Essays on the impact of government spending in uncertain times and economic slumps

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The study of economics does not seem to require any specialized gifts of an unusually high order. Is it not, intellectually regarded, a very easy subject compared with the higher branches of philosophy and pure science? Yet good, or even competent, economists are the rarest of birds. An easy subject, at which very few excel! The paradox finds its explanation, perhaps, in that the master-economist must possess a rare combination of gifts. He must reach a high standard in several different directions and must combine talents not often found together. He must be mathematician, historian, statesman, philosopher – in some degree. He must understand symbols and speak in words. He must contemplate the particular in terms of the general, and touch abstract and concrete in the same flight of thought. He must study the present in the light of the past for the purposes of the future. No part of man's nature or his institutions must lie entirely outside his regard. He must be purposeful and disinterested in a simultaneous mood; as aloof and incorruptible as an artist, yet sometimes as near the earth as a politician.

Keynes (1924, pp. 321-322)

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Contents

List of Figures

List of Tables

1 Introduction

The new millennium featured several periods of high uncertainty as well as periods of large economic slack. Outstanding examples are the Great Recession and the Covid-19 crisis. In both episodes, governments in advanced economies implemented very large fiscal stimulus packages in order to prevent their economies from freely falling into another Great Depression. One question is how effective these fiscal policy measures are and whether they crowd-in or crowd-out private spending. In her literature review, Ramey (2019) surveys the current state of knowledge about government spending multipliers. Overall, the evidence suggests that they are positive but less than or equal to unity, meaning that additional public demand raises GDP but does not stimulate private activity and may actually crowd it out. Furthermore, the evidence for larger spending multipliers during economic slumps is fragile, and the most robust results suggest GDP multipliers of one or below during these periods. At the same time, Klein and Linnemann (2019) find evidence for larger output responses during the Great Recession, a situation of high uncertainty in coincidence with a substantial degree of economic slack. Therefore, a natural research question is whether the stronger output effect is genuinely due to the level of uncertainty in the economy or, possibly, due to the cyclical state.

At a general level, uncertainty is typically defined as the conditional volatility of a disturbance that is unpredictable from the perspective of economic agents. Uncertainty affects the decisions of economic agents along many dimensions. According to the real options channel, elevated uncertainty can depress hiring and investment if agents are subject to fixed costs or partial irreversibilities that lead to wait-and-see behavior of firms. If agents are risk averse, elevated uncertainty reduces private consumption due to the precautionary savings channel. Furthermore, financial constraints tighten because financial intermediaries demand larger risk premia in response to higher uncertainty. In line with these negative effects on private consumption and investment, uncertainty shocks may be interpreted as negative aggregate demand shocks that might be easily stabilized with additional public demand.

The impact of fiscal policy on uncertainty, however, is far from obvious. On the one hand, good policy measures can reduce economic fluctuations and lower uncertainty. On the other hand, fiscal policy can also be itself the source of uncertainty and poorly designed policy measures can actually increase the volatility of economic fluctuations. Furthermore, there might be indirect effects because increased policy uncertainty can undermine fiscal sustainability and adversely affect the financing costs of the public sector. Therefore, it seems natural to investigate the role of uncertainty in the analysis of fiscal policy.

An interesting question is whether it is possible to discriminate between the roles of uncertainty and the economic cycle for the size of fiscal multipliers. Bloom et al. (2018) classify recessions as the coincidence of negative first moments (level) and positive second moment (volatility) shocks. Moreover, Ludvigson et al. (2021) show that uncertainty can be an exogenous source of business cycle fluctuations but also rise endogenously in response to first moment shocks. According to Stock and Watson (2012), the main contributions to the decline in GDP and employment in the United States during the Great Recession came from financial and uncertainty shocks. Since the effects of expansionary fiscal policy measures depend on details such as the mode of financing, the degree of financial frictions and the stance of monetary policy, it is difficult to specify a model that is parsimonious enough to control for further factors that determine the impact of fiscal policy beyond the business cycle and uncertainty. This problem is further aggravated by the fact that fiscal policy variables are at best available at a quarterly frequency and because the impact of uncertainty on household and corporate decisions depends on the level of uncertainty. In this regard, Bloom et al. (2007) show that firms investment rate declines with the level of sales uncertainty firms are facing. The impact is only minor around the median but becomes major at high levels of uncertainty. The three chapters of this dissertation contribute in different ways to address these issues and extend our understanding on the impact of government spending during uncertain times and economic slumps compared to normal episodes.[1]

Chapter 2 is co-authored with Ansgar Belke and investigates the effects of government spending using US data from 1960 onward. In this project, we employ the Self-Exciting Interacted VAR (SEIVAR) and generalized impulse response functions (GIRFs).[2] The SEIVAR augments an otherwise standard VAR with a continuous interaction term of government spending and uncertainty that captures the impact of uncertainty on the transmission of government spending. The GIRFs take into account the impact of government spending on uncertainty. This approach offers the advantage that all coefficients are estimated on the whole sample period instead of abrupt change models like threshold VARs where one estimates a separate model for each state of the economy. This parsimony allows to focus on extreme deciles of the uncertainty distribution in a short sample period and to control for a broad set of confounding factors. This is important because Caggiano et al. (2015) argue that conditioning on extreme events may be essential to avoid confounding similar states and thus failing to provide empirical evidence in favor of state dependency.

In tranquil periods, government spending increases output. In episodes of high macroeconomic uncertainty, however, the increase in public consumption and investment reduces GDP. In the first place, this result seems puzzling. However, as mentioned above, governments can

[1]When we use the term government spending in the following, we refer to the sum of public consumption and investment.

[2]The SEIVAR was introduced by Pellegrino (2021) and Caggiano et al. (2017) in the field of monetary policy.

either reduce uncertainty through stabilizing the economy or be the source of uncertainty. Indeed, the transmission of the government spending shock resembles the transmission of an uncertainty shock and reduces confidence, causing private consumption and investment to decline. Key to our results are the endogenous uncertainty channel and the interaction with consumer confidence as well as the corporate bond spread. Disregarding the latter would cause the state-dependent output effect to disappear or lead to a stronger GDP increase during uncertain periods. This coincides with a reversed response of uncertainty. In the same experiment, we explicitly shut down the uncertainty response (leading to a non Self-Exciting IVAR) and the difference across uncertain and tranquil periods becomes smaller.

We investigate whether our results hold for different components of government spending. While we find no state-dependence for government consumption and national defense expenditures, the results for government investment and public research and development expenditures differ sharply. First, the weaker impact of government spending on output appears to stem from public investment. This is not unexpected if the government shock resembles an uncertainty shock and triggers the real options channel. Second, fiscal research and development expenditures show particularly strong output effects in times of high uncertainty. One reason is that public research may be a substitute for private research explorations if firms cut their research expenditures in episodes of elevated uncertainty, for instance due to tighter financial frictions, although the composition of both diverges in reality.

Chapter 3 and Chapter 4 investigate the impact of fiscal policy measures with a different approach. Instead of using a particular parsimonious method to incorporate state-dependence in the transmission of fiscal policy, we extend the sample period back to 1890 or choose a panel approach for the set of euro area countries. In both chapters, we estimate threshold models using local projections as proposed in Jordà (2005). Furthermore, we follow Ramey and Zubairy (2018) and directly estimate cumulative GDP multipliers that take into account the multi-year path of government spending as well as the respective standard errors. In both chapters, we also analyze the transmission channels of fiscal policy by means of multipliers instead of simple impulse responses because those multipliers control for the dynamics of government spending as if these were similar across states of the economy.

In Chapter 3, we extend the historical dataset from Ramey and Zubairy (2018) with additional macroeconomic and financial variables. This sample period covers several wars, financial crises and recessions so that we can discriminate among the effects of government spending during periods of high uncertainty compared to economic downturns. The threshold level that discriminates between uncertain and normal periods is important because the GDP multipliers depend on private sectors response, which in turn hinges on the level of uncertainty. We estimate the differences between the state-dependent GDP multipliers across uncertainty percentiles and use the level that shows the largest difference at acceptable standard errors. We find a cumulative one-year GDP multiplier of two during uncertain periods and in the range of 0.4 to 0.8 during normal times. During economic slumps, the one-year multiplier is close to one.

We provide, in addition, cumulative multipliers for a wide range of macroeconomic and financial variables in order to explain the larger GDP multiplier in uncertain episodes than in economic slumps. Additional government spending stimulates employment and the stock market during slumps and uncertain times, with the latter being characterized by stronger effects. In uncertain episodes, government spending lowers corporate bond spreads/risk premiums and shifts inflation upwards which reduces the real interest rate. These two effects improve the financing conditions for companies and make precautionary savings less attractive, hereby stimulating private spending. Both effects do not occur during periods of economic slack and hence explain the smaller multiplier during slumps.

Chapters 2 and 3, like most research on the impact of fiscal policy, focus on the US economy. This is unsatisfactory for several reasons. First, the euro area is home to around 340 million people in 2022, making it a relevant area. Second, since fiscal policy variables are only available at a quarterly frequency, focusing on large levels of uncertainty in a threshold approach requires the use of a very long time period. Another solution is to use a panel approach with its slope homogeneity assumption that is most likely to be fulfilled in a set of countries with a common market and a joint monetary policy. Therefore, Chapter 4 uses a panel of euro area countries and local projections to estimate cumulative government spending multipliers in periods of elevated uncertainty and in normal times. Since Boehm (2020) has shown that public consumption and investment might have very different output effects, we estimate separate multipliers for both components of government spending.

Conditional on being in a state of high economic uncertainty, increases in government spending turn out to be more effective, with one-year GDP multipliers close to one for government consumption and close to two for public investment. During normal times, we estimate one-year multipliers for both spending types close to 0.4 euros. With respect to the economic cycle, we do not find evidence for larger GDP multipliers in slumps.

Conditional on being in a state of high uncertainty, an increase in public consumption stimulates the labor market at the extensive and intensive margins. Moreover, real wages rise such that households consume more and part of the extra income is available in the form of increased savings for private investment. Yet, one euro of additional public consumption does not increase GDP by more than one euro after one year and there are no improvements in productivity. In contrast, additional government investment leads to stronger productivity gains than in normal times or through additional public consumption. Households benefit from the increase in labor productivity through higher real wages such that private consumption rises. The different productivity effects also have implications for inflation. While public consumption spending is inflationary due to the positive aggregate demand effect, public investment is deflationary in uncertain times because of a positive supply effect due to the increase in labor productivity. Thereby, Chapter 4 augments the results in Jørgensen and Ravn (2022) who explain deflationary increases in government spending (consumption + investment) with time-varying adoption of new technology into the production process. As we show, public investment is indeed deflationary but consumption is inflationary.

2

Uncertainty and non-linear macroeconomic effects of fiscal policy in the US: a SEIVAR-based analysis

Abstract

This chapter investigates whether the macroeconomic effects of government spending shocks vary with the degree of uncertainty in the economy. We use US quarterly data from 1960 to 2017 and employ the Self-Exciting Interacted VAR (SEIVAR) to compute non-linear generalized impulse response functions to an orthogonalized government spending shock in tranquil and in uncertain times. The parsimonious design of the SEIVAR enables to focus on extreme deciles of the uncertainty distribution and to control for a broad set of confounding factors such as the financing side of the government budget, monetary policy, financial frictions and private sector expectations. Thereby, we contribute to the literature using a method that allows to control for a large set of confounding factors and treats uncertainty as endogenous. We use various uncertainty proxies and we only find statistically significant non-linearity for macroeconomic uncertainty. Fiscal spending has positive output effects in tranquil times but is contractionary during times of heightened uncertainty. Our results indicate an important role of the endogenous response of macroeconomic uncertainty. Analyzing the effects of different government spending categories, only research and development expenditures reduce uncertainty and have expansionary output effects during uncertain times.

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2.1 Introduction

The recent experience with the Great Recession in the US, which was accompanied by huge uncertainty in the real economy and the financial sector, has sparked a debate about the effect of uncertainty on macroeconomic outcomes. At the same time, an intense increase in government spending in advanced economies pushed the short-term effects of fiscal policy back on the macroeconomic research agenda. This coincidence naturally leads to the research question, if and how the effects of government spending vary with the degree of uncertainty prevalent in the economy.

How could the degree of uncertainty in the economy influence its behavior? The early literature has emphasized a real options channel of uncertainty for investment decisions (Bernanke, 1983; Dixit, 1989; Pindyck, 1991). Only recently, Bloom (2009) (in a partial equilibrium model) and Bloom et al. (2018) have shown the importance of this channel in a general equilibrium model with non-convex adjustment costs in capital as well as labor and time-varying uncertainty. They show that firms become more cautious in investing and hiring as uncertainty increases. In addition, the precautionary savings channel proposes that consumers lower their consumption expenditures and increase their savings as uncertainty surges (Challe et al., 2017; Leland, 1968; Lusardi, 1998). In line with these negative effects on private investment and private consumption, Leduc and Liu (2016) interpret uncertainty shocks as aggregate demand shocks. As summarized by Ramey (2011a), the effects of fiscal policy depend strongly on the reaction of private spending. There might also be indirect effects of uncertainty. For example, increased economic policy uncertainty can adversely affect the financing costs of sovereigns (Boumparis et al., 2017). Therefore, it seems natural to consider the role of uncertainty in the analysis of fiscal policy. We explicitly incorporate the influence of policy on the level of uncertainty. As the effects may vary with the specific category of government spending, we also scrutinize the effects of public consumption, investment, national defense as well as research and development expenditures.

We employ the Self-Exciting Interacted VAR (SEIVAR) model, recently proposed by Pellegrino (2021) and Caggiano et al. (2017) in the field of monetary policy, to estimate a potentially non-linear transmission of fiscal spending shocks to output. This model augments an otherwise standard VAR with an interaction term between government spending and uncertainty that captures the uncertainty-varying effects of fiscal spending on all endogenous variables. Accounting for the non-linearity of interest in this way leaves us with sufficient degrees of freedom to analyze the macroeconomic effects of government spending for extreme deciles of the uncertainty distribution and enables us to control for a sufficient number of confounding factors such as the financing side of the government budget, monetary policy, financial frictions and private sector expectations.

We identify exogenous shocks to government spending using two alternative strategies. First, we follow Blanchard and Perotti (2002) and identify the exogenous variation in government spending using the exclusion restriction that the government, due to decision lags, cannot react within the same quarter to other shocks. Second, we take into account implementation lags in fiscal spending. If private agents already anticipate the increase in government spending and adjust their behavior before it occurs, the estimates could be biased (Ramey, 2011b). We follow Auerbach and Gorodnichenko (2012) and augment the model with expectations of professional forecasters to control for such anticipation effects.

We obtain our main results from a SEIVAR that includes government spending growth, real GDP growth, the tax to GDP ratio, the real monetary policy rate, macroeconomic uncertainty, the corporate bond spread and the Michigan index of consumer sentiment. We construct generalized impulse response functions (GIRFs) as proposed by Koop et al. (1996) to an orthogonalized shock following Kilian and Vigfusson (2011). The method is needed to fully account for the non-linearity in our system.[1] The model is estimated at the quarterly frequency from 1960Q3 to 2017Q2. Besides macroeconomic uncertainty as propagated by Jurado et al. (2015), we also consider financial uncertainty (Ludvigson et al., 2021), indices of realized and implied stock market volatility (Berger et al., 2019; Bloom, 2009), the economic policy uncertainty index (Baker et al., 2016), a corporate bond spread and Michigan survey of consumer confidence data as a measure inversely related to uncertainty.

We obtain the following results. First, we find statistically significant non-linearity only in the case of macroeconomic uncertainty. Second, significantly different effects of government spending on GDP occur in tranquil as opposed to uncertain times. In periods of low uncertainty, government spending increases output. In uncertain times, however, the rise in public expenditures resembles uncertainty shocks and reduces confidence. The result is reduced private consumption and investment, which leads to an economic downturn. This result endures if we control for expected government spending. We examine whether the rise in uncertainty is merely a consequence of the fiscal response to elevated uncertainty. We order macroeconomic uncertainty first and shock this variable to scrutinize this issue of reverse causality. However, there is no evidence for a significant response of government spending to increased uncertainty. This mitigates our concerns about the presence of reverse causality problems.

The result of possible negative output effects of increased government spending during times of uncertainty has also been corroborated recently by Alloza (2019) who uses a different methodology with uncertainty being treated as exogenous whereas we include uncertainty as an endogenous variable in the SEIVAR. Key to our results are the endogenous uncertainty channel and the interaction with consumer confidence as well as the corporate bond spread. Disregarding the latter would cause the state-dependent output effect to

[1]Constructing impulse responses in non-linear VAR models is far from straightforward since many complexities arise in moving from linear to non-linear systems (Koop et al., 1996). In linear models, impulse responses are invariant to history, proportional to the shock size and symmetric in positive and negative shocks. However, in non-linear models, responses can depend on the magnitude and sign of the shock as well as on the histories of previous shocks.

disappear or lead to a higher increase in output during uncertain periods. This coincides with a reversed response of uncertainty. In the same experiment, we explicitly shut down the uncertainty response (leading to a non Self-Exciting IVAR) and the difference across states becomes smaller. Nevertheless, our result of a lower output response in times of heightened uncertainty persists in the first year after a shock.

The results slightly change if we consider a shorter sample period ranging from 1960Q3 to 2007Q3, the period before the Great Recession. In this case, an expansion of public spending increases output and consumer confidence during tranquil times. In that instance, however, the significant negative effect on GDP in uncertain times disappears for which we propose two explanations. First, we lose roughly forty quarters of observations, making it more difficult to find statistically significant differences. Second, the Great Recession was characterized by high uncertainty, which is now dropped from our sample period so that the difference between tranquil and uncertain times diminishes and thus the state-specific effect. Nevertheless, we still find lower output responses during uncertain times within one year after the shock.

The remainder of the paper proceeds as follows. Section 2.2 reviews the recent literature on the state-dependent effects of government spending increases with regard to uncertainty and the business cycle. Section 2.3 surveys existing uncertainty measures and sketches our empirical strategy. Section 2.4 reports our results while Section 2.5 concludes.

2.2 Non-linear effects of fiscal spending: review of the literature

This paper is related to the literature dealing with non-linear effects of public spending. We will summarize the results of the literature dealing with uncertainty-related effects of fiscal policy. We will also review results on varying effects of fiscal policy over the business cycle, since it is hard to empirically discriminate between uncertainty (as second moment shocks) and the business cycle (as first moment shocks). Due to this fact, Bloom et al. (2018) classify recessions as the coincidence of negative first moment with positive second moment shocks. We first review the empirical literature on fiscal spending and uncertainty. Since our paper is more related to this strand, we do so in more depth. We do not survey the literature on linear effects (or other sources of state-dependence) of government spending or of tax shocks since our focus is on the non-linear effects of government spending. Ramey (2011a) and Ramey (2019) provide excellent reviews of these topics.

Alloza (2019) estimates the impact of government spending shocks during periods of high and low uncertainty and during periods of booms and recessions with US data. He uses local projections à la Jordà (2005) and a threshold VAR (TVAR) in which he implicitly assumes that a fiscal policy shock cannot influence the economy to transit from one state to the other. He finds positive output effects during times of low uncertainty but contractionary effects in periods of heightened uncertainty. He identifies households' confidence as a key variable for interpreting this result as agents become more pessimistic when an increase in government spending, even if intended to stabilize the economy, confirms their negative economic outlooks.

Arčabić and Cover (2016) analyze the effects of fiscal policy under different uncertainty states in the US using a TVAR in which they endogenously estimate different uncertainty states. Contrary to Alloza (2019), they find larger effects of fiscal spending on the economy during periods of high uncertainty. Increases in fiscal spending tend to crowd out private investment during periods of average or low uncertainty while they crowd in private investment after some delay during periods of high uncertainty. In terms of government spending purpose, public investment turns out to have larger output effects than public consumption. In addition, larger shocks do not have the same dollar for dollar effect on output as small shocks.

Berg (2019) examines the relationship between business uncertainty and fiscal policy effectiveness in Germany. As opposed to the papers mentioned above, he uses measures of business uncertainty that are derived from firm-level data. He only finds minor effects of increased uncertainty on the fiscal multiplier in the short run. However, the long-run multiplier turns out to be larger in uncertain times.

Ricco et al. (2016) is more related to policy uncertainty. The authors analyze how policy communication affects the propagation of fiscal shocks in a Bayesian TVAR where they use a newly constructed index of fiscal spending disagreement as the threshold variable. They find large and positive output responses to government spending shocks in times of low disagreement between professional forecasters about future government spending. Conversely, periods of enhanced disagreement lead to more muted output responses.

The pioneering study investigating the possibly non-linear effects of fiscal spending over the business cycle is Auerbach and Gorodnichenko (2012), who adopt a Smooth Transition VAR (STVAR) to study regime-specific effects of fiscal spending. The authors find large differences in the size of spending multipliers during recessions and expansions with fiscal policy being considerably more effective in recessions than during expansions. They also looked at more disaggregated fiscal spending variables and proposed to use data of professional forecasters to control for predictable components of fiscal shocks. Other studies confirming their results are Auerbach and Gorodnichenko (2013), who extend their sample to OECD countries and use local projections instead of the STVAR, Fazzari et al. (2015) who employ a TVAR and capital utilization as a business cycle threshold variable, and Caggiano et al. (2015) who combine a STVAR with generalized impulse response functions to allow for the endogenous transition between the states in response to the shock.

However, some contributions put this positive business cycle effect into doubt. Alloza (2019) finds that fiscal spending is contractionary during recessions. He explores the differences to Auerbach and Gorodnichenko (2012) and highlights the importance of information used to determine the state of the business cycle. The smooth transition function in Auerbach and Gorodnichenko (2012) is based on a centered moving average of real GDP growth. Hence, it includes knowledge about future development that is not in the information set of economic agents. Alloza (2019) shows that government spending has negative output effects during recessions when he uses their specification with only backward looking information. Ramey and Zubairy (2018) employ historical data spanning more than 120 years in the United States. They use the local projection method from Jordà (2005) to estimate the government spending effects on output and the unemployment rate to discriminate between the states of the business cycle. Their study finds no evidence for larger multipliers when the economy is in a slack. In addition, they apply the Jordà method to the STVAR used by Auerbach and Gorodnichenko (2012). They show that the results in the latter depend on a simplifying assumption, i.e. that government spending shocks cannot lead the economy to transit between the business cycles states. Relaxing this assumption shrinks their estimated output multiplier.

We can conclude that the literature on the state-specific effects of government spending on the economy comes to different results, varies in the method used for estimation and constructing the impulse responses. We will use an econometric approach that fully takes into account the potential non-linearity between government spending and economic uncertainty and at the same time is parsimonious enough to control for a large set of confounding factors to be safeguarded against the potential problem of omitted variable bias.

2.3 Empirical strategy

In the following, we provide an overview of some empirical uncertainty proxies, present correlations among them and depict their respective time series. Section 2.3.2 elucidates our empirical approach and emphasizes its advantages. We also explain the strategy to identify a structural government spending shock and provide statistical evidence in favor of the non-linear specification. Section 2.3.3 illustrates the calculation of impulse response functions in a non-linear world whereas Section 2.3.4 explains the data.

2.3.1 Measuring uncertainty

Uncertainty is an amorphous concept. Hence, not surprisingly, there is a lively discussion in the literature on how to measure this broad concept. At a general level, uncertainty is typically defined as the conditional volatility of a disturbance that is unpredictable from the perspective of economic agents. Surges in uncertainty can depress hiring, investment or consumption if agents are subject to fixed costs or partial irreversibilities that lead to wait-and-see behavior of firms (e.g. Bernanke, 1983; Bloom et al., 2018; Dixit, 1989; Pindyck, 1991), precautionary savings if agents are risk averse (e.g. Challe et al., 2017; Leland, 1968; Lusardi, 1998) or if financial constraints tighten in response to higher uncertainty (e.g. Christiano et al., 2014; Gilchrist et al., 2014). On the other hand, an increase in future expected volatility can also raise expected profits when the loss is limited, thus leading to growth options and to higher research and development expenditures (e.g. Bar-Ilan and Strange, 1996). In addition, firms can invest to exploit good outcomes and to insure against bad outcomes in the future (Abel, 1983; Hartman, 1972; Oi, 1961). Various empirical proxies of uncertainty have been developed to grasp this amorphous concept since different channels might differ in the effects on the economy.

The empirical literature starting with the seminal paper of Bloom (2009) began with using the VXO as a measure of economic uncertainty. The VXO is a measure of percentage implied volatility on a hypothetical at the money S&P 100 option 30 days to expiration. Since the VXO is only available from 1986, Bloom (2009) used the realized monthly returns volatility calculated as the monthly standard deviation of the daily S&P 500 index normalized to the same mean and variance as the VXO index when they overlap from 1986 onward. He showed that this measure of uncertainty increased after major economic and political shocks. The underlying idea of this variable as a measure of uncertainty is that the implied volatility of share returns is the canonical measure of uncertainty in financial markets. Sometimes, however, the VIX (based on the S&P 500) is used instead. It has to be noted that an increase in the VIX is not only related to a rise in uncertainty. Bekaert et al. (2013) decompose the VIX into two components, a proxy for risk aversion and expected stock market volatility that is related to uncertainty.

Very recently, Berger et al. (2019) show the importance to distinguish between realized volatility, the arrival of large shocks today, as opposed to uncertainty defined as expected future volatility. We follow Berger et al. (2019) and distinguish in our analysis between these concepts. Realized stock market volatility is measured as the annualized standard deviation of daily S&P 500 returns over each month. Implied stock market uncertainty is the VIX (available from 1990) spliced with their related measure of implied volatility (available from 1983).

Baker et al. (2016) develop an economic policy uncertainty (EPU) index based on newspaper coverage frequency. This reflects the frequency of occurence of certain key words related to the economy, policy and uncertainty. It has to be stressed that the focus of this measure is the degree of policy uncertainty prevalent in the economy. Hence, the proxy does not rise in times of high uncertainty about future technological developments but low digression about policy actions.

Leduc and Liu (2016) propose a measure of uncertainty that is directly related to consumer confidence. They use consumer survey data from the University of Michigan relating to vehicle purchases and count the fraction of respondents that do not buy cars or other durable goods over the next twelve months because the future is uncertain. They state that the VIX and their consumer uncertainty measure are both counter-cyclical but react differently during specific events.[2] Their sample shows a correlation between the VIX/VXO

[2]An example is the possibility of a fiscal cliff the US economy faced in late 2012 that had the potential to

and their consumer confidence related measure of uncertainty of only 0.24. We deviate from them as we focus on general consumer sentiment as an inversely related measure of consumer uncertainty.

In their analysis of uncertainty and the effects of fiscal policy, Arčabić and Cover (2016) use the spread between Moody's seasoned Baa corporate bond yield and 10-year constant maturity treasury bonds yields as an alternative to the VXO. Intuitively, firms might have to pay larger risk premia if uncertainty increases and so does the spread.

Jurado et al. (2015) and Ludvigson et al. (2021) start from the premise that for making economic decisions, it is important whether the economy has become more or less predictable and not whether certain economic indicators fluctuate more or less. Based on this idea, they exploit a data-rich environment to provide direct econometric estimates of time-varying macroeconomic and financial uncertainty. Macroeconomic uncertainty is a measure of the common variation in uncertainty across many macroeconomic time series. These cover real activity indicators, price indices, as well as bond and stock market indices and foreign exchange measures. Financial uncertainty is the common variation of uncertainty relating to a broad set of financial variables.

Figure 2.1 depicts the time series of various uncertainty proxies. The blue dots indicate the periods that correspond to tranquil times whereas the red dots indicate uncertain times.[3] Shaded areas correspond to NBER recession periods. It can be seen that the choice of the uncertainty measure determines which periods are classified as uncertain times. Macroeconomic uncertainty is mainly high during 1975 to 1985, the dotcom bubble at the beginning of the 20th century and the Great Recession. There is, however, no clear trend in uncertainty. Consumer confidence, being inversely related to uncertainty, resembles this series. Interestingly, the time series of the uncertainty proxies that are related to the financial sector, turn out to be very similar to those related to broad economic uncertainty, although differences in the respective empirical realizations occur at the beginning of the seventies and during the dotcom bubble. The increase in economic policy uncertainty and the corporate bond spread over time is also striking. All tranquil periods correspond to the start of our sample. Note also that uncertainty is at least partly persistent, such that tranquil or uncertain times continue for some quarters.

Figure 2.2 shows pairwise correlations between the reviewed uncertainty measures and proposes a classification scheme. The strongest correlation exists between the financial sector related uncertainty measures: financial uncertainty, realized as well as implied S&P 500 volatility and the spread. In contrast, the smallest correlation is found between economic

trigger larger tax increases and government spending cuts when the VIX was very low but consumer uncertainty high (Leduc and Liu, 2016). See, for instance, Davig and Foerster (2019) for a deeper analysis of the effects of fiscal cliff uncertainty.

[3] We define tranquil times as periods where the respective uncertainty measure is between the 0th and the 20th percentile of its empirical distribution. Uncertain times, accordingly, are periods between the 80th and the 100th percentile of the uncertainty distribution. We justify the choice of thresholds in Section 2.4.1.

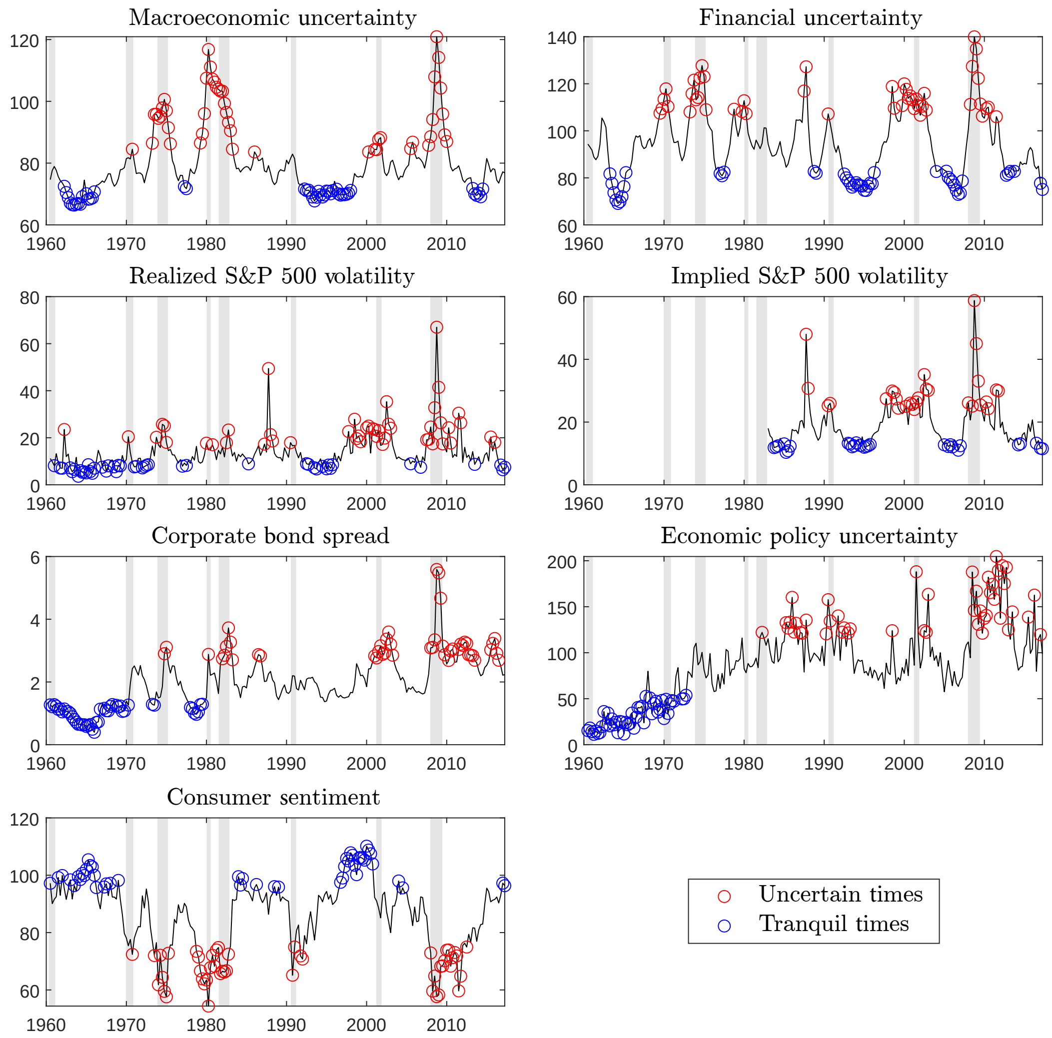

Figure 2.1 Different uncertainty measures over time. Shaded areas indicate US recessions.

policy uncertainty and the macroeconomic as well as financial uncertainty proxies. This is no surprise since the EPU index seeks to capture policy and not general economic uncertainty. A distinction between realized and implied stock market volatility is nearly impossible due to their high correlation of 0.94.[4] Notably, there is a strong correlation between economic policy uncertainty and the corporate bond spread. Therefore, one could conclude that the spread does not only capture financial frictions but also policy related uncertainty. One reason might be the inclusion of government bond yields in the spread.

2.3.2 The Self-Exciting Interacted VAR

Specification We investigate whether the real effects of government spending shocks depend on the level of uncertainty prevalent in the economy. With this in mind, we estimate a structural Self-Exciting Interacted VAR (SEIVAR), proposed by Caggiano et al. (2017)

[4]This is probably a consequence of the use of quarterly data. We take quarterly averages of the respective uncertainty measures for our analysis since we are interested in the effects of fiscal spending and those variables are only available at a quarterly frequency.

Macroeconomic uncertainty	1.00						
Financial uncertainty	0.58	1.00					
Realized S&P 500 volatility	0.50	0.72	1.00				
Implied S&P 500 volatility	0.56	0.84	0.94	1.00			
Corporate bond spread	0.48	0.40	0.61	0.61	1.00		
Economic policy uncertainty	0.30	0.24	0.46	0.35	0.70	1.00	
Consumer sentiment	-0.66	-0.37	-0.31	-0.27	-0.44	-0.43	1.00

Figure 2.2 Uncertainty correlation heatmap

and Pellegrino (2021), with quarterly US-post-WWII data to capture the possible non-linear effect of government spending relating to uncertainty parsimoniously.[5] The SEIVAR augments an otherwise standard VAR with an interaction term of government spending and uncertainty:

$$y_t = \alpha + \gamma \cdot t + \sum_{j=1}^{L} A_j y_{t-j} + \left[\sum_{j=1}^{L} c_j g_{t-j} \cdot unc_{t-j} \right] + u_t, \tag{2.1}$$

$$g_t = e_g' \cdot y_t, \tag{2.2}$$

$$unc_t = e_{unc}' \cdot y_t, \tag{2.3}$$

$$E(u_t u_t') = \Omega, \tag{2.4}$$

where y_t is the $(n \times 1)$ vector of endogenous variables, α is the $(n \times 1)$ vector of constant terms, γ is the $(n \times 1)$ vector of constant slope coefficients for the linear time trend included. A_j denote the $(n \times n)$ matrices for each lag and u_t is the $(n \times 1)$ vector of error terms whose variance-covariance matrix (VCV) is Ω.

The interaction term in brackets turns an otherwise standard VAR into a SEIVAR. The idea is to capture the interactive effects of government spending g_t and uncertainty unc_t on the endogenous variables in the L $(n \times 1)$ vectors c_j. e_g and e_{unc} are selection vectors for the respective endogenous variable in y, government spending growth and uncertainty. In other words, uncertainty and government spending are both treated as endogenous. It is important to note that the non-linearity captured by the interaction terms is possibly affecting all endogenous variables. Hence, they only capture the non-linearity in the effects of government spending induced by the historical level of uncertainty, but this may alter the responses of all variables.

We estimate the model equation by equation with OLS.[6] The lag length L is determined by the Akaike information criterion and we impose the same number of lags for the linear and the non-linear parts of the SEIVAR. Bearing in mind that serial correlation in the error

[5]The code used is based on the IVAR toolbox published with Caggiano et al. (2017) and makes use of the VAR toolbox by Cesa-Bianchi (2015).

[6]This is possible since the model includes only predetermined regressors and, although non-linear in variables, is linear in parameters and does not depend on unobservable variables or nuisance parameters. In

terms would drive our OLS estimates to be inconsistent, we use a small sample test for residual autocorrelation of order one as in Edgerton and Shukur (1999). Finally, we increase the number of lags until the null of no autocorrelation in the errors cannot be rejected at the one percent level.[7]

The SEIVAR exhibits several advantages regarding our research question over alternative non-linear specifications that also feature an observed conditioning variable like ST- and TVARs (Caggiano et al., 2017; Pellegrino, 2021).
First, the SEIVAR directly captures the non-linearity of interest, the interaction of government spending and uncertainty, without the need to estimate more parameterized and computationally intensive models. So we are not obliged to identify thresholds as in TVARs or to calibrate transition functions as in STVARs. The specific functional form in Equations (2.1) to (2.4) has been chosen with an eye on parsimony and to avoid instability problems.
Second, unlike abrupt change models featuring state-specific coefficients like TVARs, the SEIVAR estimates all coefficients exploiting the whole sample period (otherwise spoken, any state is imposed prior to estimation). This leaves us with sufficient degrees of freedom to precisely estimate empirical responses in different states of the world referring to extreme events of the uncertainty distribution. This proves especially relevant in our case since we estimate a relatively large model to avoid the potential omitted variable problem.
Third, in time-varying coefficient VARs as applied recently by Kirchner et al. (2010) and Klein and Linnemann (2019), time-varying impulse responses cannot be directly connected to the source of non-linearity of our interest, i.e. the degree of uncertainty the economy is facing. By contrast, the SEIVAR enables us to investigate whether the (possibly) non-linear macroeconomic response to a fiscal spending shock in the two states of interest is due to the relationship between uncertainty and fiscal policy or rather to different drivers. However, we admit that the estimated parameters can be biased due to other sources of non-linearities that we do not model.

Identification and statistical motivation for non-linearity We follow Blanchard and Perotti (2002) and identify a structural government spending shock from the vector of reduced form residuals imposing short-run restrictions. We order the vector of endogenous variables as follows:

$$y_t = [govgr_t, gdpgr_t, taxgdp_t, rpolicy_t, unc_t, spread_t, consconf_t]',$$

contrast to the most commonly used non-linear state-dependent models that reach non-linearity by combining two or more regime-specific linear VARs, e.g. TVARs and STVARs, the Interacted VAR is non-linear because of its interaction terms. Furthermore, the estimation with OLS is also efficient. Although the errors are correlated across equations, seemingly unrelated regressions would not be more efficient since all regressions have identical right-hand side variables (Enders, 2015, pp. 290-291).

[7] We also considered the Hannan-Quinn and Schwarz information criterion as a model selection device. However, they gave us an optimal lag length of one. This seemed too parsimonious to capture the dynamics in

where, respectively, the variables denote government consumption and investment growth, GDP growth, the tax to GDP ratio, the real policy rate, a proxy of uncertainty, a corporate bond spread and consumer confidence (the variables are described in Section 2.3.4). Hence, we assume that the government, due to decision lags in the fiscal process, cannot react to other shocks within the same quarter. This identification approach is very common in the literature dealing with the effects of government spending shocks on the economy and is for instance used in Auerbach and Gorodnichenko (2012) and Klein and Linnemann (2019). Notice that all variables ordered after government spending are allowed to react during the same quarter in response to a government spending shock but that the government is not allowed to react within the same quarter to other shocks. As a result, fiscal spending is allowed to influence the economic uncertainty level in the same period but not the other way around.[8]

Some readers might ask why we do not use instrumental variables to identify our structural government spending shock. This approach is often employed when the research interest is in the effects of tax shocks on the economy as for example in Mertens and Ravn (2014) who use the data of Romer and Romer (2010) to identify anticipated and surprise tax shocks. On the one hand, it is less plausible that taxes do not respond to other shocks within the same quarter since they are often measured by tax revenues which increase during economic upturns or decrease during downturns. On the other hand, the administration needs time to decide on future spending so that government expenditures do not react contemporaneously to changes in economic activity as proposed by Blanchard and Perotti (2002). In fact, Mertens and Ravn (2014, p. 10) show that the role of automatic stabilizers is negligible in the US such that government spending in the US does not react contemporaneously to economic conditions. We conclude that the use of instruments is not necessary since government consumption and investment expenditures do not include automatic stabilizers.

Recently, the literature highlighted another reason against the use of instrumental variables to identify an exogenous government expenditure shock: instrument relevance - that is whether the proposed instrument is actually correlated with the variable it should explain. Ramey (2016a) recognizes that many of the exogenous measures of fiscal spending shock are not very relevant instruments at all or in some subsamples. For instance, the military news variable introduced in Ramey (2011b) is a weak instrument for the post 1954 period as are the alternative measures of defense news by Fisher and Peters (2010) and Ben Zeev and Pappa (2017). In contrast, the Blanchard and Perotti (2002) shock is a strong instrument by construction, particularly at short horizons, since it represents the one-step ahead forecast error of government spending.

the data in this regard.

[8]As a robustness check against reverse causality with respect to uncertainty, we order uncertainty first and find no evidence for a contemporaneous reaction of government spending in response to an uncertainty shock.

In the following, we provide empirical evidence at the multivariate level in favor of non-linearity for our specification, in particular in favor of the SEIVAR. Given that the model nests a linear VAR, we use a LR-type test for the null hypothesis of linearity versus the alternative of a SEIVAR. For our baseline specification where we use macroeconomic uncertainty, the null hypothesis of linearity is clearly rejected at the one percent level. Referring to the other uncertainty measures, we do not find significant non-linearity at the five percent level.[9] Nevertheless, we show the results for our baseline specification for all other uncertainty indicators in Figures A.3 to A.8 in Section A.4 of the Appendix.

2.3.3 Generalized impulse response functions

We quantify the uncertainty-regime-specific impact of government spending shocks via computing generalized impulse response functions (GIRFs) à la Koop et al. (1996). The reason is that in non-linear systems, a single response does not completely characterize the dynamic effects of a shock. Instead, the impacts depend on the sign, the size and the timing of the shock (Koop et al., 1996). Formally, the generalized impulse response at horizon h of the vector y_t to a shock of size δ computed conditional on an initial history ω_{t-1} of observed histories of y is given by the following difference of conditional means:

$$\text{GIRF}_y(h, \delta, \omega_{t-1}) = E\left[y_{t+h} | \delta, \omega_{t-1}\right] - E\left[y_{t+h} | \omega_{t-1}\right] \qquad (2.5)$$

GIRFs enable us to keep track of the dynamic responses of all endogenous variables of the system conditional on the endogenous evolution of the value of the interaction terms in our framework. This is important for our analysis because an unexpected increase in government spending can alter the uncertainty level and potentially change the state of the economy. In computing GIRFs, we follow Kilian and Vigfusson (2011) and work with orthogonalized residuals to identify government spending shocks. The exact algorithm is described in Section A.2 of the Appendix.

An alternative approach would be to use local projections proposed by Jordà (2005). Similar to GIRFs, this method allows estimated responses to implicitly incorporate the average evolution of the economy between the time the shock hits and the time the shock effects are evaluated. We follow Pellegrino (2021) and do not use them here for three reasons. First, local projections are not as informative as GIRFs since they provide just the average reaction of the economy for each state while GIRFs allow us to obtain fully non-linear empirical responses for each given initial quarter in the sample. Second, they produce responses that are generally erratic and display oscillations at long horizons as

[9] However, this might be the result from our specification. Since we include consumer confidence and the corporate bond spread as explanatory variables, the other measures of uncertainty might not add enough additional information such that the interaction term is not relevant enough anymore. On the other hand, this highlights the use of general macroeconomic uncertainty. The latter thus seems to incorporate significant information in addition to consumer confidence and the spread.

discussed in Ramey (2012). Third, they would suffer significantly from a degrees of freedom problem since our analysis focuses on extreme deciles of the uncertainty distribution.

2.3.4 Data

We use quarterly US data ranging from 1960Q3 to 2017Q2. The sample is restricted mainly by the availability of the uncertainty indicators (see Section 2.3.1). Our specification closely follows Klein and Linnemann (2019) and the set of endogenous variables is $y_t = [\text{govgr}_t, \text{gdpgr}_t, \text{taxgdp}_t, \text{rpolicy}_t, \text{unc}_t, \text{spread}_t, \text{consconf}_t]'$. Herein, govgr_t is the annualized growth rate of real government consumption and investment, gdpgr_t represents the annualized growth rate of real GDP, taxgdp_t is the tax to GDP ratio (measured as federal government receipts minus transfer payments as a fraction of GDP), rpolicy_t is the difference between the Wu and Xia (2016) shadow nominal federal funds rate and inflation measured as the annualized quarterly growth rate of the GDP deflator, unc_t is our respective uncertainty indicator, spread_t represents the spread between Moody's seasoned Baa corporate bond yields and 10-year government bond yields, and consconf_t is the University of Michigan consumer sentiment index. The Appendix provides further data details in Table A.1.[10]

Taxes are included to control for the financial side of the government budget whereas we include the real policy rate to control for monetary policy. Several studies show that the conduct of monetary policy affects the macroeconomic impact of fiscal policy (e.g. Canova and Pappa, 2011; Davig and Leeper, 2011). The shadow rate is used to capture the effects of unconventional monetary policy at the zero lower bound. The spread variable is included to capture the degree of financial frictions prevalent in the economy. Fernández-Villaverde (2010) and Canzoneri et al. (2016) demonstrate in theoretical models that financial frictions should affect the economic reactions in response to government spending increases. The inclusion of the spread is based on the idea that a worsening of financial frictions should be reflected in an increase of the private bond interest rate as compared to a long-term bond rate, since the former as opposed to the latter incorporates the perceived risk of default on the part of private debtors. The inclusion of consumer confidence is based on Bachmann and Sims (2012), who find confidence to be an important channel in which fiscal policy innovations affect aggregate economic activity. As written above, consumer confidence and the spread are also sometimes used as uncertainty proxies and their inclusion might result in a high degree of multicollinearity between the included variables. Nevertheless, we include them because there is no one to one relation between financial frictions, consumer confidence and uncertainty and the interaction between them might be important.

[10]The deterministic trend is included to capture deterministic trends in variables that are not included as growth rates. Note, for example, the increase in corporate bond spreads over time in Figure 2.1.

2.4 Government spending in tranquil versus uncertain times: empirical evidence

In this section, we provide empirical evidence in favor of the hypothesis that the historical level of uncertainty has a significant effect on how the economy reacts to an unexpected increase in government spending. We begin with the baseline results in Section 2.4.1, continue with a deeper analysis of the effects on GDP components in Section 2.4.2 whereas Section 2.4.3 deals with the issue of fiscal anticipation. We analyze potential channels that might drive our results in Section 2.4.4 and Section 2.4.5 considers the sample period before the Great Recession. Section 2.4.6 presents our results when the function of government expenditure is taken into account and depicts the associated fiscal multipliers.

2.4.1 Baseline results

We first estimate our SEIVAR over the full sample and then simulate generalized impulse response functions as described above. The model is estimated with three lags. For better readability, we transform the variables used as growth rates in the estimation to levels. Uncertainty states are defined by macroeconomic uncertainty. Figure 2.3 shows the GIRFs for each historical value of macroeconomic uncertainty to a one percent government spending growth shock. First, this figure reveals some time variation in the response of government spending as well as the other variables that are induced by the interaction term between government spending growth and macroeconomic uncertainty in response to a government spending growth shock. Second, we observe some time variation in the response of taxes to GDP as well as the central bank reaction. Third, and maybe most importantly, we also observe some variation in the output effect that might be due to uncertainty and the related channels. However, these 3D impulse responses cannot be easily interpreted and do illustrate statistical uncertainty. Since we are interested in the effects of government spending during tranquil times as opposed to times of high uncertainty, we average the calculated impulse response functions over tranquil and uncertain times.[11]

Consistent with Bloom et al. (2007), who show that uncertainty has large effects on firms investment decisions only for high degrees of uncertainty, and Pellegrino (2021), we assume the tranquil times state to be characterized by initial quarters with uncertainty around the first decile of its empirical distribution whereas uncertain times represent initial quarters around its ninth decile (a ten percentile tolerance band around the top and bottom deciles is used).[12] Conditioning responses on extreme events, rather than normal times, might be important to not confound similar states and hence miss empirical responses in favor of non-linearity (Caggiano et al., 2015).

[11] Note that the GIRFs for variables in growth rates are transformed to level effects rendering them unstable. However, the responses of the growth rates of GDP and government spending converge to zero.

[12] According to Pellegrino (2021), this definition allows both, each given state to feature a number of GIRFs

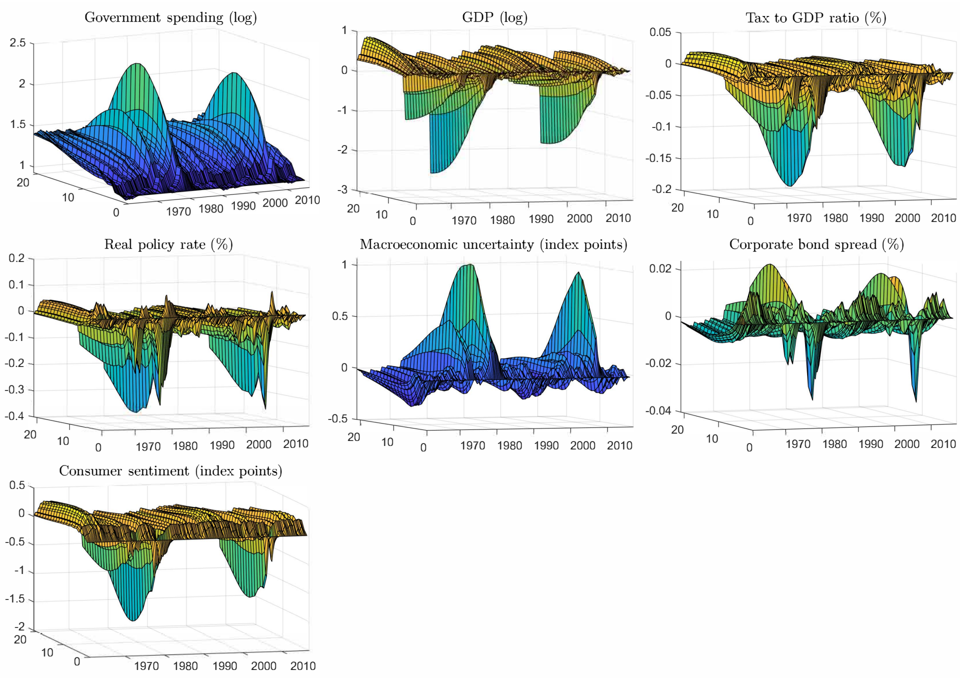

Figure 2.3 GIRFs to an orthogonalized one percent government spending growth shock for each time period in the sample

Figure 2.4 plots the empirical impulse responses to a one percent government spending growth shock along with 68% bootstrap confidence bands.[13] Some results are striking. First of all, a government spending shock in times of heightened uncertainty emerges differently and the type of government funding is state-specific. During uncertain times, increased government spending is accompanied by declines in the tax to GDP ratio while we observe no significant reaction of taxes during tranquil times. Second, we observe an increase in uncertainty and a decline in consumer confidence during periods of heightened uncertainty. This results in a crowding-out of private spending, so large that the reaction of GDP becomes negative in the medium and long run. During tranquil times, however, the increase in government spending significantly reduces uncertainty in the medium run and boosts consumer confidence. This in turn results in a positive output effect. Third, the Fed reacts differently across states. On the one hand, there is almost no significant response of the real interest rate during times of low uncertainty. On the other hand, we observe a significant reduction in the real interest rate in times of heightened uncertainty, possibly to stabilize the economy, and to prevent a disinflation resulting from the slump in aggregate

large enough to obtain representative state-conditional responses and to have results that do not depend on exceptionally extreme observations. We deviate from the authors since we use a ten, instead of a five percentile, tolerance band that includes more extreme events. However, our results are robust to the use of five percentile tolerance bands.

[13]We use the 68% instead of the 95% confidence level since we estimate a relative large SEIVAR over a relative short sample. At the same time, the number of bootstrap draws required to accurately estimate the 2.5th and 97.5th percentiles tends to be much larger than the number of draws required for the 16th and 84th percentiles (Kilian and Lütkepohl, 2017, pp. 334-335). We do not show both confidence bands in each plot for presentation reasons since each plot already displays responses for two states.

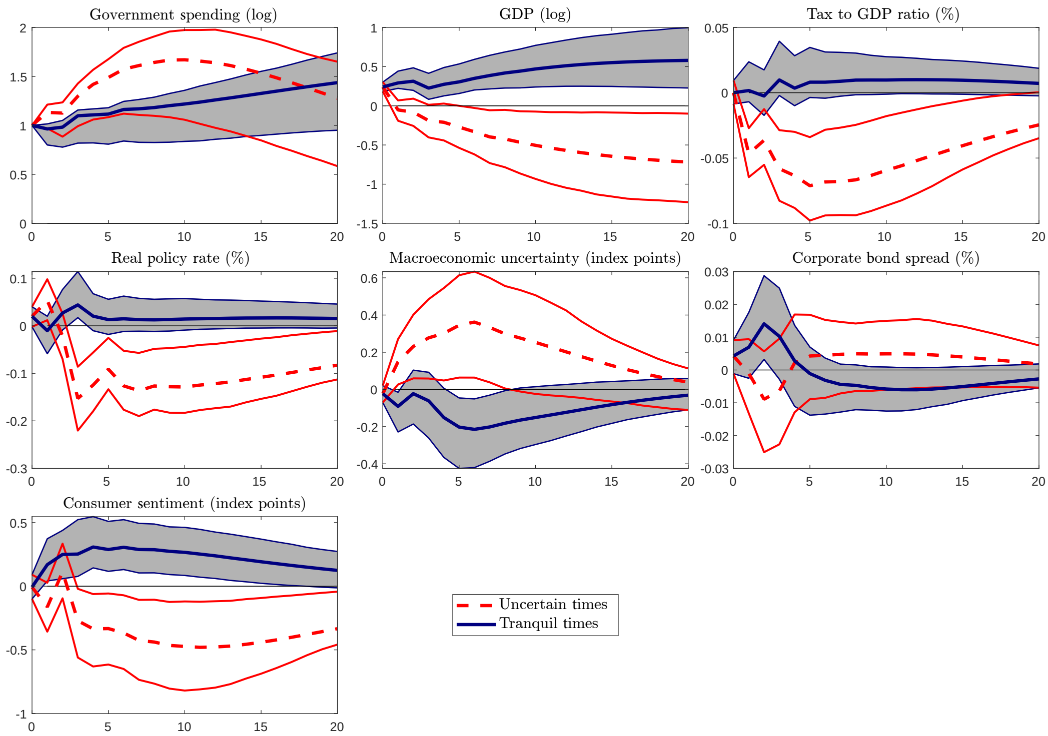

Figure 2.4 GIRFs and 68% confidence intervals to a one percent government spending growth shock. Histories are classified as tranquil times if the history level is located within the 0th and 20th percentile of the uncertainty distribution. Uncertain periods are those located within the 80th and 100th percentile.

demand.

In an earlier version, we estimated a SEIVAR specification where we included change in debt to GDP as a variable and considered inflation as well as the policy rate instead of the real interest rate. However, we decided to change our specification because we have been confronted with issues of over-parameterization due to the large number coefficients to estimate in our system.[14] Figure A.1 in the Appendix shows that the results in the larger specification are very similar to our smaller model. This serves as a robustness check that our reduced model does not neglect important variables. Another potential issue is the question whether our results are driven (only) by the most extreme histories. As positive check of this issue, Figure A.2 in the Appendix shows that the results remain qualitatively the same if we use a five percent tolerance band around the 1^{st} and 9^{th} decile of the uncertainty distribution for the calculation of tranquil and uncertain times that do not include the most extreme events of the uncertainty distribution.

So far, we can conclude that the responses to a government spending growth shock during uncertain times behave very similarly to the responses to an uncertainty shock. This raises the question of whether our results are driven by reverse causality. In other words, do we find an increase in uncertainty because government spending rises or as a result of the fiscal reaction to high uncertainty? We trace this question by arranging our uncertainty proxy as the

[14]With three lags the original model includes 32 parameters to be estimated in each equation whereas the smaller model needs to estimate only 26 parameters.

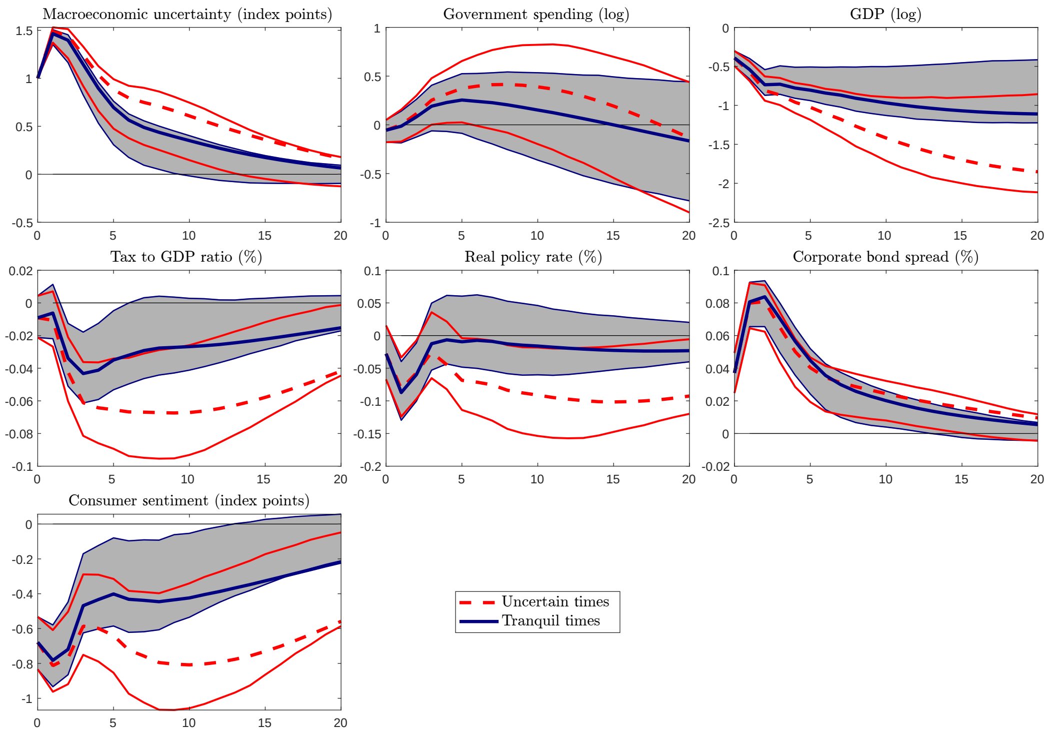

Figure 2.5 GIRFs and 68% confidence intervals to a one index point shock in macroeconomic uncertainty. See note in Figure 2.4.

first variable and analyze the impulse responses to an uncertainty shock. The results shown in Figure 2.5 mitigate our reverse causality concerns. We observe an increase in financial frictions measured by the corporate bond spread, a reduction in consumer confidence as well as a contraction in aggregate demand. Those findings are in line with the theoretical underpinnings of alleged effects of uncertainty shocks. However, the results do not reveal a significant reaction of government spending in response to the uncertainty shock.

2.4.2 The effects on private spending

In the following, we have a deeper look at the responses of GDP components and include private spending in form of personal consumption and private domestic investment to our specification. We include both as growth rates in the estimation and transform the impulse responses to levels as before. The model is estimated with three lags.

The results shown in Figure 2.6 are very similar to our baseline results. During uncertain times, a rise in macroeconomic uncertainty occurs in response to a government spending growth shock. Instead of stabilizing the economy, the government spending shock behaves similarly to an uncertainty shock. In addition to the usual crowding-out effect of fiscal spending, the rise in uncertainty seems to trigger the precautionary savings and real options channels. As a result, we observe strong declines in personal consumption and private investment that we do not find during tranquil times. The financial frictions channel captured by the spread variable, however, plays no significant role.

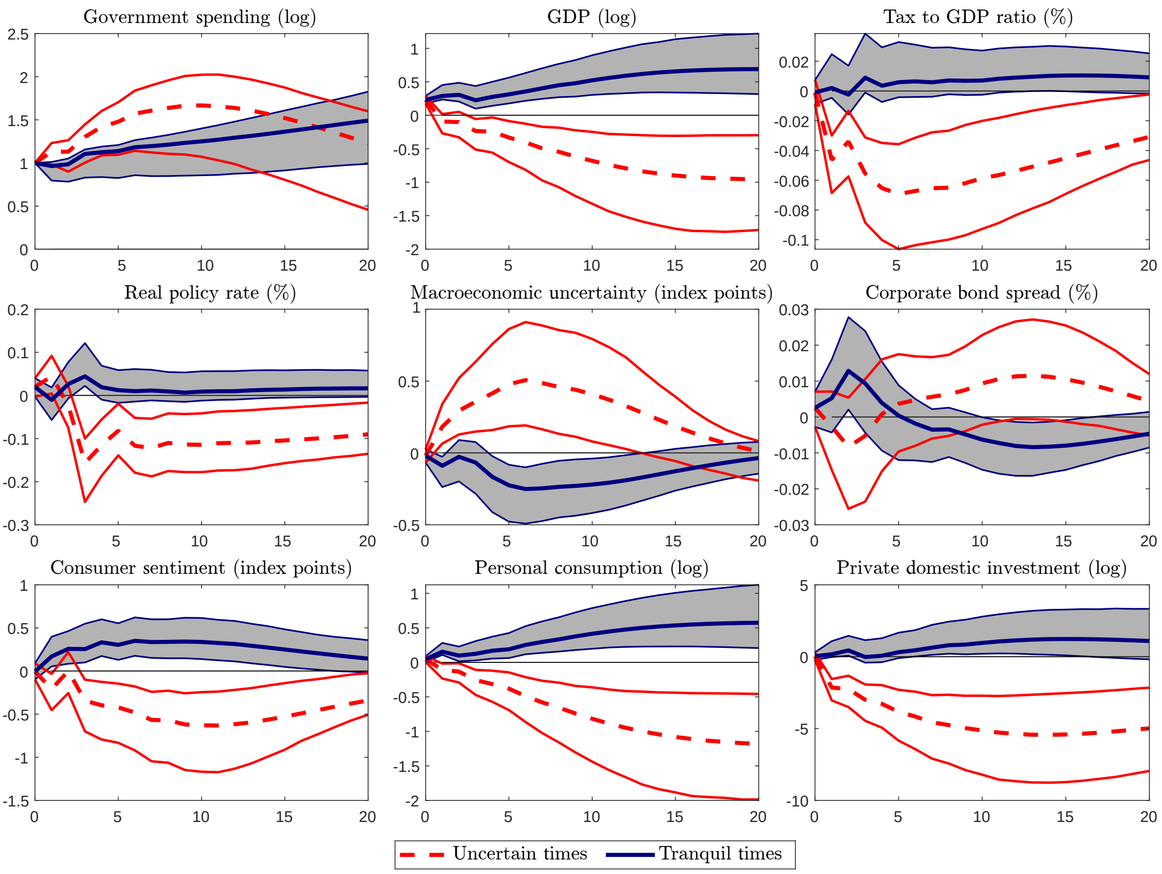

Figure 2.6 GIRFs and 68% confidence intervals with private spending to a one percent government expenditure growth shock. See note in Figure 2.4.

2.4.3 Controlling for fiscal anticipation

Are these findings just the result of non-fundamental shocks? So far, we identified the unexpected structural fiscal shock via recursive orthogonalization of the reduced form residual variance-covariance matrix. Fundamental shocks can be recovered from past and present observed variables. In contrast, shocks are non-fundamental if they are not recoverable from present and past observations. One reason for the presence of non-fundamental shocks is the fact that economic agents use additional information in decision-making that is not fully reflected in the econometric specification of the VAR model (see Kilian and Lütkepohl, 2017, chap. 17). In our case, government spending could be anticipated by the private sector such that the timing of fiscal shocks is incorrectly assessed by our econometric model.

Ramey (2011b) emphasizes that neglecting anticipation effects can render impulse responses biased and proposes to include news/expectations about future fiscal policy to overcome this potential problem. Thus, we compare our baseline results with a specification that explicitly accounts for the issue of fiscal policy anticipation. We follow Auerbach and Gorodnichenko (2012) and add real-time professional forecasts of government spending growth ordered ahead of our fiscal expenditure variable in the vector of endogenous variables. This is a spliced series of government spending forecasts provided by the Greenbook (1966Q4–1981Q2) and the survey of professional forecasters (SPF, 1982Q3–2017Q3). We take the Greenbook data from Auerbach and Gorodnichenko (2012) and augment them with the SPF data. Because the forecast variable limits the usable sample, the following estimation results are restricted to the period 1966Q4–2017Q3.[15]

The unanticipated government spending growth shock is identified as the innovation to realized government spending growth. The change in fiscal expenditure growth that is orthogonal to the respective expectation variable can then be interpreted as an unanticipated shock to government spending in the sense that it was not foreseen by professional forecasters.[16] The model is estimated with three lags.

Figure 2.7 reveals that controlling for government spending forecasts does not change qualitatively the results. We still find a state-dependent effect of a government spending growth shock on the economy. Hence, we decide to drop the forecast data for the rest of our analysis.

[15]The government spending forecasts are not available in levels before 1981. This is one reason, in addition to stationarity concerns, why we include government spending and output in growth rates.

[16]An alternative would be to use the defense news shock variable from Ramey (2011b). We do not follow this approach since the news variable has low predictive power for our sample that does not include WWII or the Korean War.

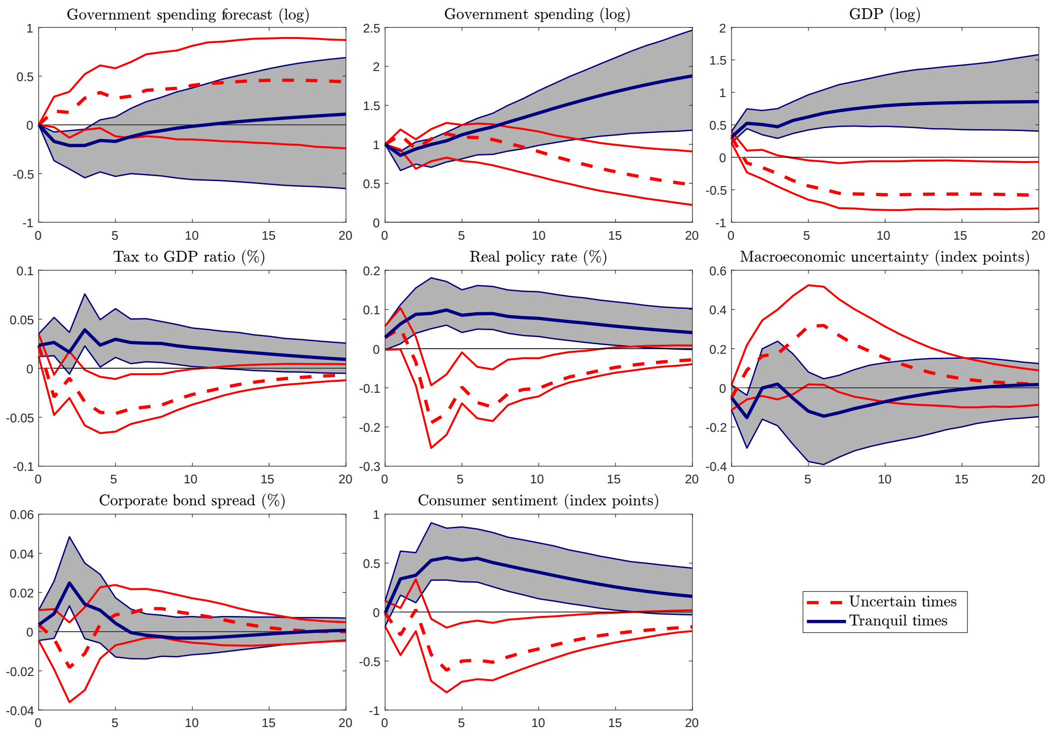

Figure 2.7 GIRFs and 68% confidence intervals with control for fiscal anticipation to a one percent government spending growth shock. See note in Figure 2.4.

2.4.4 The role of consumer confidence, the corporate bond spread and the uncertainty channel

In the following, we vary our specification to get a deeper look at the interaction between macroeconomic uncertainty, financial frictions and consumer sentiment as the latter two are sometimes used as uncertainty indicators. For this reason, we drop consumer sentiment and the corporate bond spread from our specification. The corresponding GIRFs are plotted in Figure 2.8. The left column shows the results if we drop consumer sentiment from our baseline specification while the central column shows the results omitting the spread variable from our specification. Both specifications are estimated with 3 lags according to the AIC. The right column shows the GIRFs omitting both variables. We estimate the latter including four lags.

The results show substantial differences in the response of GDP, consumer sentiment and macroeconomic uncertainty compared to the results of the baseline specification in Figure 2.4 if the control for corporate bond spreads is neglected. Omitting the latter would lead to different conclusions about the response of macroeconomic uncertainty in response to an increase in public spending. In this case, macroeconomic uncertainty turns out to be decreasing in response to a government spending shock during times of heightened uncertainty. This is in stark contrast to our baseline specification and the left column of this figure where fiscal easing leads to a surge in uncertainty. In turn, the output effect becomes positive and larger, although not significantly, than during tranquil times.

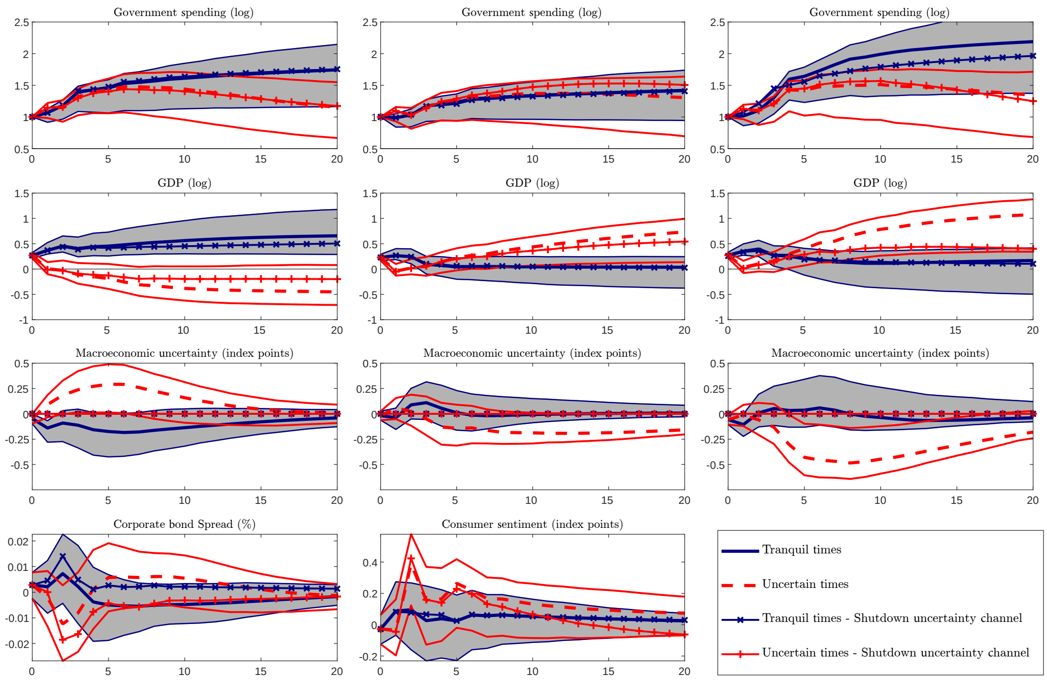

Figure 2.8 GIRFs and 68% confidence intervals to a one percent government spending growth shock not including consumer sentiment (left column), the corporate bond spread (central column) and both of them (right column). Besides the variables shown, all three specification also include the tax to GDP ratio as well as the real policy rate. GIRFs for these variables are not shown for readability reasons and due to the fact that they are very similar across specifications. See also the note in Figure 2.4.

Nevertheless, a result that all our estimated specifications have in common, is a muted short-term output response during times of heightened uncertainty. This finding is in line with the precautionary savings and real options channels. As is shown in the central column of Figure 2.8, neglecting the corporate bond spread also alters the response of consumer sentiment. In this case, fiscal easing reinforces consumer confidence during times of heightened uncertainty. Those results are more in line with Bachmann and Sims (2012) who find that government spending might increase consumer sentiment during recessions.

These additional empirical results lead to the following conclusions. First, it is important to include a large set of variables in the specification despite the loss in efficiency. The exclusion of potentially important variables, in our case the corporate bond spread, triggers the OLS estimation to suffer from omitted variable bias and is able to change the sign of the output response. In this regard, also the response of consumer sentiment turns out to be only marginally significant over a short period and ceases to be state-dependent. This underscores the advantage of the SEIVAR in contrast to less parsimonious approaches like TVARs. Since the former estimates all coefficients exploiting the available sample periods while the latter splits the sample into numerous states according to a threshold variable and estimates the parameters separately for each state, the former is able to include a larger set of (possibly) important variables (compare Section 2.3.2).
Second, the results make us feel legitimized to argue that we do not observe negative output responses in times of heightened uncertainty just because the economy is already in a slump.

Note that we use the same histories for the definition of tranquil and uncertain times as in our additional estimations. While we do observe a medium- to long-term negative output response there, this is not the case in the more parsimonious specification. We conclude that the negative output effect is not just the result of being in uncertain times. In contrast, it is the result of uncertainty which has increased in response to fiscal policy. This is in line with typical crowding-out effects and common uncertainty transmission channels as reviewed above. This is also consistent with the literature stating that macroeconomic policy itself might induce uncertainty in the economy (Baker et al., 2016; Bi et al., 2013; Fernández-Villaverde et al., 2015).

In Figure 2.8, the lines with markers show the results when we explicitly shut down the endogenous uncertainty effects. We do this by fixing the uncertainty variable to the initial value prior to the fiscal shock. The results show that the difference across states becomes smaller and in the right column the difference in the output response across states becomes very tiny. This highlights the endogenous response of uncertainty as a key mechanism that is most important if the corporate bond spread and consumer confidence are not included in the analysis.

2.4.5 Restricting the sample to the pre-Great Recession period

Are our results driven by specific periods as the recent Great Recession? It appears reasonable to think about a structural break in the relation between fiscal shocks and their output effect during this time. Indeed, using a non-parametric time-varying coefficients VAR, Klein and Linnemann (2019) find the Great Recession to be characterized by uniquely large impulse responses of output to fiscal shocks. In order to scrutinize whether our results are driven by this specific period, we estimate the model in Equations (2.1) to (2.4) again but consider only the period from 1960Q3 to 2007Q3. The model is estimated using three lags. We display the resulting impulse responses in Figure 2.9.

Figure 2.9 shows a different picture than Figure 2.4. Fiscal easing still increases output and consumer confidence during tranquil times. However, the significant negative effect on GDP disappears for which we suggest two explanations. First, we lose roughly forty quarters of observations such that it becomes harder to find statistically significant effects. Second, as Figure 2.1 reveals, the Great Recession has been a very uncertain period that is now dropped from our sample. Hence, the difference between tranquil and uncertain times diminishes and so does the state-specific effect. Nevertheless, there are also robust findings even for this shorter sample period. The GDP response is significantly lower in the short-run during uncertain times. In addition, we find a significant reduction in consumer confidence as well as an increase in the corporate bond spread over some horizons.

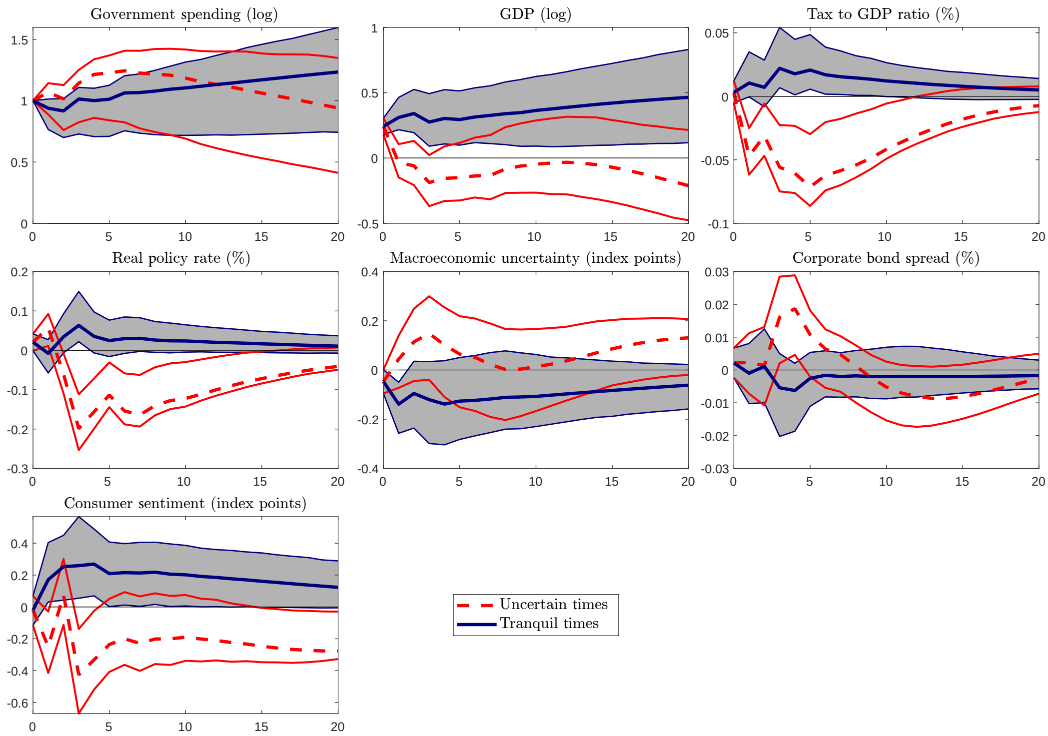

Figure 2.9 GIRFs and 68% confidence intervals to a one percent government spending growth shock when the sample ends before the Great Recession. See note in Figure 2.4.

2.4.6 Government spending categories and cumulative multipliers

In this section, we investigate whether our results hold for different purposes/functions of public spending. For this purpose, we follow Auerbach and Gorodnichenko (2012) as well as Arčabić and Cover (2016) and investigate the effects of various components of our government spending variable separately. We consider shocks in the growth rate of consumption, gross investment, research & development (R&D) and national defense expenditures. We depict the the corresponding GIRFs in Figure 2.10.

It turns out that government consumption does not significantly increase output but leads to lower (higher) corporate bond spreads during tranquil (uncertain) times. In contrast, the results reveal state-specific responses if government investment is considered. During uncertain times, the debt-financed shock raises uncertainty, tightens financial frictions and weakens consumer confidence. This results in a negative output effect. In tranquil times, the results are of the opposite direction. This pattern is actually puzzling, since we would have expected positive effects of government investment shocks because investments in infrastructure tend to result in higher future productivity and lead to larger incentives for increases in private spending.

In contrast to the results received so far, the impulse responses for R&D spending underscore the effectiveness for fiscal stabilization politics. In that case, we observe significant positive GDP responses on the short and medium term horizon despite an increase in the tax to GDP ratio. R&D increases result in lower short-run uncertainty, reduce risk premia and

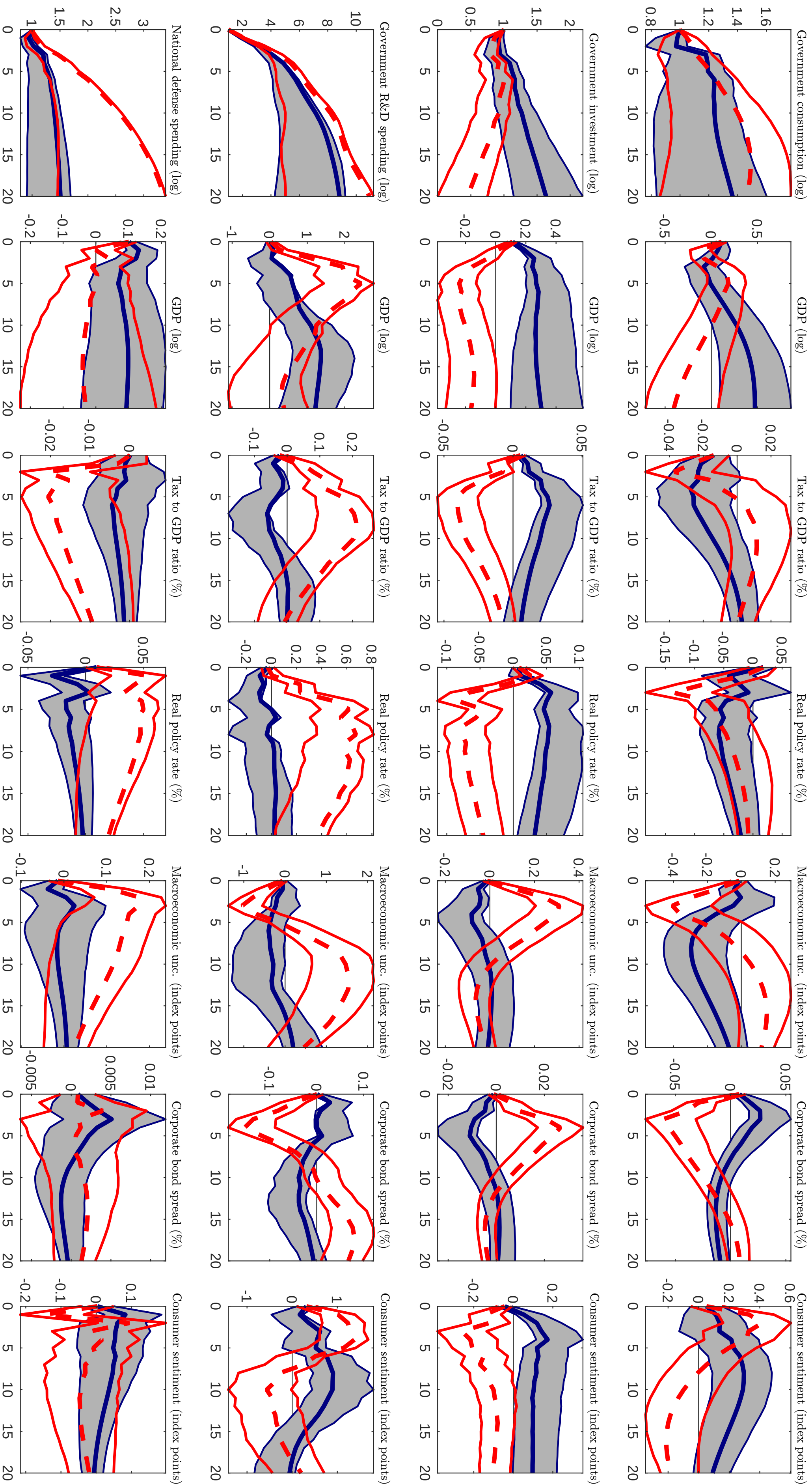

Figure 2.10 GIRFs and 68% confidence intervals to a one percent spending growth shock for different government spending categories. The red lines depict GIRFS and confidence intervals during uncertain times and the blue lines during tranquil times. See also the note in Figure 2.4.

enhance consumer confidence in the short run. We propose two possible reasons for this. First, if firms cut their research expenditures in times of high uncertainty, for example due to tighter financial frictions, fiscal research expenditures might be a replacement for private explorations, although the composition of both might diverge in reality. The second is related to the growth option channel of uncertainty (Bar-Ilan and Strange, 1996). If uncertainty is large and mean-reverting, the expected profit or technology increase induced by research effort can be larger. However, this effect is mitigated in the long run. Explanations for this are the sustained rise in taxes as well as the counteracting monetary policy. Both of them could also serve as explanations for the increase in uncertainty at longer horizons.[17]

Increases in national defense spending only slightly affect the economy. Output does not react significantly during uncertain times and occurs to be marginally positive in the short run during tranquil times. In general, the confidence intervals turn out to be very large. From our point of view, the results emphasize the need to analyze effects for different types of government spending.

Figure 2.11 depicts the cumulative fiscal multipliers by type of government spending. We calculate them following Ramey and Zubairy (2018) as $\frac{\sum_{i=1}^{h}\widehat{gdp}_h}{\sum_{i=1}^{h}\widehat{gov}_h}$ where $\widehat{gov}_h$ is the log-level response of the respective government variable at horizon h and $\widehat{gdp}_h$ represents the log-level GDP response at horizon h. This type of multiplier measures the cumulative output response relative to the accumulated government spending over a given time horizon. Therefore, it incorporates the persistence of fiscal spending. Those cumulative multipliers are more informative for policymakers than the original fiscal multiplier proposed by Blanchard and Perotti (2002), that just focuses on the ratio between the peak of the output response and the impact response of government spending, because they account for the costs and benefits of the implementation of fiscal policy interventions.[18][19]

An inspection of Figure 2.11 reveals that the cumulative fiscal multiplier varies by government spending purpose. We find evidence for state-dependent multipliers in case of general government spending as well as public investment and R&D programs. In contrast, we find no significant differences for defense and consumption expenditures. Overall, it can be stated that different types of government spending have positive multipliers during tranquil times but turn out to be insignificant or negative during uncertain times. This challenges fiscal policy as a stabilization tool during times of heightened uncertainty. Instead

[17] Although the level responses of government R&D expenditures might look unstable, the growth rates converge close to zero after some quarters. The large increase in GDP during times of heightened uncertainty is also not due to the pure amount of government spending since R&D expenditures only account for a small part of government spending.

[18] This multiplier was originally proposed by Mountford and Uhlig (2009) and Uhlig (2010) who calculate a present value multiplier, using the long-run average interest rate to discount. Ramey and Zubairy (2018) use the simple cumulative multiplier because of its close relationship to the areas under the impulse responses. We follow the latter.

[19] Note that these are no dollar-to-dollar multipliers. Since government purchases and output effects are transformed to log-levels, the multipliers must be scaled by the sample ratio of output to government spending to derive dollar-to-dollar multipliers.

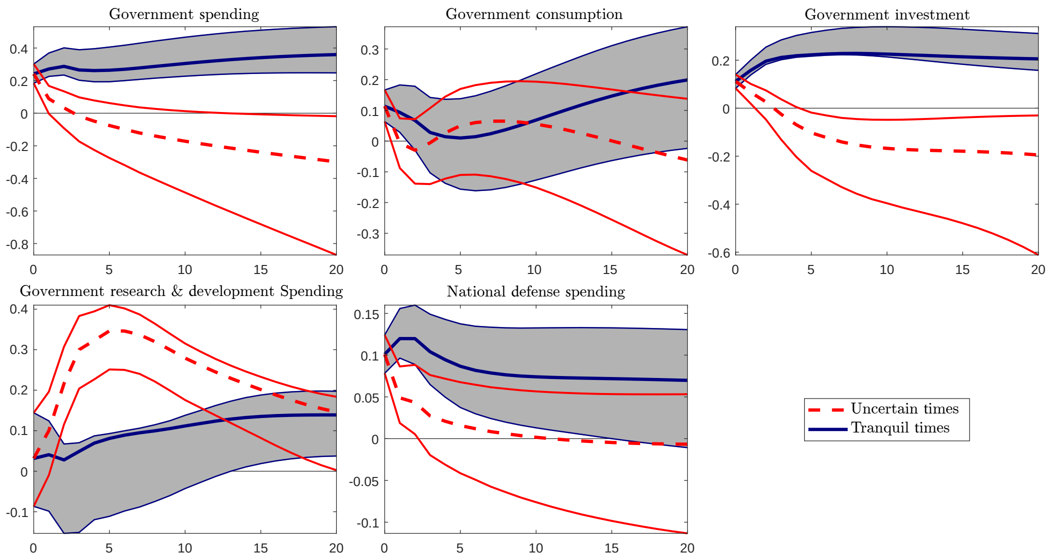

Figure 2.11 Cumulative fiscal multipliers and 68% confidence intervals for different government spending categories. See note in Figure 2.4.

of stabilizing the economy, the government seems to confirm private agents in their view that the economy is in a slump and raises uncertainty even more. However, we find public R&D programs to lower uncertainty and to reinforce confidence in the short term leading to a significantly larger multiplier. This is the case, although we observe an increase in the tax to GDP ratio.

2.5 Conclusions

We use a non-linear framework to study macroeconomic effects of fiscal spending shocks in the US during tranquil and uncertain times to take into account that uncertainty may react to fiscal spending. We find evidence that the output effects of fiscal spending vary with the level of macroeconomic uncertainty. An unexpected increase in government spending raises output significantly during tranquil times but turns out to be contractionary during times of heightened uncertainty.

The empirical finding of negative output responses to positive government spending shocks are by far not uncommon in the literature. Among others, it also arises in settings of other types of non-linearities than considered in our paper (e.g. Corsetti et al., 2013). Instead of reducing uncertainty, the public spending resembles the transmission of an uncertainty shock. Soared uncertainty, working through precautionary saving and real options channels, turns a fiscal policy oriented at stabilization purposes into a contractionary one.

We come up with slight evidence in favor of a contractionary fiscal expansion[20] when

[20]This term hints at the literature on an expansionary fiscal contraction that has been popularized by Giavazzi and Pagano (1990) and has been analyzed systematically by Barry and Devereux (2003) and Alesina and Ardagna (2013). Nevertheless, we can not derive any evidence of an expansionary fiscal contraction in a stricter sense from our results since we analyzed expansionary fiscal policy in a non-linear model where impulse responses are not symmetric in positive and negative shocks.

we control for fiscal anticipation and different models of financing government expenditure, monetary policy, financial frictions, consumer confidence and the government spending purpose. The point estimates of cumulative multipliers of government spending and public investment become negative in the long run. However, we would like to stress that these multipliers are only slightly significantly negative at the 68% level. According to our results, only public R&D spending can help to stabilize the economy.

The results change if we only consider periods before the Great Recession. In this case, the significant contractionary effects of fiscal spending disappear, mainly due to two reasons. First, the loss of roughly one fifth of our observations makes it more difficult to find statistical significantly differences. Second, the Great Recession initiated a very uncertain time period that is not considered anymore. Hence, the difference between tranquil and uncertain times diminishes as does the state-specific effectiveness of fiscal policy. Nevertheless, the result that government spending has smaller short-run effects remains valid.

Our result that a government shock can act like an uncertainty shock in some circumstances is an innovative empirical finding in the realm of fiscal policy though backed by early analogous findings in the area of monetary policy. The most famous example in this regard is Milton Friedman's helicopter money allegory: "(T)he mere appearance of the helicopter might increase the degree of uncertainty anticipated by members of the community which in turn might change the demand for real cash balances" (Friedman, 1969). Friedman argues that this effect is especially relevant if information is scarce or noisy in times of high uncertainty. During these periods agents are concerned that the economy switches into a significant downturn which tends to reduce their future levels of income (Alloza, 2019). Analogously, a government spending shock during periods of enhanced uncertainty may thus simply confirm this pessimistic perspective. This, in turn, causes a decline in consumption and activity, especially if the private sector has ambiguity averse preferences (Alloza, 2019; Ilut and Schneider, 2014). Correspondingly, it has become a stylized fact that uncertainty can be caused and enhanced by endogenous drivers, as for instance by macroeconomic policy itself (Baker et al., 2016; Bi et al., 2013; Fernández-Villaverde et al., 2015).

Since we have also found prima facie evidence of an interaction between uncertainty, financial risk premiums and consumer sentiment in the transmission of government spending shocks, we are looking forward to new theoretical models that can explain our results in a more formal way. We leave this task to further research.

A Appendix to Chapter 2

A.1 Data sources

Table A.1 Data description

	Variable	Source/Construction	Quandl ID
(1)	Real GDP	FRED	FRED/GDPC1
(2)	Real government spending (consumption expenditures and gross investment)	FRED	FRED/GCEC1
(3)	Federal government current receipts	FRED	FRED/FGRECPT
(4)	Federal government current transfers	FRED	FRED/W011RC1Q027SBEA
(5)	Nominal GDP	FRED	FRED/GDP
(6)	Government taxes to GDP	((3)-(4))/(5)	
(7)	Federal government credit market instruments	FRED	FRED/FGSDODNS
(8)	State/local governments credit market instruments	FRED	FRED/SLGSDODNS
(9)	Government debt to GDP	((7)+(8))/(5)	
(10)	Implicit price deflator for GDP (2012=100)	FRED	FRED/GDPDEF
(11)	Effective federal funds rate	FRED	FRED/FEDFUNDS
(12)	Shadow federal funds rate[1]	Wu and Xia (2016)	SHADOWS/US
(13)	Corporate spread: Moody's Seasoned Baa corporate bond yield relative to yield on 10-year treasury constant maturity	FRED	FRED/BAA10YM
(14)	Inflation	$400(log(GDPDEF_t) - log(GDPDEF_{t-1}))$	
(15)	Consumer confidence	Michigan Survey of Consumers	UMICH/SOC1
(16)	CBOE volatility index: VIX, index, daily, not seasonally adjusted	FRED	FRED/VIXCLS
(17)	S&P 500 (ĜSPC) historical prices	Yahoo Finance	
(18)	SP500Vol (quarterly average)	annualized monthly standard deviation of daily returns of (17)	
(19)	S&P 500 implied volatility (VIX) extended to 1983 (quarterly average)	Berger et al (2019)	
(20)	Ivol (quarterly average)	composite series of (16) and (19)	
(21)	Economic policy uncertainty[2] (quarterly average)	policyuncertainty.com	
(22)	Financial uncertainty (h=3, then quarterly av., multiplied by 100)	Sydney Ludvigson's homepage	
(23)	Macroeconomic uncertainty (h=3, then quarterly av., multiplied by 100)	Sydney Ludvigson's homepage	
(24)	Real personal consumption expenditures	FRED	FRED/PCECC96
(25)	Real gross private domestic investment	FRED	FRED/GPDIC1
(26)	Greenbock forecast for real government spending growth (1966:4-1981:2)	Auerbach & Gorodnichenko (2012)	
(27)	Survey of Professional Forecasters data for real government spending growth (1982:3-2017:3)	Federal Reserve Bank of Philadelphia	
(28)	Government consumption expenditures[4]	FRED	FRED/A955RC1Q027SBEA

	Variable	Source/Construction	Quandl ID
(29)	Price index for government consumption expenditures (2012=100)	FRED	FRED/A955RG3Q086SBEA
(30)	Real government consumption expenditures	(28)/(29/100)	
(31)	Government gross investment[4]	FRED	FRED/A782RC1Q027SBEA
(32)	Price index for government gross investment	FRED	FRED/A782RG3Q086SBEA
(33)	Real government gross investment	(31)/(32/100)	
(34)	Government gross investment: research and development	FRED	FRED/Y057RC1Q027SBEA
(35)	Price index for government gross investment: research and development (2012=100)	FRED	FRED/Y057RG3Q086SBEA
(36)	Real government research and development expenditures	(34)/(35/100)	
(37)	National defense consumption expenditures and gross investment	FRED	FRED/FDEFX
(38)	Price index for national defense expenditures (2012=100)	FRED	FRED/B824RG3Q086SBEA
(39)	Real national defense expenditures	(37)/(38/100)	

[1] For our variable policy rate, we splice the shadow rate for the period before and during the zero lower bound with the federal funds rate for the period after the zero lower bound. The quarterly data is obtained by taking averages.
[2] Since the new economic policy uncertainty index is only available from 1985-2018 and the historical uncertainty index is available from 1900-2014, we combine them by normalizing the historical index to have the same mean and standard deviation as the new economic policy uncertainty index during the overlapping period.
[3] Government consumption expenditures are services (such as education and national defense) produced by government that are valued at their cost of production. Excludes government sales to other sectors and government own-account investment (construction, software, and research and development).
[4] Gross government investment consists of general government and government enterprise expenditures for fixed assets; inventory investment is included in government consumption expenditures.

A.2 Computation of generalized impulse response functions

This section documents the algorithm employed to compute the GIRFs and their confidence intervals. The algorithm follows Koop et al. (1996) with the modification of considering an orthogonal structural shock as in Kilian and Vigfusson (2011).

Following Koop et al. (1996), the theoretical GIRF of the vector of endogenous variables y_t, h periods ahead, for a starting condition $\omega_{t-1} = \{y_{t-1}, \ldots, y_{t-L}\}$ and a structural shock of size δ_t in period t can be expressed following as:

$$\text{GIRF}_{y,t}(h, \delta, \omega_{t-1}) = E\left[y_{t+h}|\delta, \omega_{t-1}\right] - E\left[y_{t+h}|\omega_{t-1}\right], \text{h = 0,1,...,H} \tag{A.1}$$

where $E[\cdot]$ represents the expectation operator. The algorithm to estimate the state-conditional GIRF is the following:

1. Pick an initial condition $\omega_{t-1} = \{y_{t-1}, \ldots, y_{t-L}\}$, i.e. the historical values for the lagged endogenous variables at a particular date $t = L+1, \ldots, T$. This set includes the values for the interaction terms since both interaction variables are modeled as endogenous.

2. Draw randomly with repetition a sequence of n-dimensional residuals $\{u_{t+h}\}^s$, h = 0,1,...,H $= 20$, from the empirical distribution $d\left(0, \hat{\Sigma}\right)$ where $\hat{\Sigma}$ is the estimated residual variance-covariance matrix. In order to preserve the contemporaneous structural relationships among variables, residuals are assumed to be jointly distributed, so that we draw all n residuals together for period t.

3. Conditional on ω_{t-1}, on the estimated model Equations (2.1) to (2.4) and using $\{u_{t+h}\}^s$ simulate the evolution of the vector of endogenous variables over the following H periods to obtain the path y^s_{t+h} for $h = 0, 1, \ldots, H$. s denotes the dependence of the path on the particular sequence of residuals used.

4. Conditional on ω_{t-1}, on the estimated model Equations (2.1) to (2.4) and using $\{u_{t+h}\}^s$ simulate the evolution of the vector of endogenous variables over the following H periods when a structural shock δ_t is imposed to u^s_t. In particular, we Cholesky-decompose $\hat{\Sigma} = CC'$, where C is a lower-triangular matrix. The structural innovations are then recovered as $\varepsilon^s_t = C^{-1}u^s_t$. We add a quantity $\delta > 0$ to the scalar element of ε^s_t that refers to government spending, i.e. $\varepsilon^s_{t,\text{gov}}$. We then move again to the residual associated with the structural shock $u^{s,\delta}_t = C\varepsilon^{s,\delta}_t$ to proceed with simulations as in point 3. Call the resulting path $y^{s,\delta}_{t+h}$.

5. Compute the difference between the previous two paths for each horizon and for each variable, i.e. $y^{s,\delta}_{t+h} - y^s_{t+h}$ for $h = 0, 1, \ldots, H$.

6. Repeat steps 2-5 for $S = 500$ different draws from the empirical residuals and then take the average across s. During this computation, the starting quarter $t-1$ does not change. In this way, we obtain a consistent point estimate of the GIRF for each given starting quarter in our sample, i.e. $\widehat{\text{GIRF}}_{y,t}(h, \delta, \omega_{t-1}) = \{E[y_{t+h}|\delta, \omega_{t-1}] - E[y_{t+h}|\omega_{t-1}]\}_{h=0}^{20}$. If a given initial condition ω_{t-1} brings an explosive response (namely if this is explosive for most of the sequences of residuals drawn $\{u_t\}^s$, in the sense that the response of the variable shocked diverges instead than reverting to zero), it is discarded and not considered for the computation of state-conditional responses at the next step. Note that this stability condition is imposed on the GIRF in the original form of variables that is used in estimation and not in the transformed form that is plotted where GIRFs for variables modeled as growth rates or changes are transformed to level responses.

7. These history-dependent GIRFs are then averaged over a particular subset of initial conditions of interest to produce the state-dependent GIRFs. For this, an initial condition ω_{t-1} is classified to belong to the "tranquil times" state if unc_{t-1} is within a ten percentile tolerance band from the bottom decile of the empirical uncertainty distribution and to the "uncertain times" state if unc_{t-1} is within the same band around the top decile of the uncertainty distribution. In this way, we obtain the $\widehat{\text{GIRF}}_{y,t}(\delta_t, \text{tranquil times})$ and $\widehat{\text{GIRF}}_{y,t}(\delta_t, \text{uncertain times})$.

8. Confidence bands around the point estimates obtained in point 7 are computed through bootstrap. In particular, we simulate $R = 1999$ datasets statistically equivalent to the actual sample and for each of them the interaction terms are constructed coherently with the simulated series. Then, for each dataset, (a) we estimate the SEIVAR and (b) implement steps 1-7. In implementing this procedure this time, the starting conditions and variance-covariance matrix used in the computation depend on the particular dataset r used, i.e. ω_{t-1}^r and $\hat{\Sigma}^r$. The 16^{th} and 84^{th} percentiles of the resulting distribution of state-conditional GIRFs are taken to construct the confidence bands.

A.3 Generalized impulse response functions estimating a larger specification and using smaller tolerance bands for the definition of tranquil and uncertain times

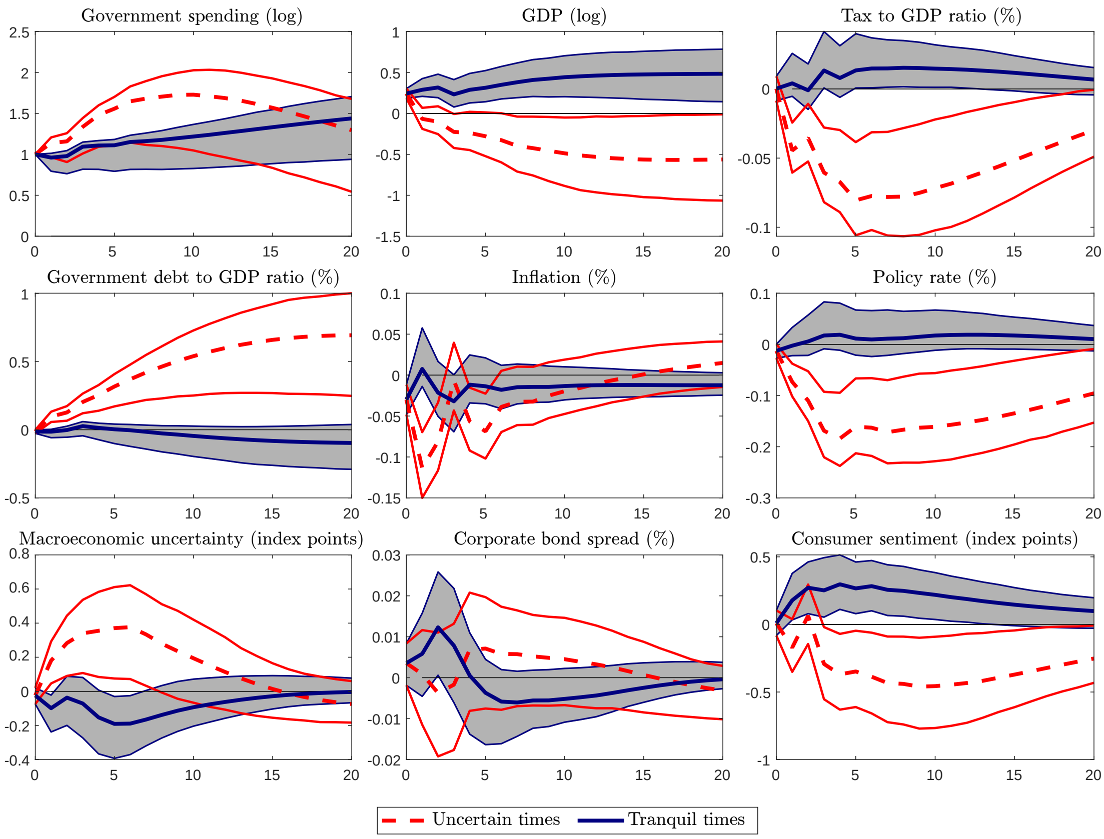

Figure A.1 GIRFs and 68% confidence intervals to a one percent government spending growth shock for our original specification. See note in Figure 2.4.

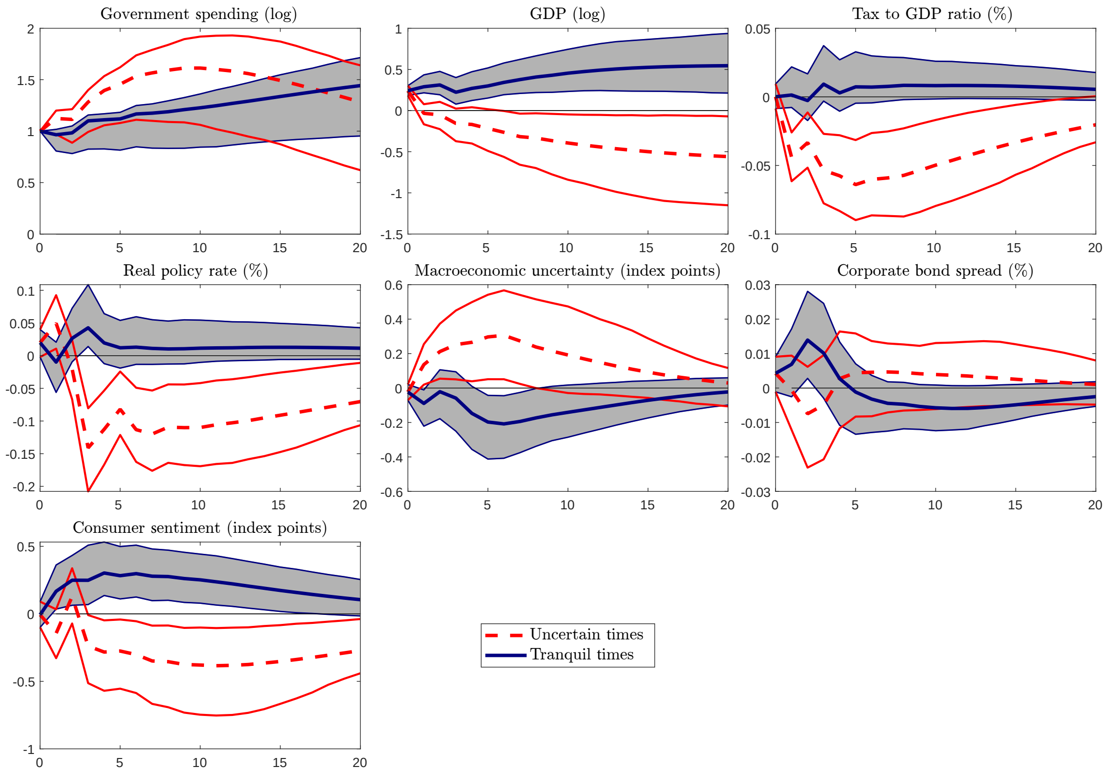

Figure A.2 GIRFs and 68% confidence intervals to a one percent government spending growth shock using smaller tolerance bands for the definition of tranquil and uncertain times. Histories are classified as tranquil times if uncertainty corresponds to periods within the 5^{th} and 15^{th} percentile of the uncertainty distribution. Uncertain times are those periods located within the 85^{th} and 95^{th} percentile.

A.4 Generalized impulse response functions for the baseline specification using different uncertainty measures

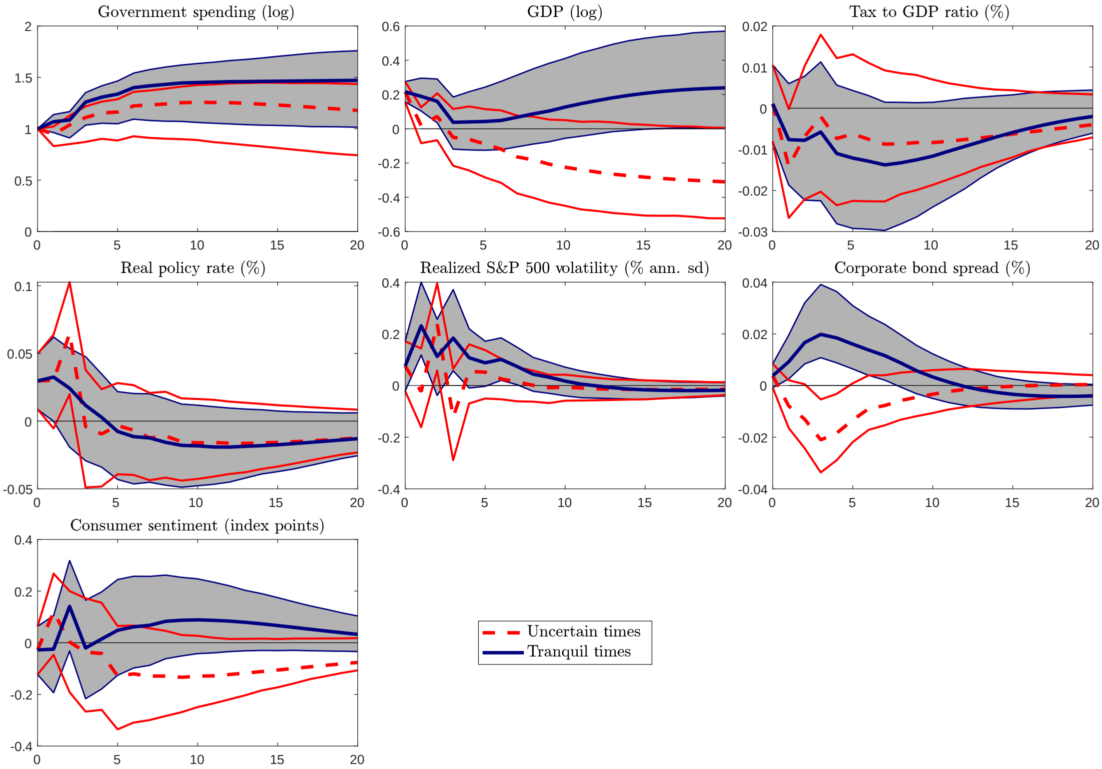

Figure A.3 GIRFs and 68% confidence intervals to a one percent government spending growth shock using the annualized monthly standard deviation of daily S&P 500 returns as uncertainty proxy. See note in Figure 2.4.

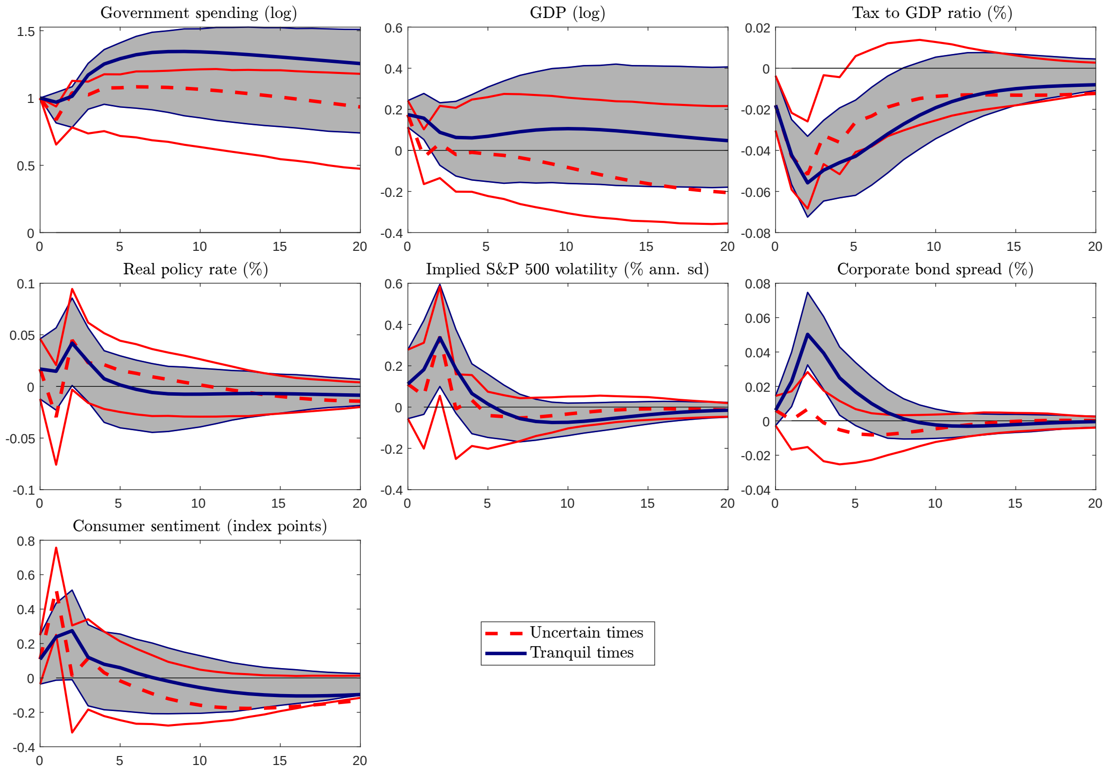

Figure A.4 GIRFs and 68% confidence intervals to a one percent government spending growth shock using implied volatility of daily stock market returns as uncertainty indicator. See note in Figure 2.4.

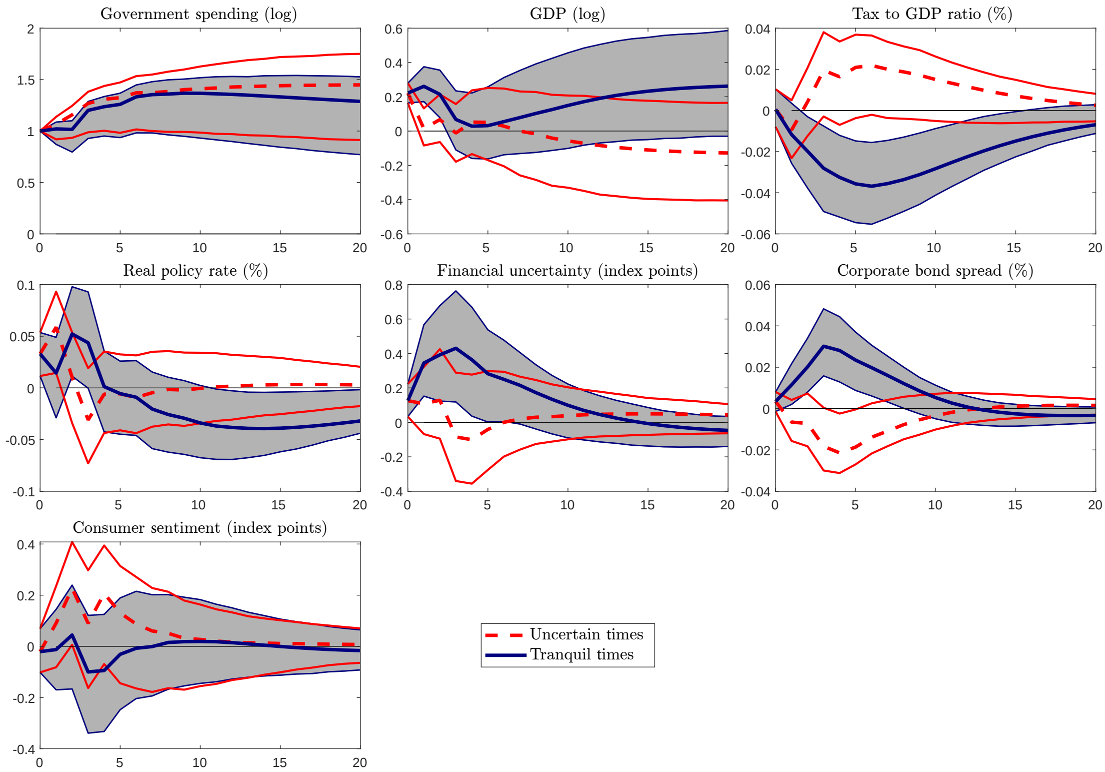

Figure A.5 GIRFs and 68% confidence intervals to a one percent government spending growth shock using financial uncertainty as uncertainty measure. See note in Figure 2.4.

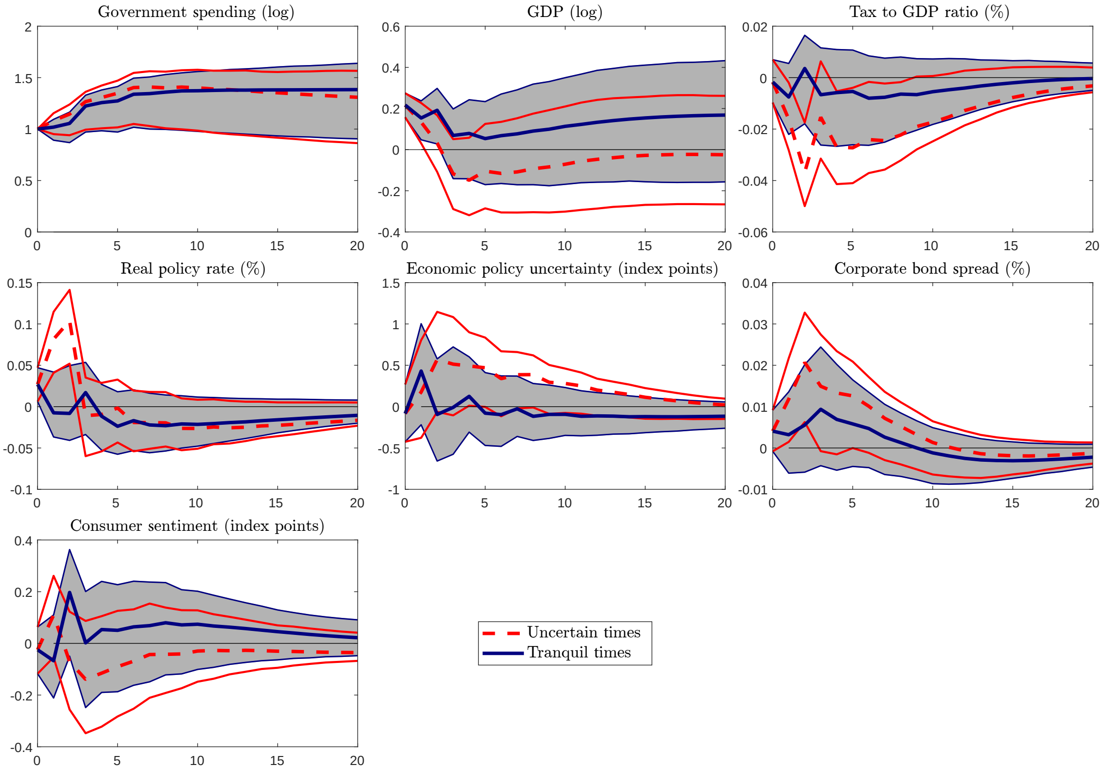

Figure A.6 GIRFs and 68% confidence intervals to a one percent government spending growth shock using economic policy uncertainty as uncertainty indicator. See note in Figure 2.4.

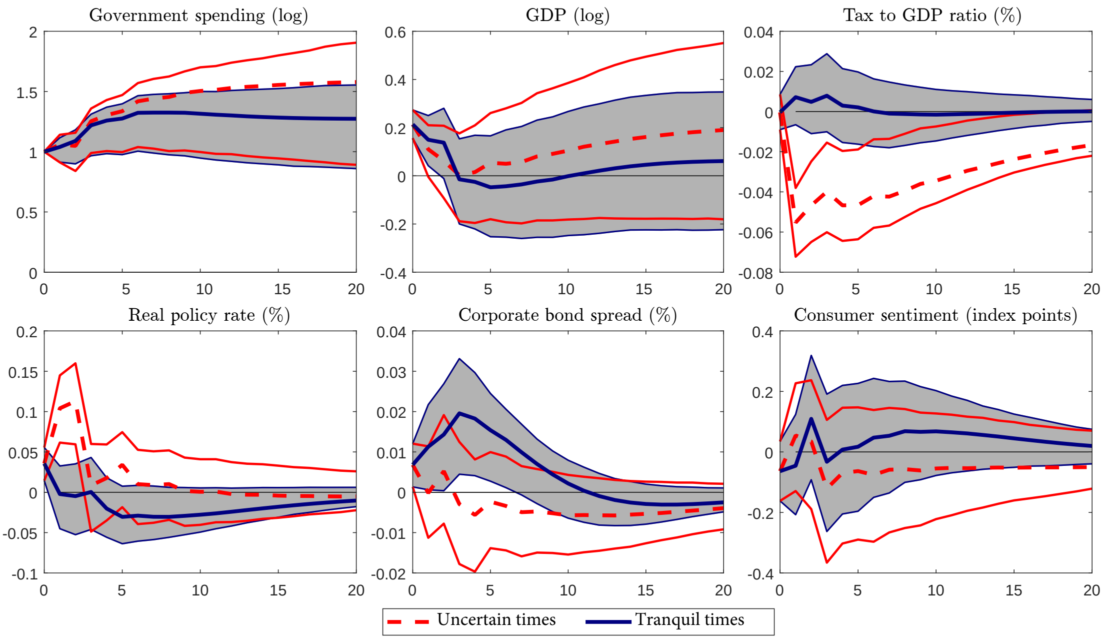

Figure A.7 GIRFs and 68% confidence intervals to a one percent government spending growth shock using the corporate bond spread as uncertainty proxy. See note in Figure 2.4.

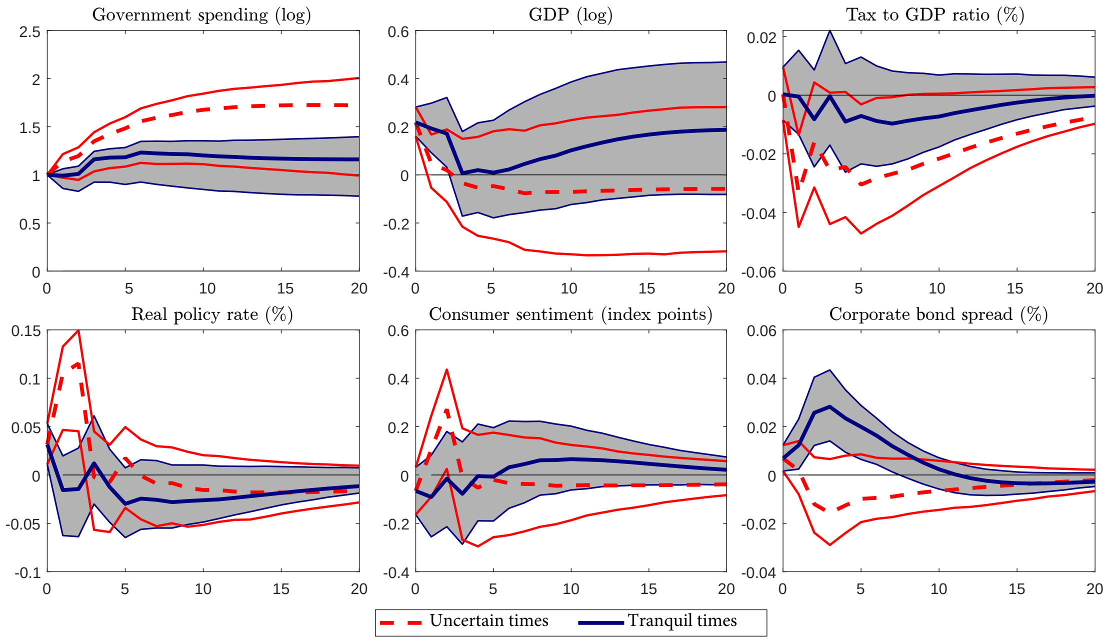

Figure A.8 GIRFs and 68% confidence intervals to a one percent government spending growth shock when consumer confidence is considered as an inversely related uncertainty proxy. See note in Figure 2.4.

3

Historical evidence for larger government spending multipliers in uncertain times than in slumps

Abstract

We investigate whether US government spending multipliers are higher during periods of heightened uncertainty or economic slumps as opposed to normal times. Using quarterly data from 1890 onward and local projections, we estimate a cumulative one-year multiplier of two during uncertain periods. In contrast, the multiplier is about one in times of high unemployment and about 0.4 – 0.8 during normal times. While we find positive employment effects in slumps as well as in uncertain times, two transmission channels can explain the higher multipliers in the latter: greater price flexibility leading to short-term inflation (lowering the real interest rate) and diminishing risk premiums.

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Presented at: Ruhr Graduate School Jamboree 2019 and German Economic Association Annual Conference 2020

Keywords: Government spending multiplier, fiscal policy, uncertainty, slump, local projections, historical data

JEL classification: E62, E32, N12

3.1 Introduction

The recent experience of the Great Recession, which was accompanied by large uncertainty in the real and financial sectors, has sparked a debate about the impact of uncertainty on macroeconomic outcomes. At the same time, governments have responded to the crisis with substantial public spending. Likewise, the current Covid-19 crisis is characterized by high uncertainty and simultaneous jumps in unemployment rates. To stabilize the economy, governments respond by increasing public demand. This raises the question of whether fiscal policy is particularly effective in uncertain times or economic slumps such that one additional dollar of government spending increases output by more than one dollar.

Recently, this research question has been explored by a number of authors. On the one hand, Bachmann and Sims (2012), Auerbach and Gorodnichenko (2013, 2012), Fazzari et al. (2015) and, in extreme recessions, Caggiano et al. (2015) find larger multipliers during economic slumps. On the other hand, Ramey and Zubairy (2018) and Alloza (2019) find small or even negative government spending multipliers in times of slack. Related to the uncertainty level, Arčabić and Cover (2016) as well as, in the long run, Berg (2019) find larger multipliers during uncertain times while Alloza (2019); Belke and Goemans (2022); Jerow and Wolff (2022); Ricco et al. (2016) as well as Fritsche et al. (2021) find lower or negative output multipliers.[1] At the same time, Klein and Linnemann (2019) find evidence for larger output responses during the Great Recession, a situation of large uncertainty in coincidence with economic slump.

With exception of Ramey and Zubairy (2018), all studies mentioned are based on post-World War II (WWII) data. The theory shows that government expenditure multipliers depend on details of the current situation such as the persistence of government expenditure increases, the mode of financing, the degree of financial frictions, the stance of monetary policy as well as the labor market situation.[2] In addition to first moment effects, second moment effects through uncertainty furthermore complicate this issue.[3] The information in post-WWII data may not be sufficient to identify the government expenditure multiplier and

[1]Strictly speaking, Arčabić and Cover (2016) do not systematically test for larger multipliers in uncertain versus normal times. Instead, they estimate a threshold VAR and calculate generalized impulse response functions (GIRFs) where the responses of the variables depend on the lagged uncertainty level. Afterwards, they choose three dates which refer to large (2008Q4), medium (1987Q3, close to their threshold) and low (2005Q3) levels of uncertainty. Based on the responses at these three dates, instead of calculating the average response above/below the chosen threshold level, they claim to find larger output effects of a government spending shock in uncertain times.

[2]Ramey (2011a) and Ramey (2019) provide good reviews of the government spending literature.

[3]For instance, Bloom et al. (2018) classify recessions as the coincidence of a negative first moment (level) with a positive second moment (volatility) shock. According to the theoretical uncertainty literature, higher volatility diminishes private demand through a real options channel (increasing the option value of waiting, reducing investment and hiring) (see e.g. Bernanke, 1983; Bloom, 2009; Dixit, 1989; Pindyck, 1991), precautionary savings (lowering consumption) (see e.g. Challe et al., 2017; Leland, 1968; Lusardi, 1998) and higher financial risk premiums (extending financial constraints) (see e.g. Christiano et al., 2014). Bloom (2014) as well as Fernández-Villaverde and Guerrón-Quintana (2020) provide good reviews of this literature.

thus explain the different findings. Historical data covering multiple wars, financial crises and deep recessions is needed to perform this task.

Against this background, we contribute to the literature by using quarterly US data from 1890 onward to (1) estimate cumulative government expenditure multipliers in uncertain and normal times and (2) distinguish between uncertainty and economic slumps. Using Jordà (2005) local projections and news implied stock market volatility from Manela and Moreira (2017) as our uncertainty indicator, we find a cumulative one-year multiplier of two during uncertain periods and in the range of 0.4 to 0.8 in normal times. This result is robust to different identification methods and choices of control variables. While we generally find higher multipliers in times of large expected stock market volatility, the one-year multiplier is close to one when the unemployment rate is above 6.5%.

Our third contribution is to provide cumulative multipliers for a wide range of macroeconomic and financial variables in order to explain the higher multipliers in uncertain times compared to slumps. To do so, we extend the dataset of Ramey and Zubairy (2018) with a broad set of further variables. The transmission channels are analyzed by means of multipliers instead of simple impulse responses because those multipliers control for the difference in the dynamics of government spending as if the increase in public expenditure is similar across states. We find that an unexpected increase in government spending has a positive impact on employment levels and the stock market during slumps and uncertain times, with the latter being characterized by stronger effects. In uncertain episodes, expansionary fiscal policy lowers corporate bond spreads/risk premiums and shifts inflation upwards which reduces the real interest rate. These two effects improve the financing conditions of companies and make precautionary saving less attractive, hereby stimulating private spending. These two effects do not occur in times of heightened unemployment, which explains the lower multiplier during slumps.

Our findings deviate from the results of several other contributions. Using the same sample period and the identification of a fiscal policy shock following Blanchard and Perotti (2002), our estimated one/two-year slump multipliers of about one are larger than the two-year multiplier of about 0.7 in Ramey and Zubairy (2018). This can be explained by different model specifications since Ramey and Zubairy (2018) only include real GDP and government spending while we, in addition, take account of changes in the average tax rate, a corporate bond spread, the real monetary policy rate as well as the change in stock prices. This has several advantages. First, this larger set controls for differences in the fiscal stance, financial constraints as well as the monetary policy response over time. Second, as the Blanchard-Perotti schock is identified as the part of current government spending that is not explained by the other lagged variables, the forward-looking financial variables help us to tackle the fiscal anticipation problem which would bias the estimated fiscal multiplier. Third, as also pointed out in Ramey and Zubairy (2018), the state-dependent (and horizon-specific) constants and lagged variables in the local projection framework will embed information on the average behaviour of the economy to transition to the other state at future horizons that are not due to the increase in public spending. In Section B.3, we replicate their results in Figure B.5 including only their variables. Thereby, the lower multiplier in Ramey and Zubairy (2018) can be explained by omitted variable bias.

Alloza (2019); Belke and Goemans (2022); Fritsche et al. (2021); Ricco et al. (2016) and Jerow and Wolff (2022) find negative/lower output responses/multipliers during episodes of uncertainty/volatility while we find larger multipliers. Our paper differs from these contributions in using historical data back to 1890 allowing us to include a larger set of variables to avoid the omitted variable bias. Furthermore, this longer sample period contains more extreme events such as the Great Depression as well as more variation in government spending. We show that the difference in multipliers across states increases with the degree of uncertainty above which periods are classified as uncertain. Thereby, an increase in government demand is particularly effective during extremely uncertain episodes. To illustrate the importance of this relationship for the divergence of our results from Alloza (2019) and Jerow and Wolff (2022), we replicate their lower multipliers in Section B.3 with our specification but similar samples and threshold values as in their analysis. Once we focus on more extreme episodes, higher thresholds, we find evidence for positive and large multipliers during uncertain periods. This result is also reflected in the qualitative changes in the responses of some key transmission variables, i.e. the real interest rate and the corporate bond spread or stock prices. For instance, using a similar threshold as Jerow and Wolff (2022), the corporate bond spread increases in response to the rise in public demand which dampens private investment. In more extreme periods, however, the corporate bond spread instead declines which makes private investment more attractive.

Fritsche et al. (2021) employ a Markov switching in heteroskedasticity structural vector autoregressive model to classify low/high volatility states. Their estimated lower government spending multiplier in the high volatility regime probably reflects a less stable policy environment in which fiscal policy deviated from a policy rule that induces government debt stability (Davig and Leeper, 2011). This unstable fiscal policy environment increases economic uncertainty reflected in larger fluctuations of aggregate variables. This interpretation is in line with the findings of Belke and Goemans (2022) where the GDP response to the public spending shock depends on the response of uncertainty. They find contractionary (expansionary) output effects, if the growth in public demand increases (decreases) uncertainty. This interpretation is further supported by Ricco et al. (2016) who find a muted output response in times of more disagreement amongst US professional forecasters about future government spending.

This paper proceeds as follows. The econometric methodology is explained in Section 2.3. In Section 3.3, we show that the fiscal multiplier rises with the degree of uncertainty prevalent in the economy. We also conduct various robustness checks and distinguish between uncertainty and business cycle states. Herein, we consider four combinations: high uncertainty in an economic slump, high uncertainty outside of a slump, low uncertainty in a slump and low uncertainty without an economic slump. Section 3.4 explores transmission channels that serve to explain the larger multiplier in times of uncertainty. Section 2.5 concludes.

3.2 Empirical strategy

We estimate state-dependent government spending multipliers using local projections as proposed by Jordà (2005) and as applied in the fiscal policy literature for instance by, among others, Auerbach and Gorodnichenko (2013), Ramey and Zubairy (2018) as well as Miyamoto et al. (2018). In particular, we are interested in the dynamics of the cumulative government spending multiplier which measures the cumulative change in GDP relative to the cumulative change in government spending up to quarter $t+h$ in response to a government spending shock occurring in period t.[4]

Following Ramey and Zubairy (2018), we estimate the cumulative multiplier directly by a series of regressions at each horizon $h = 0, \ldots, 15$ for each state:

$$\begin{aligned}\sum_{j=0}^{h} y_{t+j} =& I_{t-1}^{HU}\left[\alpha_h^{HU} + \phi_h^{HU}(L)X_{t-1} + m_h^{HU}\sum_{j=0}^{h} g_{t+j}\right] \\ &+ (1 - I_{t-1}^{HU})\left[\alpha_h^{NU} + \phi_h^{NU}(L)X_{t-1} + m_h^{NU}\sum_{j=0}^{h} g_{t+j}\right] \\ &+ \gamma_{1h}t + \gamma_{2h}t^2 + \gamma_{3h}t^3 + \varepsilon_{t+h}\end{aligned} \tag{3.1}$$

where $\sum_{j=0}^{h} y_{t+j}$ denotes the sum of real GDP from t to $t+h$ and $\sum_{j=0}^{h} g_{t+j}$ denotes the sum of real government spending from t to $t+h$ (both in % of potential GDP). The latter consists of government consumption expenditures and gross investment. The α's denote state-specific constants whereas the $t's$ capture the effects of deterministic time trends up to a polynomial of order 3, for instance to control for the increasing (and then decreasing) role of the government over time, while X_{t-1} denotes the vector of control variables. I_t^{HU} denotes a dummy variable that indicates periods of elevated uncertainty when the shock takes place. We set $I_t^{HU} = 1$ if the quarter is classified as uncertain times. The regressions include I_{t-1}^{HU} to rule out contemporaneous correlations between fiscal shocks and the state of the economy.

The cumulative government spending multipliers for each state and horizon are then given by m_h^{HU} and m_h^{NU}. Herein, m_h^{HU} (m_h^{NU}) measures the cumulative multiplier in uncertain (normal) times up to quarter $t+h$ to a government spending shock in t. We allow all

[4] Mountford and Uhlig (2009) proposed the use of present value cumulative multipliers $m_h = \frac{\sum_{j=0}^{h}(1+i)^{-j} y_{t+j}}{\sum_{j=0}^{h}(1+i)^{-j} g_{t+j}}$. As argued in Ramey (2019), different interest rates i (including $i = 0$) for discounting result in nearly identical multipliers because the timing of the government spending and output responses are very similar. We also find evidence for this. The results are available on request.

coefficients of the model to vary with the state of the economy. Furthermore, note that the local projection method incorporates the average transition of the economy from one regime to another. In other words, if the government spending shock moves the economy from state HU to regime NU, or vice versa, this effect is absorbed into the estimated multipliers.[5] We normalize output and government spending by potential GDP as in Gordon and Krenn (2010). This allows us to estimate dollar for dollar multipliers without the need to multiply the estimated elasticity multipliers, that would be received from a log-log estimation with real GDP and real government spending, with the ratio of GDP to fiscal spending that varies substantially within the historical sample (Ramey and Zubairy, 2018).

In our baseline specification, we use g_t as an instrumental variable for the cumulative change in government spending $\sum_{j=0}^{h} g_{t+j}$. Since the set of controls will, among others, include lagged measures of real government spending and real output, this identification strategy is equivalent to the structural VAR (SVAR) identification proposed by Blanchard and Perotti (2002). Hence, we assume that government spending does not contain components that automatically fluctuate with the business cycle and that policymakers need at least one quarter to decide on, approve and implement discretionary changes in fiscal policy.

A potential obstacle for estimating the effects of fiscal shocks is the fiscal foresight problem. It arises when economic agents not only react to actual increases in government spending, but also to news about forthcoming future spending plans. In this case, it is not possible to recover the true unexpected spending shocks because of an information misalignment (Leeper et al., 2013). There are different proposals in the literature to take this problem into account. Some researchers suggest including a fiscal news variable in the empirical model that captures anticipated changes in government spending (Fisher and Peters, 2010; Ramey, 2011b). Others add a series of professional forecasts of government spending to the set of control variables (Auerbach and Gorodnichenko, 2012). A third strand in the literature proposes to include forward-looking variables as controls since they may capture information about future fiscal policy actions (Beetsma and Giuliodori, 2011; Forni and Gambetti, 2010; Yang, 2007). In our baseline specification, we follow the latter route and include stock prices, more exactly the log difference of the S&P 500 index, to the set of our control variables. This route has the advantage of controlling for first moment changes in the stock market, hence realized stock price developments should not confound our results which focus on expected stock market volatility.[6]

Apart from the stock market data, the vector of control variables X_{t-1} includes four quarterly lags of the following variables: GDP and government expenditures, both normalized by potential GDP, and the change in the average tax rate to account for changes in fiscal finances. The latter is measured by the ratio of federal current receipts to GDP.[7] Additionally, we

[5]We use the terms ”state” and ”regime” interchangeably.

[6]We include the log difference since we cannot reject a unit root at conventional significance levels.

[7]We include the change instead of the level since we cannot reject a unit root at conventional significance

include a corporate bond spread measured by Moody's seasoned Baa corporate bond yield relative to yield on 10-year treasury constant maturity. The spread serves as an indicator of financial frictions/risk premiums firms are confronted with. Fernández-Villaverde (2010) and Canzoneri et al. (2016) demonstrate in theoretical models that financial frictions ought to affect the economic reactions in response to expansive public spending. As some authors have shown the importance of the monetary policy reaction (Canova and Pappa, 2011; Davig and Leeper, 2011) for the effects of fiscal policy, we include a real policy rate.[8] Yang (2007) argues that interest rates and price variables might cover information about future fiscal policy. Thus, including the real interest rate helps to account for fiscal anticipation.

One drawback of the Jordà-method is the serial correlation in the error terms induced by the successive leading of the dependent variable. Thus, we apply the Newey and West (1987) correction to obtain statistics that are robust to serial correlation and heteroskedasticity. Recent excellent econometric treatments of the local projection framework are Stock and Watson (2018) and Plagborg-Møller and Wolf (2021). If not stated otherwise, the estimation period is from 1890Q1 until 2015Q4.[9] Section B.1 provides a description of all variables and corresponding graphs showing the ones employed in estimation.

3.3 Output multipliers during uncertain and normal times

The estimation of state-dependent fiscal multipliers with Equation (3.1) is a non-trivial task. First, we need an uncertainty proxy that is available over a long time period. Second, we have to decide on a threshold value to distinguish between uncertain and normal times.

Our measure of uncertainty is the news implied VIX (NVIX) from Manela and Moreira (2017). The authors use Wall Street Journal articles to construct a text-based measure of expected stock market uncertainty back to the end of the 19th century. They split titles and abstracts to n-grams (word combinations) and use support vector regressions to predict the VXO or VIX from which at least one is available from 1986 onward.[10] They divide the period where the VXO is available in two parts: (1) a training sample, 1996–2009, to estimate the dependency between news data and implied volatility and (2) a test sample, 1986–1995, for out-of-sample tests of model fit. Since the news articles are available since

levels due to permanent shifts around war periods. Normalizing tax revenues with potential output instead of GDP to be more consistent with the Gordon-Krenn transformation gives almost identical results.

[8]We follow Olson and Enders (2012) and proxy the monetary policy with a short-term commercial paper rate. To calculate the real interest rate, we then subtract the year-over-year inflation rate. Using the annualized quarterly inflation rate gives similar results.

[9]The sample end is restricted by the availability of the uncertainty indicator and the military news variable that we later use for robustness checks.

[10]The VXO (VIX) measures the option implied annualized standard deviation of S&P 100 (S&P 500) returns. Bloom (2009) proposes to use the VXO (VIX) as an uncertainty proxy due to the fact that the implied stock return volatility is the canonical measure of uncertainty in financial markets. He also shows that time series stock market volatility is highly correlated with a number of cross-sectional measures of uncertainty. See also the discussion in Bloom et al. (2007).

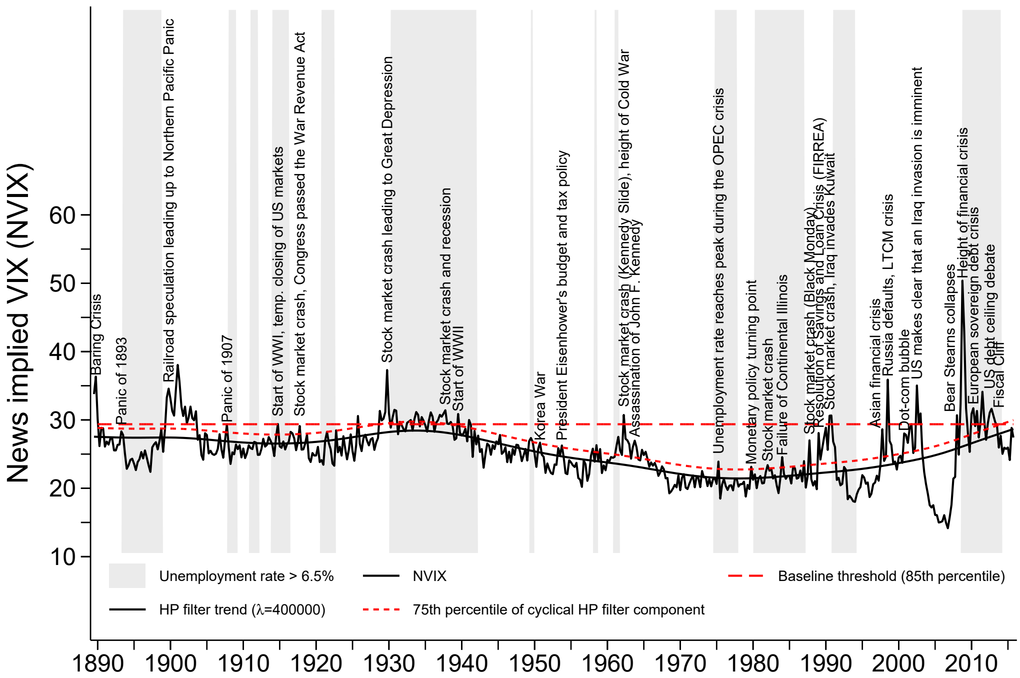

Figure 3.1 Uncertainty through time. The figure shows the NVIX from Manela and Moreira (2017). The red dashed line indicates our baseline threshold to classify periods as uncertain times. The red short-dashed line denotes a threshold that is used in a robustness analysis. The large smoothing parameter is chosen for two reasons: First, Drehmann et al. (2012) emphasize the importance of the medium cycle for some financial variables. Second, it allows us to choose a time-varying threshold without classifying a large fraction of the Great Depression as normal times.

1889, they can use their model to predict the NVIX for a long time period.

Figure 3.1 depicts the historical development of the NVIX and indicates high unemployment periods. It shows significant variation over time and rises during world wars, financial crises, times of policy-related uncertainty as well as stock market crashes. Examples for spikes are the railroad speculation that led to the Northern Pacific Panic at the beginning of the twentieth century, the start of World War I (WWI) in 1914, and the stock market crash in 1929 leading to the Great Depression which became a period of prolonged uncertainty. There is a decline after WWII until it sharply increases at the stock market crash in 1962, the Black Monday in 1987, the 1990 Iraqi invasion in Kuwait or the Long-Term Capital Management (LTCM) crisis in 1998. The twenty-first century began with large uncertainty due to the Dot-com bubble and the fight against terrorism. Afterwards, uncertainty remained at a low level until it surged due to the Financial Crisis 2008 and its consequences. Mishkin and White (2002) describe many stock market crashes and Walton and Rockoff (2013) provides a very good overview over the economic history of the United States. See also Noyes (1909).

Before we continue with the historical analysis, we compare the NVIX with other uncertainty indicators for overlapping samples. Figure 3.2 depicts the development of the NVIX, the financial and macroeconomic uncertainty indices (Jurado et al., 2015; Ludvigson et al., 2021), the economic policy uncertainty index (EPU) from Baker et al. (2016) and the VXO. The figure shows the largest similarities among the measures of financial uncertainty

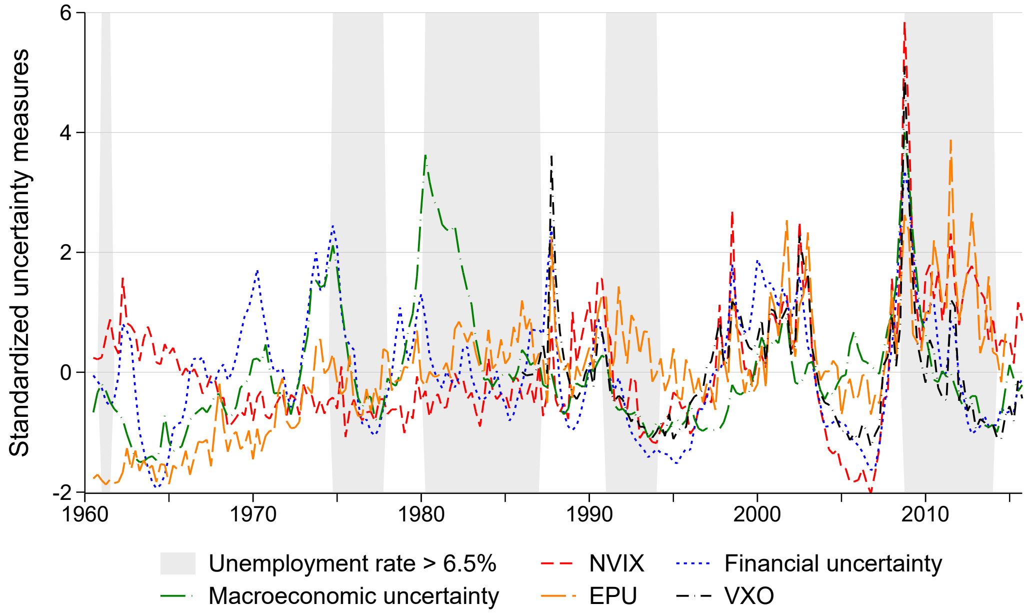

Figure 3.2 Comparison of different uncertainty measures. The uncertainty proxies are made comparable by standardizing to mean 0 and standard deviation 1 over this period.

Table 3.1 Correlation among uncertainty and economic indicators

	NVIX	VXO	Fin. unc.	Macro. unc.	EPU	Output gap	Unempl.	Corp. bond spread
1960-2015								
NVIX	1							
VXO	0.68*	1						
Financial uncertainty	0.43*	0.85*	1					
Macroeconomic uncertainty	0.15*	0.59*	0.58*	1				
Economic policy uncertainty	0.44*	0.54*	0.32*	0.36*	1			
Output gap	−0.29*	−0.02	−0.02	−0.31*	−0.49*	1		
Unemployment rate	0.19*	0	0.01	0.32*	0.44*	−0.85*	1	
Corporate bond spread	0.48*	0.61*	0.43*	0.52*	0.74*	−0.66*	0.52*	1
1986-2015								
NVIX	1							
VXO	0.68*	1						
Financial uncertainty	0.67*	0.85*	1					
Macroeconomic uncertainty	0.50*	0.59*	0.66*	1				
Economic policy uncertainty	0.72*	0.54*	0.46*	0.36*	1			
Output gap	−0.42*	−0.02	−0.04	−0.20*	−0.47*	1		
Unemployment rate	0.36*	0	0.08	0.12	0.49*	−0.84*	1	
Corporate bond spread	0.74*	0.61*	0.63*	0.69*	0.68*	−0.55*	0.45*	1

Notes: ∗ indicates that the statistics is significant at the 5% level. The output gap is based on real potential GDP of the Congressional Budget Office.

(NVIX, financial uncertainty and VXO). However, the NVIX resembles the EPU, especially after the Financial Crisis 2008. Based on the annotations in Figure 3.1, this can be explained by the fact that the NVIX also captures concerns about sovereign risk. In general, the NVIX shows substantial differences in the 70s and 80s from the macroeconomic uncertainty index which is strongly driven by the OPEC crises. Table 3.1 confirms these differences. The NVIX is significantly correlated with all uncertainty indicators, but only slightly with macroeconomic uncertainty over the subsample 1960–2015. From 1986 onward, it shows substantial correlation with macroeconomic uncertainty.[11] Notably, in contrast to the VXO and the financial uncertainty index, the NVIX is negatively correlated with economic activity. Since the NVIX is based on news, it presumably captures a mix of economic and policy uncertainty being relevant for the average investor. The strong correlation with the spread/risk premium indicates that it measures uncertainty with direct effects on firms' financing conditions. Its major advantage is the long availability which allows us to include the Great Depression and other important historical events.

The long-dashed line in Figure 3.1 depicts the threshold chosen to discriminate between uncertain and normal times in our baseline specification. Bloom et al. (2007) show that the annual firm investment rate declines with the level of sales uncertainty firms are facing. In particular, the impact of uncertainty is only muted close to the median but the effects can be large at extreme levels 75th and 90th percentile). Thereupon, we estimate the difference in fiscal multipliers across uncertain and normal times for each threshold ranging from the 70th to the 90th percentile of the NVIX distribution. This is possible due to the use of historical data which provides enough observations even for extreme events.[12]

We can rewrite Equation (3.1) to estimate the difference between cumulative multipliers across states for each horizon $h = 0, 1, ..., 15$:

$$\begin{aligned}\sum_{j=0}^{h} y_{t+j} =& m_h^{DIFF} I_{t-1}^{HU} \sum_{j=0}^{h} g_{t+j} + m_h^{NU} \sum_{j=0}^{h} g_{t+j} \\ &+ I_{t-1}^{HU} \left[\alpha_h^{HU} + \phi_h^{HU}(L) X_{t-1}\right] + (1 - I_{t-1}^{HU}) \left[\alpha_h^{NU} + \phi_h^{NU}(L) X_{t-1}\right] \\ &+ \gamma_{1h} t + \gamma_{2h} t^2 + \gamma_{3h} t^3 + \varepsilon_{t+h}\end{aligned} \tag{3.2}$$

with $m_h^{DIFF} = m_h^{HU} - m_h^{NU}$ from Equation (3.1). As before, we use the Blanchard and Perotti (2002) identification and instrument $\sum_{j=0}^{h} g_{t+j}$ with g_t and $I_{t-1}^{HU} \sum_{j=0}^{h} g_{t+j}$ with $I_{t-1}^{HU} g_t$.

Figure 3.3 shows the estimated difference in multipliers for each threshold together with 90% confidence intervals. In general, the results depict no difference across impact multipliers. In contrast, the difference in multipliers increases non-linearly with the threshold

[11] A plausible reason for this is the training sample period starting in 1996 which does not cover any OPEC crises. See Hamilton (2011) for a description of historical oil shocks.

[12] Our sample includes about 500 quarters. Setting a threshold at the 85th percentile of the NVIX results in 75 observations for the state of heightened uncertainty. In contrast, frequently used samples from 1960 onward would contain as few as 35 uncertain quarters.

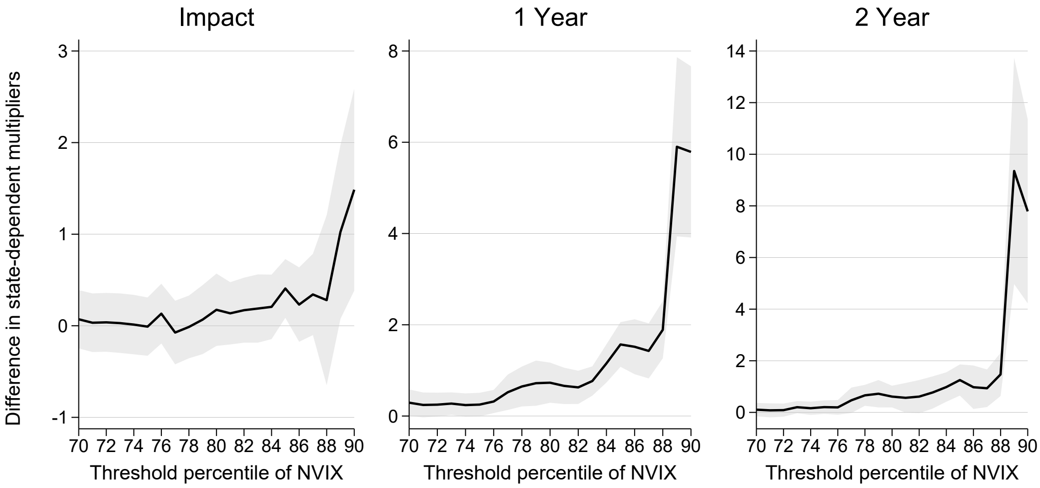

Figure 3.3 Difference in state-dependent government spending multipliers for different thresholds. Shaded areas depict 90% heteroskedasticity and serial correlation robust confidence intervals.

at the one and two year horizon. This is expected from the above finding in Bloom et al. (2007). We choose the 85th percentile of the NVIX distribution based on a trade-off between disentangling the difference across both states at high levels of uncertainty and low estimation precision due to the low number of observations in the high uncertainty state for very large thresholds.

We now present the estimated cumulative government spending multipliers based on Equation (3.1) and the 85th percentile of the NVIX distribution as the threshold level. In addition to the state-dependent model, we consider results from the linear model which assumes that multipliers are invariant to the uncertainty level.

The upper left panel of Figure 3.4 shows the cumulative fiscal multiplier with 90% confidence bands for a version of Equation (3.1) without different states (henceforth called linear model). On impact, output increases only less than forty cents per dollar of government spending. Although the fiscal multiplier increases after the shock, it remains significantly below one. Correspondingly, public spending crowds out private expenditures.

The upper right panel of Figure 3.4 shows the cumulative government spending multiplier in uncertain times (HU, in red) versus normal episodes (NU, in blue with markers). The multiplier during normal times mirrors the one estimated from the linear model.[13] However, the red line shows that fiscal policy can be very effective during HU periods. Over a horizon of one year, a one dollar increase in government consumption and investment boosts output by about two dollars. The bottom right panel shows that the p-values for the difference between HU and NU multipliers for each horizon *h* are below conventional levels.

The lower left panel depicts the Montiel Olea and Pflueger (2013) effective first stage F statistic for the state-dependent as well as the linear fiscal multipliers. The results indicate high instrument relevance for the Blanchard-Perotti shock. Even after two years, the first

[13]This is expected since the threshold classifies 85% of the sample as normal periods.

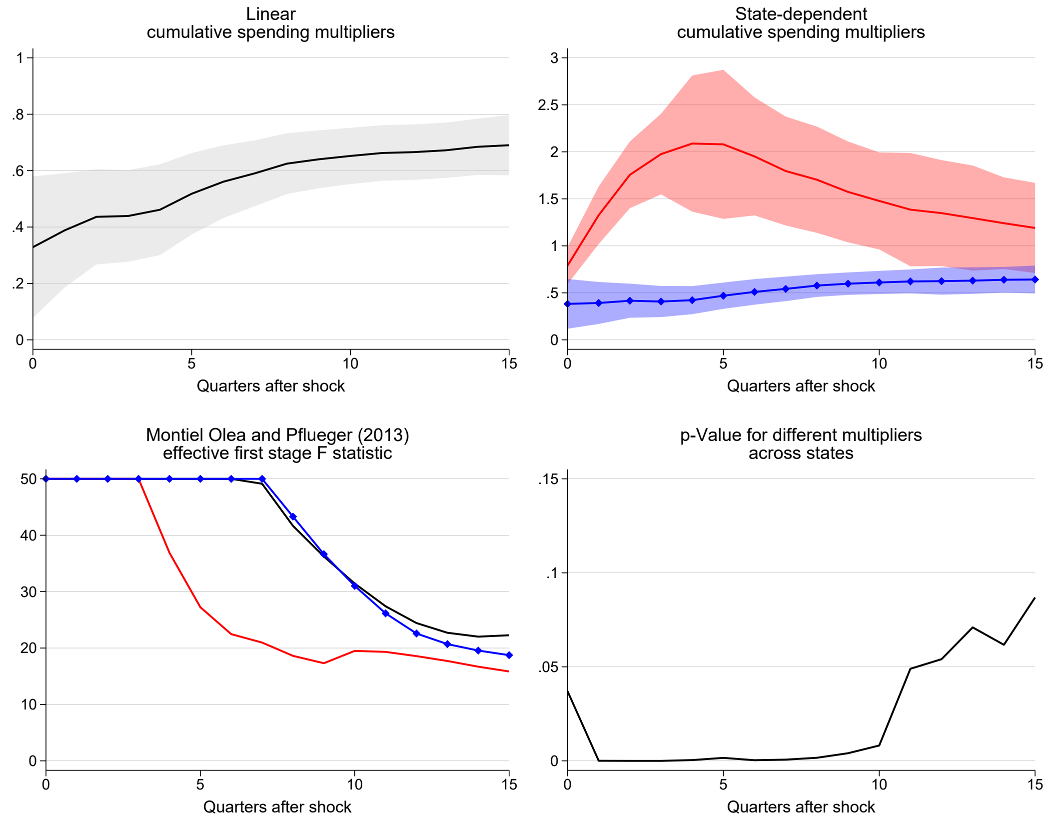

Figure 3.4 Cumulative multipliers to a Blanchard-Perotti shock. The upper left panel shows the cumulative government spending multipliers for each horizon in the linear model (in black). The upper right panel shows the state-dependent multipliers during uncertain (in red) and normal (in blue with markers) times. 90% heteroskedasticity and serial correlation robust confidence intervals are shown in all cases. The bottom left panel shows the first stage F statistic that is robust to heteroskedasticity and serial correlation. The bottom right panel shows the p-value for different multipliers across states.

stage F statistic in the high uncertainty states and the linear model is close to twenty.[14] We conclude that the large HU multipliers are not due to weak instruments.

3.3.1 Robustness

Our baseline result of larger HU multipliers is potentially sensitive to numerous specification decisions we made like the specific choice of control variables in Equation (3.1) or the identification of a government spending shock. In this section, we explore the sensitivity of our findings to those specification decisions as well as the issue of subsample stability.[15]

We first include the unemployment rate because it might contain important information about the state of the business cycle relative to output data (Barro and Redlick, 2011). Second,

[14] The F statistics are from the regression of $\sum_{j=0}^{h} g_{t+j}$ on the shock in t. The regression also includes all the other controls from the second stage. A common rule of thumbs is that a first stage F statistic less than ten indicates that the instruments are weak (Stock and Watson, 2020, Chapter 12). However, heteroskedasticity and serial correlation can affect instrument strength (Montiel Olea and Pflueger, 2013). The critical values for a worst case bias of ten percent are 23.109 (19.748) at the 5 (10)% confidence level (Pflueger and Wang, 2015). The statistic is capped at a maximum of 50 for readability reasons.

[15] Figure B.3 in Section B.2 also investigates the effects of different thresholds.

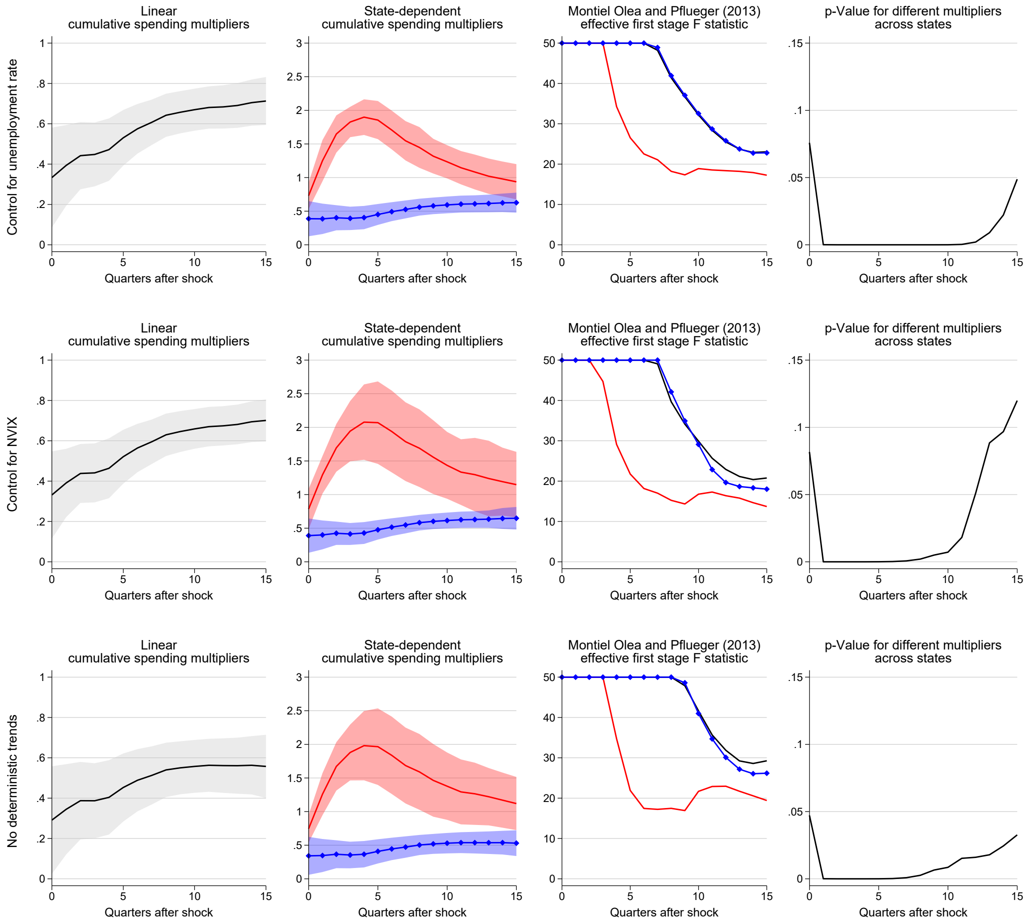

Figure 3.5 Robustness to including additional control variables. The figure shows cumulative government spending multipliers to a Blanchard-Perotti shock from a linear model (in black) and in uncertain (in red) as well as normal (in blue with markers) times. 90% confidence intervals are shown in all cases. All statistics are robust to heteroskedasticity and serial correlation.

we include the NVIX in the set of our controls. Lastly, we drop the deterministic trends from our specification. Figure 3.5 shows that our results remain qualitatively and quantitatively similar if we include additional controls or drop the trend components. Therefore, we continue with our baseline specification.

In Figure 3.6, we investigate robustness with respect to different identification methods of a government spending shock as well as to excluding WWII from our estimation. The upper panel shows the multiplier to a military news shock as in Ramey (2011b) and Ramey and Zubairy (2018). The series is based on newspaper readings and focuses on changes in government spending due to political and military events since these changes are most likely independent of the state of the economy. This series is constructed as changes in the expected present discounted value of government spending to account for the fact that defense expenditures might be anticipated long before they show up in NIPA tables. Ramey (2016b) describes the underlying narrative.

In this case, $\sum_{j=0}^{h} g_{t+j}$ is instrumented with the military news variable $news_t$ (also normalized by potential output) and the set of controls is extended with four lags of this

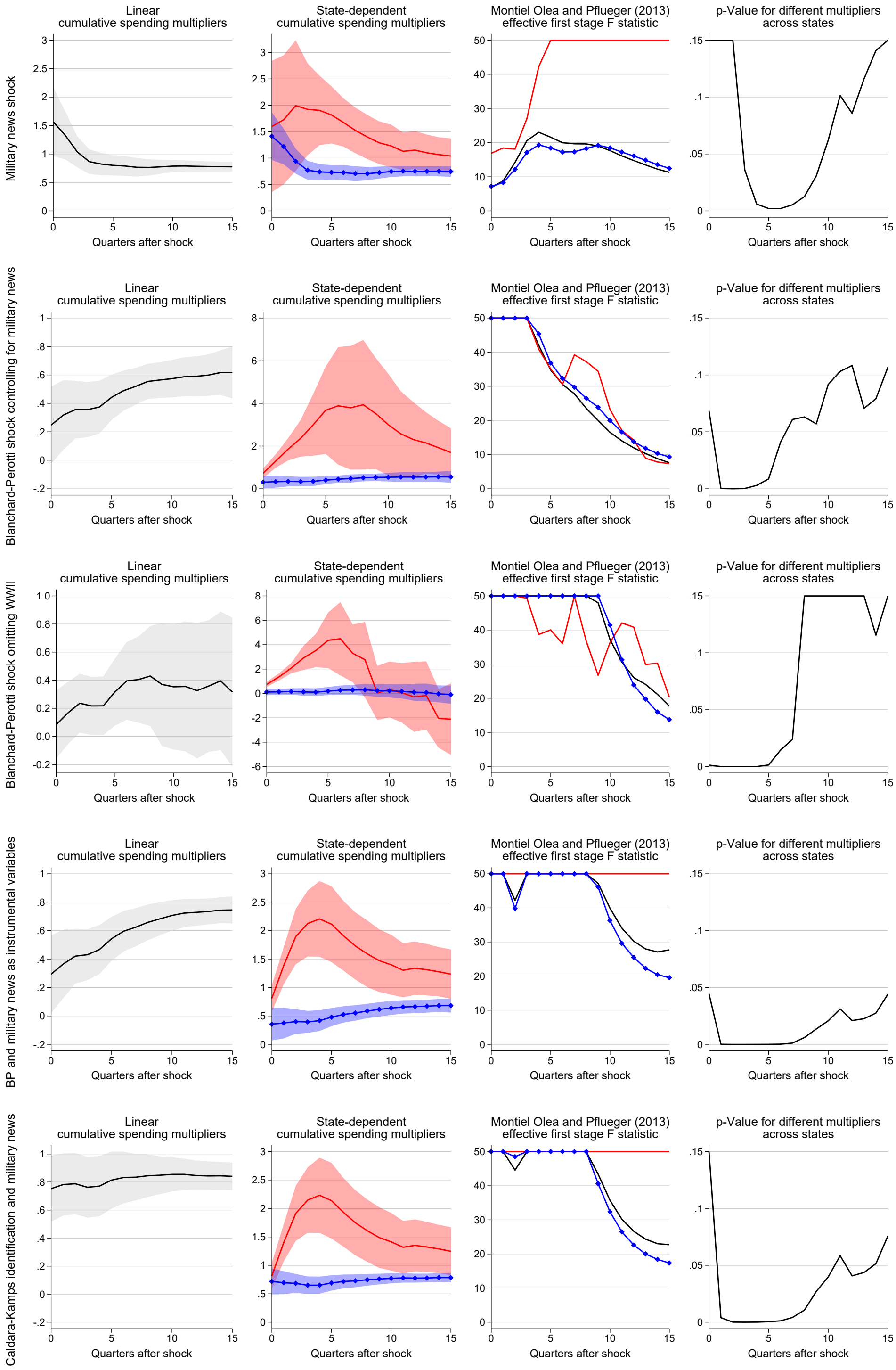

Figure 3.6 Robustness across identification methods and excluding WWII. The figure shows cumulative government spending multipliers from a linear model (in black) and in uncertain (in red) as well as normal (in blue with markers) times. 90% confidence intervals are shown in all cases. All statistics are robust to heteroskedasticity and serial correlation.

variable to capture serial correlation among news. Although we still find state-dependent multipliers over some horizons, the results differ in two respects. The most remarkable feature are the larger linear and NU multipliers. However, since this corresponds with very low first stage F statistics, the large short-run multiplier during tranquil times should be doubted. Furthermore, the linear and NU multipliers attenuate to the baseline results as the first stage F statistics increase. The other feature is related to the variation in military news. In our case, from 504 observations, military news differs from zero in only 108 quarters. This problem becomes more severe if state-dependence is considered. The news variable shows variation in only 12 during uncertain and 96 quarters in normal times. This explains the large standard errors compared to the baseline results in Figure 3.4.

Complementary, we also include the military news variable in the set of controls but use the Blanchard-Perotti identification. The government spending shock can then be interpreted as being orthogonal to news about military spending. The second row of Figure 3.6 depicts larger HU multipliers of about four. Perotti (2014) argues that additional military spending might have very different effects on the economy compared to increases in civilian government expenditures which not only crowd out resources from the private sector but also provide benefits to society. This reasoning is in line with the third row where we exclude WWII from our estimation.[16] As can be seen, the HU multipliers are very similar in both panels. However, the standard errors become large when dropping this special period characterized by large variation in public expenditures.

Further evidence of robustness is provided by exploiting an idea from Ramey and Zubairy (2018) who instrument $\sum_{j=0}^{h} g_{t+j}$ with g_t and $news_t$. We show the results in the fourth row of Figure 3.6 which are very similar to the baseline results. Although it is not totally clear how this shock can be interpreted, this experiment provides two insights. First, the instrument relevance remains high beyond two years after the shock occurs. Second, since we now have two instruments for one endogenous variable in each regime, we can use the Sargan-Hansen test of overidentifying restrictions and combine this with an idea from Caldara and Kamps (2017).

Caldara and Kamps (2017) show that different fiscal multipliers in the literature (based on various identification approaches) can be explained by different assumptions on a simple rule that relates government spending to output. Thereupon, we use

$$\tilde{g}_t = g_t - \left[I_{t-1}^{HU} \mu^{HU} + (I - I_{t-1}^{HU}) \mu^{NU} \right] y_t \qquad (3.3)$$

[16] We follow Ramey and Zubairy (2018) and do not use observations when either the dependent variable, the shock or the lagged control variables occur during WWII. They classify the period 1941Q3-1945Q4 on rationing and capacity reasons. However, we follow Gorodnichenko (2014) and start WWII after the German invasion into Poland (1939Q3) and add a few quarters (until 1946Q4) to get rid of the period with massive demobilization. For instance, the military news variable is about 29 percent of potential GDP in 1940Q2, and 38 in 1941Q2. These are some of the largest military shocks in the sample as can be seen from Figure B.1 in Section B.1. We also exclude those periods in the calculation of the threshold to ensure that 15 percent of the observations are classified as uncertain periods.

and $news_t$ as instruments. We experiment with different values and choosing $\mu^{HU} = 0$ and $\mu^{NU} = -0.18$ results in p-values larger than 0.1 for the Sargan-Hansen test. In the linear model, $\mu^{LIN} = -0.2$ results in p-values larger than 0.1. The bottom panel of Figure 3.6 resembles our baseline conclusions. Note, however, the increase of linear and NU multipliers. Nevertheless, we continue with our baseline identification and set $\mu^{HU} = \mu^{NU} = \mu^{LIN} = 0$ for the rest of our analysis.

Figure 3.7 examines the robustness of the larger HU multipliers across different subsample periods. First, we only consider the period between 1914 and 2015. This serves to ascertain whether our finding is the result of institutional differences after establishing the Federal Reserve system. The estimated multipliers are similar to the baseline. Interestingly, the instrument relevance of the Blanchard-Perroti shock in the HU state remains very strong at longer horizons. This reinforces our confidence that the higher multipliers during uncertain times are not an artifact of weak instruments.

The second panel shows the results from a post-WWII analysis. The impact HU multiplier increases to two, but after two years it decreases to the level of the NU multiplier. Due to the increase in standard errors, the NU multiplier is within an interval between slightly below zero to above one. This reinforces our belief that historical data provide useful information for the estimation of fiscal multipliers. This is especially important if state dependency is under consideration.

As mentioned in the introduction, some authors reported evidence for lower or even negative HU multipliers. Since some uncertainty proxies are only available from 1960 onward, we check the robustness of our results for this time period in the bottom three panels. Indeed, the results in the third row provide evidence for lower HU multipliers in the medium term. One reason might be that the government itself has become a driver of uncertainty. This view would be supported by soared uncertainty, for instance due to the fiscal cliff after the Financial Crisis 2008 in Figure 3.1 (see also Davig and Foerster, 2019). However, this finding could also have another cause. Figure 3.3 shows that large multipliers mainly materialize in times of strongly heightened uncertainty. While the 85th percentile for the entire historical sample and 1914–2015 period is above 29, it is below 28 for the subsample starting in 1960. To test the impact of the lower threshold for classifying uncertain periods, we re-estimate the model using the 90th percentile (29.5) for this subsample. Since that threshold only classifies 23 quarters as uncertain periods, estimation with the baseline specification is not feasible. For this reason, we first use the control variables from the baseline specification but with only two lags. The second specification contains controls only for government spending, GDP, taxes and stock returns, but with four lags. Both results indicate higher multipliers in uncertain times. This shows that the lower HU multiplier in the third panel is not the result of structural breaks. Rather, we interpret the findings for the 1960–2015 period as evidence for the need of longer time series since the results for this space of time are not robust. We provide two reasons for this. As shown in Figure B.1 of

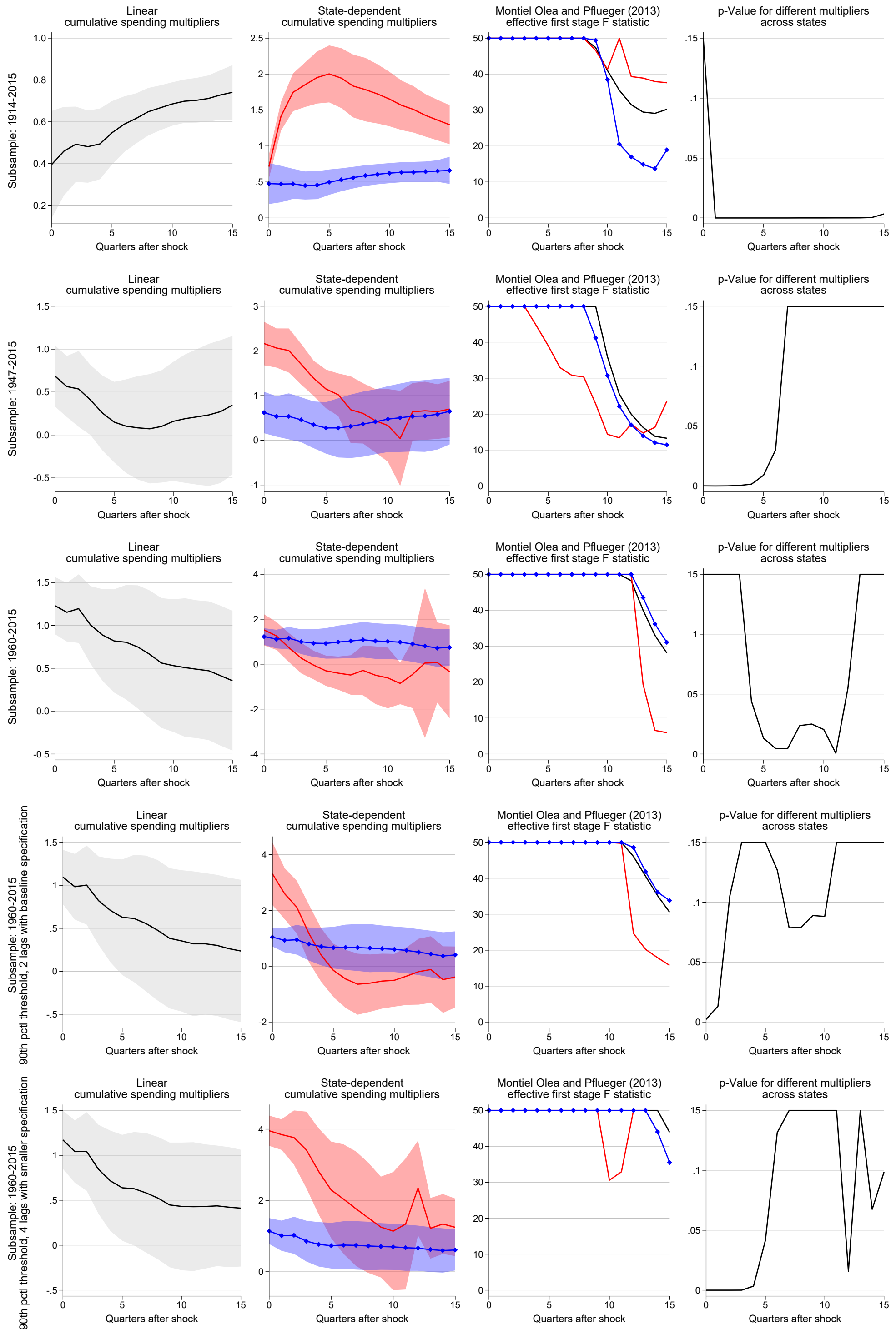

Figure 3.7 Robustness across subsamples. The figure shows cumulative government spending multipliers to a Blanchard-Perotti shock from a linear model (in black) and in uncertain (in red) as well as normal (in blue with markers) times. 90% confidence intervals are shown in all cases. All statistics are robust to heteroskedasticity and serial correlation.

Section B.1, this sub-period includes less variation in output as well as government spending. Most importantly, it has the drawback of omitting the Great Depression, a period of large and secular uncertainty.

3.3.2 Uncertainty versus economic slumps

We provide historical evidence for substantially different government spending multipliers in uncertain compared to normal times. Ramey and Zubairy (2018), on the other hand, do not find larger multipliers across recessions and expansions with historical data. An interesting research question is to what extent uncertainty is a more important determinant of the effects of fiscal policy and to what extent a distinction can be made between the state of the economic cycle and the degree of uncertainty.

To answer this research question, we extend our model as follows:

$$\begin{aligned}\sum_{j=0}^{h} y_{t+j} =& I_{t-1}^{HU} I_{t-1}^{SLUMP} \left[\alpha_h^A + \phi_h^A(L)X_{t-1} + m_h^A \sum_{j=0}^{h} g_{t+j} \right] \\ &+ I_{t-1}^{HU}(1-I_{t-1}^{SLUMP}) \left[\alpha_h^B + \phi_h^B(L)X_{t-1} + m_h^B \sum_{j=0}^{h} g_{t+j} \right] \\ &+ (1-I_{t-1}^{HU}) I_{t-1}^{SLUMP} \left[\alpha_h^C + \phi_h^C(L)X_{t-1} + m_h^C \sum_{j=0}^{h} g_{t+j} \right] \\ &+ (1-I_{t-1}^{HU})(1-I_{t-1}^{SLUMP}) \left[\alpha_h^D + \phi_h^D(L)X_{t-1} + m_h^D \sum_{j=0}^{h} g_{t+j} \right] \\ &+ \gamma_{1h} t + \gamma_{2h} t^2 + \gamma_{3h} t^3 + \varepsilon_{t+h}\end{aligned} \tag{3.4}$$

Herein, we set $I_t^{HU} = 1$ if period t belongs to the high uncertainty state and $I_t^{SLUMP} = 1$ if the period is characterized as a slump. Since there are several approaches to distinguish between economically good and bad episodes, we use several indicators. As before, we use the 85th percentile of NVIX as a threshold and four lags of all control variables. However, we drop stock returns as including these would lead to values of the first stage F statistics below ten (at longer horizons) in at least one specification. With twice the number of states and thus a lower number of observations per state, we consider only eight quarters after the government spending increase.

The first two classifications are based on the unemployment rate. In the upper panel, we follow Owyang et al. (2013) and set $I_t^{slump} = 1$ if the unemployment rate is above 6.5%. They chose the value in accordance with the Federal Reserve's use at this time. The second panel follows a robustness analysis in Ramey and Zubairy (2018) and assumes a threshold value of 8% as state-dependent effects may be found more likely at higher degrees of economic slump. The bottom two classifications of economic performance, by contrast, are based on output. The third panel uses the Hamilton (2018) filter to determine a time-varying threshold and

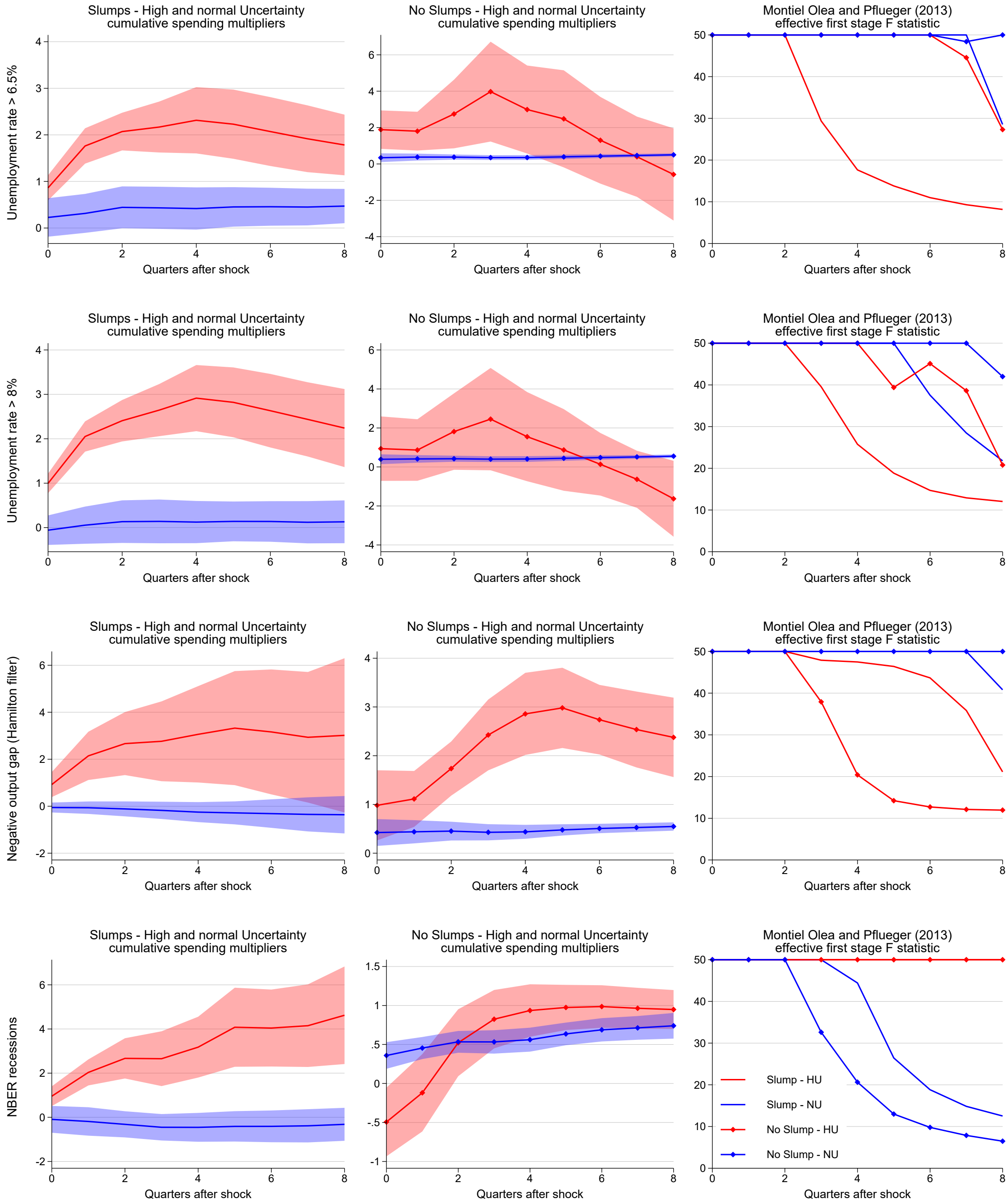

Figure 3.8 Government spending multipliers over the economic cycle - the role of uncertainty. The figure shows the cumulative government spending multipliers to a Blanchard-Perotti shock estimated from Equation (3.4). 90% confidence intervals are shown in all cases. All statistics are robust to heteroskedasticity and serial correlation.

the bottom panel sets $I_t^{SLUMP} = 1$ during National Bureau of Economic Research (NBER) recession periods.

The left column of Figure 3.8 provides evidence for higher multipliers in an economic crisis only when it is accompanied by a high degree of uncertainty. Accordingly, we find one-year SLUMP-HU multipliers about two while the SLUMP-NU multipliers are below one. Similarly, the NOSLUMP-HU multipliers in the middle column are mostly above the NOSLUMP-NU multipliers. From the right-hand side, it can be seen that instrument relevance is not a problem, at least for the one-year multipliers. The punchline of this experiment is that multipliers above one, even in economically challenging times, materialize in times of high uncertainty.[17]

3.4 Transmission channels

Our results provide evidence for government spending multipliers around two in uncertain times, while they are smaller in recessions. This result should be reflected in the channels of transmission of government spending increases. We, therefore, now focus on the concrete transmission mechanisms and analyze the effects on a number of macroeconomic as well as financial variables, government expenditure funding and the monetary policy response.

Specifically, we estimate state-dependent cumulative multipliers from local projections for each horizon $h = 0, 1, ..., 15$:

$$\sum_{j=0}^{h} x_{t+j} = I_{t-1}\left[\alpha_h^A + \phi_h^A(L)X_{t-1} + m_h^A \sum_{j=0}^{h} g_{t+j}\right] + (1 - I_{t-1})\left[\alpha_h^B + \phi_h^B(L)X_{t-1} + m_h^B \sum_{j=0}^{h} g_{t+j}\right] + \gamma_{1h}t + \gamma_{2h}t^2 + \gamma_{3h}t^3 + \varepsilon_{t+h} \quad (3.5)$$

where the dependent variable x_t is, respectively, output or private spending (both in % of potential GDP), the unemployment rate, the change in debt as well as tax receipts relative to GDP, the corporate bond spread, the percentage change of the S&P 500 index, the NVIX, the nominal and real interest rate as well as the inflation rate or a financial stress index.[18] In all cases, we analyze multipliers to a Blanchard and Perotti (2002) shock. X_{t-1} includes four lags of variables used in the baseline specification as well as the dependent variable.[19] Cumulative multipliers control for the difference in the dynamics of government spending as if the increase in public demand is similar across states. For GDP components,

[17] In Figure B.4 of Section B.2, we provide graphs for the estimated multipliers across different measures of economic slack without distinguishing across uncertainty states. We find multipliers close to one in periods of high unemployment.

[18] To calculate private spending, we subtract government spending from output. In the estimation, we then replace real GDP with private spending.

[19] For the x_{t+h} variables in differences (the change in debt to GDP, the change in tax receipts to GDP, the percentage change of the S&P 500 index), the multiplier at horizon h denotes the change in levels from period $t-1$ to $t+h$.

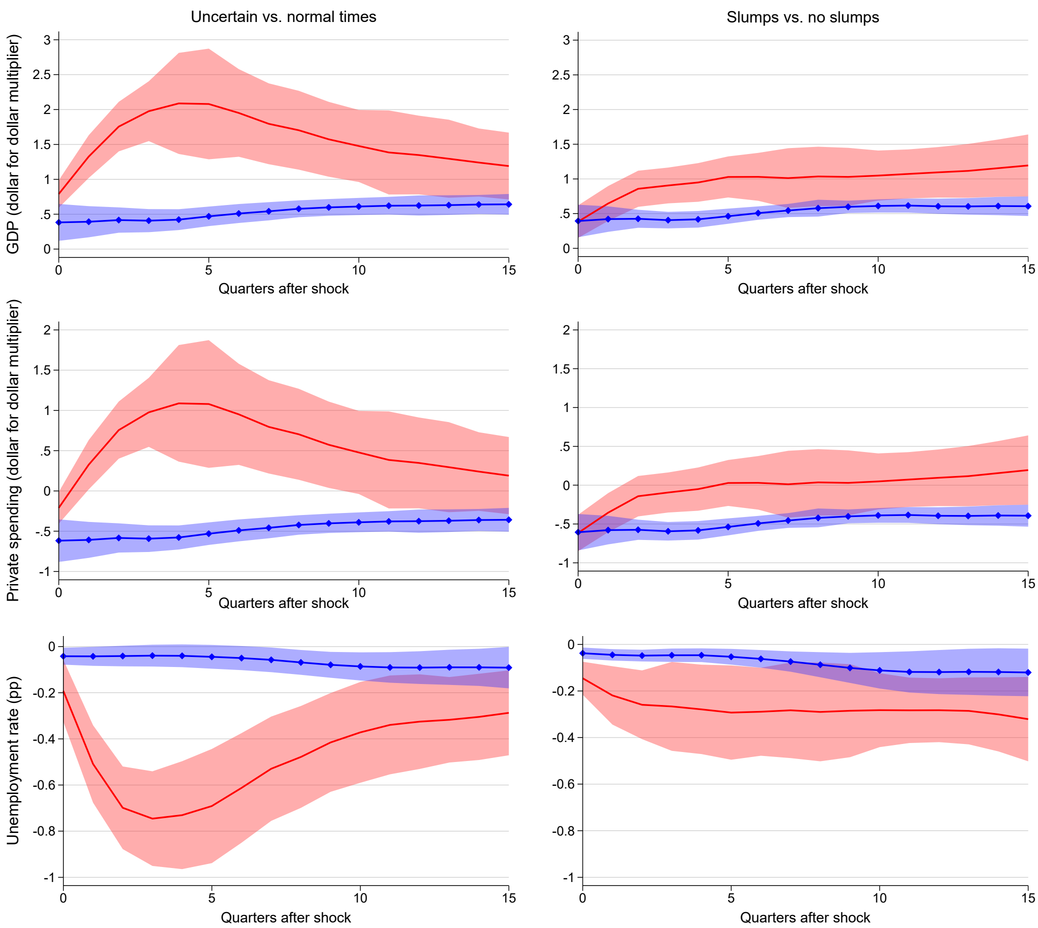

Figure 3.9 Macroeconomic effects in uncertain times and economic slumps. The figure shows cumulative multipliers to a Blanchard-Perotti shock in uncertain or slump (both in red) as opposed to normal times (in blue with markers) together with 90% heteroskedasticity and serial correlation robust confidence intervals.

these multipliers are dollar to dollar multipliers. In case of the other variables, it is the cumulative change in x divided by the cumulative change in government spending, expressed in percentage points (pp) of potential GDP, at the same horizon. If e.g. x denotes the unemployment rate, the change is measured in percentage points.

Figure 3.9 depicts the estimated multipliers for a range of macroeconomic variables. The red lines indicate multipliers for the high uncertainty (or economic slump) state while the blue line with markers depicts the normal times multipliers. Periods with the NVIX above the 85th percentile are classified as uncertain. Slump episodes correspond to periods with an unemployment rate above 6.5%. One year after the shock, the output multiplier is as high as two during uncertain times, in slumps, however only around one. This is in line with the crowding in of private consumption and investment during uncertain times as shown in the second row. During slumps, public spending does not crowd out private expenditures but it does not crowd it in, either. Leduc and Liu (2016) interpret uncertainty shocks as negative aggregate demand shocks. In times of elevated uncertainty and reduced private spending, the government is able to increase demand and employment, shown by the significant decline in the unemployment rate in the bottom panel. Without the increase in public demand firms

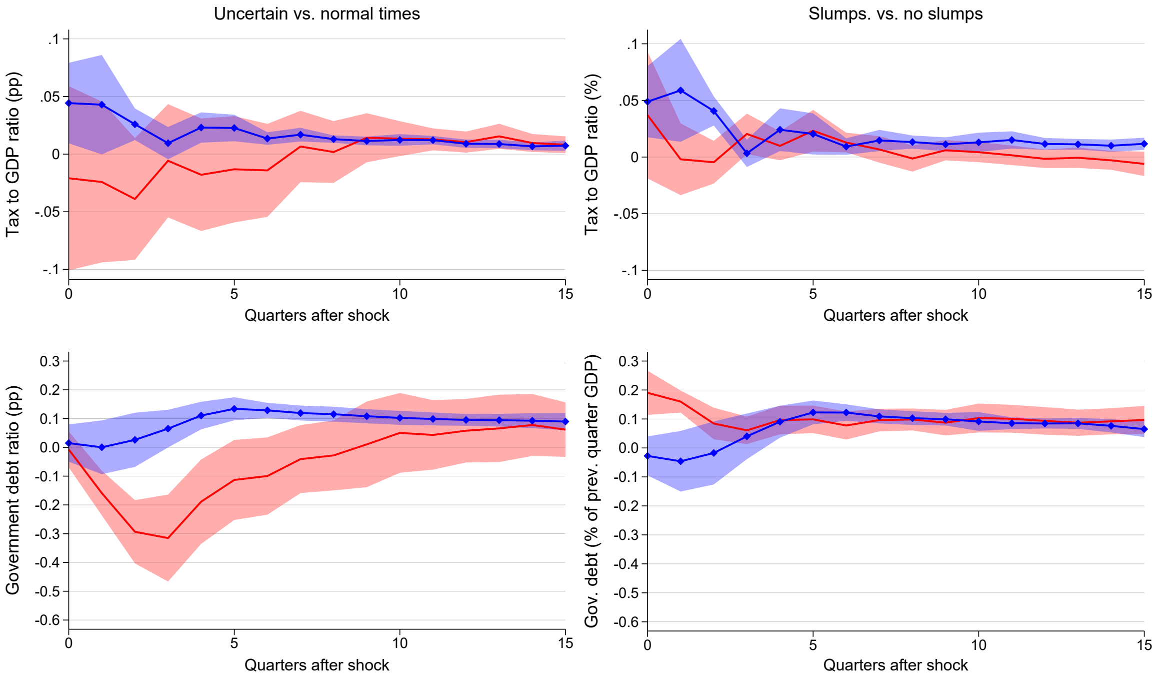

Figure 3.10 Public finances in uncertain times and economic slumps. The figure shows cumulative multipliers to a Blanchard-Perotti shock in uncertain or slump (both in red) as opposed to normal times (in blue with markers) together with 90% heteroskedasticity and serial correlation robust confidence intervals.

would not hire new workers due to the real options channel.

Figure 3.10 examines whether the larger HU multipliers are due to different forms of public funding. In normal times, the increase in government spending is tax-financed in the short term whereas the debt ratio rises after one year. Furthermore, the results indicate a combination of spending increases with tax cuts during uncertain times which are, however, not significant. The most interesting finding is the negative debt multiplier due to the large output multiplier in uncertain times. In contrast, the short-run debt ratio increases during slumps.

Figure 3.11 examines whether the higher multipliers in uncertain times are due to accommodative monetary policy. The real interest rate decreases significantly in the HU state, while it decreases only slightly during elevated unemployment. Although the second row shows a more accommodative monetary policy in uncertain times, the real interest rate falls primarily due to the rise in inflation. Government demand may save the economy from a deflationary spiral due to the decline in private spending.[20] Vavra (2013) shows that price flexibility increases in times of high volatility, which can also explain the strong price increase in the short run, which we do not observe in times of elevated unemployment. The impact of decreased real interest rates is twofold. On the one hand, investments become more attractive; on the other hand, precautionary saving becomes less attractive because the interest yield declines.

[20] Indeed, the inflation rate has a mean of about 0.6 in the high uncertainty regime and 2.8 during normal times.

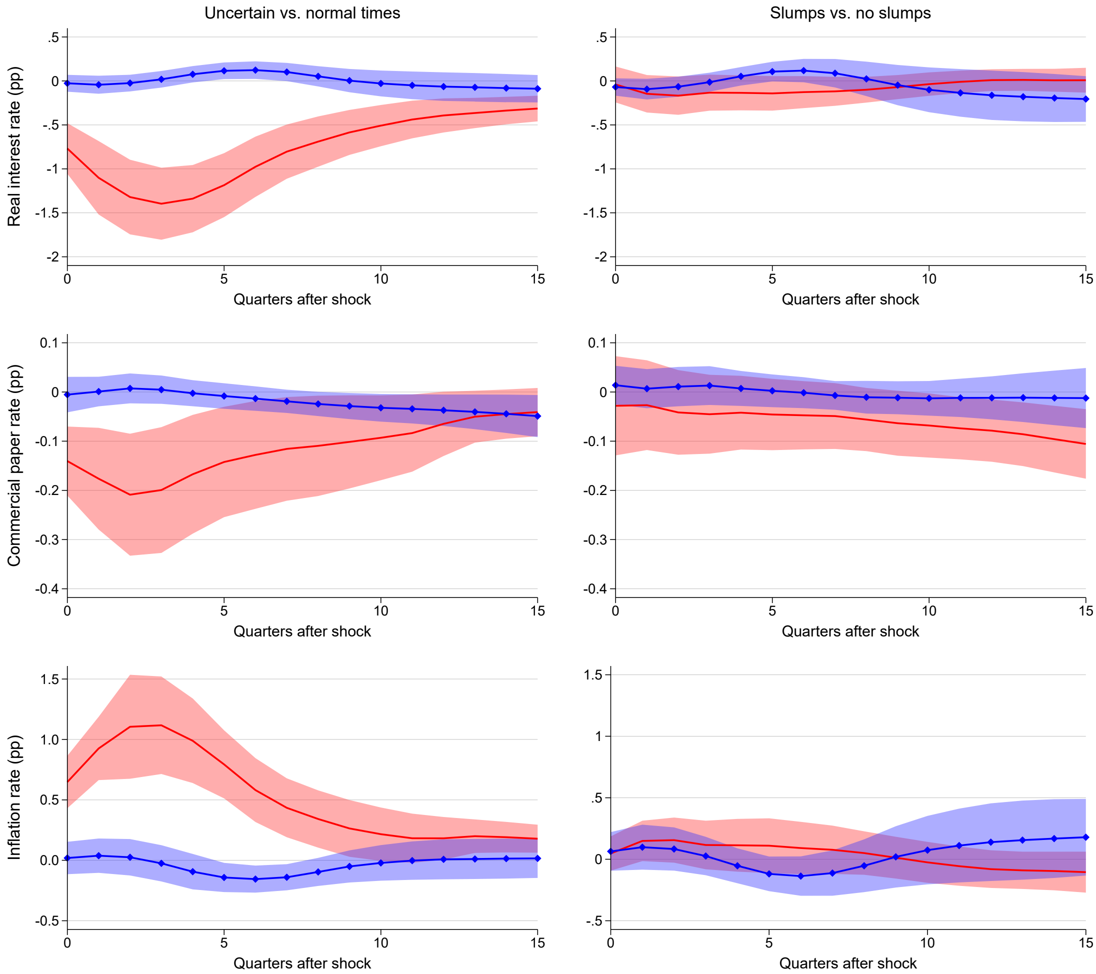

Figure 3.11 Monetary policy response in uncertain times and economic slumps. The figure shows cumulative multipliers to a Blanchard-Perotti shock in uncertain or slump (both in red) as opposed to normal times (in blue with markers) together with 90% heteroskedasticity and serial correlation robust confidence intervals.

Figure 3.12 shows the estimated multipliers for a number of financial market variables. In times of high uncertainty, the increase in government spending significantly lowers risk premiums firms have to pay. Thereby, it crowds in private investments when firms have difficulties to finance their activities. In combination with lower real interest rates, investment now becomes more attractive for companies. This effect can outweigh the decline through the real options channel. Furthermore, the figure depicts an increase in stock prices in times of high uncertainty and recessions. This is in line with the confidence channel of government spending in Bachmann and Sims (2012). Additionally, it gives us confidence that the findings are not the result of fiscal foresight. Stock prices are forward-looking by their very nature and if the government spending shock is anticipated, we should not find significant multipliers. Fiscal policy might also directly reduce stock market uncertainty. However, the NVIX multiplier turns out to be insignificant at all horizons. The bottom panel shows the multiplier for the financial stress index of Püttmann (2018). The decline of financial stress is in line with lower risk premiums in times of intense uncertainty in response to the rise in public demand.

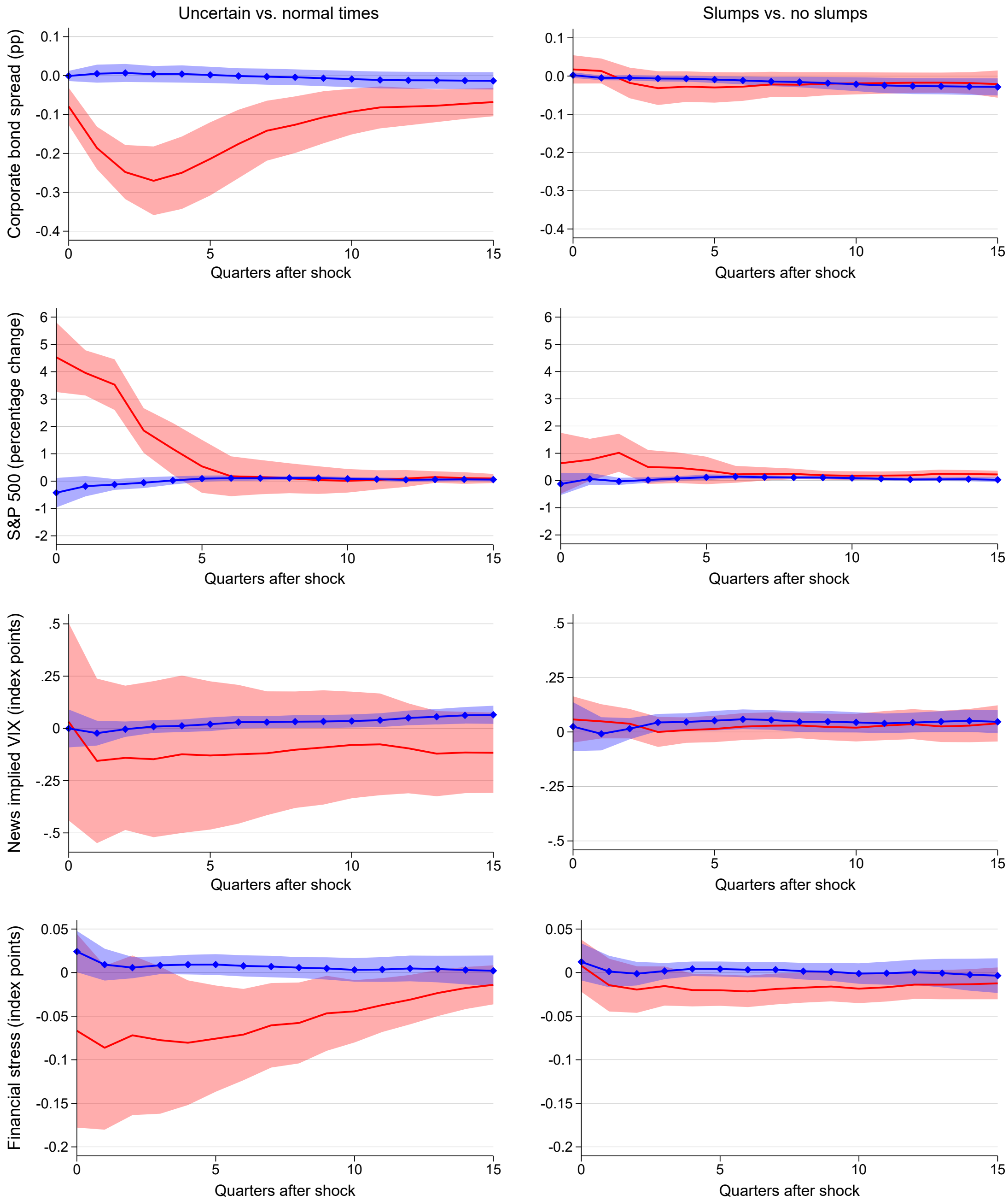

Figure 3.12 Financial effects in uncertain times and economic slumps. The figure shows cumulative multipliers to a Blanchard-Perotti shock in uncertain or slump (both in red) as opposed to normal times (in blue with markers) together with 90% heteroskedasticity and serial correlation robust confidence intervals.

3.5 Conclusions

We investigate whether government spending multipliers vary depending on the degree of uncertainty and slump in the economy. We use quarterly data spanning more than 120 years for the United States to maximize the amount of variation in the data in order to reveal state-dependent multipliers. To do so, we extend the dataset from Ramey and Zubairy (2018) with a broad set of macroeconomic and financial variables.

Using local projections, we find that the cumulative government spending multiplier rises with the uncertainty level prior to the fiscal easing. During uncertain times, the one-year government spending multiplier is about two. This result is robust across a broad range of specifications and identifying assumptions about the government spending shock. Hence, public expenditures crowd in private demand during uncertain episodes. At first sight, this comes as a surprise. According to the uncertainty theory, firms postpone investment as well as hiring decisions and consumers increase their precautionary savings faced with prevalent uncertainty. Indeed, Bloom et al. (2018) model fiscal policy as a wage subsidy and show that the effects of such a policy is smaller when implemented at the time uncertainty first hits the economy but slightly larger when the policy is conducted one year later.

However, Leduc and Liu (2016) interpret an uncertainty shock as an aggregate demand shock as it increases unemployment and lowers inflation. The economy faced with sharply increased uncertainty, we find that expansive public spending lowers unemployment and raises inflation which on the one hand prevents a deflationary spiral and on the other hand generates additional investment incentives by effectively lowering the real interest rate. The latter also reduces precautionary saving incentives. The finance conditions are further improved through diminished risk premiums for firms. Moreover, we find an increase in stock prices consistent with the confidence channel in line with Bachmann and Sims (2012). By tackling the effects of uncertainty, increasing public demand turns out to be more effective, not less as suggested by other empirical studies which tend to focus on shorter historical data excluding for example the Great Depression.

With respect to the economic cycle, we find slightly larger multipliers than Ramey and Zubairy (2018) around one in periods of increased unemployment. Our analysis shows that the expansive public spending increases employment as well as confidence in the economy, witnessed by the positive response in stock prices. However, there is neither evidence for a substantial rise in inflation, lowering the real interest rate, nor do we find decreasing risk premiums. Both channels have primary effects on economic decisions and can explain why government spending crowds in private demand during uncertain episodes. Contrary to this, in economic slumps, public spending does not displace it, but it does not strengthen it either.

B Appendix to Chapter 3

B.1 Data appendix

Table B.1 Data description

Variable	Source / Construction
Nominal government consumption and gross investment	Ramey and Zubairy (2018)
Nominal GDP	Ramey and Zubairy (2018)
GDP deflator	Ramey and Zubairy (2018)
Real government consumption and gross investment	Nominal government consumption and gross investment divided by GDP deflator.
Real GDP	Nominal GDP divided by GDP deflator.
Military news	Ramey and Zubairy (2018). The underlying narrative is available in Ramey (2016a).
Nominal Federal current receipts	Ramey and Zubairy (2018), NIPA accrual basis.
Real potential GDP	CBO real potential GDP is available from 1949Q1. We regress the logarithm of real GDP on a cubic trend for the period from 1889Q1 to 1956Q4. We then splice the predicted real GDP with the CBO potential when it's available. Choosing 1956Q4 as the end of the regression leads to a very smooth transition between both series.
News implied VIX	Manela and Moreira (2017). We take quarterly averages of monthly values. The news implied VIX is not available in 1892Q1 and 1892Q2. We replace these missing values with nearest neighbour interpolation.
S&P 500	Homepage of Robert Shiller. We take quarterly averages of the monthly S&P 500 price index. In the estimation, we use the log difference between two quarterly values and multiply this with 100.
Commercial paper rate	1875-1983: Balke and Gordon (1986), 1875-1889: commercial paper rate in New York City, 1890-1980: 4-6m prune com. paper from Gordon "Price inertia", 1981-83: 6m com. paper from various issues of the FED, from 1984: 6m treasury constant maturity rate (FRED).
Baa corporate bond yields	1875-1983: Balke and Gordon (1986), FRED afterwards. 1875-1918: yields on railroad bonds, 1919 onwards: yields on Baa corporate bonds. During WWI, the market was closed in 1914Q3 and 1914Q4 resulting in missing values. Since the yields have been 6.5 % before and afterwards, we used this value to replace the missing data.
10-year treasury constant maturity rate	Homepage of Robert Shiller. We take quarterly averages of monthly values.
Corporate bond spread	Baa corporate bond yields minus 10-year treasury constant maturity rate.
Year-over-year inflation rate	Log-difference of the GDP deflator from quarter t and $t-4$ multiplied by 100.
Real interest rate	Commercial paper rate minus year over year inflation rate.
Tax receipts to GDP	Nominal federal current receipts divided by nominal GDP and multiplied with 100. In the estimation, we use the change between two quarters.
Government debt	Ramey and Zubairy (2018). Nominal federal debt in the hands of the public, cash basis.
Government debt to GDP	Government debt divided by nominal GDP in the previous quarter and multiplied with 100. In the estimation, we use the change between two quarters.
NBER recession indicator	Ramey and Zubairy (2018)
Civilian unemployment rate	Ramey and Zubairy (2018)
Financial stress index	Püttmann (2018). We take quarterly averages of monthly values.
Economic policy uncertainty	Baker et al. (2016). We take quarterly averages of monthly values.
Macroeconomic uncertainty	Homepage of Sidney Ludvigson. We take quarterly averages of monthly values with $h=3$.

Variable	Source / Construction
Financial uncertainty	Homepage of Sidney Ludvigson. We take quarterly averages of monthly values with $h = 3$.
VXO	Yahoo Finance. We take quarterly averages of daily close values.
Realized stock market volatility	We use daily returns to the Standard and Poor's (S&P) composite portfolio from Bloom (2009) and Yahoo Finance to calculate annualized monthly stock return volatility. We normalize this volatility to have the same mean and standard deviation as the VXO on the overlapping sample. We take quarterly averages of monthly values.

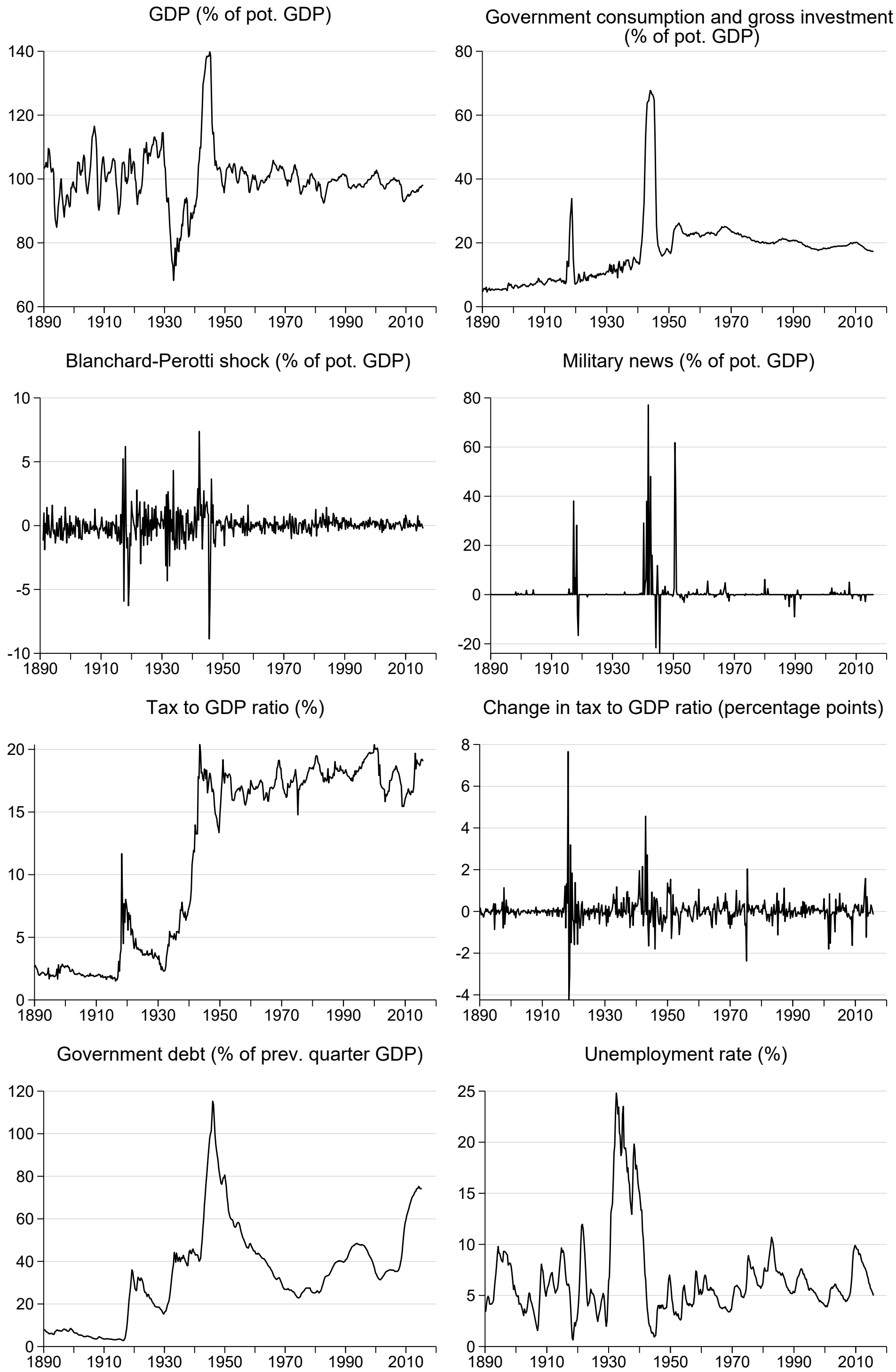

Figure B.1 Real variables through time

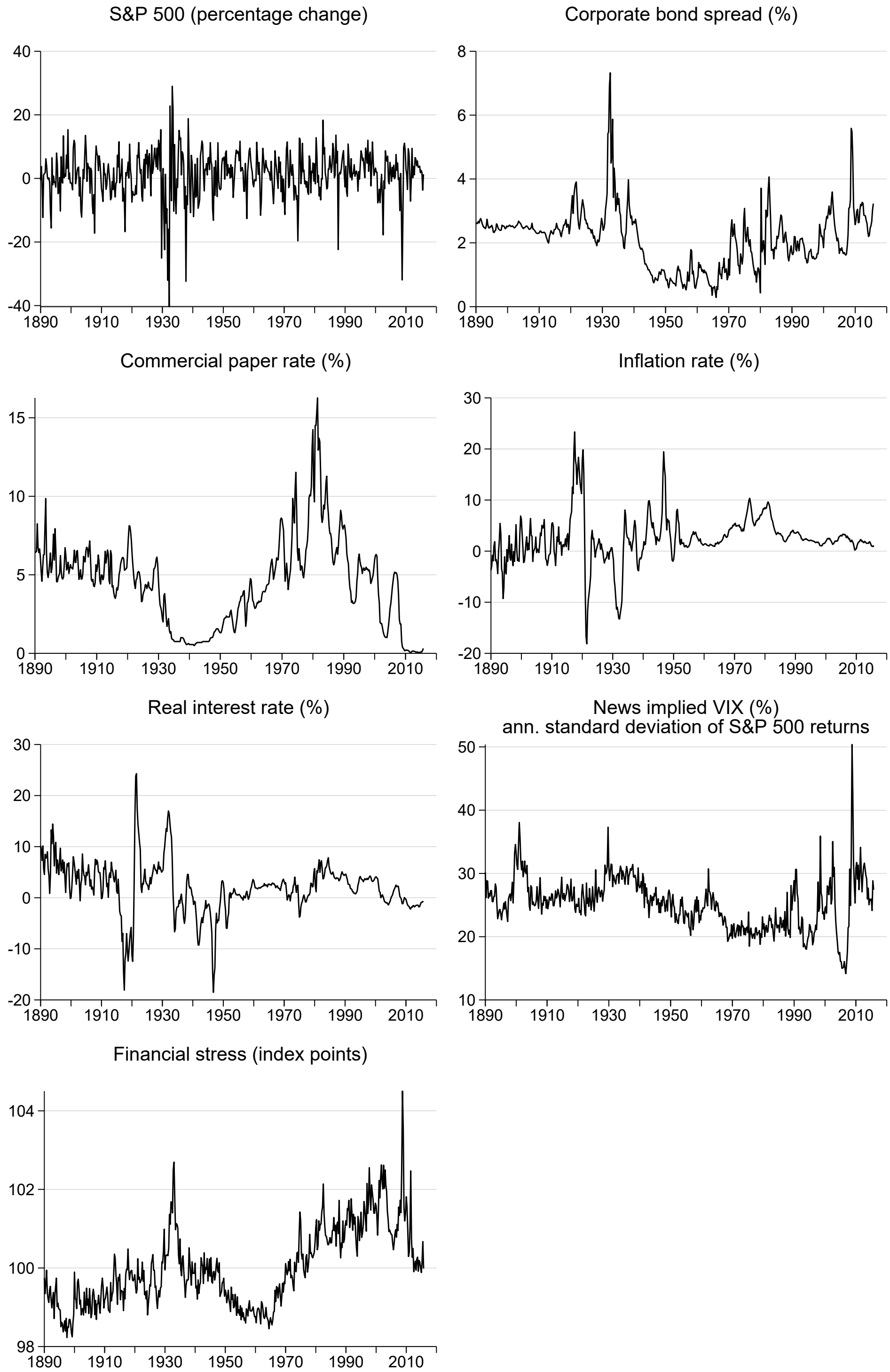

Figure B.2 Financial variables through time

B.2 Further robustness checks

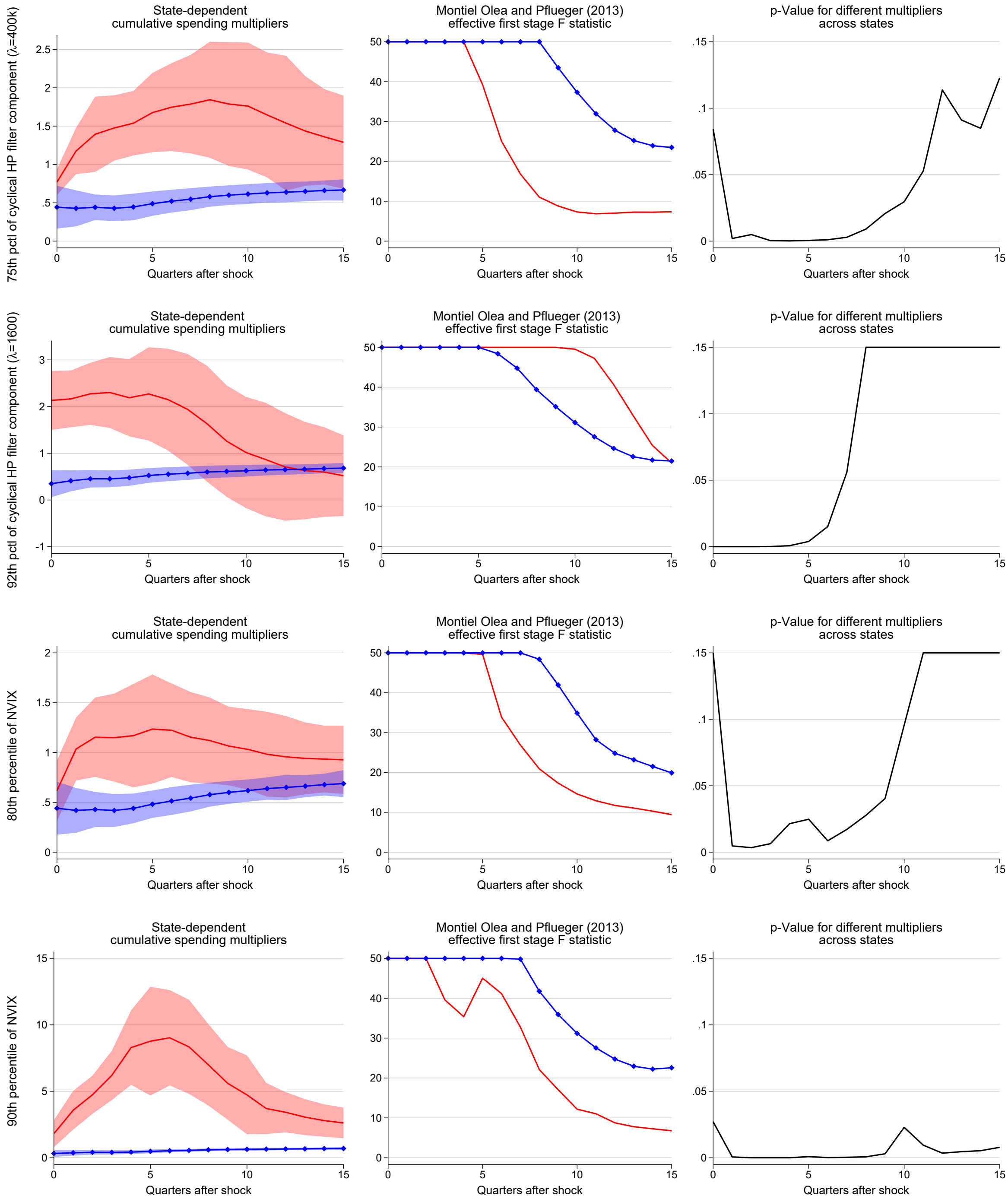

Figure B.3 Cumulative multipliers considering different thresholds. The figure shows cumulative government spending multipliers to a Blanchard-Perotti shock during uncertain (in red) and normal times (in blue with markers). 90% confidence intervals are shown in all cases. All statistics are robust to heteroskedasticity and serial correlation. In the upper panel, we choose $\lambda = 400000$ for two reasons: First, Drehmann et al. (2012) emphasize the importance of the medium cycle for some financial variables. Second, it allows us to choose a time-varying threshold without classifying a large fraction of the Great Depression to be classified as normal episodes. In the second row, we choose $\lambda = 1600$ and classify episodes above the 92th percentile of the cyclical HP-filter component as uncertain to identify extreme events.

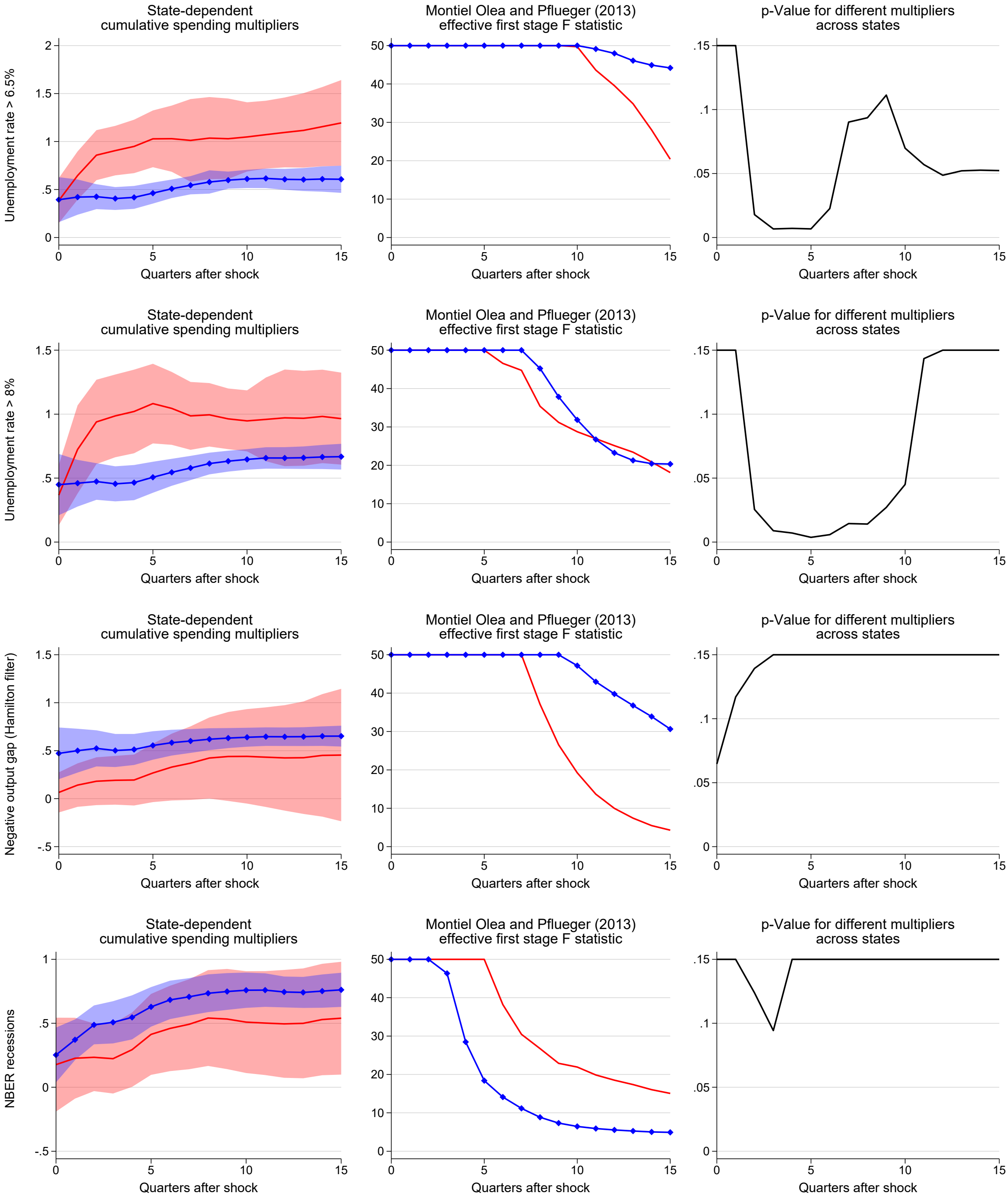

Figure B.4 Cumulative multipliers over the economic cycle. The figure shows cumulative government spending multipliers to a Blanchard-Perotti shock in slumps (in red) and normal times (in blue with markers). 90% confidence intervals are shown in all cases. All statistics are robust to heteroskedasticity and serial correlation.

B.3 Comparison with other papers

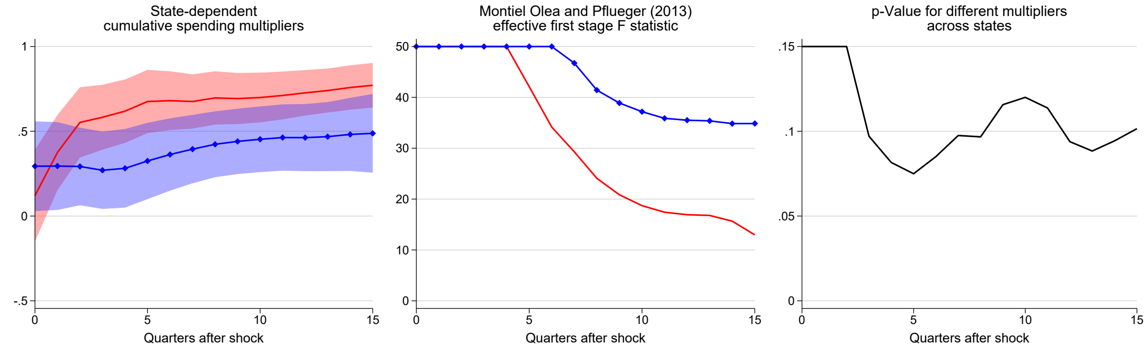

Figure B.5 The included variables explain the higher slump multipliers than in Ramey and Zubairy (2018). The figure shows cumulative government spending multipliers to a Blanchard-Perotti shock during slumps (unemployment rate above 6.5%, in red) and normal times (in blue with markers). We include four lags of real government spending and real GDP (both in % of potential GDP) as well as a cubic deterministic time trend. 90% confidence intervals are shown. All statistics are robust to heteroskedasticity and serial correlation. This figure depicts smaller slump multipliers compared to the first row in Figure B.4 which follows our baseline specification. Consequently, Ramey and Zubairy (2018) estimate too low multipliers by omitting various variables (stock price changes, tax changes, the real interest rate, and the corporate bond spread).

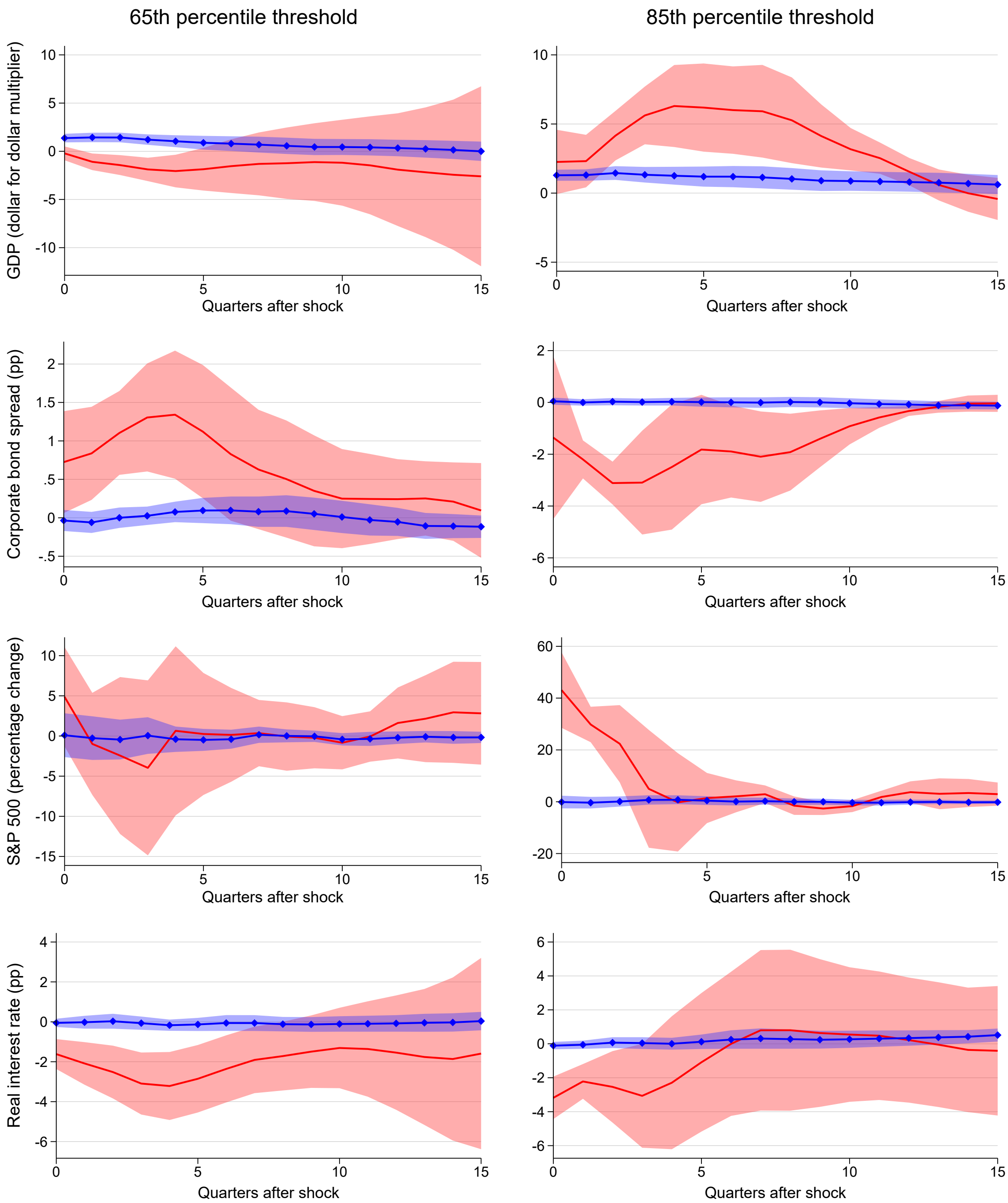

Figure B.6 Different threshold values explain the deviating results from Jerow and Wolff (2022). The figure depicts cumulative multipliers to a Blanchard-Perotti shock during uncertain (in red) and normal times (in blue with markers) with 90% heteroskedasticity and serial correlation robust confidence intervals. We include the same set of variables as in the baseline specification. Uncertainty is proxied with macroeconomic uncertainty from Ludvigson et al. (2021) which restricts the sample period to 1960Q3–2015Q4. The left column defines HU periods with uncertainty above the 65th percentile (77 HU periods) as in Jerow and Wolff (2022). It is apparent from the right column that increasing the threshold to the 85th (38 HU periods) percentile changes the sign of the GDP multiplier from negative to positive. This can be explained with a change in the responses of key transmission variables. By reducing the corporate bond spread and increasing confidence, the rise in public demand crowds in private demand in very uncertain periods while it can actually increase the risk premium and hence dampen private investment at lower thresholds.

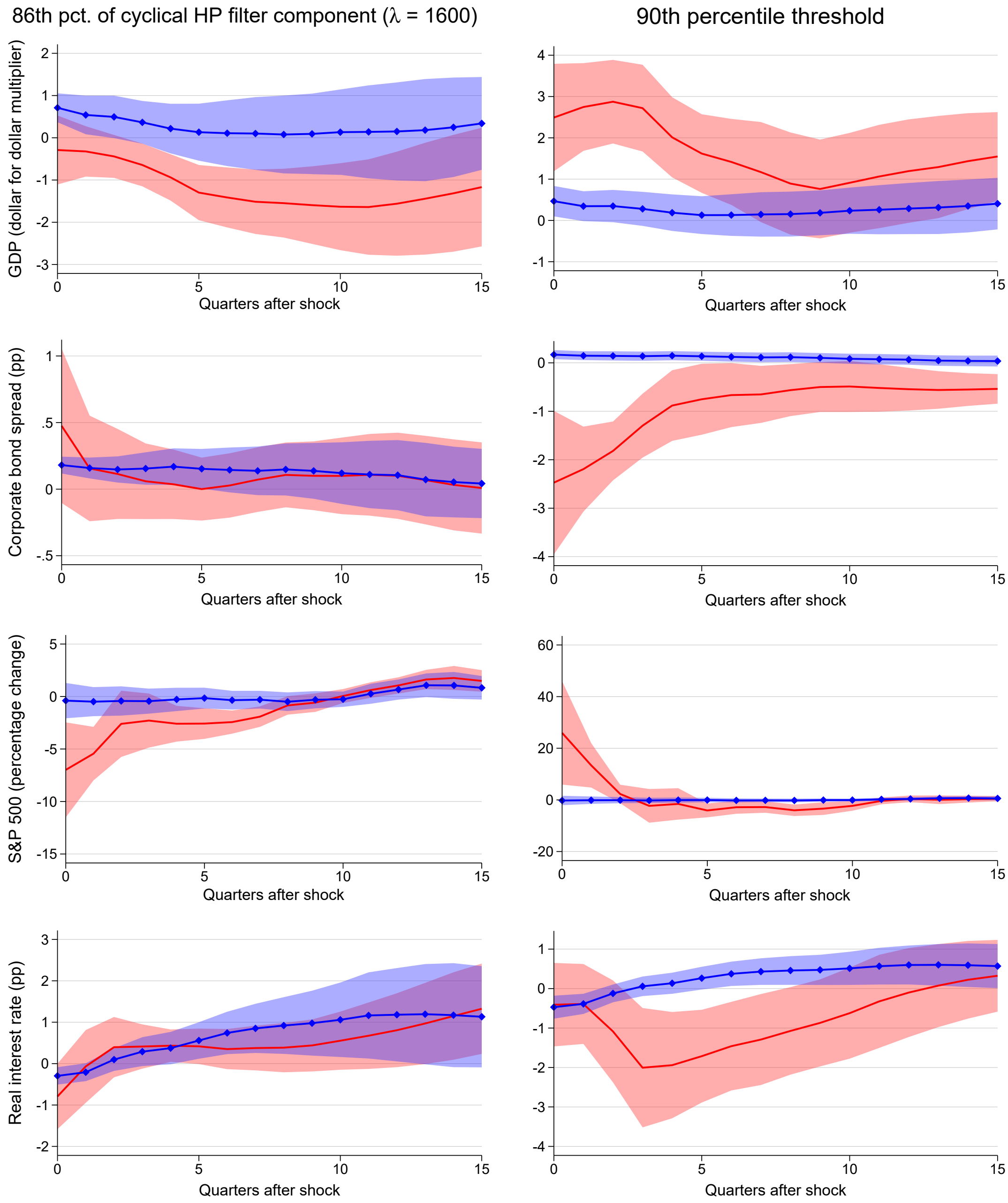

Figure B.7 Different threshold values explain the deviating results from Alloza (2019). The figure depicts cumulative multipliers to a Blanchard-Perotti shock during uncertain (in red) and normal times (in blue with markers) with 90% heteroskedasticity and serial correlation robust confidence intervals. We include the same variables as in the baseline specification. To compare our results, we estimate the multipliers over the sample period 1947Q1–2015Q4 and measure uncertainty by realized stock market volatility (before 1986) and the VXO afterwards. The left column replicates the lower multiplier in uncertain times from Alloza (2019) when we classify periods as uncertain if the volatility is above the 86th percentile of a cyclical HP-filter component (38 HU periods). For the right column, we use the 90th (28 HU periods) percentile as the threshold and include only three lags due to the low number of HU periods. It is apparent that increasing the threshold replicates our finding of a larger multiplier during uncertain periods. Importantly, these different GDP multipliers are backed by changes in multipliers for important transmission variables like the corporate bond spread, stock returns and the real interest rate.

4

The impact of public consumption and investment in the euro area during periods of high and normal uncertainty

Abstract

The new millennium featured several periods of high uncertainty in which fiscal policy responded as expansionary. The literature focuses heavily on the United States and does not distinguish between different effects of public consumption and investment. We estimate multipliers for both government spending components using local projections and quarterly panel data from 1999 to 2019 for the euro area countries. In times of high economic uncertainty, an increase in public consumption or investment of one euro increases GDP by about one and two euros, but only 0.4 euros in normal episodes. The larger output effect of public consumption during uncertain periods results from additional employment and increased labor income because of higher real wages which raise inflation. Government investment substantially increases GDP through productivity improvements that are partly transferred to workers via higher wages. Due to the positive supply effect, government investment, unlike consumption, is not inflationary.

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JEL classification:	E62, E32, E31

4.1 Introduction

In the Great Recession as well as the Covid-19 crisis, many governments responded with expansionary fiscal policy measures to support the economy and to prevent a prolonged slump. The impact of such policies is measured by the fiscal/output multiplier, which reflects the increase in output from additional euro in government spending or a tax cut of one euro. Theory shows that these multipliers depend on details of the respective situation, the mode of financing, the degree of financial frictions, the monetary policy stance as well as the labor market situation (Ramey, 2011a, 2019).

In recent years, the economic profession has begun to study the impact of uncertainty on the effects of expansionary fiscal and monetary policies. According to alleged channels of uncertainty, firms postpone investment as well as hiring decisions due to a real options channel (Bernanke, 1983; Bloom, 2009; Dixit, 1989) and consumers increase their precautionary savings (Challe et al., 2017; Leland, 1968; Lusardi, 1998) when faced with elevated uncertainty. Moreover, policymaking can also be the source of uncertainty (Baker et al., 2016; Born and Pfeifer, 2014). Hence, not surprisingly, there is only mixed evidence on the impact of uncertainty on the efficacy of fiscal policy.

In line with the real options channel, one strand of the literature argues for weaker or even negative output effects of expansive fiscal policy. On the theoretical side, Bloom et al. (2018) show that the output impact of wage subsidies during uncertain times is lower than in normal episodes because firms become more cautious in responding to price changes. On the empirical side, Alloza (2019) and Belke and Goemans (2022), both using post World War II data for the United States, find increases in government spending during uncertain times to confirm private sector's belief that times are bad, thereby elevating uncertainty even more and reducing confidence as well as private spending. Jerow and Wolff (2022) and Fritsche et al. (2021) also find lower output responses/multipliers during episodes of high uncertainty/volatility. Related to policy uncertainty, Ricco et al. (2016) show that, during periods of high disagreement on fiscal policy, public spending has weaker output effects compared to episodes of low disagreement.

In contrast, Leduc and Liu (2016) view increases in uncertainty as negative demand shocks because they raise unemployment and mute the price level.[1] In line with this reasoning, Goemans (2022) finds evidence for larger GDP multipliers during times of heightened uncertainty using quarterly historical US data back to 1890. In this situation, it seems reasonable that the increase in public demand does not crowd out private demand. Exploring why the results differ from the previous literature, the author shows that increasing government spending turns out to be particularly effective in episodes of very large uncertainty which

[1] Kumar et al. (2021) show that uncertainty shocks behave like demand shocks in advanced economies but act like supply shocks and induce inflation pressure in emerging economies. It is reasonable to assume that uncertainty shocks act like demand shocks in the euro area members because these are classified as advanced economies by the International Monetary Fund.

occur more often in longer sample periods including the Great Depression.[2]

Against this background, we contribute to the literature in several ways. First, we use a panel of euro area countries and Jordà (2005) local projections to estimate cumulative government spending multipliers in uncertain and normal times. To the best of our knowledge, we are the first who consider this research question from a European perspective. We are interested in economic and not policy uncertainty, so we use the index from Rossi and Sekhposyan (2017) that measures uncertainty in output growth forecasts.[3] Second, since Boehm (2020) has shown that public consumption and investment can affect the economy very differently, we allow for different multipliers for both components of government spending in a linear and in a threshold model that incorporates the level of uncertainty in the economy.

In order to analyze the impact of unexpected increases in government spending, we follow Blanchard and Perotti (2002) and assume that policymakers need at least one quarter to decide on, approve and implement discretionary policy measures. We tackle the fiscal anticipation problem (Leeper et al., 2013; Ramey, 2011b) by including forecasts for government consumption and public investment from the European Commission as in Mencinger et al. (2017) in the set of control variables. Regarding the criticism of Caldara and Kamps (2017) on using timing restrictions for the identification of fiscal policy shocks, we show that neither government consumption nor public investment respond to economic activity within the same quarter.

Our results are as follows. In a linear model, we find one-year GDP multipliers for public consumption and investment of about 0.6 although the confidence bands range from 0.25 to one. Conditional on being in a state of high economic uncertainty, government spending turns out to be more effective with one-year multipliers close to one for government consumption and close to two for public investment. During times of normal uncertainty, the estimated one-year output multipliers for both spending types turn out to be small with values close to 0.4 euro per euro of government spending.

Our third contribution is to provide cumulative multipliers for a wide range of variables in order to explain the larger GDP multipliers during uncertain episodes. Conditional on being in a state of high uncertainty, public consumption stimulates the labor market at the extensive and the intensive margin. Thus, more people become employed and those who are employed also work more. It is worth noting that unemployment declines more sharply for people younger than 25. Moreover, real wages rise such that households consume more and part of the extra income is available in the form of increased savings for private investment. Although government consumption increases GDP in the same quarter by more than one euro, the one-year multiplier is close to one because public consumption does not induce

[2] To illustrate this point, Goemans (2022) replicates the results of Alloza (2019) and Jerow and Wolff (2022) with similar samples and threshold values as in their analysis. Once the author focuses on more extreme periods, using higher thresholds, he finds evidence for larger multipliers during uncertain times.

[3] We obtain similar results if we use the index proposed by Ozturk and Sheng (2018).

persistent productivity improvements.

The transmission channel for government investment shows a different picture. Since private investment would decline anyway in times of high uncertainty due to the real options channel, it is less crowded out by public investment. As a result, the increase in government investment leads to stronger productivity gains than in normal times or through additional public consumption. Households benefit from the increase in labor productivity via rising real wages and increase their consumption. The different productivity effects have implications for inflation. While public consumption is inflationary due to the positive aggregate demand effect, public investment is deflationary because of the positive supply effect owing to improved labor productivity. Thereby, our paper augments the results in Jørgensen and Ravn (2022) who explain deflationary increases in government spending (consumption + investment) with time-varying adoption of new technology into the production process. As we show, public investment is indeed deflationary but government consumption is inflationary.

The remaining of the paper proceeds as follows. Section 4.2 elucidates the empirical approach. Section 4.3 shows and discusses the results for the GDP multipliers in the linear and threshold models. In addition, we examine the plausibility of the slope homogeneity assumption, the importance of the underlying type of uncertainty (economic or policy) for the results and whether uncertainty and not the business cycle is genuinely responsible for the larger GDP multipliers. Section 4.4 investigates various transmission variables to rationalize the larger output multipliers during uncertain periods as well as for public investments. Section 4.5 concludes.

4.2 Empirical strategy

We estimate linear and state-dependent government spending/output multipliers using local projections as proposed by Jordà (2005) and as applied in the fiscal policy literature for instance by Auerbach and Gorodnichenko (2013), Ramey and Zubairy (2018), Miyamoto et al. (2018) and Goemans (2022).

We follow Ramey and Zubairy (2018) and estimate the cumulative GDP multiplier which measures the cumulative change in real GDP relative to the cumulative change in real public consumption, $g^{c}_{i,t}$, or real government investment (capital formation), $g^{cf}_{i,t}$, up to quarter $t+h$ directly by a series of regressions at each horizon $h = 0,\dots,8$:

$$\sum_{j=0}^{h} y_{i,t+j} = \alpha_{i,h} + \lambda_{t,h} + \gamma_{i,h}t + \phi_h(L)X_{i,t-1} + m^{c}_{h}\sum_{j=0}^{h} g^{c}_{i,t+j} + m^{cf}_{h}\sum_{j=0}^{h} g^{cf}_{i,t+j} + \varepsilon_{i,t+h} \quad (4.1)$$

where the $\alpha_{i,h}$'s and $\lambda_{t,h}$'s capture horizon-specific country and time fixed effects while the $\gamma_{i,h}$'s control for country-specific linear time trends. $\phi_h(L)$ is a lag polynomial in which we allow for four lags and use the vector of control variables $X_{i,t-1}$. $\sum_{j=0}^{h} y_{i,t+j}$ refers to the sum of real GDP from quarter t to $t+h$ and the $\sum_{j=0}^{h} g_{i,t+j}^{c,cf}$'s denote the sum of real public consumption and investment from quarter t to $t+h$. Following Gordon and Krenn (2010), y and g are normalized to percent of potential real GDP to estimate euro for euro multipliers. We obtain the cumulative GDP multipliers $m_h^{c,cf}$ as well as the respective standard errors from a two stage least squares (2SLS) regression using $g_{i,t}^{c}$ and $g_{i,t}^{cf}$ as instruments for $\sum_{j=0}^{h} g_{i,t+j}^{c}$ and $\sum_{j=0}^{h} g_{i,t+j}^{cf}$. Throughout, we use Driscoll and Kraay (1998) standard errors that are robust to heteroskedasticity and account for serial and cross-sectional dependence.[4]

The key identification assumption of unexpected increases (shocks) in government consumption and investment relates to the contemporaneous relationship between those fiscal variables and their determinants, in particular output. Using $g_{i,t}^{c}$ and $g_{i,t}^{cf}$ as instruments for $\sum_{j=0}^{h} g_{i,t+j}^{c}$ and $\sum_{j=0}^{h} g_{i,t+j}^{cf}$, we follow Blanchard and Perotti (2002) and assume that government consumption and investment, unlike transfers, do not contain components that automatically fluctuate with the business cycle and that policymakers need at least one quarter to decide on, approve and implement discretionary changes in fiscal policy. Therefore, public consumption and investment are assumed to respond to past economic developments.

The literature has identified two potential problems with the Blanchard and Perotti (2002) identification: the fiscal foresight/anticipation problem (Leeper et al., 2013; Ramey, 2011b) and the possibly contemporaneous response of fiscal policy to macroeconomic developments, most importantly output, as outlined in Caldara and Kamps (2017) for the United States. The fiscal foresight problem arises when economic agents do not only react to actual increases in government spending, but also to news about forthcoming future expenditure plans. In this situation, the econometrician can not recover the true unexpected fiscal shocks because of an information misalignment between economic agents and the econometrician (Leeper et al., 2013). Some researchers suggest to include a news variable in the empirical model that captures anticipated changes in government spending (Ramey, 2011b). Others add a series of professional forecasts for public spending to the set of control variables (Auerbach and Gorodnichenko, 2013, 2012; Forni and Gambetti, 2016; Mencinger et al., 2017). Another strand in the literature proposes to include forward-looking variables as controls since they may capture information about changes in future fiscal policy (Beetsma and Giuliodori, 2011; Corsetti et al., 2012; Yang, 2007).

Forni and Gambetti (2016) argue that public spending over the next year might be well anticipated, but the exact timing across different quarters is highly unpredictable. Therefore, we include forecasts for government consumption over the next two years as well as forecasts for public investment over the next two years. Unfortunately, in contrast to the United States with the Survey of Professional Forecasters, there are no quarterly forecasts available for the euro area countries. Instead, the European Commission only provides semiannual origin

[4] Stock and Watson (2018) and Plagborg-Møller and Wolf (2021) provide recent econometric treatments of the local projection framework.

(spring and autumn) forecasts for the yearly growth in government consumption and the ratio of public investment to GDP. We transform those forecasts to quarterly origin projections for government consumption and public investment over the next two years (see Section C.1.2 for a detailed description).[5] Regarding the criticism of Caldara and Kamps (2017), we show that neither government consumption nor public investment respond to economic activity within the same quarter (see Section 4.3.1). This is not unexpected as government consumption and investment, unlike transfers, do not contain components that automatically fluctuate with the business cycle and due to decision and implementation lags in fiscal policy.

Besides of the contemporaneous values and four lags of the forecasts for government consumption over the next two years and the predictions for public investment over the next two years, $X_{i,t-1}$ includes four lags of the following variables: real government consumption as well as investment, real GDP, real net tax revenues (tax revenues minus subsidies), the real interest rate on long-term government bonds as well as the economic sentiment index of the European Commission and the unemployment rate.[6] The sentiment index and the unemployment rate entail information about future economic activity and serve to capture the possibly systematic response of fiscal policy to output if these are not already captured by the forecasts. Moreover, the unemployment rate controls for differences in labor market slack across countries. The real interest rate is included because Yang (2007) argues that interest rates and prices might entail information about future fiscal policy. Furthermore, the interest rate serves as a control for monetary policy and for larger required risk premiums if considerable public debt has been accumulated.[7]

The major aim of the paper is to provide cumulative GDP multipliers conditional on the degree of uncertainty in the economy. For this purpose, we use a threshold model version of Equation (4.1) which conditions the output multiplier on the uncertainty level:

$$\begin{aligned}\sum_{j=0}^{h} y_{i,t+j} =& I\left(unc_{i,t-1}\right)\left\{\alpha_{i,h}^{HU} + \phi_h^{HU}(L)X_{i,t-1} + m_h^{c,HU}\sum_{j=0}^{h} g_{i,t+j}^{c} + m_h^{cf,HU}\sum_{j=0}^{h} g_{i,t+j}^{cf}\right\} \\ &+ \left[1 - I\left(unc_{i,t-1}\right)\right]\left\{\alpha_{i,h}^{NU} + \phi_h^{NU}(L)X_{i,t-1} + m_h^{c,NU}\sum_{j=0}^{h} g_{i,t+j}^{c} + m_h^{cf,NU}\sum_{j=0}^{h} g_{i,t+j}^{cf}\right\} \\ &+ \lambda_{t,h} + \gamma_{i,h}t + \varepsilon_{i,t+h}\end{aligned} \tag{4.2}$$

[5]In the past, some authors preferred to work with semiannual data (for example Auerbach and Gorodnichenko, 2013; Boitani et al., 2022; Mencinger et al., 2017). However, we justify our transformation to quarterly forecasts as follows. First, at each point in time, the expectations are based on the information set available to economic agents, i.e. we do not use forecasts that are not available in the specific quarter. Second, working with semiannual data has severe drawbacks because it is more plausible that the government responds to the economic situation within a half year and it considerably reduces the number of observations available. Third, aggregating the uncertainty variable to a semiannual frequency might be misleading since uncertainty seems to be a rather short-lived and quickly changing state.

[6]The real interest rate is constructed as the nominal interest rate minus the year-over-year inflation rate based on the GDP deflator. The GDP deflator is used to construct real values for all national account data.

[7]We use the long-term interest rate instead of the (shadow) monetary policy rate from Wu and Xia (2020)

Herein, the cumulative GDP multipliers for an increase in public consumption $m_h^{c,HU}, m_h^{c,NU}$ and investment $m_h^{cf,HU}, m_h^{cf,NU}$ may differ at each horizon h across states of high and normal uncertainty. Furthermore, the coefficients on the country and horizon-specific fixed effects $\alpha_{i,h}^{HU,NU}$ as well as the control variables $\phi_h^{HU,NU}$ may vary across states. We use the same vector of control variables $X_{i,t-1}$ and allow for four lags. As before, the time-fixed effects $\lambda_{t,h}$ control for common shocks across countries while the γ_i's capture country-specific linear time trends. $I(unc_{i,t-1})$ is a dummy variable that indicates episodes of high uncertainty and equals one if the uncertainty measure unc is above a country-specific threshold. Note that we use $I(unc_{i,t-1})$, in line with our identification assumption that the government does not respond within the same quarter to economic conditions, to rule out contemporaneous correlations between fiscal shocks and the state of the economy.

Our baseline threshold variable unc is uncertainty in real GDP growth forecasts as proposed in Rossi and Sekhposyan (2015) and applied to 17 euro area countries with forecasts from Consensus Economics in Rossi and Sekhposyan (2017).[8] The index is based on the comparison of the realized forecast error with the unconditional distribution of forecast errors in real GDP growth. If the realized forecast error is located in the tail of the distribution, it can be concluded that the realization was very difficult to predict and hence the macroeconomic environment is very uncertain. For example, if according to the distribution of realized forecast errors, the probability of a forecast error of $x\%$ is very unlikely (e.g., a forecast error of $x\%$ is in the 95th percentile of the historical distribution of forecast errors), and the realized forecast error is actually $x\%$, then the index indicates that there is considerable uncertainty. The index from Rossi and Sekhposyan (2017) is only available until 2015Q2. However, due to the leading dependent variable in the local projection approach, the regression for $h = 8$ uses observations until 2017Q3. In contrast to other indices of economic uncertainty as proposed in Ozturk and Sheng (2018), it is available for almost all countries of the euro area.

Projection of Equation (4.2) provides the multipliers for an increase in government spending conditional on the degree of uncertainty. Formally, the cumulative multipliers at horizon h to an unexpected increase in public consumption or investment $g_{i,t}^z$ with $z = \{c, cf\}$, conditional on the economy experiencing a particular state in the previous quarter, indexed by $unc_{i,t-1}$, is given by the coefficients on $\sum_{j=0}^{h} g_{t+j}^z$ in Equation (4.2) from a 2SLS regression using $I(unc_{i,t-1}) \times g_{i,t}^z$ and $[1 - I(unc_{i,t-1})] \times g_{i,t}^z$ as instruments.[9] Thereby, the GDP multiplier at horizon h for a specific government spending type z in each period in a

because the shadow rate takes the same value for all euro area countries. Furthermore, the shadow rate takes extreme values down to -5% and -7% in 2017 and 2019, respectively.

[8] The index is available for Austria, Belgium, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Lithuania, Portugal, Slovakia, Slovenia, Spain and the Netherlands. We exclude Cyprus from our analysis since our measure of real potential GDP is not available for this country. In addition, Estonia is omitted due to the lack of data for yields on long-term government bonds.

[9] This means that we use four instruments for the endogenous regressors, the cumulative sum of government consumption and investment in each of the states, such that the equation is exactly identified.

particular country is:

$$\left.\frac{\frac{\partial \sum_{j=0}^{h} y_{i,t+j}}{\partial g_{i,t}^{z}}}{\frac{\partial \sum_{j=0}^{h} g_{i,t+j}^{z}}{\partial g_{i,t}^{z}}}\right|_{\substack{unc_{i,t-1}\\ X_{i,t-1}}} = I\left(unc_{i,t-1}\right) m_{h}^{z,HU} + \left[1 - I\left(unc_{i,t-1}\right)\right] m_{h}^{z,NU} \tag{4.3}$$

Equation (4.3) illustrates two characteristics of this approach. First, the linear multipliers for government consumption m_h^c and investment m_h^{cf} are linear combinations of the two state-dependent multipliers. Second, computing multipliers based on a single equation approach requires no additional assumptions on the economy remaining in a particular state. As discussed in Ramey and Zubairy (2018), the Jordà approach is similar to a direct forecasting method. Thereby, the estimated multiplier is a forecast of how $\sum_{j=0}^{h} y_{i,t+j}$ will differ induced by $\sum_{j=0}^{h} g_{i,t+j}^{z}$ if $g_{i,t}^{z} = 1$ compared to $g_{i,t}^{z} = 0$ conditioned on the set of control variables X_{t-1} and the uncertainty value $unc_{i,t-1}$. This means that if the average unexpected increase in public consumption or investment is likely to change the uncertainty state, this will be captured in the multipliers $m_h^{z,HU}$ and $m_h^{z,NU}$. Furthermore, the state-dependent (and horizon-specific) constants and lagged control variables will embed information on the average behavior of the economy to transit between uncertainty states at future horizons that are not due to the unexpected increases in the components of government spending.

In order to estimate Equation (4.2), we need to specify a threshold value for the uncertainty measure to distinguish between uncertain and normal periods. In principle, one can follow the approach in Goemans (2022) and estimate the difference in multipliers across states for each possible threshold value and then choose the threshold that maximizes this difference. However, since we estimate GDP multipliers for government consumption and investment in the same equation, this approach would potentially result in different optimal thresholds for both fiscal policy variables. The estimation of the multipliers for government consumption and investment in one equation has the advantage that, for instance, we control for the response of government consumption in response to a public investment shock. Moreover, from an economic perspective, there should only be one threshold to classify periods as uncertain. Therefore, we choose the 80th percentile of the respective uncertainty measure as the threshold value. This number is inspired by Bloom et al. (2007), who show that the impact of uncertainty on the annual firm investment rate is small for uncertainty values close to the median, but that it can be large at extreme levels (75th and 90th percentile). It is also close to the threshold value in Goemans (2022) who uses the 85th percentile.

If not stated otherwise, the estimation period is 1999–2019 wherein we got an unbalanced panel data set. The start of the sample period is based on several reasons: (1) the introduction of the euro for accounting purposes as well as electronic payments, (2) the data availability of tax revenues and public investment for most economies and (3) the availability of the forecasts prepared by the European Commission. The sample end is chosen due to the upcoming Covid-19 crisis in 2020 which is a rather atypical event. Fiscal policy measures during this period are likely to be endogenous which negatively affects the identification of exogenous shocks. Furthermore, several lockdowns during this period cast doubt on a normal response of economic agents to public spending increases. Moreover, the inclusion of this period would sharply impact the results of the linear model (see Lenza and Primiceri, 2022) and hence hamper the comparison with the previous literature. We describe the variables and the data sources in Table C.1 of the Appendix.

4.3 Cumulative GDP multipliers in times of high and normal uncertainty

This section presents estimated GDP multipliers for unexpected increases in government consumption and investment for the linear and the threshold model. Furthermore, we show that the cumulative output multipliers are quantitatively robust when we investigate the plausibility of the panel slope homogeneity assumption. We also investigate the impact of the type of uncertainty on our results and show that our finding of larger multipliers during uncertain episodes is not simply a result of multipliers being larger during periods of low economic activity.

Figure 4.1 shows the estimated GDP multipliers for unexpected increases in public consumption as well as government investment. As shown in the left panel, the 1-year multipliers for public consumption (in black) and investment (in dashed green) are very similar with values close to 0.6. Note also that the 90% confidence bands are relatively wide such that we can neither reject a crowding-in of private spending in response to an increase in public investment, as indicated by a multiplier of above one, nor a multiplier of zero two years after the expansionary fiscal policy. Moreover, the confidence intervals include the estimated 1-year cumulative multipliers for government spending in the euro area of 0.87 in Burriel et al. (2010) and 0.7 to 1 in Coenen et al. (2012, based on the upper right panel in their figure 6). The confidence intervals also contain many of the estimated multipliers for the United States (Ramey, 2019, compare table 1).

The linear multipliers can be interpreted as averages of the state-dependent output multipliers in the second and third panel of Figure 4.1. Herein, the red dashed-lines depict the GDP multipliers during times of high uncertainty whereas the blue lines with markers display the output multipliers during times of normal uncertainty. It is striking that the linear model masks the large GDP multipliers for public consumption and investment during episodes of high uncertainty. In particular, the estimated GDP multiplier for public consumption is above one on impact and close to one afterwards such that we do not find evidence for a crowding-out of private spending. The multiplier for public investment is one on impact and reaches its peak of about two one year after the expansionary fiscal policy

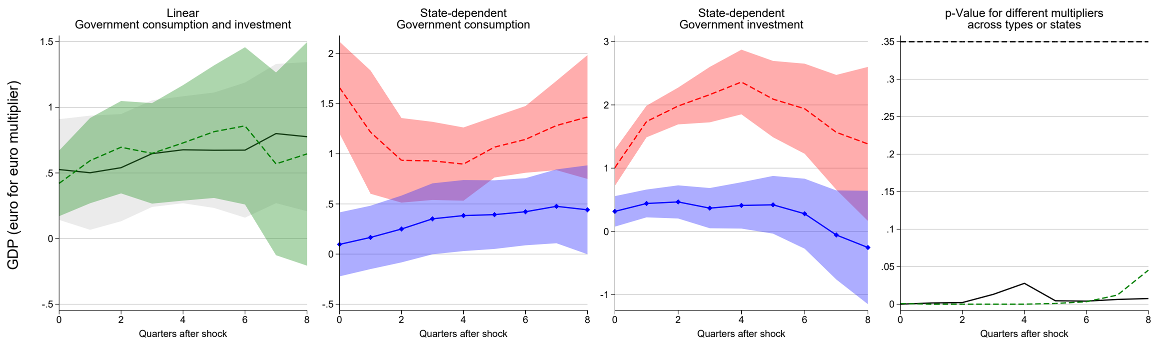


Figure 4.1 GDP multipliers. The left panel shows cumulative GDP multipliers for public consumption (black with gray confidence bands) and investment (dashed green with green confidence bands). The second and third panels show state-dependent multipliers during times of high (in dashed red) and normal (in blue with markers) uncertainty. 90% confidence intervals are shown in all cases. The right panel shows the p-values for different multipliers across types of government spending and states. The p-values (no difference across types in the linear model in dashed black and consumption (investment) across states in black (dashed green)) are capped at a maximum of 0.35 for readability reasons. All statistics are based on Driscoll and Kraay (1998) standard errors.

measure. This result is very close to the estimated multiplier for government spending (consumption plus investment) during uncertain times in Goemans (2022). In contrast, public consumption and investment turn out to be an ineffective fiscal policy tool in times of normal uncertainty with estimated multipliers close to 0.4. In the right panel, it can be seen that the differences across states are significant even at very low error levels (government consumption (investment) in black (dashed green)).

Our results provide two insights. First, the uncertainty prevalent within an economy should be taken into account when analyzing and planning fiscal policy measures. Second, it is useful to distinguish between the effects of public consumption and investment because investment is the more effective policy measure during episodes of high uncertainty. This can be rationalized, among other things, by the real options channel of uncertainty, according to which firms postpone investment because the return is more uncertain. In these situations, the public sector can make investments without crowding out those from the private sector.[10]

4.3.1 Robustness check I: test of the identification assumption

Our baseline results rely on the assumption that policymakers need at least one quarter to decide on, approve and implement discretionary fiscal policy measures (Blanchard and Perotti, 2002). This implies that government consumption as well as investment do not respond to other economic shocks, most importantly GDP, within the same quarter since both types of government spending, unlike transfers, do not contain components that automatically fluctuate with economic activity. To test the reliability of this assumption, we follow Caldara

[10] Figure C.1 in the Appendix depicts the Sanderson and Windmeijer (2016) first stage F-statistic for the linear as well as for the state-dependent GDP multipliers for government consumption and investment which is a test of weak identification of an individual regressor. As can be seen, the F-statistics are large enough such that our results should not be driven by weak instrument relevance.

and Kamps (2017) and estimate the intra-quarter response of government consumption and public investment to economic activity with the following regressions:

$$g^z_{i,t} = \alpha_i + \lambda_t + \gamma_i t + \phi(L)X_{i,t-1} + \beta^z y_{i,t} + \varepsilon_{i,t} \tag{4.4}$$

$$\begin{aligned} g^z_{i,t} =& I\left(unc_{i,t-1}\right)\left\{\alpha_i^{HU} + \phi^{HU}(L)X_{i,t-1} + \beta^{z,HU} y_{i,t}\right\} \\ &+ \left[1 - I\left(unc_{i,t-1}\right)\right]\left\{\alpha_i^{NU} + \phi^{NU}(L)X_{i,t-1} + \beta^{z,NU} y_{i,t}\right\} + \lambda_t + \gamma_i t + \varepsilon_{i,t} \end{aligned} \tag{4.5}$$

Herein, $g^z_{i,t}$ with $z = \{c, cf\}$ denotes real government consumption or investment and y_{it} denotes real GDP (all in percent of potential GDP). We include the same vector of control variables $X_{i,t-1}$ as in Equations (4.1) and (4.2) and allow for four lags. As in the baseline case, *unc* is based on the uncertainty in real GDP growth forecasts from Rossi and Sekhposyan (2017) and the 80th percentile is chosen as the threshold to distinguish between times of high HU and normal uncertainty NU. Note, however, that we can not estimate these equations with OLS due to endogeneity concerns: the error term in each regression is likely to be correlated with $y_{i,t}$ if an exogenous shock impacts both economic activity and fiscal policy. Therefore, we instrument $y_{i,t}$ with $f_{i,t}$ in the linear model. In the state-dependent regression, we instrument $I\left(unc_{i,t-1}\right)y_{i,t}$ and $\left[1 - I\left(unc_{i,t-1}\right)\right]y_{i,t}$ with $I\left(unc_{i,t-1}\right)f_{i,t}$ and $\left[1 - I\left(unc_{i,t-1}\right)\right]f_{i,t}$.

A valid instrumental variable must satisfy two conditions. In our case, it must be uncorrelated with unexpected changes in government consumption and investment. However, it must be correlated with the level of economic activity $y_{i,t}$. In the spirit of Bai and Ng (2010), we construct an instrument via a factor approach. To do so, we use the first principal component $f_{i,t}$ of the variables in $x = \{bscicp03, cscicp03, bsempl, bsesi, bsici, bsrci, bssci, urate\_fm\}$. $bscicp03$ and $cscicp03$ are business and confidence indicators from the OECD. *bsempl* denotes an indicator that measures employment expectations over the next three months and *bsesi* is an economic sentiment indicator. *bsici*, *bsrci* and *bssci* are sector-specific indicators for the industry, retail as well as service sector. *urate_fm* denotes the unemployment rate. $f_{i,t}$ is measured at a quarterly frequency. Because all variables in x are available at a monthly frequency, we use values in the first month of a quarter to ensure exogeneity of $f_{i,t}$ with respect to fiscal policy measures within the same quarter. We standardize all variables in x and estimate the first principal component separately for each country. Since $x_{i,t}$ contains missing values for some variables, we estimate $f_{i,t}$ in two steps. We first estimate $f^{temp}_{i,t}$ on the subset $x^{temp} = \{bscicp03, bsesi, bsici, bsrci, urate\_fm\}$ and predict the missing values for the other variables using $f^{temp}_{i,t}$. In the second step, we estimate the first principal component $f_{i,t}$ using the filled $x_{i,t}$.

Table 4.1 shows that none of the β's is significantly different from zero at the 10% level. Moreover, the Sanderson and Windmeijer (2016) first stage F-statistics indicate that there are no problems with weak instrument relevance. Unfortunately, we can not test for overidentifying restrictions because the equations are exactly identified. We tried to use two

Table 4.1 The estimated intra-quarter response of government consumption and investment to GDP

	β	SWF^{lin}	β^{HU}	SWF^{HU}	β^{NU}	SWF^{NU}
Gov. consumption	−0.01	19.35	0.07	15.80	−0.15	24.24
	(0.81)		(0.67)		(0.18)	
Gov. investment	0.11	19.35	0.09	15.80	−0.14	24.24
	(0.35)		(0.52)		(0.27)	

p-Values for the null hypotheses $\beta = 0$, $\beta^{HU} = 0$ or $\beta^{NU} = 0$ in parentheses. All statistics are based on Driscoll and Kraay (1998) standard errors.

principal components but this results in weak instruments. However, remember that we used values in the first month of a quarter for all variables in x to ensure exogeneity of f_{it} with respect to fiscal policy measures within the same quarter. Overall, we can not reject the validity of timing restrictions for the identification of shocks to government consumption and public investment.

4.3.2 Robustness check II: the slope homogeneity assumption

The fixed effects regressions in Equations (4.1) and (4.2) implicitly assume that the GDP multipliers for government consumption and investment are the same across countries, the so-called slope homogeneity assumption. This leads to more efficient estimates as this assumption holds true.

In order to assess how important any individual country is for the results, we follow Boehm (2020) and Klein and Winkler (2021) and estimate GDP multipliers with Equations (4.1) and (4.2) but now sequentially leave out one country. To simplify comparability, Figure 4.2 also includes the results from the baseline specification with all countries. For instance, the second entries in Figure 4.2 show the estimated one-year multipliers and 90% confidence bands *without* Austria. It can be seen that the results are almost identical to the baseline such that the influence of Austria on the average euro area multiplier is negligible. Overall, Figure 4.2 provides two insights. First, although there is some variation in the estimated multipliers by omitting one country at a time, there is no evidence against the panel homogeneity assumption. Second, although there seem to be some countries which are relatively influential (Spain, Greece, Latvia and Portugal), public investment always turns out to be a more effective policy tool during uncertain episodes. For example, leaving out Spain or Latvia leads to public investment multipliers that are significantly above two.

4.3.3 Robustness check III: different uncertainty proxies

In Figure 4.3, we examine the role of the uncertainty type, i.e. economic vs. policy uncertainty, for our findings. In this respect, we estimate state-dependent multipliers using three additional uncertainty measures. For a fair comparison across uncertainty proxies, we always choose the 80th percentile to distinguish between normal and uncertain episodes.

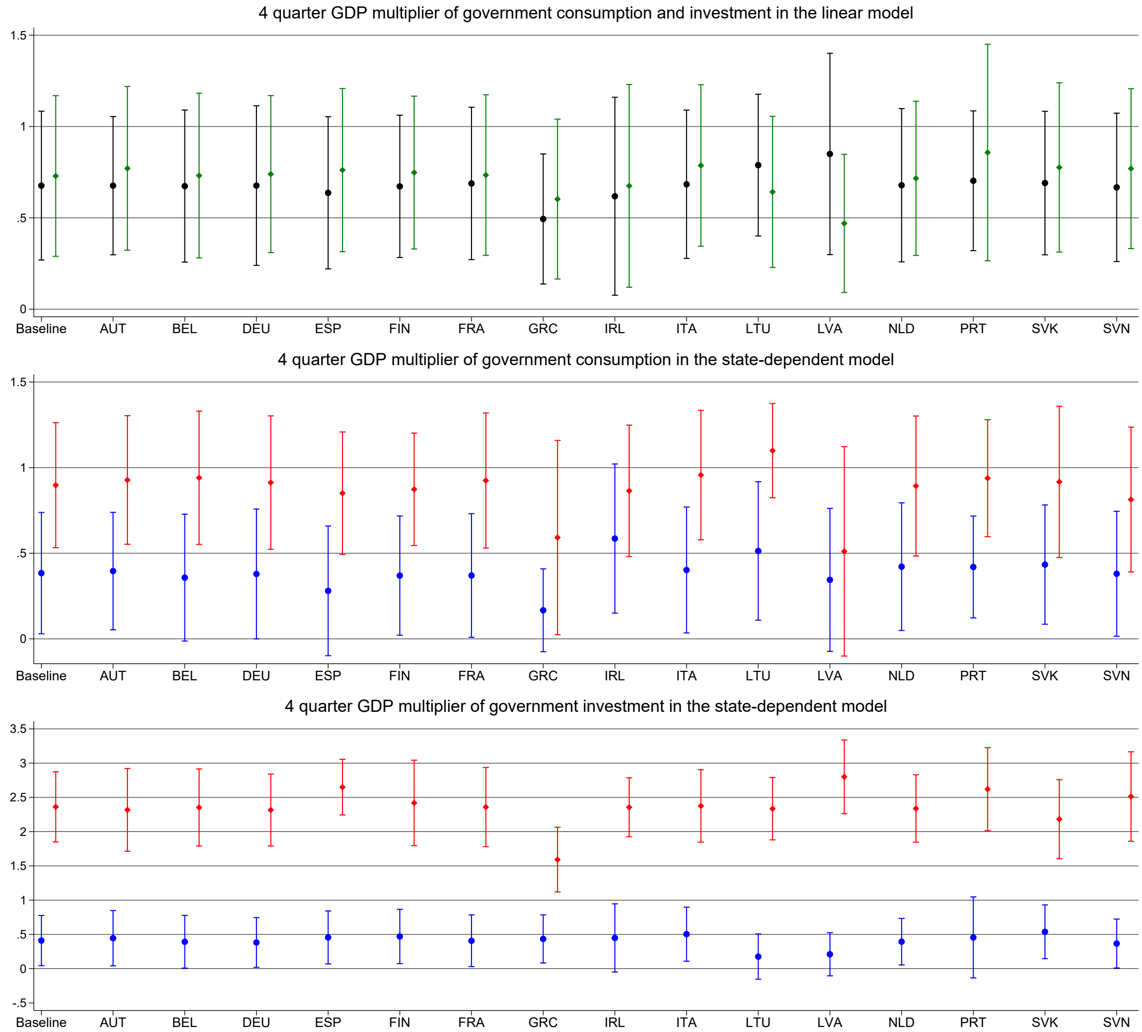


Figure 4.2 Test of the panel homogeneity assumption - leave out one country. The figure shows linear and state-dependent one-year multipliers for government consumption (black) and investment (green) omitting one country at a time. We depict multipliers in times of high uncertainty in red and during normal times in blue. The vertical bars depict 90 percent confidence intervals based on Driscoll and Kraay (1998) standard errors. We use the country abbreviations from the OECD database.

The first column uses the index of Ozturk and Sheng (2018) which is based on forecast errors in Consensus Economics data. To construct an index of economic uncertainty, they use forecast errors for the annual growth rates of GDP, consumption, investment, industrial production as well as for the levels of inflation, short- and long-term interest rates and the unemployment rate to determine the variable-specific uncertainty. This is the sum of common uncertainty among all analysts, which is estimated with a stochastic volatility model, and the disagreement among forecasters, as estimated with the interquartile range. The country-specific economic uncertainty is then measured by the average of those variable-specific uncertainties.[11]

The other columns show the estimated GDP multipliers for two text-based uncertainty proxies which reflect the frequency of the word ”uncertainty” and its variations in newspaper articles or reports from the Economist Intelligence Unit. In the middle panel, we use the economic policy uncertainty (EPU) index as first proposed in Baker et al. (2016) for the United States. The results in the third column are based on the world uncertainty index from Ahir et al. (2022). In contrast to the EPU index, it does not rely on newspapers. Instead, it is based on country reports from the Economist Intelligence Unit that are tailored to national economic and political developments. The reports follow a standardized process and structure, making the resulting uncertainty index reasonably comparable across time and countries. Furthermore, the process through which the country reports are produced helps to mitigate concerns about the accuracy, ideological bias and consistency of the world uncertainty index (Ahir et al., 2022).

Figure 4.3 shows that the source and measurement of uncertainty matters for the estimated GDP multipliers. The results based on the economic uncertainty index of Ozturk and Sheng (2018) largely coincide with our baseline findings for uncertainty about GDP growth from Rossi and Sekhposyan (2017). The major difference is that the government investment multiplier remains particularly large at the two-year horizon. In contrast, we clearly obtain different results for the two text-based uncertainty measures. This is not unexpected for the following reasons. On the one hand, the government can reduce uncertainty with good policy. On the other hand, it can also be a source of uncertainty as it would be indicated by a high value of the economic policy uncertainty index. In this regard, also the world uncertainty index is not only related to economic uncertainty as can be seen from annotations for uncertainty spikes in Ahir et al. (2022). Other possible reasons why the text-based measures lead to different results could be that these are less country-specific as news might reflect global events rather than domestic economic uncertainty and that these proxies exhibit more spikes with less persistence in uncertainty.

[11]For more details on the construction see Ozturk and Sheng (2018).

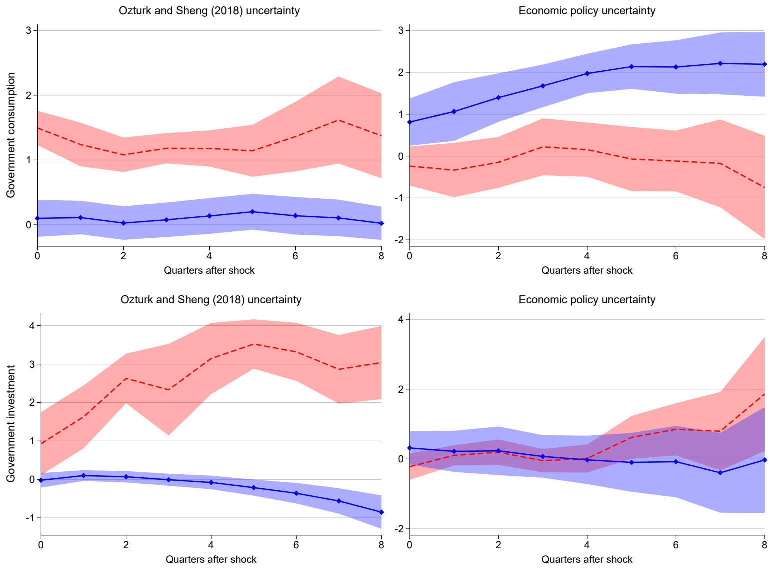


Figure 4.3 GDP multipliers using other uncertainty proxies. The figure shows state-dependent multipliers during times of high (in dashed red) and normal (in blue with markers) uncertainty. 90% confidence intervals based on Driscoll and Kraay (1998) standard errors are shown in all cases. The index of Ozturk and Sheng (2018) is available for France, Germany, Italy, Latvia, Lithuania, Netherlands, Slovenia and Spain. Economic policy uncertainty is available for Belgium, France, Germany, Greece, Ireland, Italy, Netherlands and Spain (Algaba et al., 2020; Baker et al., 2016; Ghirelli et al., 2019; Hardouvelis et al., 2018; Kroese et al., 2015; Zalla, 2016). The world uncertainty index from Ahir et al. (2022) is available for all countries in our sample. All indices are available over the whole sample period 1999–2019.

4.3.4 Robustness check IV: uncertainty versus the business cycle

One strand of the literature finds stronger output responses to government spending during (deep) recessions (for example Auerbach and Gorodnichenko, 2013, 2012; Bachmann and Sims, 2012; Boitani et al., 2022; Caggiano et al., 2015). This raises the question of whether the larger GDP multipliers in uncertain episodes are genuinely due to higher levels of uncertainty or simply a result of multipliers being larger in periods of low economic activity which may often be characterized by high uncertainty.[12] In order to investigate this question, we estimate Equation (4.2) but now distinguish between periods of economic slack/slump (a recession or period of high unemployment) and normal times.[13] We set $I_{i,t-1}^{slack} = 1$ if a country is in slump according to the OECD recession indicator or if the unemployment rate is above the country-specific median. To rule out that it is simply the degree of labor market slack that drives our results, we also estimate a version where $I_{i,t-1}^{slack} = 1$ only holds when the unemployment rate is above the 80th percentile in the specific country. Table C.3 in the

[12]Note that the distinction between uncertainty and the business cycle is very difficult. For instance, Bloom et al. (2018) classify a recession as the coincidence of a negative first moment (level) with a positive secondary moment (volatility) shock. Ludvigson et al. (2021) show that uncertainty can be an exogenous source of business cycle fluctuations but also an endogenous response to first moment shocks. Also the theoretical framework in Cacciatore and Ravenna (2021) implies that uncertainty increases during economic slumps, reflecting the endogenous response of the economy to first moment shocks.

[13]As explained in Ramey and Zubairy (2018), a recession indicator shows periods when the economy moves from its peak to its trough. In this context, a recession includes periods in which unemployment rises from its low to its high, and thus is not really an indicator of a state of economic slack.

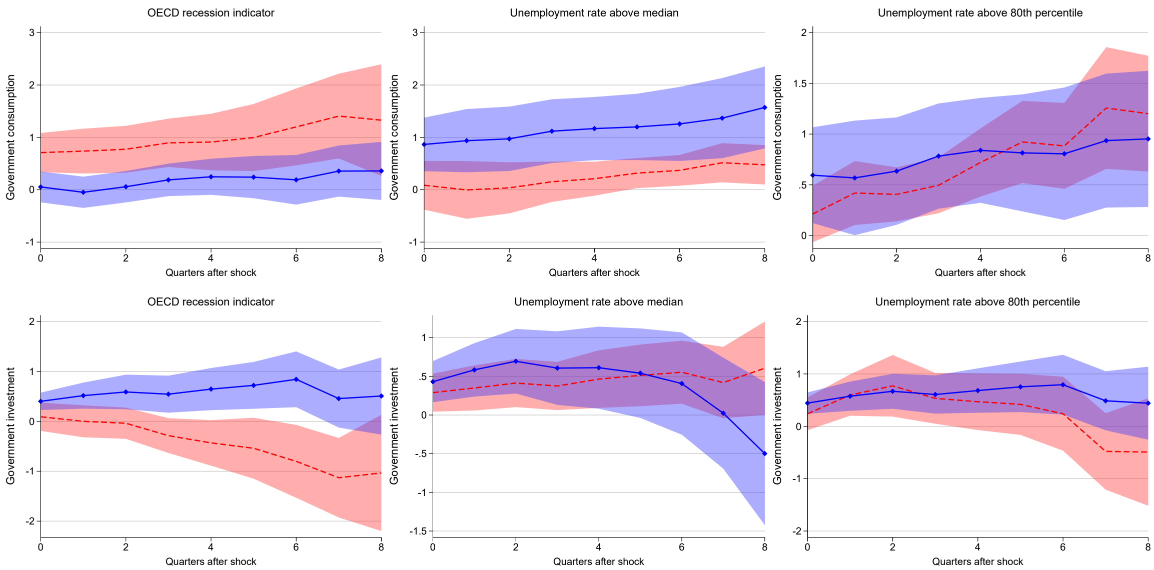


Figure 4.4 GDP multipliers across the business cycle. The figure shows state-dependent multipliers during times of slack (in dashed red) and normal (in blue with markers) episodes. 90% confidence intervals based on Driscoll and Kraay (1998) standard errors are shown in all cases.

Appendix reveals that only about half of the observations classified as uncertain periods are also episodes of economic slack.

According to Figure 4.4, we do not find evidence in favor of larger GDP multipliers during economic slumps. In contrast, public investment is even less effective during a recession when we use the OECD indicator. In the first place, the negative multiplier for investment seems puzzling. However, Alloza (2022) also finds stronger GDP responses to government spending (consumption plus investment) during expansions than in recessions. Once we use the unemployment rate, the differences in the GDP multipliers conditional on the degree of slack in the economy turn insignificant. It is striking that we find no multipliers above one even in periods of high unemployment. This result is in accordance with the literature summary in Ramey (2019). At the same time, Klein and Linnemann (2019) find stronger output responses to government spending during the Great Recession, an economic slump accompanied by large uncertainty. One reason can be that limited downward wage flexibility during economic slumps generates strong and state-dependent amplification of uncertainty shocks that deepen the recession (Cacciatore and Ravenna, 2021). We show later that government consumption and investment raise wages so that both prevent the economy from hitting a downward wage constraint and thus make government spending particularly effective during uncertain periods.

As an additional robustness check, we first regress the uncertainty index from Rossi and Sekhposyan (2017) on the respective measure of economic slack, the OECD recession indicator or the unemployment rate, and then use the residuals of these regressions, $unc^{cleaned}$ as the threshold variable in Equation (4.2) to distinguish between periods of high and normal uncertainty. As evident from Figures C.3a and C.3b of the Appendix, the estimated GDP multipliers for government consumption and investment are very similar to the baseline multipliers in Figure 4.1.

The findings are supported by Goemans (2022) who investigates the effects of government spending (consumption plus investment) in uncertain times and economic slumps. In a robustness check, he allows the government spending multipliers to differ across four states: high uncertainty in a slump, high uncertainty without a slump, normal uncertainty in a slump and normal uncertainty without a slump. Multipliers above one, even in periods of low economic activity, materialize only in episodes of high uncertainty. The author also investigates why government spending is more effective during uncertain episodes compared to economic slumps. Since we already distinguish between the effects of government consumption and investment, we only investigate the transmission mechanisms that render fiscal policy more effective in episodes of elevated uncertainty compared to normal times.

4.4 Transmission channels

Our results provide evidence for larger output multipliers in uncertain times than in normal episodes. This result should be reflected in the transmission channels of public consumption and investment. We, therefore, now focus on the concrete transmission mechanisms and analyze the effects on a number of macroeconomic variables, the funding of expansive fiscal policy and the monetary policy response.

In particular, we estimate linear and state-dependent cumulative multipliers from local projections at each horizon $h = 0, \ldots, 8$:

$$\sum_{j=0}^{h} x_{i,t+j} = \alpha_{i,h} + \lambda_{t,h} + \gamma_{i,h} t + \phi_h(L) X_{i,t-1} + m_h^c \sum_{j=0}^{h} g_{i,t+j}^c + m_h^{cf} \sum_{j=0}^{h} g_{i,t+j}^{cf} + \varepsilon_{i,t+h} \tag{4.6}$$

$$\begin{aligned}\sum_{j=0}^{h} x_{i,t+j} =& I\left(unc_{i,t-1}\right) \left\{ \alpha_{i,h}^{HU} + \phi_h^{HU}(L) X_{i,t-1} + m_h^{c,HU} \sum_{j=0}^{h} g_{i,t+j}^c + m_h^{cf,HU} \sum_{j=0}^{h} g_{i,t+j}^{cf} \right\} \\ & + \left[1 - I\left(unc_{i,t-1}\right)\right] \left\{ \alpha_{i,h}^{NU} + \phi_h^{NU}(L) X_{i,t-1} + m_h^{c,NU} \sum_{j=0}^{h} g_{i,t+j}^c + m_h^{cf,NU} \sum_{j=0}^{h} g_{i,t+j}^{cf} \right\} \\ & + \lambda_{t,h} + \gamma_{i,h} t + \varepsilon_{i,t+h}\end{aligned} \tag{4.7}$$

where the dependent variable $x_{i,t}$ is the variable for which we estimate the cumulative multiplier. Cumulative multipliers are estimated because they, in contrast to impulse responses, control for the dynamics of public consumption and investment as if the path of fiscal policy were similar across uncertainty states. For GDP components, these multipliers are euro for euro multipliers because we include those variables in percent of potential GDP (Gordon and Krenn, 2010). In case of the other variables, it is the cumulative change in x divided by the cumulative change in government consumption or investment, expressed in percentage points (pp) of potential GDP, at the same horizon. If e.g. x denotes the savings rate, the change is measured in percentage points. If the variable x is included in first differences, the multiplier at horizon h denotes the change in levels from period $t-1$ to $t+h$ divided by the cumulative change in public consumption/investment. As before, we receive the multipliers in the threshold model from a 2SLS regression using $I\left(unc_{i,t-1}\right) \times g_{i,t}^{z}$ and $\left[1 - I\left(unc_{i,t-1}\right)\right] \times g_{i,t}^{z}$ as instruments for $\sum_{j=0}^{h} g_{i,t+j}^{z}$ with $z = \{c, cf\}$. We include the same vector of control variables $X_{i,t-1}$ as in Equations (4.1) and (4.2), augment this vector with the lagged dependent variable $x_{i,t-1}$ and allow for four lags.

Figure 4.5 depicts the estimated cumulative multipliers for private consumption, private investment and net exports. In the linear model, we observe slightly different effects of public consumption compared to increases in public investment. An increase in government consumption of one euro stimulates private consumption by roughly 0.5 euros. At the same time, the increase in public consumption reduces private investment, although not significantly at most horizons, as well as net exports. While we also observe this deterioration of the trade balance in response to an increase in public investment, the decline is stronger for public consumption. However, the differences across government spending components are not significant at most horizons.

In the threshold model, the private consumption multipliers for public consumption are positive and similar across states, although the impact multiplier during uncertain episodes is particularly large. In contrast, the private consumption multipliers for public investment during normal times are close to zero or even negative at longer horizons. In times of elevated uncertainty, however, the one-year private consumption multiplier for public investment is close to 0.5. This can be explained with productivity improvements induced by public investment when firms pass on larger profits to workers partly through higher real wages.

It is striking that, conditional on being in uncertain times, public consumption stimulates private investment. Two explanations are the estimated multipliers for the household savings rate and financial frictions in Figure 4.6. Conditional on being in a state of high uncertainty, an exogenous increase in government consumption prompts a rise in household savings that we do not find during normal episodes. This could be explained with the precautionary savings channel of uncertainty in conjunction with risen labor income that is partly saved. As outlined in Challe et al. (2017), aside from the negative demand effect due to lower consumption, the increase in household savings also has a positive aggregate supply effect because these additional savings lower the equilibrium interest rate which increases the private sector demand for capital. At first sight, it might be puzzling that we observe an increase in private consumption during uncertain times despite the rise in the savings rate. However, as we will see later, conditional on being in a state of high uncertainty, the increase in public consumption stimulates employment. This explains how households can consume and save more at the same time.

Fernández-Villaverde (2010), Canzoneri et al. (2016) and Hristov (2022) demonstrate

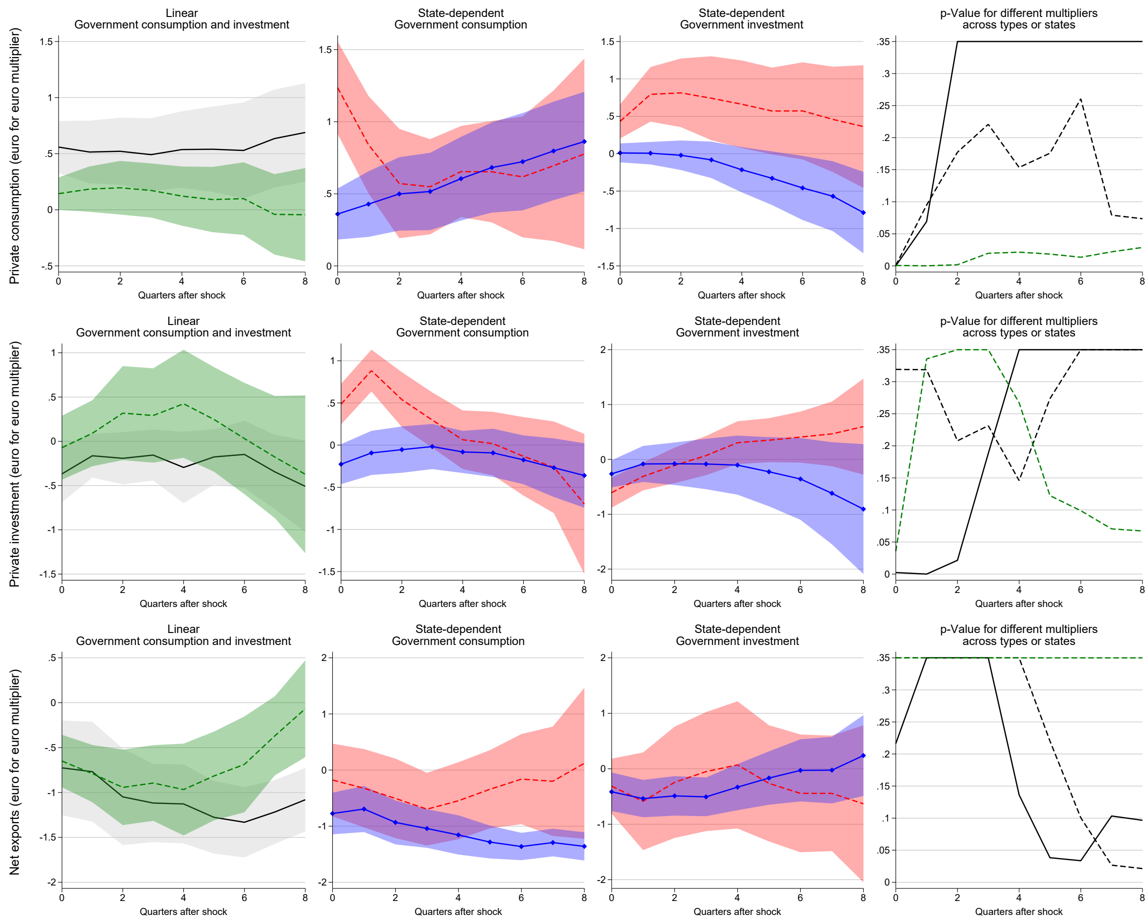


Figure 4.5 Multipliers for private consumption, private investment and net exports. The left panel shows cumulative multipliers for public consumption (black with gray confidence bands) and investment (dashed green with green confidence bands). The second and third panel show state-dependent multipliers during times of high (in dashed red) and normal (in blue with markers) uncertainty. 90% confidence intervals are shown in all cases. The right panel shows the p-values for different multipliers across types of government spending and states. The p-values (no difference across types in linear model in dashed black, consumption (investment) across states in black (dashed green)) are capped at a maximum of 0.35 for readability reasons. All statistics are based on Driscoll and Kraay (1998) standard errors.

in theoretical models that financial frictions affect household and business responses to fiscal policy measures. In this regard, we find that conditional on being in a state of high uncertainty, increases in public consumption as well as government investment ease financial frictions. One reason can be the increase in households savings which provides more capital. Another reason is that investors want to be compensated for the higher risk in uncertain times by means of heightened financing costs (see eg Christiano et al., 2014). In this situation, the additional public demand can reduce the risk that companies will not repay their loans. Accordingly, risk premiums fall and with them financing constraints as we see in Figure 4.6. Note that the decrease in financial constraints is stronger for government consumption. Although the reduction in financial frictions is short-lived, it can explain the immediate rise of private investment through government consumption in uncertain times.

In contrast to public consumption, conditional on being in a state of high uncertainty, the

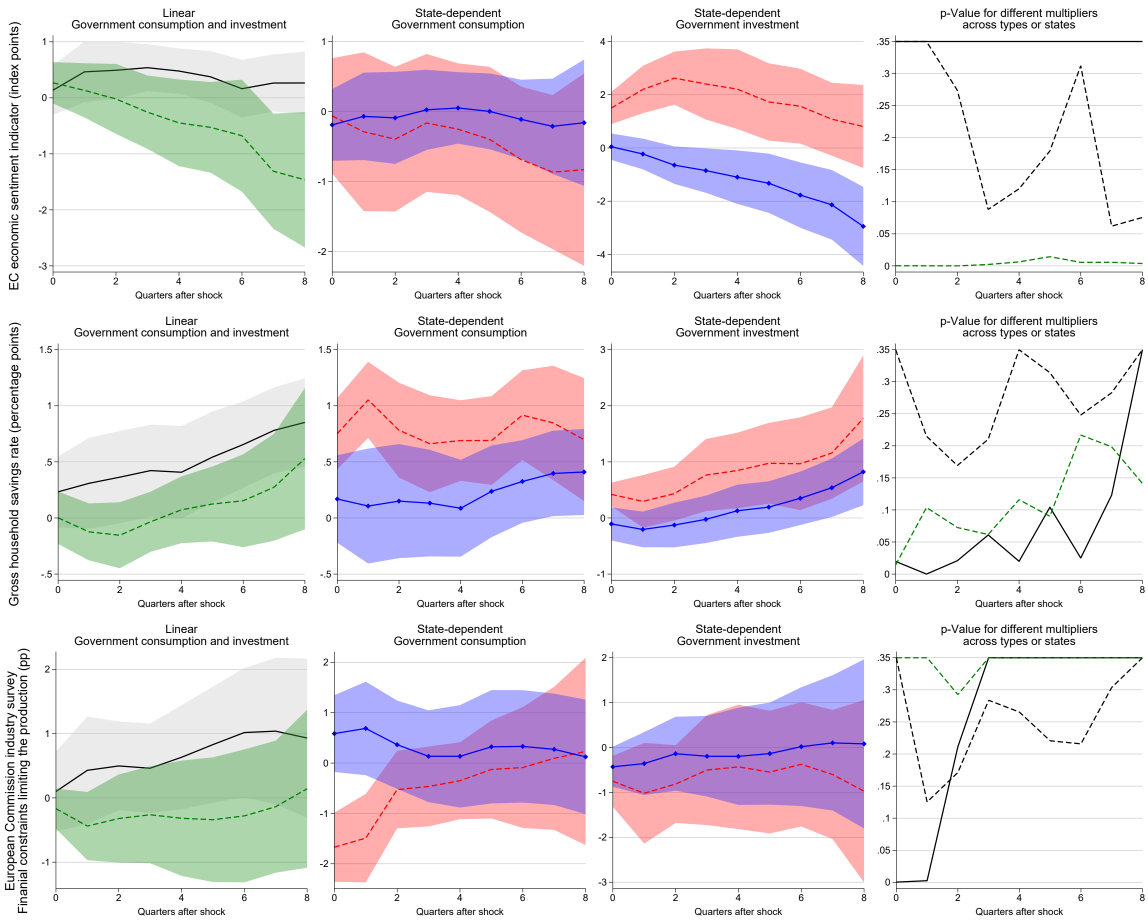


Figure 4.6 Confidence and financial friction multipliers. The left panel shows cumulative multipliers for public consumption (black with gray confidence bands) and investment (dashed green with green confidence bands). The second and third panel show state-dependent multipliers during times of high (in dashed red) and normal (in blue with markers) uncertainty. 90% confidence intervals are shown in all cases. The right panel shows the p-values for different multipliers across types of government spending and states. The p-values (no difference across types in the linear model in dashed black and consumption (investment) across states in black (dashed green)) are capped at a maximum of 0.35 for readability reasons. All statistics are based on Driscoll and Kraay (1998) standard errors.

increase in government investment boosts confidence as measured by the economic sentiment index of the European Commission. This channel has been proposed by Bachmann and Sims (2012) as a reason why government spending turns out to have stronger output effects during recessions. The reinforcement of confidence via public investment in uncertain episodes is also consistent with the increase in private consumption.

Figure 4.7 investigates whether the findings are a consequence of different forms of public funding. In the linear model, the GDP multipliers for public consumption and investment are very similar although public consumption seems to be funded by tax hikes as indicated by the rise in net tax revenues and the cut in the government debt ratio. The financial markets reward the fiscal consolidation by means of lower sovereign bond spreads (interest rates on long-term government bonds relative to German government bonds with the same maturity). Remarkably, sovereign bond spreads do not rise despite the debt-financed public investments.

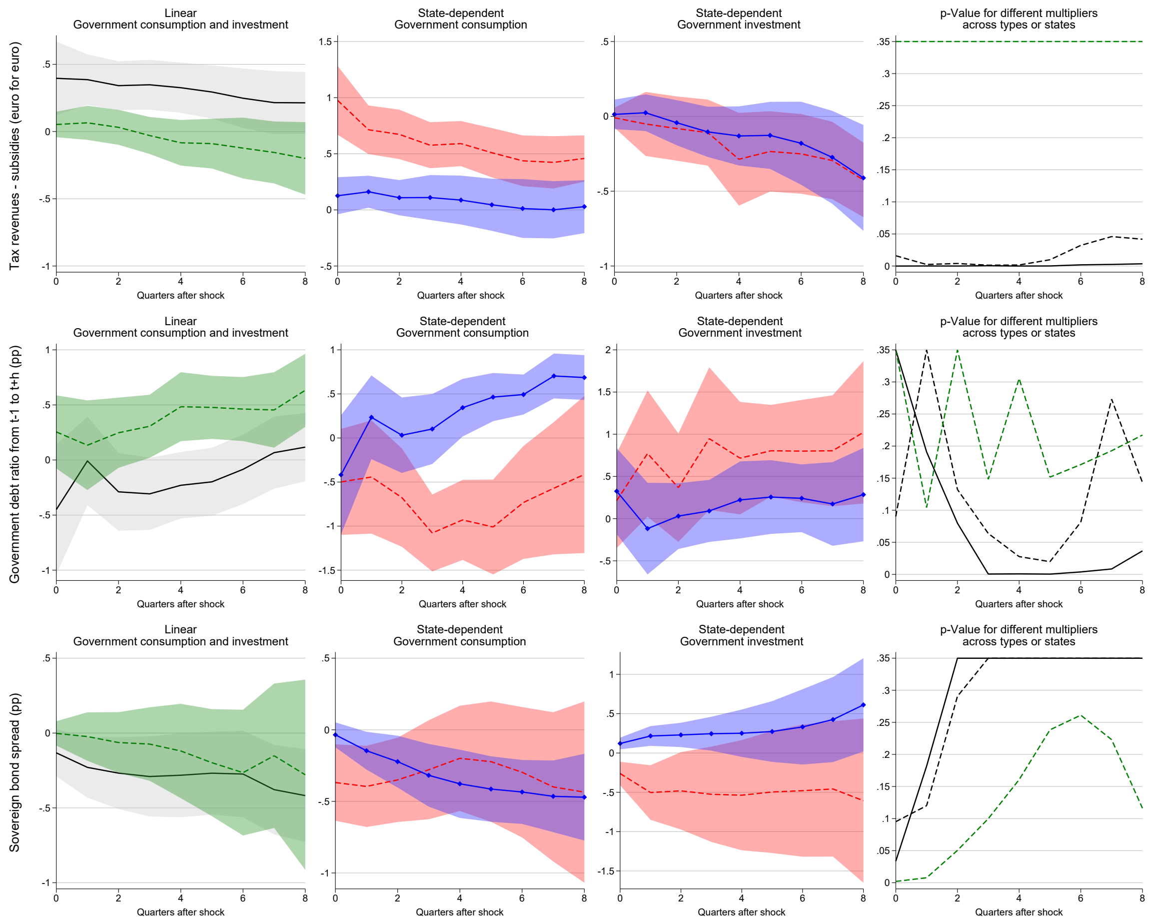


Figure 4.7 Public finance multipliers. The left panel shows cumulative multipliers for public consumption (black with gray confidence bands) and investment (dashed green with green confidence bands). The second and third panel show state-dependent multipliers during times of high (in dashed red) and normal (in blue with markers) uncertainty. 90% confidence intervals are shown in all cases. The right panel shows the p-values for different multipliers across types of government spending and states. The p-values (no difference across types in the linear model in dashed black and consumption (investment) across states in black (dashed green)) are capped at a maximum of 0.35 for readability reasons. All statistics are based on Driscoll and Kraay (1998) standard errors. We use the change in the government debt ratio because we could not reject the null of a unit root at conventional significance levels based on Breitung (2000).

One reason for this could be that investment is regarded as productivity-enhancing and does not undermine the sustainability of larger debt ratios.

Figure 4.7 also shows that the degree of uncertainty affects the response of public finances. For example, the positive and significant tax multipliers in the linear model for public consumption are driven by the strong increase in tax revenues during uncertain times, as is the reduction of the debt ratio. A plausible reason is the larger GDP multiplier in uncertain times because the increase in private spending generates additional tax revenues. It is noteworthy that the sovereign bond spread multiplier for public investment is negative despite the increase in public debt. As already mentioned, the improvements in productivity induced by public investment may outweigh the risk of larger debt ratios.

Figure 4.8 depicts the labor market effects of public consumption and investment. Two characteristic differences in multipliers across both types of government spending already

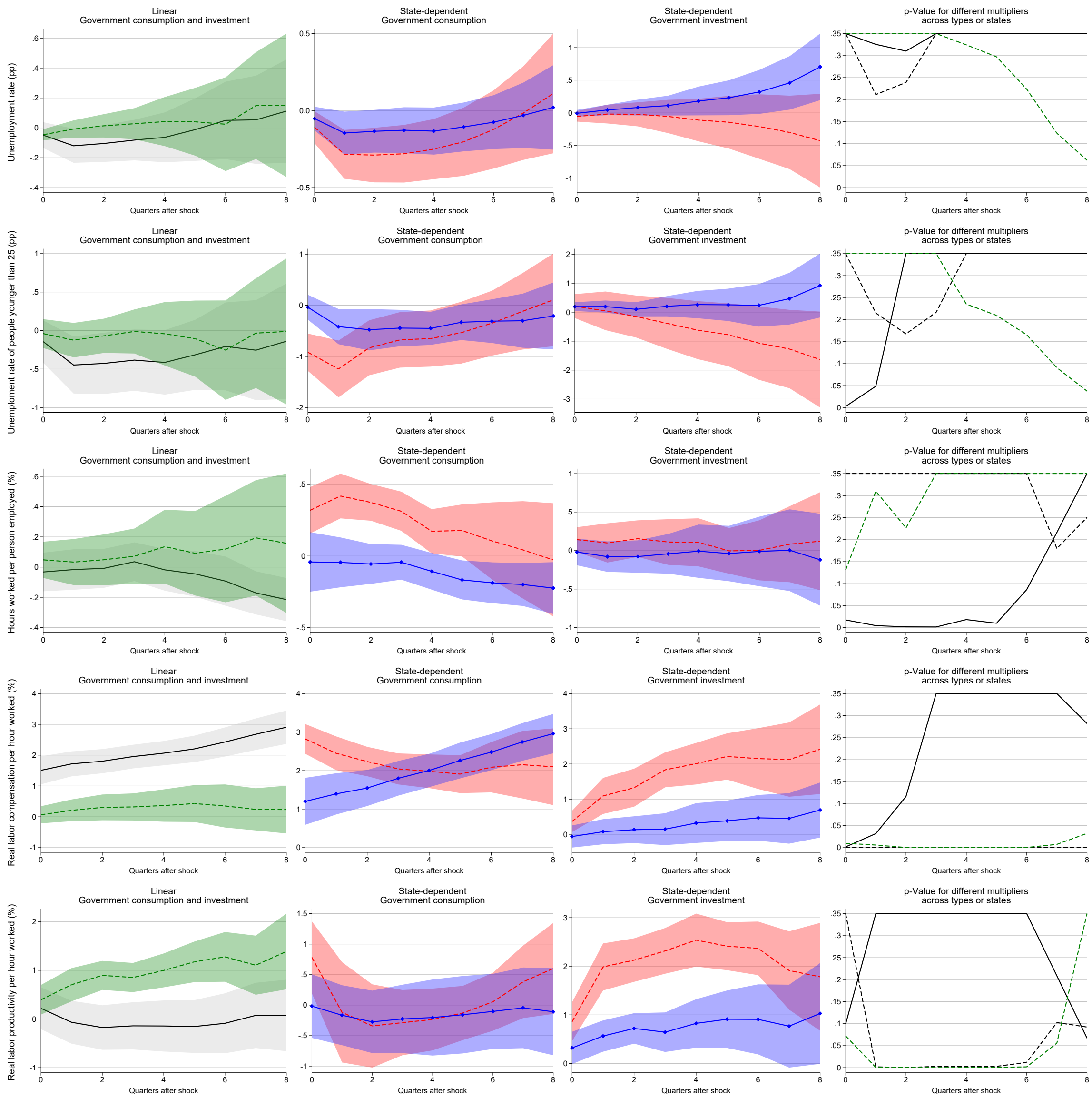


Figure 4.8 Labor market multipliers. The left panel shows cumulative multipliers for public consumption (black with gray confidence bands) and investment (dashed green with green confidence bands). The second and third panel show state-dependent multipliers during times of high (in dashed red) and normal (in blue with markers) uncertainty. 90% confidence intervals are shown in all cases. The right panel shows the p-values for different multipliers across types of government spending and states. The p-values (no difference across types in the linear model in dashed black and consumption (investment) across states in black (dashed green)) are capped at a maximum of 0.35 for readability reasons. All statistics are based on Driscoll and Kraay (1998) standard errors.

emerge in the linear model: public investment increases labor productivity and government consumption raises real wages.

The labor market responses can explain the larger GDP multipliers in uncertain times. Conditional on being in a state of high uncertainty, government consumption raises hours worked per person employed. In addition, public consumption stimulates employment at the extensive margin such that the unemployment rate declines. In this regard, it is remarkable that particularly young people become employed. One reason is that in uncertain times companies prefer to hire employees without a permanent contract and that young people are more willing to accept a temporary contract. Ma (2019) shows that the poor increase consumption but the rich decrease their consumption in response to government spending. Assuming that young people under the age of 25 belong to the group of the poor, this can also explain the particularly large impact GDP multiplier for government consumption. This heterogeneity can also explain the coincidence of a rise in private consumption and the household savings rate. The increase in private consumption is also supported by higher labor income due to risen wages. This wage channel serves as an important explanation why government consumption and investment increase GDP stronger during uncertain episodes. Cacciatore and Ravenna (2021) show that occasionally binding downward wage rigidity amplifies the impact of uncertainty shocks. As the increase in public demand leads to wage gains, it can prevent the economy from reaching this downward wage rigidity and thus make government spending particularly effective during uncertain periods.

With regard to productivity, government investment can lead to persistent improvements in labor productivity. This enhancement is particularly strong in episodes of high uncertainty. One reason would be the real options channel of uncertainty. Let us illustrate this point by means of a simple example. Conditional on being in normal periods, private as well as public investment would boost labor productivity. In this situation, however, the increase in government investment would be inefficient since it crowds out private capital formation (for instance, due to an increase in borrowing costs that we see in Figure 4.9). In a situation of heightened uncertainty, however, firms may prefer to wait and delay their investment decision. Thereby, the capital formation of the public sector is more efficient because it enables a rise in productivity that would not have occurred without the increase in public investment. This explains why we find larger productivity multipliers for public investment in uncertain episodes. Another explanation would be the growth option channel. If uncertainty is large and mean reverting, the expected technology increase induced by research effort can be larger (Bar-Ilan and Strange, 1996). According to Figure 4.8, employees participate through higher real wages from increases in labor productivity due to public investment only during periods of elevated uncertainty. This raise in labor income explains the positive and large private consumption multiplier for public investment in Figure 4.5.

Figure 4.9 examines whether the larger output multipliers in uncertain periods are the result of a more accommodative monetary policy and investigates differences in price

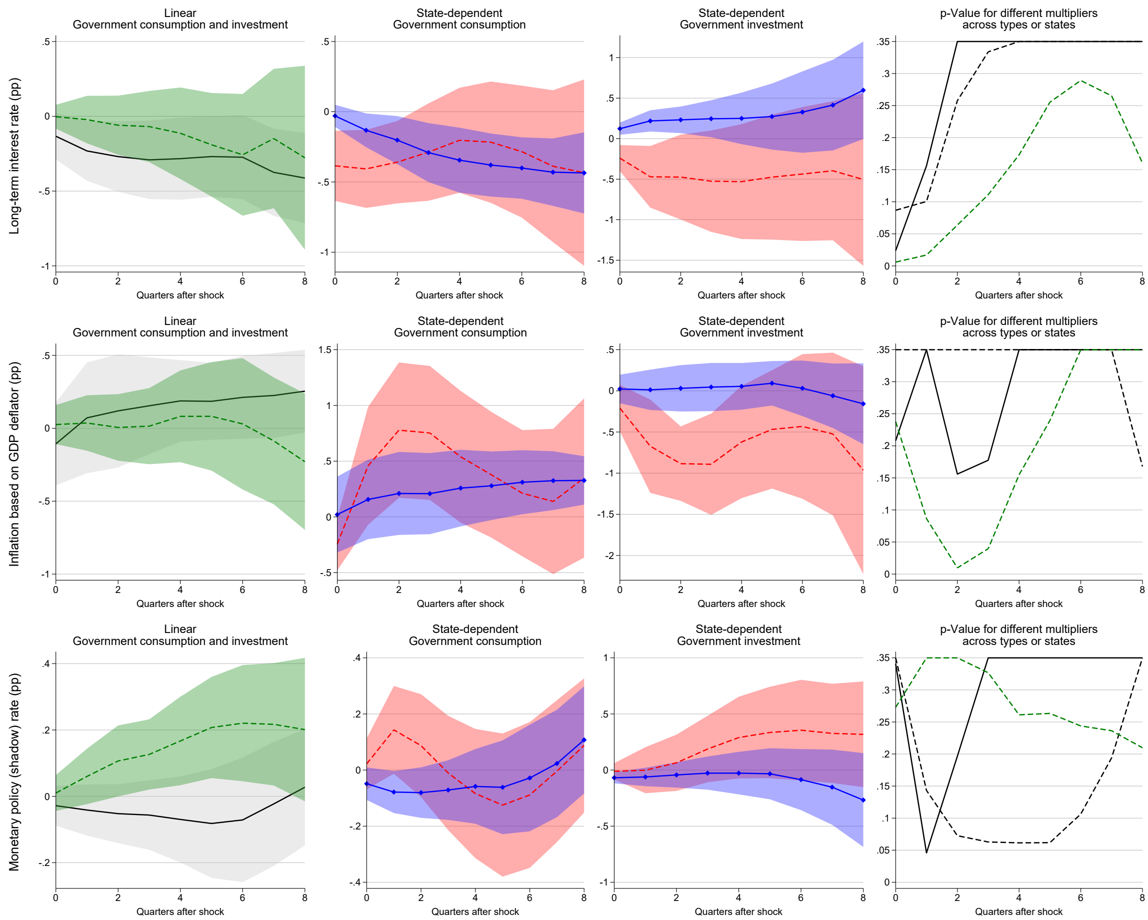


Figure 4.9 Price level and interest rate multipliers. The left panel shows cumulative multipliers for public consumption (black with gray confidence bands) and investment (dashed green with green confidence bands). The second and third panel show state-dependent multipliers during times of high (in dashed red) and normal (in blue with markers) uncertainty. 90% confidence intervals are shown in all cases. The right panel shows the p-values for different multipliers across types of government spending and states. The p-values (no difference across types in the linear model in dashed black and consumption (investment) across states in black (dashed green)) are capped at a maximum of 0.35 for readability reasons. All statistics are based on Driscoll and Kraay (1998) standard errors.

adjustments. It turns out that the price adaptions across states and types of government spending are very different. Conditional on being in a state of high uncertainty, public consumption is inflationary while public investment lowers the price level. At first sight, this might seem surprising because the textbook New Keynesian model predicts that expansive government spending is inflationary.

To explain deflationary effects of government spending found in the literature, Jørgensen and Ravn (2022) propose a New Keynesian model in which firms decide how much of the available technology level they want to utilize. After an increase in aggregate demand due to additional government expenditures, firms find it optimal to raise the utilization rate of technology in order to meet the increase in aggregate demand, despite the costs associated with a higher utilization rate. The increase in technology utilization raises productivity in line with the results for public investment in times of high uncertainty documented in

Figure 4.8. Provided this mechanism is sufficiently powerful, it dominates the upward pressure on marginal costs stemming from higher wages. Lower marginal costs pave the way for companies to lower their prices.

Note that Jørgensen and Ravn (2022) provide this argument for government spending, i.e. consumption plus investment. However, as we show in Figure 4.9, this result only holds for productivity-enhancing public investment. Conditional on being in a state of high uncertainty, increases in government consumption turn out to be inflationary as implied by the textbook New Keynesian model. This is also in line with the surge in real labor compensation in response to public consumption in Figure 4.8.

In the situation of lower inflation, the European Central Bank (ECB) has no reason to increase the interest rate. Indeed, we do observe a decline in the long-term interest rate and no significant response in the Wu and Xia (2016) shadow rate to an increase in public investment.[14] Interestingly, conditional on being in a state of high uncertainty, the European Central Bank does not raise the shadow rate after the increase in public consumption as we would expect with a rising price level. One reason is that the ECB has euro-wide targets and does not respond to developments in a particular country. The decline in long-term government bond yields in response to public consumption despite the inflation pressure can be ascribed to the fiscal consolidation in Figure 4.7.

4.5 Conclusions

The new millennium has been characterized by remarkable fluctuations in uncertainty due to the Great Recession, the European sovereign debt crisis, Brexit, the Covid-19 crisis and also the current energy crisis from the war in Ukraine. Against this background, there is an ongoing debate whether expansionary fiscal policy is more or less effective in avoiding recessions during uncertain times in particular. The corresponding literature has up to now largely focused on the US economy. Therefore, we investigate the impact of discretionary increases in government spending using a panel approach for the euro area. Furthermore, we follow Boehm (2020) and estimate separate GDP multipliers for public consumption and investment.

Overall, we find that increases in government spending are characterized by stronger output effects in times of high economic uncertainty. In particular, we estimate one-year GDP multipliers for public consumption around one and close to two for public investment. This stands in contrast to the effects of fiscal policy under normal circumstances. There, we find lower multipliers, generally around 0.4 and similar for public consumption and investment. Furthermore, we do not find larger GDP multipliers in periods of economic slack. Thereby, we support the findings of Goemans (2022) who shows that GDP multipliers above

[14]Note that we have to estimate the multipliers for the shadow rate without time-fixed effects as the shadow rate is the same for all countries.

one, even during economic slumps, materialize only in episodes of high uncertainty. One possible reason is that limited downward wage flexibility during periods of low economic activity generates strong and state-dependent amplification of uncertainty shocks that deepen the recession (Cacciatore and Ravenna, 2021). In this situation, by increasing public demand, government consumption and investment raise wages, thus preventing the economy from hitting this downward wage constraint.

Part of our contribution is to explain the transmission mechanisms why unexpected increases in government spending turn out to be particularly effective during uncertain episodes and why we find larger GDP multipliers for public investment compared to consumption. Conditional on being in a state of high uncertainty, an increase in public consumption turns out to stimulate the labor market at the extensive and intensive margin. Thus, more people become employed and those who are employed also work more. Moreover, real wages rise such that households consume more and part of the higher income is available for investment in the form of increased savings. However, one euro of additional public consumption does not increase GDP by more than one euro and there are no enduring productivity improvements.

A clearly different picture emerges for increases in government investment. Since private investment would decline anyway in times of high uncertainty due to the real options channel, it is not displaced by additional public investment. Therefore, government investment leads to stronger productivity gains than in normal times or through public consumption. Households participate through higher real wages from productivity improvements and increase their consumption. The different productivity effects also have implications for price developments in the economy. While public consumption is inflationary due to the positive aggregate demand effect, public investment turns out to be deflationary because of the positive supply effect through improved productivity.

Our results have direct policy implications in the realm of Next Generation EU, an EU-wide investment and reform plan that is a cornerstone of Europe's common policy response to the economic challenges raised by the Covid-19 pandemic, a particularly uncertain episode.[15] Since the largest part of this plan is geared towards government investment, our results suggest that the recovery plan will stabilize the European economies and increase productivity. Importantly, in light of sharply risen inflation rates in 2022, it is not expected to be inflationary.

[15] See Bańkowski et al. (2022) for a description.

C Appendix to Chapter 4

C.1 Data

C.1.1 Data description and data sources

Table C.1 Data description

Variable	Code	Source/Contruction
Nominal GDP	b1_ge_cqrsa	OECD (QNA)
Real GDP	b1_ge_lnbqrsa	OECD (QNA)
GDP deflator	b1_ge_dnbsa	OECD (QNA)
Real potential GDP	rgdppot_eo	OECD economic outlook 109; annual values are divided by 4 to calculate quarterly levels and then linearly interpolated
Nominal household and NPISH final consumption expenditure	p31s14_s15b_cqrsa	OECD (QNA)
Nominal final consumption expenditure of general government	p3s13_cqrsa	OECD (QNA)
Nominal gross fixed capital formation	p51_cqrsa	OECD (QNA)
Nominal gross fixed capital formation of general government	p51g_s13_cp_meur_sa	Eurostat (NASQ_10_NF_TR); we seasonally adjust the data with X-13ARIMA-SEATS
Nominal gross fixed capital formation of private sector		p51_cqrsa - p51g_s13_cp_meur_sa
Nominal net exports	b11_cqrsa	OECD (QNA)
Taxes on production and imports, receivable	d2recv	Eurostat (NASQ_10_NF_TR)
Current taxes on income, wealth, etc., receivable	d5recv	Eurostat (NASQ_10_NF_TR)
Capital taxes, receivable	d91recv	Eurostat (NASQ_10_NF_TR)
Subsidies paid by general government	d3paid	Eurostat (NASQ_10_NF_TR)
Nominal net taxes		d2recv+d5recv+d91recv-d3paid; we seasonally adjust the data with X-13ARIMA-SEATS
Government consolidated gross debt (% of GDP)	gd	Eurostat Quarterly government debt (GOV_10Q_GGDEBT)
Long-term interest rates (% pa)	irlt	OECD (MEI_FIN); monthly values are transformed to quarterly means
Sovereign bond spread (% pa)	sovspread	Long-term interest rates minus long-term interest rates for Germany; for Germany we use its own long-term interest rate
Forecast of government consumption, volume (percentage change on preceding year)		European Commission spring and autumn forecasts
Forecast of public investment (% of GDP)		European Commission spring and autumn forecasts
Nominal compensation of employees	d1s1_cqrsa	OECD (QNA)
Deflator for household and NPISH final consumption expenditure	p31s14_s15_dnbsa	OECD (QNA)
Employment total, persons employed seasonal adjusted (thousands persons)	eto_persa	OECD (QNA)

Variable	Code	Source/Contruction
Employment total, hours worked seasonal adjusted (mio hours)	eto_hrssa	OECD (QNA)
Real labor compensation per hour worked	rlc_hrsa	(d1s1_cqrsa/(p31s14_s15_dnbsa/100))/(eto_hrssa); we use 100 log(rlc_hrsa) in the regressions
Hours worked per person employed	hwpw	(eto_hrssa*1000000)/(eto_persa*1000); we use 100 log(hwpw) in the regressions
Unemployment rate (% of population in the labour force)	urate	Eurostat (UNE_RT_M); monthly values are transformed to quarterly means
Unemployment rate (% of population in the labor force who are less than 25 years old)	urate_y_lt25	Eurostat (UNE_RT_M); monthly values are transformed to quarterly means
Real labor productivity per hour worked	rlpr_hw_sca	Eurostat (NAMQ_10_LP_ULC); we use 100 log(lrlpr_hw_sca) in the regressions
Economic sentiment indicator	eci_esi	Eurostat (EI_BSSI_M_R2); monthly values are transformed to quarterly means
Gross household savings rate (%)	srg_s14_s15	Eurostat (NASQ_10_KI); this variable is not available at quarterly frequency for Latvia, Lithuania, Slovakia and Slovenia such that we use the annual database (NASA_10_KI) for these countries and linearly interpolate the data to obtain quarterly frequency observations
European Comission industry survey - Financial constraints limiting the production (% yes answers)	bs_flp6_pc	Eurostat (EI_BSIN_Q_R2)
World uncertainty index	wui_t6	Ahir et al. (2022); monthly values are transformed to quarterly means
Economic policy uncertainty		Algaba et al. (2020); Baker et al. (2016); Ghirelli et al. (2019); Hardouvelis et al. (2018); Kroese et al. (2015); Zalla (2016); monthly values are transformed to quarterly means
Output growth uncertainty		Rossi and Sekhposyan (2017)
Total economic uncertainty		Ozturk and Sheng (2018); monthly values are transformed to quarterly means
Recession indicator		Country specific monthly indicator from the OECD; we classify a quarter as a recession if all associated months are classified as such
Monetary policy shadow rate (% pa)	policy	Wu and Xia (2020); The shadow rate is available since 2004M9, before we use the money call interest rate irstci from OECD (MEI_FIN); monthly values are transformed to quarterly means
OECD businces confidence indicator	bscicp03	OECD(MEI_CLI); first month of quarter
OECD consumer confidence indicator	cscicp03	OECD(MEI_CLI); first month of quarter
Employment expectations indicator over the next 3 months (Index)	bsempl	Eurostat(EI_BSEE_M_R2); first month of quarter
Economic sentiment indicator	bsesi	Eurostat(EI_BSSI_M_R2; first month of quarter)
Industrial confidence indicator	bsici	Eurostat(EI_BSSI_M_R2); first month of quarter
Retail confidence indicator	bsrci	Eurostat(EI_BSSI_M_R2); first month of quarter
Services confidence indicator	bssci	Eurostat(EI_BSSI_M_R2); first month of quarter
Unemployment rate	urate_fm	Eurostat (UNE_RT_M); first month of quarter

C.1.2 Construction of the quarterly government spending forecasts

In contrast to the United States with the Survey of Professional Forecasters, there are no quarterly forecasts of government consumption and investment available for the euro area economies. However, in spring (March/April) and autumn (October/November) at forecast origin year k, the European Commission provides forecasts for real government consumption expenditure (percentage change on preceding year) and public investment/capital formation (percent of GDP) for years k and $k+1$. In autumn, it also provides forecasts for year $k+2$. We use these projections to create quarterly variables that serve to purge our estimates of the fiscal multiplier from the expected/anticipated changes in government consumption as well as investment. To do so, we first transform the semiannual origin forecast values to quarterly origin forecasts as depicted in Table C.2. Herein, $gr(\cdot)$ denotes the growth rate and s as well as a refer to the spring and autumn forecasts respectively.

In the first quarter of a given year k, there are no forecasts for government consumption or investment available for year k and $k+1$ because European Commission's spring forecasts are not published until March/April. Therefore, we use the autumn projections made in year $k-1$ for k and $k+1$. In this way, we do not use information that is not available to the economic agents when we transform the projections from semiannual to quarterly origin. In the second and third quarter, the spring forecasts of year k contain new information, so we use these forecasts for government consumption and investment in year k and $k+1$. In the fourth quarter, the spring forecast is outdated because the autumn forecast for year k and $k+1$ is available to economic agents.

Let us explain this transformation by means of an example. Since the spring forecast for the growth rate of government consumption in 2001 is not available in Q1 of 2001, we use the forecasts made in autumn 2000 for the next year such that $\mathrm{E}_{2001Q1}[gr(g^c_{2001})] = gr(g^c)_{2001|\overset{a}{2000}}$. Similarly, the forecast for the growth rate of public consumption in 2002 that is available in Q1 of 2001 is $\mathrm{E}_{2001Q1}\left[gr(g^c_{2002})\right] = gr(g^c)_{2002|\overset{a}{2000}}$. In Q2 and Q3, the spring

Table C.2 Construction of a quarterly forecast from European Commission's spring/autumn forecasts

Quarter in year k	$\mathrm{E}_t\left[gr(g^c_k)\right]$	$\mathrm{E}_t\left[g^{cf}_k\right]$	$E_t\left[gr(g^c_{k+1})\right]$	$E_t\left[g^{cf}_{k+1}\right]$
Q1	$gr(g^c)_{k\|\overset{a}{k-1}}$	$g^{cf}_{k\|\overset{a}{k-1}}$	$gr(g^c)_{k+1\|\overset{a}{k-1}}$	$g^{cf}_{k+1\|\overset{a}{k-1}}$
Q2	$gr(g^c)_{k\|\overset{s}{k}}$	$g^{cf}_{k\|\overset{s}{k}}$	$gr(g^c)_{k+1\|\overset{s}{k}}$	$g^{cf}_{k+1\|\overset{s}{k}}$
Q3	$gr(g^c)_{k\|\overset{s}{k}}$	$g^{cf}_{k\|\overset{s}{k}}$	$gr(g^c)_{k+1\|\overset{s}{k}}$	$g^{cf}_{k+1\|\overset{s}{k}}$
Q4	$gr(g^c)_{k\|\overset{a}{k}}$	$g^{cf}_{k\|\overset{a}{k}}$	$gr(g^c)_{k+1\|\overset{a}{k}}$	$g^{cf}_{k+1\|\overset{a}{k}}$

Forecasts of government consumption g^c and investment g^{cf} with year index k. $gr(\cdot)$ denotes the growth rate and s as well as a refer to the spring and autumn forecasts respectively.

forecasts become available to economic agents, so that $\mathrm{E}_{2001Q2}[gr(g^c_{2001})] = gr(g^c)_{2001\left|\overset{s}{2001}\right.}$ and $\mathrm{E}_{2001Q3}[gr(g^c_{2001})] = gr(g^c)_{2001\left|\overset{s}{2001}\right.}$. In Q4, the agents update their information set, so that $\mathrm{E}_{2001Q4}[gr(g^c_{2001})] = gr(g^c)_{2001\left|\overset{a}{2001}\right.}$.

From these transformed quarterly origin forecasts, we construct the projections for government consumption $\mathrm{E}_t\left[G^c\right]$ and public investment $\mathrm{E}_t\left[G^{cf}\right]$ over the next two years as follows:

$$\mathrm{E}_t\left[G^c\right] = 4\left(1+\frac{\mathrm{E}_t\left[gr(g^c_k)\right]}{400}\right)g^c_{t-1} + 4\left(1+\frac{\mathrm{E}_t\left[gr(g^c_k)\right]}{400}\right)\left(1+\frac{\mathrm{E}_t\left[gr(g^c_{k+1})\right]}{400}\right)g^c_{t-1} \tag{C.1}$$

$$\mathrm{E}_t\left[G^{cf}\right] = 4\,\mathrm{E}_t\left[g^{cf}_k\right] + 4\,\mathrm{E}_t\left[g^{cf}_{k+1}\right] \tag{C.2}$$

Equation (C.1) takes into account that the forecasts are for the annual growth rate of government consumption. Because the forecasts for government investment are for the public investment to GDP ratio in each year, we transform the forecasts to quarterly values for real government investment and use these values in Equation (C.2). We do so by multiplying the projected public investment to GDP ratio with the realized quarterly level of nominal GDP and deflate the resulting value with the GDP deflator. To ensure that $\mathrm{E}_t\left[G^c\right]$ and $\mathrm{E}_t\left[G^{cf}\right]$ have the same units as the public expenditure variables in the regressions, we transform the expectations into percent of real potential GDP. We include the contemporaneous values as well as four lags of $\mathrm{E}_t\left[G^c\right]$ and $\mathrm{E}_t\left[G^{cf}\right]$ in the local projections.

C.2 Further results

C.2.1 Instrument relevance

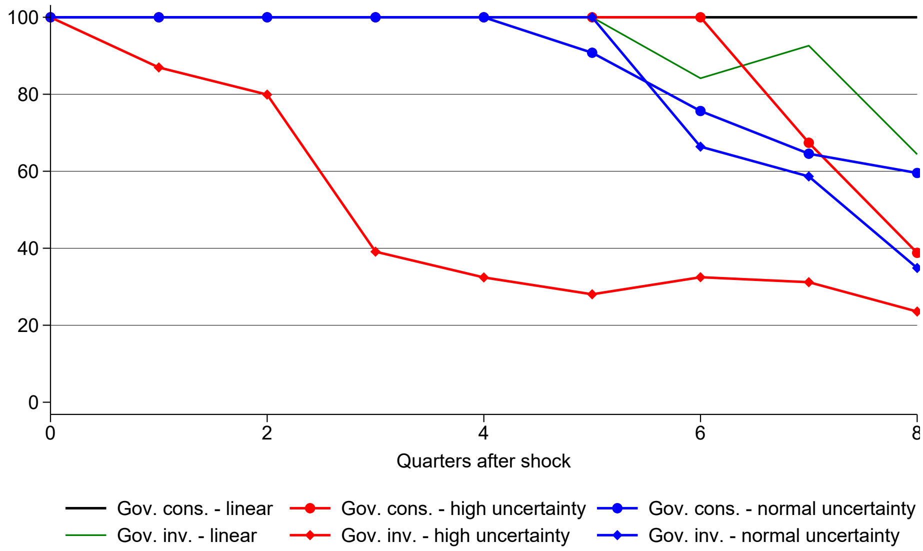


Figure C.1 Instrument relevance. This figure depicts the Sanderson and Windmeijer (2016) first stage F-statistic for the linear as well as for the state-dependent GDP multipliers for government consumption and investment which is a test of weak identification of an individual regressor. The F-statistics are large enough such that the results should not be driven by weak instrument relevance.

C.2.2 Impulse response functions for the baseline specification

Figure C.2 displays impulse responses for the baseline variables to shocks in government consumption and investment estimated in the linear model with Equation (C.3) and the state-dependent model by means of Equation (C.4):

$$y_{i,t+h} = \alpha_{i,h} + \lambda_{t,h} + \gamma_{i,h}t + \phi_h(L)X_{i,t-1} + \beta_h^c g_{i,t+h}^c + \beta_h^{cf} g_{i,t+h}^{cf} + \varepsilon_{i,t+h} \tag{C.3}$$

$$\begin{aligned} y_{i,t+h} =& I\left(unc_{i,t-1}\right)\left\{\alpha_{i,h}^{HU} + \phi_h^{HU}(L)X_{i,t-1} + \beta_h^{c,HU} g_{i,t+h}^c + \beta_h^{cf,HU} g_{i,t+h}^{cf}\right\} \\ &+ \left[1 - I\left(unc_{i,t-1}\right)\right]\left\{\alpha_{i,h}^{NU} + \phi_h^{NU}(L)X_{i,t-1} + \beta_h^{c,NU} g_{i,t+h}^c + \beta_h^{cf,NU} g_{i,t+h}^{cf}\right\} \\ &+ \lambda_{t,h} + \gamma_{i,h}t + \varepsilon_{i,t+h} \end{aligned} \tag{C.4}$$

Herein, the dependent variable y denotes either real government consumption g^c, real public investment g^{cf} or real GDP (all in percent of real potential GDP). The $\alpha_{i,h}$'s and $\lambda_{t,h}$'s capture horizon-specific country and time fixed effects while the $\gamma_{i,h}$'s control for country-specific linear time trends. $\phi_h(L)$ is a lag polynomial in which we allow for four lags and use the vector of control variables $X_{i,t-1}$ in which we include the following variables: real government consumption as well as investment, real GDP, real net tax revenues (tax revenues minus subsidies), the real interest rate on long-term government bonds as well as

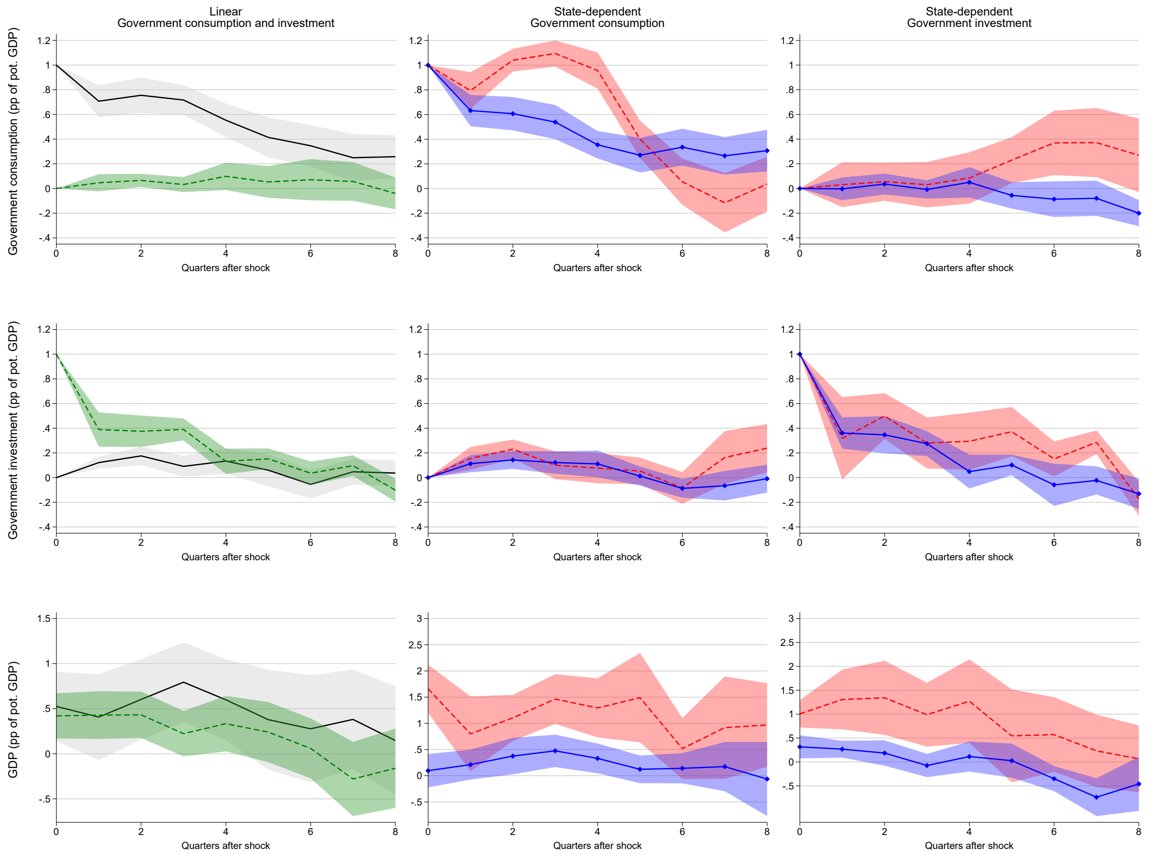


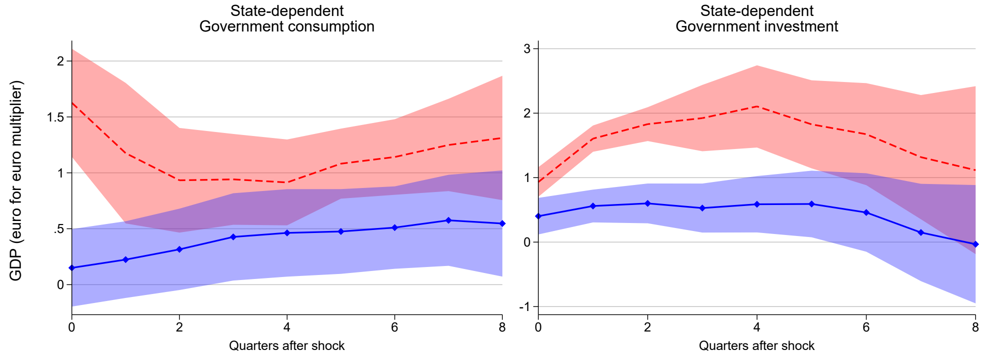
Figure C.2 Impulse responses to shocks in government consumption and investment. The figure depicts impulse responses to shocks in public consumption (in the first row) and investment (in the second row). The third row displays the response of real GDP to shocks in government consumption and investment. The first column depicts impulse responses for public consumption (black with gray confidence bands) and investment (dashed green with green confidence bands). The second and third columns show state-dependent impulse responses during times of high (in dashed red) and normal (in blue with markers) uncertainty. 90% confidence intervals are shown in all cases. All statistics are based on Driscoll and Kraay (1998) standard errors.

the economic sentiment index of the European Commission and the unemployment rate. As before, we follow Blanchard and Perotti (2002) and assume that the government does not respond within the same quarter to other shocks. To tackle the fiscal anticipation problem, we also include the contemporaneous values and four lags of the forecasts for government consumption as well as investment over the next two years. As in the baseline case, *unc* is based on the uncertainty in real GDP growth forecasts from Rossi and Sekhposyan (2017) and the 80th percentile is chosen as the threshold to distinguish between times of high HU and normal uncertainty NU.

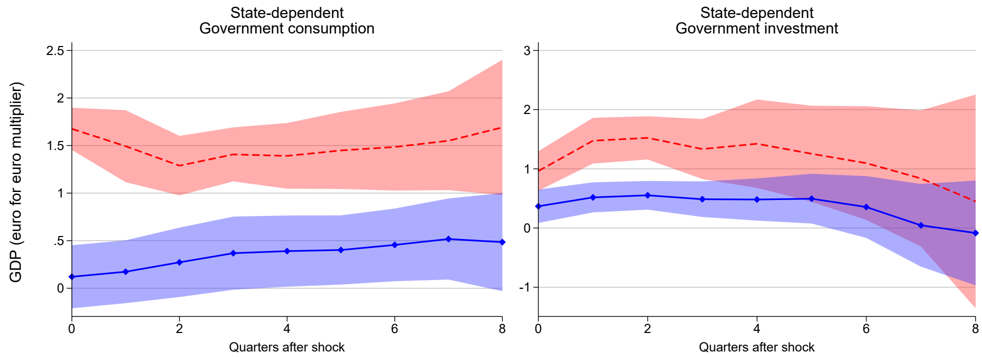
The first row in Figure C.2 shows the impulse responses for government consumption and investment to a shock in public consumption (one percentage point of pot. GDP). As can be seen in the left column, the linear case, the increase in government consumption is persistent and remains significantly positive for two years after the shock. Notably, the response of public investment is small an insignificant at most horizons. The state-dependent model reveals that, within the first year, the increase in public consumption is larger during uncertain episodes but more persistent in normal times. Furthermore, conditional on being in a state of high uncertainty, there is also a larger increase in government investment more than one year after the initial increase in public consumption. The third row depicts the impulse responses for real GDP to the increase in government consumption. In the linear model, an initial increase in public consumption of one percentage point of potential GDP increases output by 0.5 percentage points. The second column shows that the output response is larger when the increase in public consumption occurred during a period of heightened uncertainty. However, at the same time, also the increase in public consumption is larger compared to normal periods. Therefore, the results emphasize the importance of estimating cumulative multipliers, as done in the main text, instead of relying on simple impulse responses.

The second row in Figure C.2 shows the impulse responses for public consumption and investment to a shock in government investment (one percentage point of pot. GDP). As can be seen in the left column, the shock only has a small impact on public consumption in the linear model. This observation also remains valid in the state-dependent model as can be seen in the second column. Interestingly, the increase in public investment is more persistent if the shock takes place during uncertain periods. As before, although the impact of a public investment shock on output is larger during times of high uncertainty, it is important to calculate cumulative multipliers because the increase in government investment is more persistent than in normal episodes.

C.2.3 Uncertainty versus economic slack



(a) OECD recessions



(b) Unemployment rate

Figure C.3 GDP multipliers in times of high and normal uncertainty after cleaning the uncertainty variable from business cycle effects. The figure shows state-dependent multipliers during times of high (in dashed red) and normal (in blue with markers) uncertainty after cleaning the uncertainty variable from business cycle effects. To do so, we first regress the uncertainty index from Rossi and Sekhposyan (2017) on (a) the OECD recession indicator or (b) the unemployment rate, and then use the residuals of these regressions, $unc^{cleaned}$ as the threshold variable in Equation (4.2). 90% confidence intervals based on Driscoll and Kraay (1998) standard errors are shown in all cases.

Table C.3 Distribution of observations as related to uncertainty and economic activity

	OECD recession	Unemployment rate	
		above median	above 80th percentile
HU - slump	85	79	27
HU - no slump	103	109	161
NU - slump	285	395	182
NU - no slump	462	352	565

This table shows the number of observations in times of high uncertainty (HU) and normal uncertainty (NU) depending of the degree of economic slack. We classify a period as uncertain if the uncertainty index from Rossi and Sekhposyan (2017) is above its country-specific 80th percentile. A slump is either indicated by the OECD recession indicator or if the unemployment rate is above its country-specific threshold (median or 80th percentile).

5 Conclusions

This dissertation contributes to the literature on the state-dependent macroeconomic impact of increases in government spending. More specifically, it highlights the importance of uncertainty in the economy for the transmission of fiscal policy measures. Chapter 2 finds *weaker* output effects of additional government spending during uncertain times than in tranquil periods. Similar results are also provided in Alloza (2019), Fritsche et al. (2021) and Ricco et al. (2016). In contrast, Chapters 3 and 4 provide evidence in favor of *stronger* output effects in uncertain periods. This seems puzzling but may be explained by several reasons.

As shown in Chapter 3, one reason is the level of uncertainty. The difference in multipliers across states increases with the degree of uncertainty above which periods are classified as uncertain. Thereby, an increase in government demand is particularly effective during extremely uncertain episodes. To illustrate the importance of this relationship for the divergence of our results from Alloza (2019) and Jerow and Wolff (2022), we replicate in Section B.3 these lower multipliers with our specification but using similar samples and threshold values as in their analyses. Once we focus on more extreme episodes using higher thresholds, we find evidence for positive and large multipliers in very uncertain periods. This result is also reflected in the qualitative changes in the responses of some key transmission variables. Note also that the 80th percentile of the uncertainty distribution using post-WWII data in Chapter 2 is lower than the same percentile using data back to 1890 as the latter contains more extreme events such as the Great Depression.

A further potential reason is that we consider a temporary growth shock to government spending (permanent level shock) in Chapter 2 but temporary level shocks in Chapters 3 and 4. A permanent increase in the level of government spending may undermine fiscal sustainability such that public authority itself becomes a source of uncertainty (Baker et al., 2016; Bi et al., 2013; Davig and Foerster, 2019; Fernández-Villaverde et al., 2015; Ricco et al., 2016). In this context, the lower government spending multiplier in the high volatility regime in Fritsche et al. (2021) may reflect a less stable policy environment reflected in larger fluctuations of aggregate variables.

The third reason is a methodological one. The SEIVAR used in Chapter 2 incorporates the state-dependence of fiscal policy in a more parsimonious way than the threshold models used in Chapters 3 and 4. However, this implicitly assumes that the impact responses of all variables to government spending shocks are the same across states. If this assumption is wrong, the generalized impulse responses at longer horizons can be biased because these are recursively constructed from the impact responses.

Chapters 3 and 4 show that one-year GDP multipliers for government consumption and investment during uncertain episodes are larger than in economic slumps. Chapter 3 highlights that additional public demand can reduce financial risk premia and shift inflation upwards, thereby lowering the real interest rate. Both effects improve the financing conditions for companies and make precautionary savings less attractive, hereby crowding-in private spending. The result is a one-year GDP multiplier close to two in uncertain times. In contrast, during periods of high unemployment, the increase in public demand only stabilizes employment resulting in a GDP multiplier close to one. In Chapter 4, we also find GDP multipliers for government consumption or investment around or below one in periods of economic slack. Therefore, our findings are in line with the literature summary in Ramey (2019) who states that the most robust results suggest GDP multipliers of one or below in economic slumps. These findings are in line with Klein and Linnemann (2019) who argue that the Great Recession, a period of elevated uncertainty, was special in that additional government spending during this period had a strongly negative effect on financial risk premia and boosted consumer confidence. Chapter 4 shows that both, government consumption as well as public investment, raise labor compensation during uncertain periods. Cacciatore and Ravenna (2021) show that limited downward wage flexibility in economic downturns generates strong and state-dependent amplification of uncertainty shocks that deepen the slump. In this situation, the additional public demand can prevent the economy from hitting the downward wage constraint and thus make government spending particularly effective during uncertain periods.

We provide several directions for future research. Instead of increasing the number of observations by extending the sample period backwards or using a panel approach, one could apply Bayesian methods for estimating cumulative multipliers with local projections to deal with the coincidence of limited observations and state-dependence in the transmission of fiscal policy. Furthermore, it might be interesting to allow for asymmetric effects of increases and reductions in government consumption and investment. Recent contributions in this regard are Barnichon et al. (2022) and Ben Zeev et al. (2023). Moreover, the source of business cycle fluctuations can determine the impact of fiscal policy measures. In this regard, Ghassibe and Zanetti (2022) find large government spending multipliers in demand-driven recessions and small multipliers in supply-driven slumps.

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