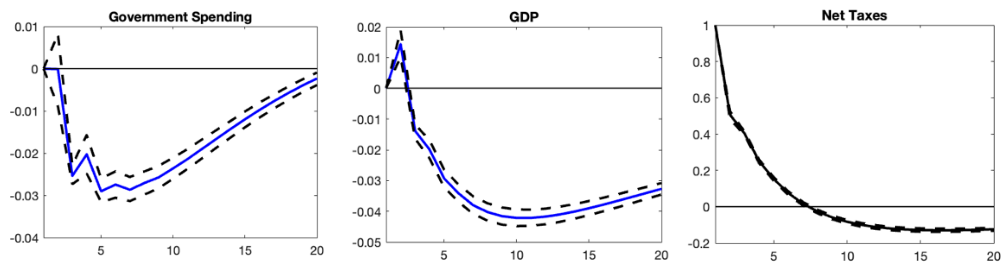


Figure A.25 *- Different ordering: Shock to Net Taxes 2 lags (Baseline Model)*

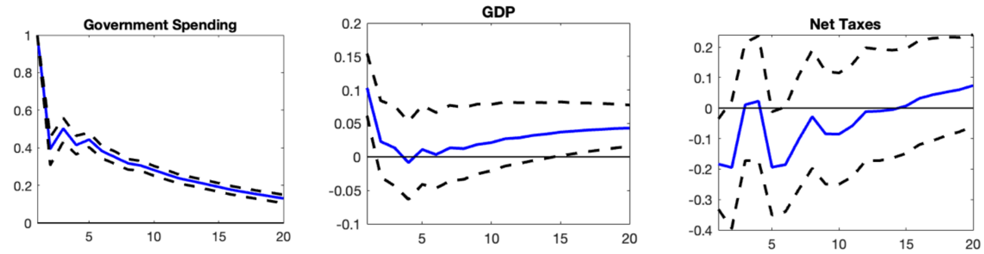


Figure A.26 *- Different ordering: Shock to Government Spending 4 lags (Baseline Model)*

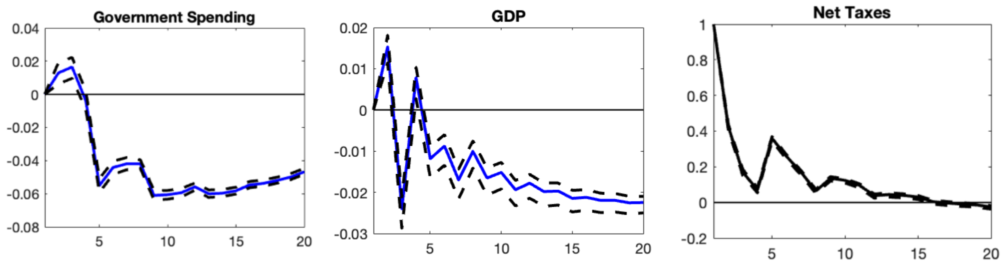


Figure A.27 *- Different ordering: Shock to Net Taxes 4 lags (Baseline Model)*

A7.3 Changing the Ordering (Extended Model)

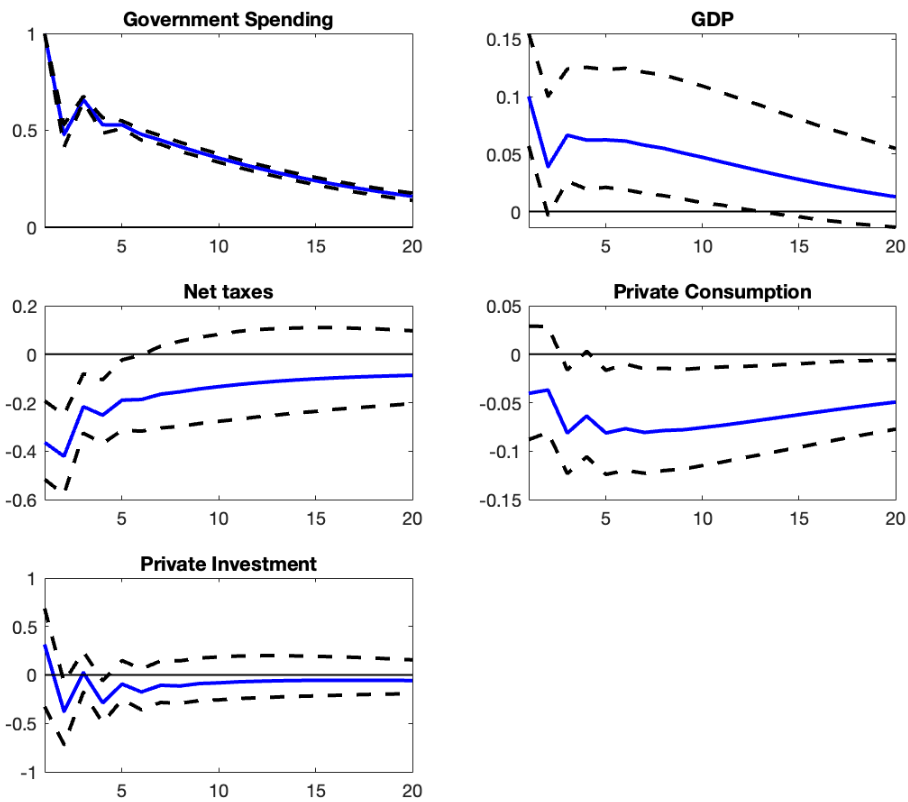


Figure A.28 *- Different ordering: Shock to Government Spending 2 lags (Extended Model I)*

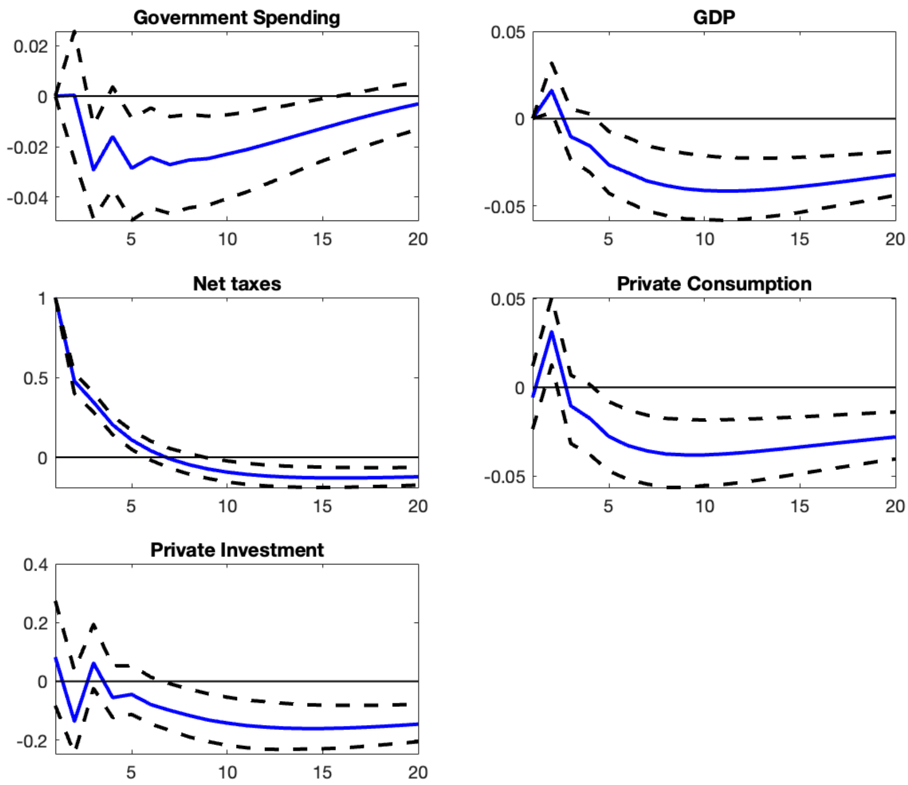


Figure A.29 *- Different ordering: Shock to Net Taxes 2 lags (Extended Model I)*

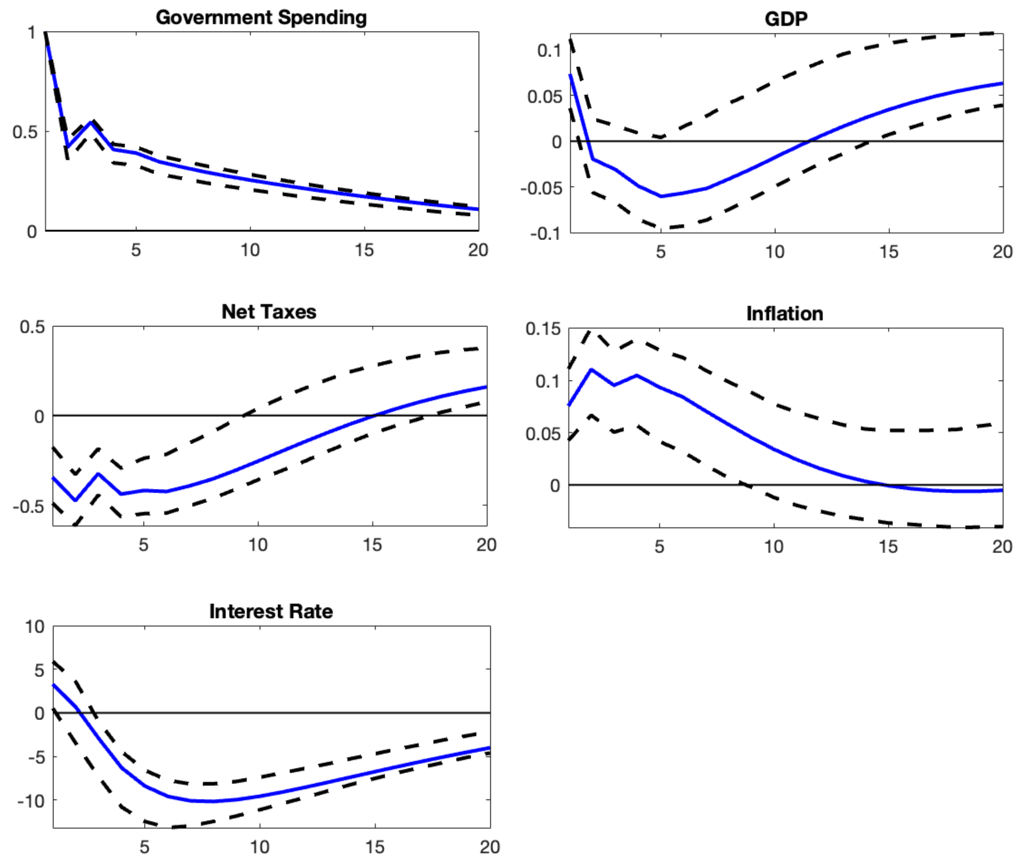


Figure A.30 *- Different ordering: Shock to Government Spending 2 lags (Extended Model II)*

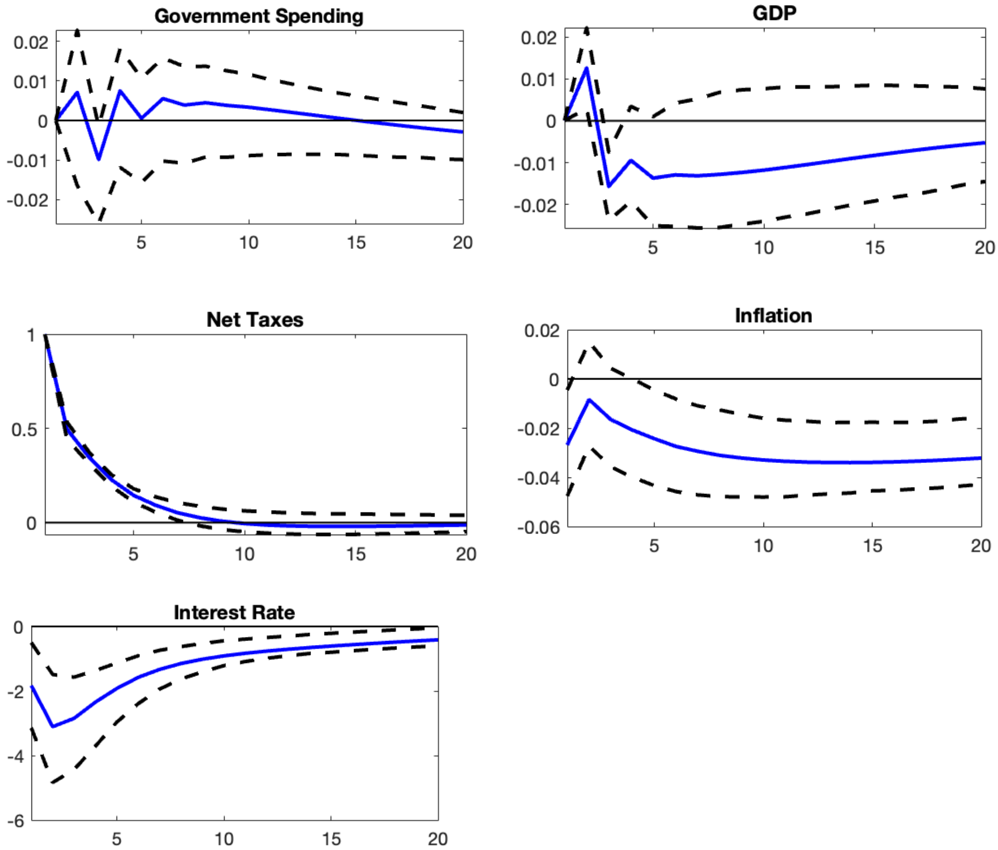


Figure A.31 *- Different ordering: Shock to Net Taxes 2 lags (Extended Model II)*

A7.4 Splitting the Sample

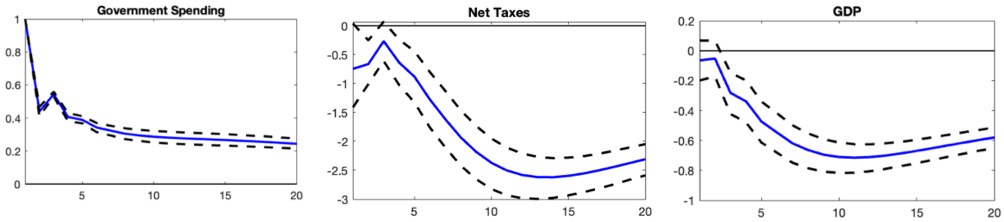


Figure A.32 *– Subsample: Period 1: 1978Q1-1991Q4 – Government Spending Shock 2 lags (Baseline Model)*

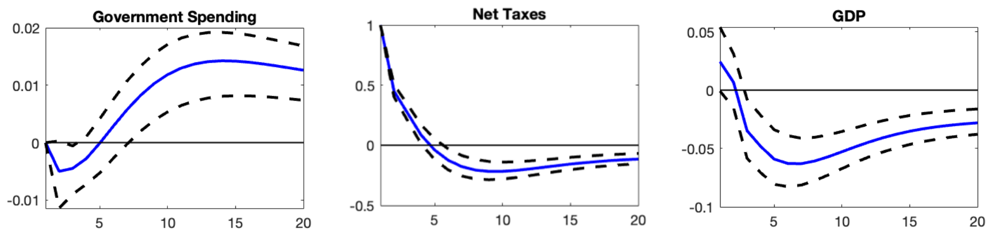


Figure A.33 *- Subsample: Period 1: 1978Q1-1991Q4 – Net Taxes Shock 2 lags (Baseline Model)*

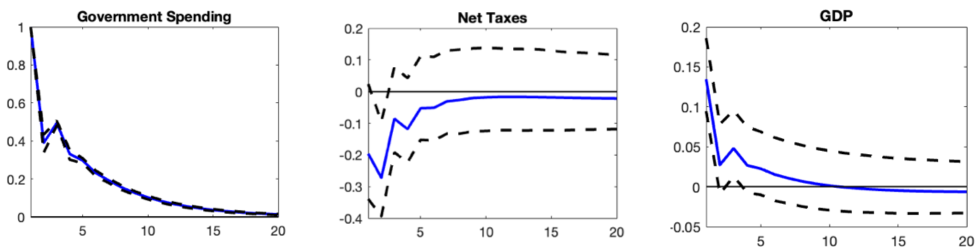


Figure A.34 *- Subsample Period 2: 1992Q1 - 2017 Q4 – Government Spending Shock 2 lags (Baseline Model)*

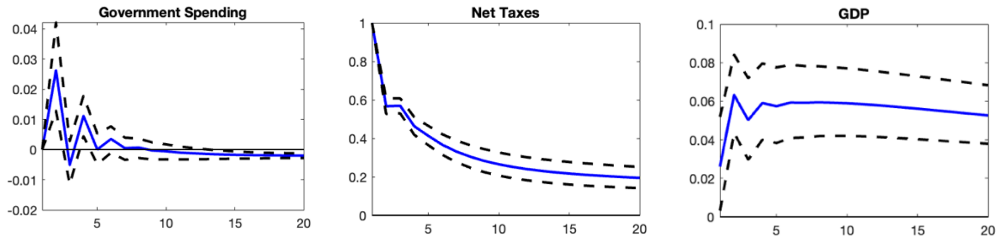


Figure A.35 *- Subsample Period 2: 1992Q1 - 2017 Q4 – Net Taxes Shock 2 lags (Baseline Model)*

A7.5 Robustness Test - Seven-Variable VAR

In this model we have included all the variables discussed in the theis, i.e. Government Spending, Net Taxes, GDP, Private Consumption, Private Investment, Inflation and Interest rate.

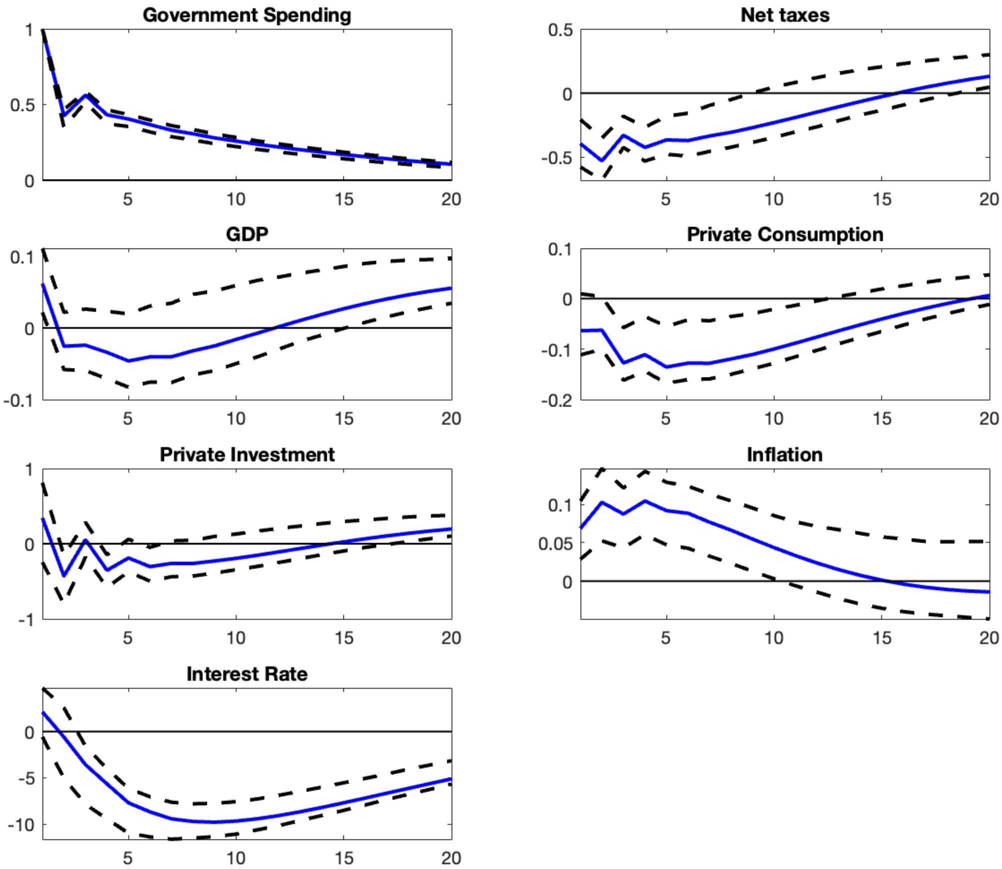


Figure A.36 - *Seven-variable VAR - Shock in Government Spending 2 lags*

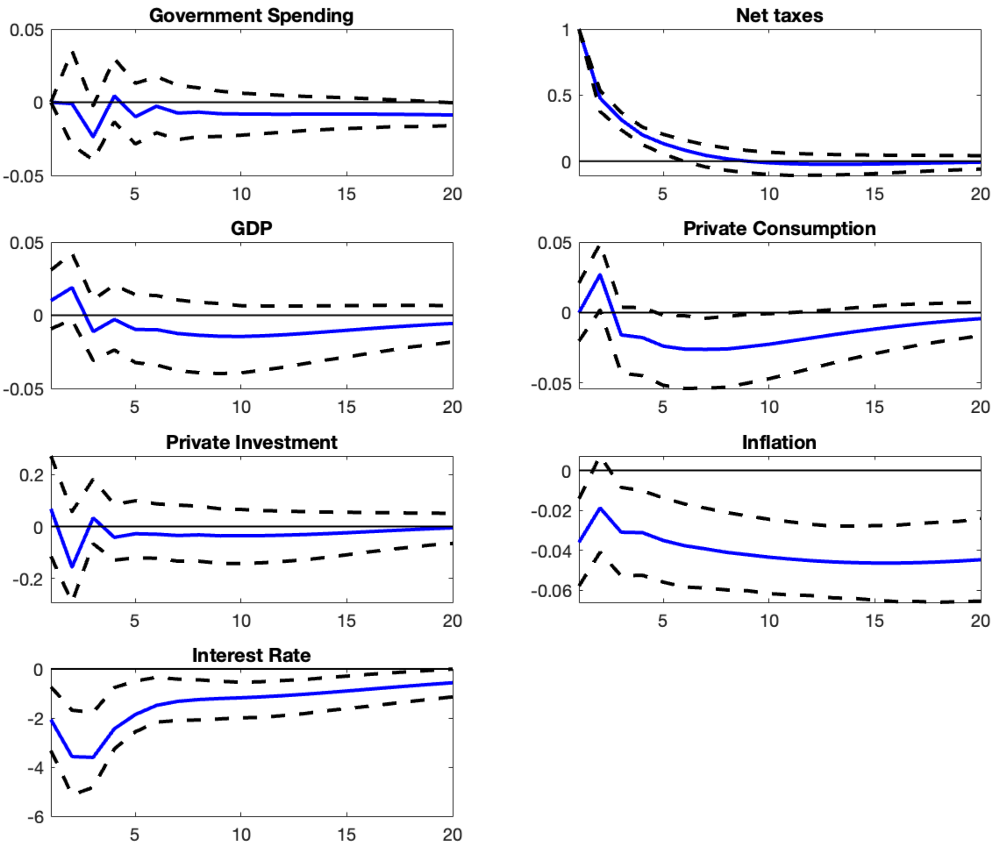


Figure A.37 *- Seven-variable VAR - Shock in Net Taxes 2 lags*