Is Fiscal Policy More Effective in Uncertain Times or During Recessions?*

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Abstract

This paper estimates the impact of government spending shocks on economic activity during periods of high and low uncertainty and during periods of boom and recession. We find that government spending shocks have larger impacts on output in booms than in recessions and larger impacts during tranquil times than during uncertain times. We explore the reasons why our results differ form other work in the literature and highlight the importance of the information used to define periods of recession. Finally, we explore a potential economic mechanism that suggests that confidence plays an important role in explaining the non-linear impact of government spending.

Keywords: fiscal policy, vector autoregressions, uncertainty.
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1 Introduction

How do uncertainty and the state of the business cycle affect the effectiveness of fiscal policy? Economic models incorporating non-convex adjustment costs, as in Bloom et al. (2018), suggest that high levels of uncertainty make agents more cautious when taking investment/hiring decisions, thereby reducing the effect of fiscal policy.[1] Michaillat (2014) argues that slackness in the economy will improve the effectiveness of some fiscal policies.[2] In this paper we attempt to shed light on this question by empirically characterizing how uncertainty and the state of the business cycle influence the effects of government spending.

Our empirical strategy is based on a nonlinear specification that allows for differing effects of government spending shocks during times of high (HU) and low (LU) uncertainty, or during times of recession (R) and boom (B). Following Bloom (2009), we identify periods of HU as those with unusually high implied stock market volatility. We define periods of R as times with at least two consecutive quarters of negative growth rates of output. Exogenous shocks to government spending are identified using three alternative strategies. In the first case, we follow a narrative approach and identify government spending shocks using the news about future defense spending produced by Ramey (2011a). The narratively identified shocks are then classified according to whether they occur during times of HU or LU or, alternatively, during times of R or B. An advantage of this this framework is that it allows us to address issues such as anticipation effects of the shocks. In the second case, exogenous variation in government spending is isolated using the exclusion restriction that this variable cannot react within one quarter to shocks to output and tax revenues (a method pioneered by Blanchard and Perotti (2002)). In the third case, we identify government spending shocks as the differences between actual and forecasted government spending, using data from the Survey of Professional Forecasters produced in Ramey (2011a). This framework offers an alternative assessment of the exogeneity of the shocks.

[1]Bloom et al. (2018) develop a model in which uncertainty is time-varying and affects the volatility of technology shocks, and firms are heterogeneous and face non-convex adjustment costs in capital and labour. Fiscal policy is modeled as a wage subsidy. The effect of such a policy is smaller when the policy is implemented at the time uncertainty first hits the economy but slightly larger when the policy is conducted one year later.

[2]Michaillat (2014) considers a New Keynesian model with a search and matching friction where an increase in the size of the public workforce during periods of slack (unemployment increases from 5 to 8%) doubles its effect (as measured by the additional number of workers employed when one more worker is employed in the public sector) compared to that under non-recessionary conditions. Other theoretical work based on costly financial intermediation that yield non-linear responses to fiscal shocks can be found in Canzoneri et al. (2016) propose an alternative mechanism based on costly financial intermediation to understand the non-linear impact of government spending.

We apply this methodology to US data between 1947q1 and 2016q4.[3] We construct impulse responses for different states of the economy using local projections (Jordà (2005)) and structural vector autoregressions (SVARs).[4]

The results suggest that the response of output to a positive government shock is positive during times of LU or B but negative (or at most not significantly different from 0) during times of HU or R. These results are obtained across a wide variety of specifications that employ the three alternative identification methods, two different ways of computing impulse responses (local projections or SVAR) and are subjected to several robustness tests. We put special emphasis on minimizing the effect that a certain regime can have on output beyond the impact of the fiscal shock. All these tests lead us to conclude that the negative (or at most negligible) response of output seems to be a well ingrained feature in postwar US data.[5]

The results we obtain contrast with previous literature that finds government spending shocks to be more effective in stimulating the economy during periods of R than B (Auerbach and Gorodnichenko (2012)). We reconcile the two views and conclude that these differences arise from the information used to define periods of R. In particular, we find that using forward-looking information to define current states of R can bias the results. When adopting measures of R exclusively based on past or current information we find that our benchmark results emerge regardless of the specification employed.

In order to rationalize the fact that output may contract after a government spending shock, we explore an economic mechanism where information is scarce or noisy during times of HU. In this context, agents are concerned that the economy may take a downturn and reduce their future levels of income. A government spending shock during times of heightened uncertainty may then simply confirm these pessimistic views, in turn producing a decline in consumption and activity.[6] We find evidence of measures of

[3]The end of the sample is dictated by the availability of the Ramey's news on future defense spending. When using the measure of the forecast errors, the sample is reduced to 1968q2 to 2008q4.

[4]By using the VAR framework to obtain impulse response functions, we are imposing the restriction that responses are fixed for each regime (history-independence), an issue that is not present when using local projections as in Jordà (2005). While this problem is particularly relevant for medium and long-term horizons, in the next section we argue that responses computed using SVARs still present several advantages (namely efficiency).

[5]Negative responses to positive government spending shocks also arise in other non-linear contexts. For example, Corsetti et al. (2013) propose a theoretical framework where the health of public finances might not only affect the magnitude but also the sign of the response of output to government spending. In recessions in an economy with a high level of debt and where monetary policy is constrained (e.g. because of the zero lower bound), an increase in government spending may increase the probability of default, lowering demand. Under certain conditions, the multiplier can shift from positive to zero, or even become negative and large.

[6]This is compatible with the existence of agents that display ambiguity averse preferences as in Ilut and Schneider (2014). In their setting, times of heightened uncertainty make it more difficult for

household-sector confidence reacting negatively to a government spending shock during times of HU, together with consumption.

Traditional empirical research on fiscal policy, starting with the influential work of Blanchard and Perotti (2002) and subsequent papers such as Ramey (2011a) and Barro and Redlick (2011),[7] has focused on the linear effects of fiscal policy (i.e. the effect of the fiscal policy is assumed to be the same regardless of potentially changing conditions). The conclusion of the above research is that government spending stimulates economic activity, although the precise impact, as measured by the so-called fiscal multiplier, is still controversial (Hall (2010)).[8] Another strand of the literature suggests the opposite effect: government spending cuts have expansionary effects under certain conditions. This is the implication of work by Giavazzi and Pagano (1990) and Alesina and Ardagna (2013).[9]

There is, however, a recent emphasis on allowing for nonlinear effects of fiscal policy, as highlighted in Parker (2011). For example, Bertola and Drazen (1993) and Bi et al. (2013) argue that expectations about future government spending can generate such nonlinear effects. These authors explore the idea that cuts in government spending can cause an economic expansion if they induce agents to believe that government spending will be higher in the future. Bi et al. (2013) build on this idea and suggest that changes in agents' expectations about fiscal policy (the timing of it and instruments used) can generate positive or negative effects on economic activity, depending on other elements of the economy such as the monetary policy stance or the level of government debt.

A growing body of evidence (Bloom (2009), Baker et al. (2016)) suggests that uncertainty does have a negative effect on economic activity. However, we have little evidence on how uncertainty affects fiscal policy.[10] This question could have important implications from a policy-making standpoint, regarding the extent to which a fiscal intervention may be appropriate during a period of turmoil.

Our work does relate to an increasing amount of empirical studies focusing on whether business cycle conditions are associated with nonlinear effects of fiscal pol-

the agents to assign probabilities to all relevant events. In this case, agents act *as if* they evaluate potential future outcomes using a worse case set of probabilities.

[7]Other works on the economic effects of government spending include, for example, Ramey and Shapiro (1998), Burnside et al. (2004), Perotti (2004) and Mountford and Uhlig (2009).

[8]The government spending multiplier is defined as the ratio of output change to an exogenous discretionary increase in government spending. See Ramey (2011b) for a survey on the fiscal multiplier.

[9]See Alesina (2010) for a review of the expansionary effects of fiscal consolidations.

[10]Ricco et al. (2016) explore how fiscal policy uncertainty (a noisy policy communication, measured by disagreement amongst professional forecasters) can affect government spending. The authors find that the output effect from increases in government spending is positive and large, fostered by an increase in private investment. However, the effect is muted during times of elevated disagreement. Aastveit et al. (2017) investigate the effects of uncertainty on the effectiveness of monetary policy.

icy, for example Auerbach and Gorodnichenko (2012), Auerbach and Gorodnichenko (2013), Bachmann and Sims (2012), Mittnik and Semmler (2012), Fazzari et al. (2015), Bognanni (2012), Brückner and Tuladhar (2013) , Owyang et al. (2013), Ramey and Zubairy (2018) and Caggiano et al. (2015).[11] However, the variety of methodologies employed and the heterogeneity in the definitions of what can be considered a recession (or a slack economy) yield very different results. Some of these studies find that recessions or periods of slack in the economy make government spending a particularly powerful tool. This is true of Auerbach and Gorodnichenko (2012), one of the most prominent studies in this body of literature. These authors use a smooth-transition SVAR in which the probability of recession is weighted by a seven-period centered moving average of the growth rate of output, their measure of the state of the business cycle. Bognanni (2012) finds the opposite: a smaller multiplier during recessions in a Markov-switching VAR in which the probability of recession is estimated period by period. Owyang et al. (2013) and Ramey and Zubairy (2018), meanwhile, find no impact of the state of the business cycle on government spending multipliers.[12]

The present analysis differs from the studies that focus on the effects of fiscal policy across the business cycle by proposing an alternative definition of recessions strictly based on contemporaneous or past information. In doing so, we avoid common problems in the literature than can bias the results. Additionally, we provide evidence on how uncertainty can affect the responses of macroeconomic variables to government spending shocks and propose an economic mechanism that could help rationalize these results.

The rest of the paper is organized as follows. Section 2 describes the empirical strategy and presents the different methods employed to identify the government spending shocks. Section 3 contains the results for nonlinearities due to the business cycle. Since our findings are in striking contrast to previous conclusions in the literature, in this section we investigate the sources of these differences. Section 4 describes the results when the non-linearities are due to episodes of high uncertainty. We also provide evidence suggesting that confidence could play a role in explaining the results. Section 5 concludes and offers directions for future research.

[11]Ramey (2018) reviews the recent advances in the fiscal policy literature, with special emphasis on the potential non-linear effects of government spending shocks. Tenreyro and Thwaites (2016) analyze how the business cycle affects monetary policy.

[12]With the exception of a specification based on Blanchard-Perotti, Ramey and Zubairy (2018) conclude that responses under both R and B are below unity and not statistically significant from each other.

2 Empirical stragegy

To estimate the responses of government spending shocks under different regimes, we first propose three identification procedures that aim at isolating the exogenous variation in government spending. Then, we define wether the economy is in a specific state (e.g. periods of recessions *versus* booms, or low *versus* high uncertainty) according to different criteria. Lastly, we construct responses of output and other variables to shocks in government spending that occur during a specific regime.

2.1 Identification of exogenous government spending shocks

The empirical literature on the effects of fiscal policy disagrees on which is the best way to identify government spending shocks (ε^G). The most commonly used frameworks differ in their assumptions and in the results obtained (see Hall (2010)). In this paper we explore three different identification schemes which can be usually found in the empirical literature.[13]

The first method considered here, identifies government spending shocks following Ramey and Shapiro (1998), who use unexpected changes in defense spending as a measure of exogenous government spending shocks. In particular, we make use of the measure of news about future government spending (as a percentage of GDP) described in Ramey (2011a) and updated in Ramey and Zubairy (2018) to identify exogenous shocks.[14].

The second method is based on Blanchard and Perotti (2002), which identifies exogenous government spending shocks as the only ones that can affect government spending contemporaneously. This is achieved using exclusion restrictions: government spending does not react contemporaneously to other structural shocks. This assumption implies that there is a time lag of one quarter required to enact public spending bills. Following Blanchard and Perotti (2002), the plausibility of this restriction rests on the minimum required time that the fiscal authority faces when adjusting government spending to surprise changes in fiscal (as measured by shocks to tax revenues) or general (as measured by shocks to output) macroeconomic conditions.

Note that the first identification method (based on Ramey (2011a)) is better equipped

[13] An alternative method would be to restrict the sign of some responses of the system to achieve identification, as in Mountford and Uhlig (2009).

[14] Ramey (2011a) constructs a time series of the expected discounted values of government spending changes by obtaining quantitative information about estimated defense spending from periodicals (hence its name of narrative identification). A simpler approach based on the same strategy can be found in Ramey and Shapiro (1998), where the authors use war dates to identify exogenous changes in defense spending.

to deal with potential mistiming of events than the second approach (Blanchard-Perotti). The latter identification procedure relies on two assumptions: (i) government spending shocks are a surprise to agents and (ii) government spending cannot react within one quarter to other shocks affecting the economy. However, it could be the case that government spending plans are anticipated by agents, which would violate assumption (i) above. This possible mistiming of events has been voiced as a criticism of the Blanchard-Perotti approach, and can be potentially solved using announcements about future government spendings (see Ramey (2011a)). Regarding the second assumption, it could be argued that the intervention lag of one quarter taken by the fiscal authorities to respond to developments in the economy, assumed in the previous subsection, is more likely to be violated during times of R or HU (since it could be the case that governments will act faster in passing bills in such times). This would cause a problem of a lack of exogeneity. The use of narrative identification of shocks using news about defense spending again allows us to deal with this problem, since the defense news variable is more likely to be driven by exogenous foreign political events, wars, etc (Ramey (2011a)).

Lastly, the third identification method follows the news variable from Ramey (2011a) based on professional forecasters. Particularly, this series quantifies the one-quarter ahead forecast error defined as the difference between actual and forecasted real defense spending growth between two adjacent quarters, using data from the Survey of Professional Forecasters. As the author argues, this variable can be seen as a complement to the future defense spending series mentioned above, since it offers a greater variation than military spending in recent decades.[15]

2.2 Estimation of responses to government spending shocks

We construct the responses of variables of interest to fiscal shocks using two alternative methods. In the benchmark results, we employ the local projection methodology proposed by Jordà (2005) to estimate the responses, while we use the conventional moving average representation found in the SVAR literature as a robustness method. The reason for this choice is based on the implicit restrictions embedded in the construction of responses following a moving average representation when the variables result from a non-linear data generating process. In this case (e.g. using a SVAR), responses are linear when conditioning on a given state and are therefore history-independent. This is equivalent to assuming that fiscal policy, through government spending, cannot change

[15] However, this series is available for a shorter sample starting in 1968q1.

the regime from HU to LU (or from R to B) or vice versa. While uncertainty is defined here as exogenous events (most of the episodes of HU are not economics-related), these events are mostly short-lived. It is also plausible to believe that government spending can influence the economic situation. Although these shortcomings are less likely to appear in the short run, we follow Auerbach and Gorodnichenko (2013) and Ramey and Zubairy (2018) in using a methodology that takes these issues into account.

Hence, we use the local projection approach proposed in Jordà (2005), which relaxes the assumption that the state of the nonlinear model remains fixed throughout the entire horizon of the impulse response analysis.[16] We estimate a series of single equations over the horizon h:[17]

$$\begin{aligned} x_{t+h} = H_{t-1}\left[\alpha_{A,h} + \beta_{A,h}(L)\boldsymbol{x}_{t-1} + \delta_{A,h}\varepsilon_t^G\right] + \\ (1 - H_{t-1})\left[\alpha_{B,h} + \beta_{B,h}(L)\boldsymbol{x}_{t-1} + \delta_{B,h}\varepsilon_t^G\right] + \quad \psi_{t+h} \end{aligned} \tag{1}$$

where $\boldsymbol{x}_t = [g_t, y_t, tr_t]'$ is a vector of the log of real per capita total government spending, output and tax revenues.[18] x_t is an outcome variable of interest (output or government spending) and ε_t^G is an exogenous government spending shock identifies using one of the three methods described above. Note that equation 1 allows for the coefficients to change for each horizon h. $\beta_{s,h}(L)$ is a polynomial in the lag operator of order 4.[19] The coefficient $\delta_{L,h}$ measures the response of the variable x_t to a government spending shock ε_t^G during state A (which represents times of LU or B) and, conversely, $\delta_{B,h}$ captures the response during state B (times of HU or R).[20] The responses of the variable of interest to government spending shocks during state A (or B) are given by a series of $\delta_{A,h}$ (or $\delta_{B,h}$) obtained from each regression h. Note that equation 1 allows for time-varying intercepts. This is particularly relevant since they capture the effect that a given regime has on the response of the variables of interest (minimizing the possibility that coefficients $\delta_{A,h}$ reflect the impact of a given regime A instead of that

[16]As discussed in Ramey and Zubairy (2018), the use of local projections does not dominate that from a SVAR, since the former tend to be more erratic due to a loss of efficiency. For this reason, we pay attention to both estimation procedures (local projections and SVARs), which, reassuringly, yield similar results.

[17]The estimation of a series of equations for different values of h induces serial correlation in the residuals. To correct for this issue, confidence intervals are constructed using Newey-West standard errors.

[18]See Appendix A for details. Sample spans 1947q1 to 2016q4 (the Ramey's series of news about future defense spending is available until 2016q4)

[19]As shown in the robustness section, results are not qualitatively sensitive to different dynamic specifications.

[20]The procedures followed to construct H_t for the case of business cycle fluctuations or variation in the level of uncertainty will be detailed in Section 3 and Section 4, respectively.

of the government spending shock.[21] Equation 1 also includes a quadratic trend.

When ε_t^G is identified using the news about future defense spending or forecast errors, this variable is scaled by previous quarter nominal output and x_t becomes either $x_t = \frac{Y_{t+h} - Y_{t-1}}{Y_{t-1}}$ or $x_t = \frac{G_{t+h} - G_{t-1}}{Y_{t-1}}$, where Y and G are the level of real per capita output and government spending, respectively. This transformation follows Hall (2010) and allows the equations for output and government spending to be expressed in the same units.[22] Hence, the cumulative fiscal multiplier under regime i and up to horizon h can be defined as the sum over h of the $\delta_{i,h}$ coefficients resulting from estimating equation 1 using output as the left-hand-side variable, over the sum of the same coefficients that arise when government spending is used as dependent variable. To implement the Blanchard-Perotti identification, ε_t^G is defined to be the log of real per capita government spending, while x_t becomes either real per capita output or government spending. The coefficients in equation 1 become elasticities that can be translated into multipliers following Blanchard and Perotti (2002) and multiplying these elasticities by the sample average $\frac{G}{Y}$.[23]

2.3 Linear responses

Before investigating the potential non-linear effects of fiscal policy, we estimate a linear version of equation 1 by setting $H_t = 1$ for al periods t.

Figure A1 shows the results of this estimation, under three different identification schemes. When considering the effects of government spending shocks identified as news about future defense spending, we observe a positive response of output throughout the considered horizon of 20 quarters. The implied cumulative multiplier amounts to 0.7-0.8 during the first three years. This results are very close to those from Ramey and Zubairy (2018), which employ a very similar methodology and data, but an historical sample starting at the end of the XIX century[24]. When considering and identification based on a Blanchard-Perotti approach, the response of output remains positive for the first three years, but the significance is lower. The resulting multiplier implied by these elasticities for the first year is smaller at 0.4. Finally, when employing the forecast errors as a measure of government spending shocks, we observe that the response of output

[21]In the robustness section we checked that alternative specifications (e.g. including lags of the regime variable) do not alter the results.

[22]This transformation is also followed in Barro and Redlick (2011) and explained in Ramey and Zubairy (2018).

[23]This is the original construction of fiscal multipliers as in Blanchard and Perotti (2002). Substituting the use of sample averages by the conversion of the variables in the output and government equations to the same units yields very similar results for this sample.

[24]Ramey and Zubairy (2018) find a 2-year cumulative multiplier of 0.66.

to the shocks remains only positive during the first two quarters, becoming negative afterwards. These contractionary effects replicate the results from Ramey (2011a), who notes that this result holds in a variety of situations.

In the Online Appendix, we replicate the results using the same data but estimating the responses using a SVAR (see Appendix B for further details). While all the results are qualitatively similar, the estimates of multipliers tend to be higher. Figure B1 shows the responses to a government spending shock following a Blanchard-Perotti approach and using a SVAR. When translated into multiplier terms, the average multipliers for the first and second years are 0.55 and 0.42, respectively (similar to Blanchard and Perotti (2002), albeit slightly smaller in size). Figure B2 (top panel) shows the responses when identifying government spending shocks using Ramey's news about future defense spending in a SVAR setting. The implied multiplier after two years is 1.1, which replicate the estimates found in Ramey (2011a). Lastly, Figure B2 (bottom panel) shows the responses of the variables of interest when shocks are identified using forecast errors. As commented earlier and following Ramey (2011a), while the contemporaneous response of output to the shock is positive, it becomes negative after a year.

3 Fiscal policy during recessions

This section describes the results obtained after estimating equation 1 while allowing H_t to refer to periods of recession.

3.1 Defining periods of recessions

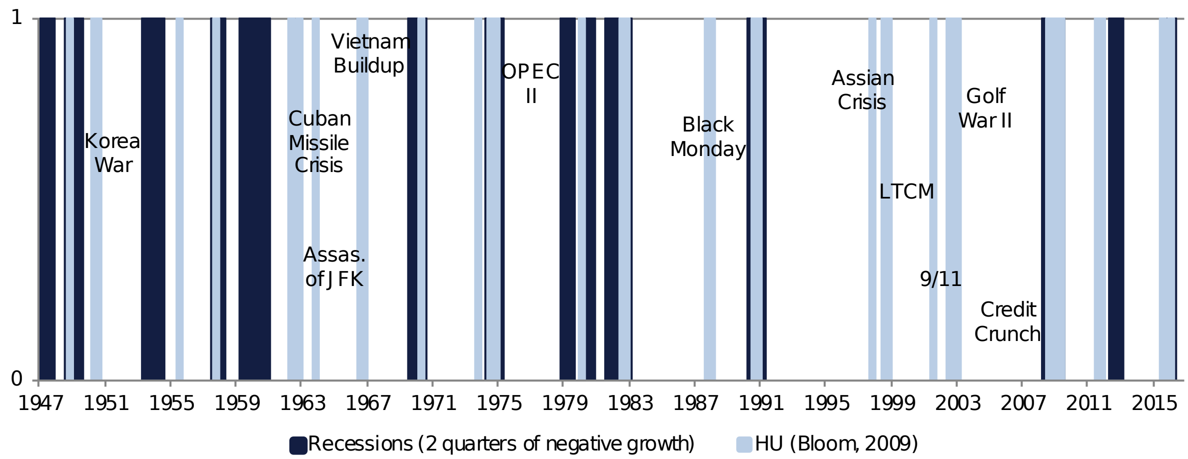
Our definition of quarters of R or B considers recessions as periods of time with at least two consecutive quarters of negative growth of real output. We choose this definition of business cycles as opposed to other traditional measures such as the one offered by the NBER because we want to define recessions according to information that does not contain a forward looking component (this important point will be explained later at the end of the section).[25] However, we will also check the robustness of our results to alternative definitions of recessions.

Figure 1 shows the episodes of recessions in our sample, which amount to 41 quarters, with an average recession lasting for 2.6 quarters.[26]

[25] Our measure of recessions and the NBER dating have positive and significant correlation slightly above 60%.

[26] The average length of recessions using the NBER dating is higher: 4.7 quarters in our sample from 1947q1).

Figure 1: Periods of R and H between 1947q1 and 2016q4



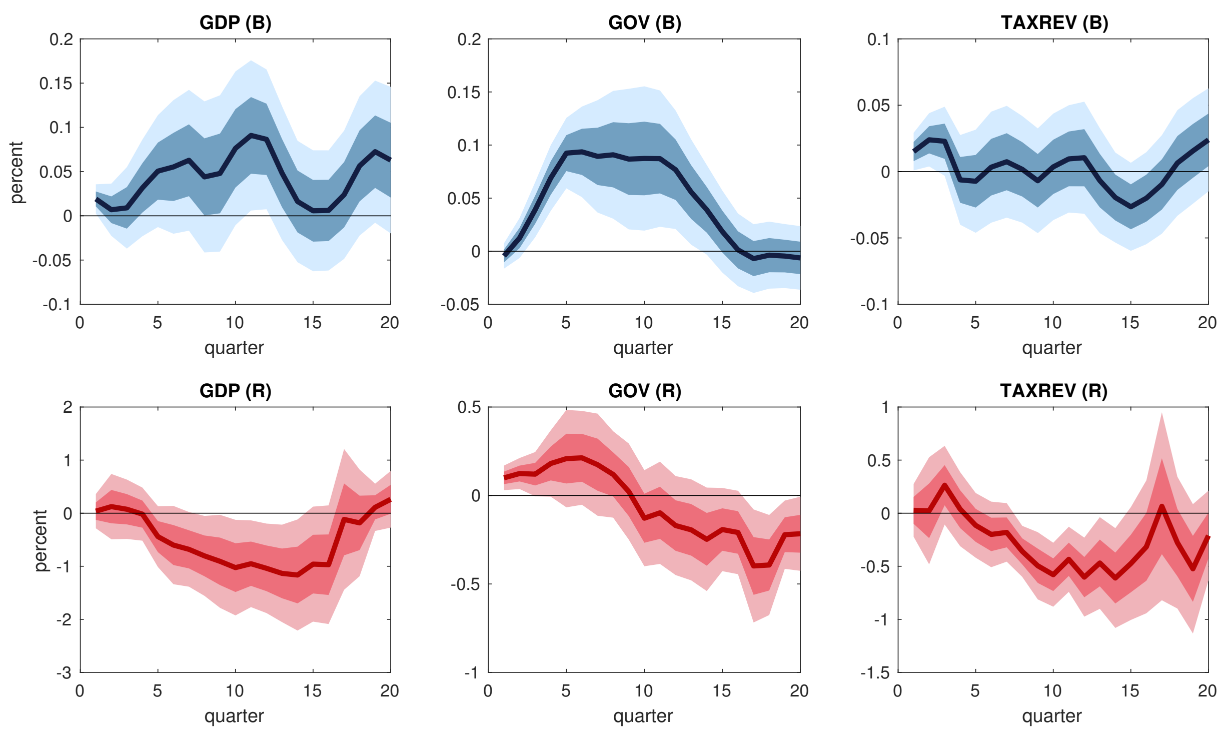
3.2 Results

Figure 2 shows the responses of the variables of interest to a government spending shock identified using news about future defense spending both during times of B (upper panel) and during R (bottom panel). During B, output responds positively to a government spending shock throughout the horizon considered (20 quarters), with a cumulative multiplier of approximately 0.6 after the second year. The same shock has, however, very different effects when it takes place during R. A government spending increase, while not having a notable effect during the first quarters, it seems to significantly contract output after the first year. The 2-year cumulative fiscal multiplier during periods of R is estimated at -1.86.

Figure 3 displays the results of the same exercise when government spending shocks are identified using the Blanchard-Perotti approach. When the shock occurs during times of B, output reacts positively and significantly during the fist year, although its effect becomes not significant afterwards. In particular, a shock that increases government spending by 1% on impact, raises output by 0.15%. According to the sample average $\frac{Y}{G}$ of 4.9 this implies an impact multiplier of 0.72. The cumulative multiplier after the first year is around 0.5. On the contrary, when the spending increase occurs during R, output contracts during the first year (although only significantly at confidence levels of 68%). The impact multiplier is -0.26, with a 1-year cumulative multiplier of around -0.8.

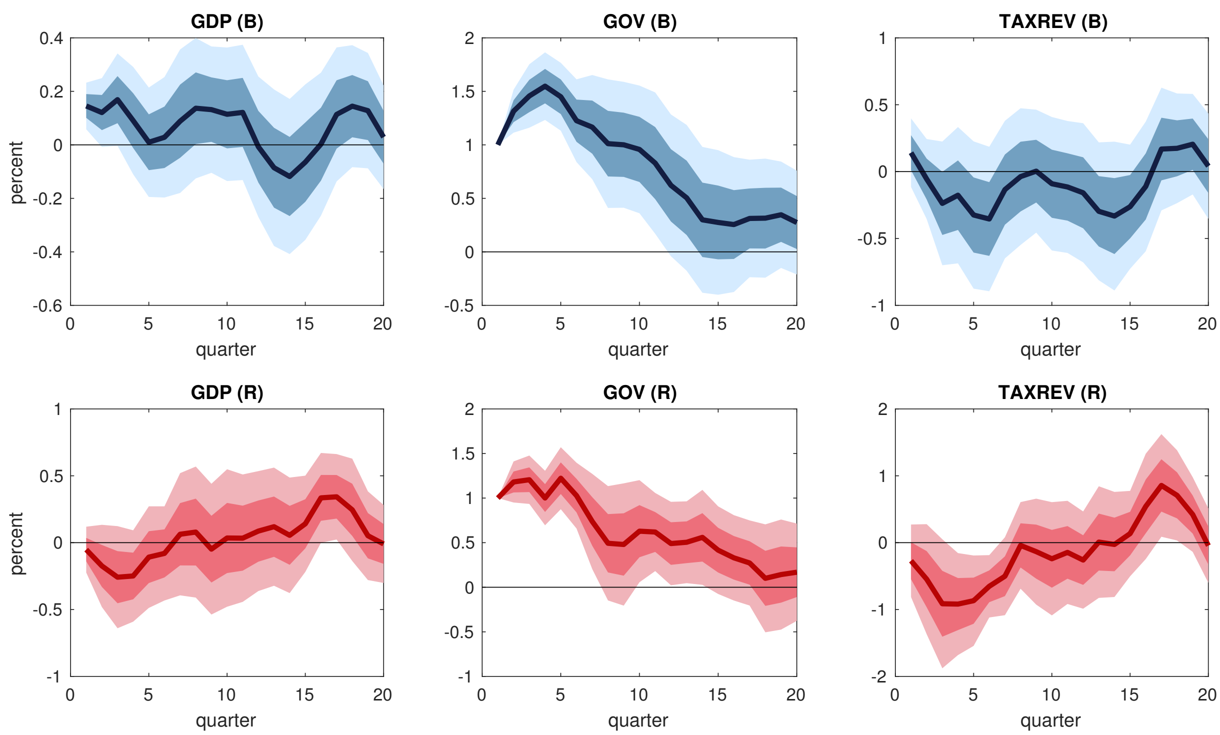
Lastly, Figure 4 shows the responses to a government spending shock identified

Figure 2: Responses to government spending shocks in R and B (Ramey news)



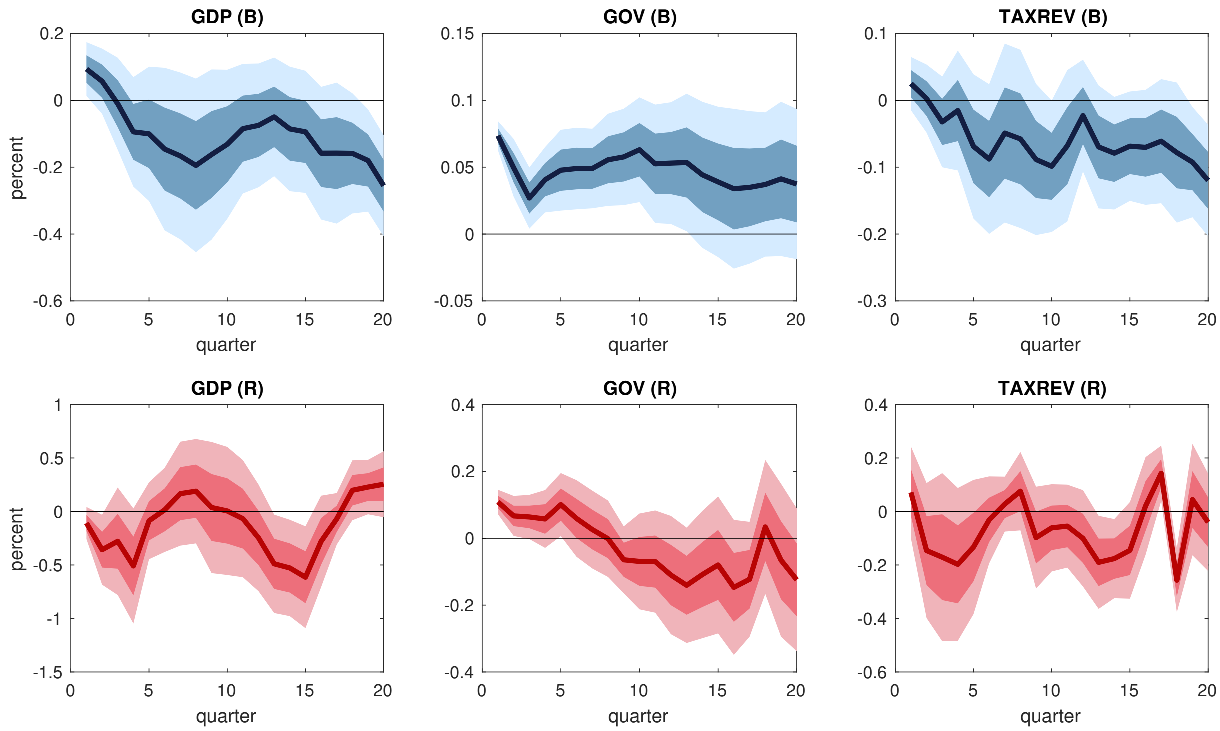
The top panel (in blue) shows responses to a government spending shock (identified using news about future defense spending) during times of boom. The bottom panel (in red) shows responses during times of recession. The 68% and 95% confidence bands are computed using Newey-West standard errors.

Figure 3: Responses to government spending shocks in R and B (Blanchard-Perotti)



The top panel (in blue) shows responses to a government spending shock (identified using exclusion restrictions) during times of boom. The bottom panel (in red) shows responses during times of recession. The 68% and 95% confidence bands are computed using Newey-West standard errors.

Figure 4: Responses to government spending shocks in R and B (forecast errors)



The top panel (in blue) shows responses to a government spending shock (identified using forecast errors in government spending from the Survey of Professional Forecasters) during times of boom. The bottom panel (in red) shows responses during times of recession. The 68% and 95% confidence bands are computed using Newey-West standard errors.

using forecast errors. The results show a similar dynamic in the very short run: a government spending shock significantly increases output on impact during B (with an impact multiplier of 1.28) and contracts it when it occurs during R (multiplier of -0.98).[27]

3.3 Robustness

In this subsection we test the sensitivity of the above results to changes in the definition of R, alternative methods to compute the responses, addition of control variables and alternative empirical specifications.

[27]The dynamics in the medium-run are however different to the results from the other identification approaches. In a similar way to the linear estimations presented above, a government spending shock during booms tend to contract output after the first year. During R, the behavior is slightly erratic after that time, with the estimates not being generally significant.

Alternative definition of recessions. In our benchmark results, R is defined as periods with two consecutive quarters of negative output growth. Here we estimate alternative specifications that vary in how H_t (recessions) is defined in equation 1, when shocks are identified using the news about future defense spending. The first alternative specification (showed in dashed lines in Figure 5) defines R following the NBER dating procedure.[28] The second alternative (pointed lines) follows Ramey and Zubairy (2018) and defines recessions as periods when unemployment rate is above the threshold of 6.5.[29] The third alternative (dash-point lines) builds on this last procedure defining recessions as quarters with unemployment rate being one standard deviation above the sample mean (i.e. setting a threshold of 7.3). The results using these alternative specifications (displayed in Figure 5[30]) show that the estimations presented above are not sensitive to different definitions of recession: the response of output is positive after a government spending shock increase during B, but it is contractionary when the shock occurs during R.[31] This seems to suggest that our results do not particularly hinge on some specific definition of recession.[32]

Computing responses using a non-linear SVAR. In the benchmark specification of equation 1, responses to government spending shocks are computed using local projections. While this method is particularly advantageous in non-linear settings (it is more robust to misspecification of the model and allows to compute impulse responses without assuming that a certain regime will last throughout the whole response horizon) it also has some shortcomings. Mainly, local projections imply a loss in efficiency when the model is correctly specified and tend to show a more erratic behavior (as noted in Ramey and Zubairy (2018)). Here, we compute the responses using a SVAR (i.e. from a moving average representation) using the Blanchard-Perotti and Ramey's identification approach (military news).[33] While these responses implicitly assume that

[28]This is perhaps the most commonly used measure of recessions. The NBER institute defines a recession in retrospective manner (once the recession is well in place) using several indicators.

[29]The author argues that unemployment rate is a better measure of the degree of slack that is present in the economy.

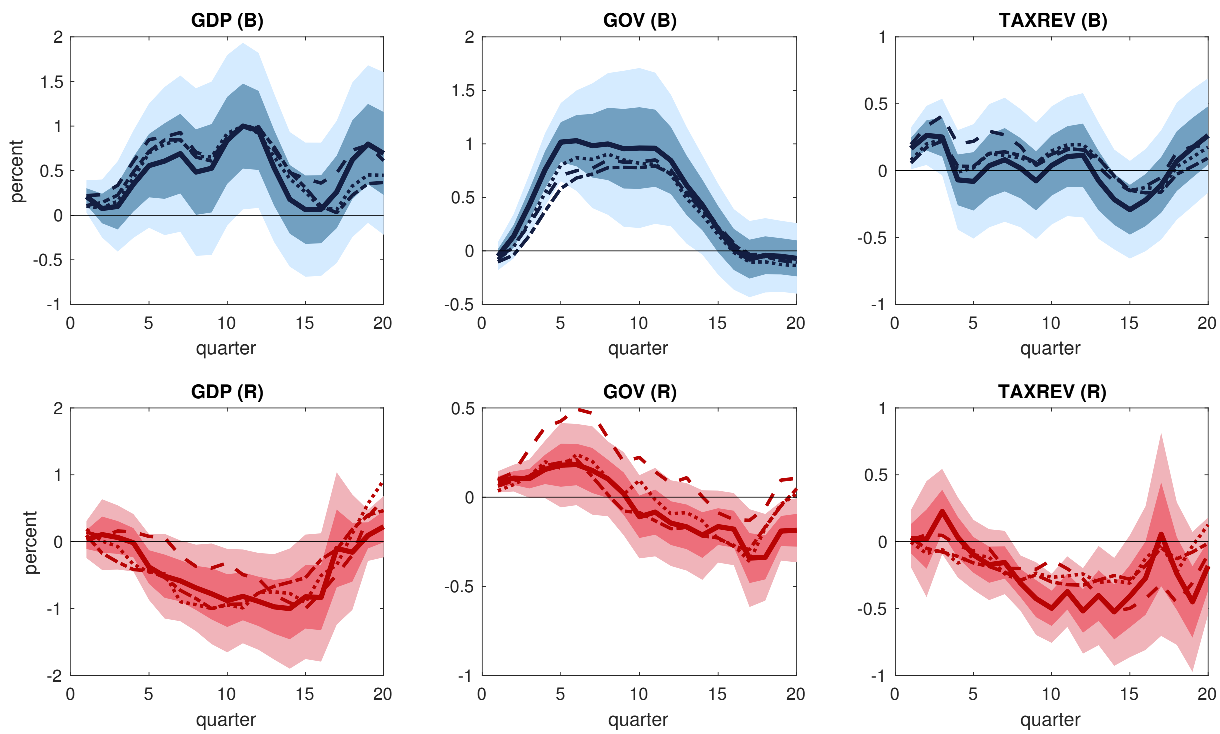
[30]To facilitate the visualization of the results, the responses of the variables are normalized so that output is equal to 1 at its peak during B (-1 in the case of R). This transformation, since it affects all the responses, does not have any effect on the computation of the multipliers).

[31]Figure B3 in the Appendix shows the results when combining alternative definitions with our 3 identification approaches. In the case of the Blanchard-Perotti approach, the results are qualitatively similar when using the NBER specification (the negative output effect of government spending shocks remains negative for longer), but not conclusive when using measures based on unemployment.

[32]While the benchmark definition is highly correlated with the NBER dating (60%) it is much less correlated with our two measures based on unemployment rate (4 and 12%).

[33]The details on how these identification approaches are embedded in a non-linear SVAR are detailed in Appendix B.

Figure 5: Robustness to different specifications of recession (Ramey news)



The top panel (in blue) shows responses to a government spending shock (identified with news about future defense spending) during times of boom. The bottom panel (in red) shows responses during times of recession. Solid lines refer to the benchmark specification (recessions defined as two consecutive quarters of negative output growth). Dashed lines refer to specifications with recessions defined by the NBER. Pointed lines display the results when recessions are defined as periods with an unemployment rate above 6.5. Dash-point lines refer to specifications with recessions defined as periods with unemployment rate higher than one standard deviation above the sample average. The 68% and 95% confidence bands are computed using Newey-West standard errors.

a shock cannot affect the transition from one regime to the other during the response horizon (i.e. fiscal policy could not influence the economy to transit from recession to boom during 20 quarters), at the very least, the short-run responses should not be affected by this assumption and allows to obtain a more efficient estimations when a non-linear VAR is an adequate representation of the economy.

Figure 6 shows the responses of the variables of interest to a government spending increase during B (upper panel) and during R (bottom panel). We consider two cases: i) when assuming that government spending follows a linear process and ii) when government spending is allowed to be nonlinear. In the first case (solid lines), output reacts positively and significantly during the first year after a shock that occurs during B, with a decreasing effect afterwards. At the peak, a shock that raises government spending by 1% at its maximum, increases output by 0.1%, which implies a multiplier of 0.5 in the second quarter (the average multiplier for the first year is 0.38). However, when the shock occurs during R, the short run effect on output is negative and significant, with an average multiplier of -1.6 in the first year.[34] [35]

Figure 7 shows the results to a similar exercise when the shocks are identified using news about future defense spending. When the shock occurs during times of B, output expands significantly during all the considered horizon, with an average multiplier of around 0.8 during the first year. However, when the shock occurs during a R, output contracts in a persistent manner (significantly different from 0 when considering levels of confidence of 68%). The average multiplier during the first year of a recession is slightly below 1.5.

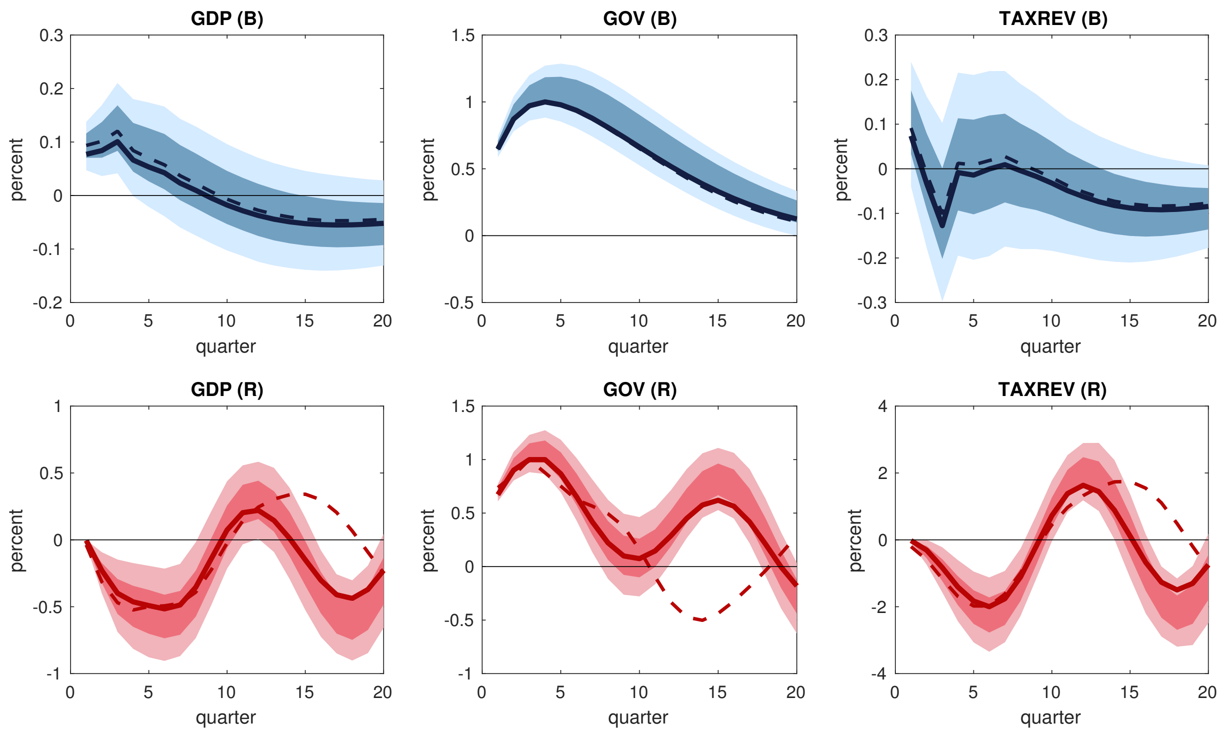
Hence, when computing the responses using non-linear VARs, the results seem to confirm the qualitative implications obtained before: a positive government spending shock is expansionary during B but can potentially contract output during R. This would indicate that our benchmark results are not a product of a particular estimation method.

Further controls. In all our benchmark specifications, we have included (in addition to time-varying intercepts and quadratic trends) tax revenues as a control variable. The inclusion of this variable allows to analyze deficit-financed increases in spending, an important issue since some fiscal action tend to include both changes in spending and taxes. In this section we investigate whether our results could arise as the result of the

[34]Standard errors in this subsection are computed using a non-parametric bootstrap. Details are described in Appendix B.

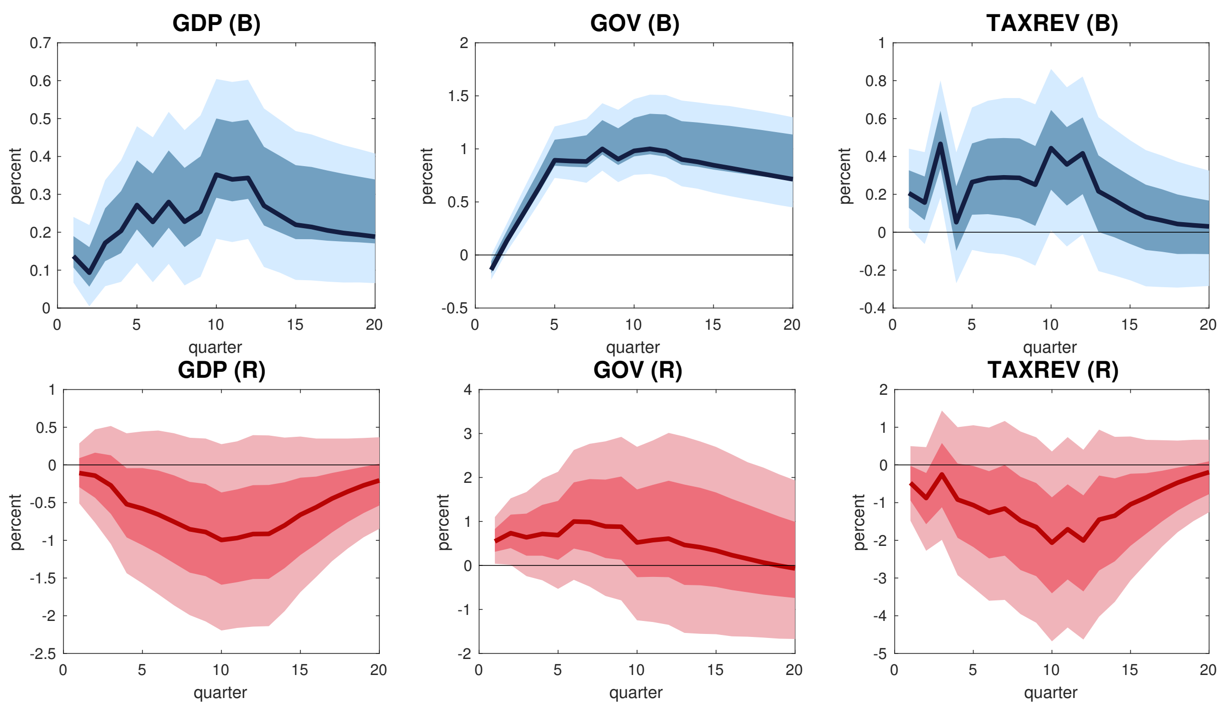
[35]The effects remain very similar when the shocks are identified from a non-linear government spending process (dashed lines in Figure 6).

Figure 6: Responses using a non-linear SVAR in R and B (Blanchard-Perotti)



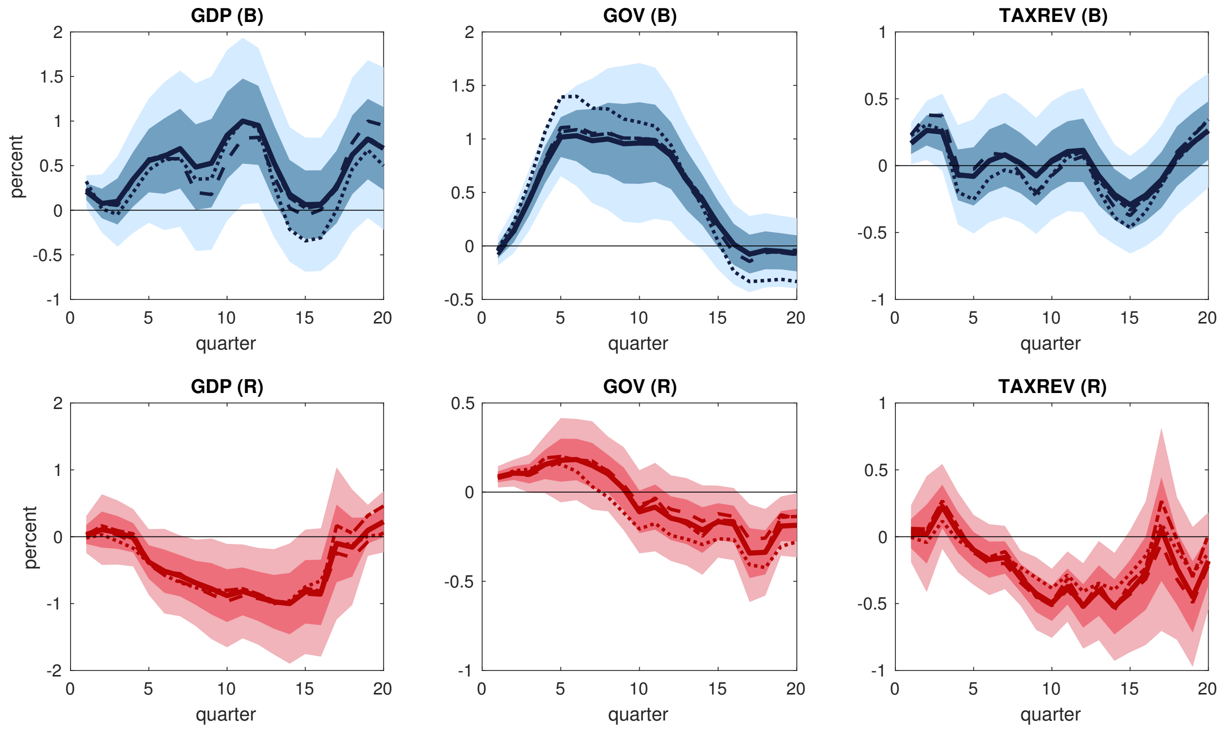
The top panel (in blue) shows responses to a government spending shock (identified using exclusion restrictions) during times of boom. The bottom panel (in red) shows responses during times of recession. Solid lines represent the estimations when government spending is assumed to be a linear process. Dashed lines represent the estimations when the shocks are identified using a non-linear process for government spending. The 68% and 95% confidence bands are computed using a non-parametric bootstrap.

Figure 7: Responses using a non-linear SVAR in R and B (Ramey news)



The top panel (in blue) shows responses to a government spending shock (identified using news about future defense spending) during times of boom. The bottom panel (in red) shows responses during times of recession. The 68% and 95% confidence bands are computed using a non-parametric bootstrap (for the first specification).

Figure 8: Robustness to the inclusion of additional controls in R and B specifications (Ramey news)



The top panel (in blue) shows responses to a government spending shock (identified using news about future defense spending) during times of boom. The bottom panel (in red) shows responses during times of recession. Solid lines indicate the benchmark specifications. Dashed lines refer to estimates that include interest rates. Pointed line shows the results of specifications that include prices. Dash-point lines refer to specifications that also include two additional lags of the dummy variable H_t. The 68% and 95% confidence bands are computed using Newey-West standard errors.

lack of further control variables that could originate a problem of omitted variables.This would indicate that our identification approaches are not recovering shocks that are fully exogenous to macroeconomic conditions.

In a first test, we include additional macroeconomic variables (one at time): short-term interest rates (3-month Treasury Bills) and prices (GDP deflator). The results are shown in Figure 8 in dashed and pointed lines, respectively. In a second test (dash-point lags) we include additional lags of the dummy variable H_{t-1} in equation 1, this allows to control for the potential lagged impact that the current regime can have in the response of output. This is important because it allows to control for the the potential dynamic effect that the current regime may have on the response of the variables. However, in all cases the responses are all very similar to the benchmark estimates, suggesting that there does not seem to be a problem originated by the omission of these variables.

Other robustness tests In the Online Appendix we investigate alternative specifications. In the first case, Figure B4 shows the responses using different definitions of recession (as in Figure 5) but switching H_{t-1} in equation 1 by H_t. While dating the states in period $t-1$ reduces potential sources of endogeneity, under the assumption that shocks are completely exogenous including states dated in period t would allow for a more contemporaneous response.[36] The results show that the responses are qualitatively very similar to the benchmark estimations, with the only exception that the negative effects of the shocks during R are more persistent in time.

On a second test, Figure B4 shows the results when altering some aspects of the specification in equation 1 such as using federal government spending and tax revenues instead of total aggregates (which also include state and local components) or using a different dynamic structure (including 6 or 8 lags instead of 4). Again the results seem to suggest that the qualitative message does not hinge on a particular element of the benchmark specification.

3.4 Comparing the results to previous literature

Our empirical results suggest that government spending shocks have negative effects on output during recessions. Other studies arrive at the opposite conclusion: recessions make government spending more expansionary than booms. In order to understand why these findings are so different, we now compare our results with those of Auerbach and Gorodnichenko (2012), whose study is one of the most prominent in this area.[37]

Auerbach and Gorodnichenko (2012) use a Smooth-Transition VAR to investigate the variation in the response of output between periods of R and B. They estimate the

[36] Conceptually, one would be more interested in the effect of a shock during a current recession as opposed to the effect when the economy was in a recession in the previous period.

[37] Ramey and Zubairy (2018) propose a different estimation method using local projections similar to that of Section 2 and historical data from 1889 to 2016 (which relies on interpolated figures until 1947). They find no significant differences in responses during periods of B and R when using an identification strategy based on news about future defense spending. However, when their methodology and data are used for the post-War period used in this paper, the results are very similar to those presented earlier in this section, with output contracting after positive government spending shocks during times of R (see bottom panel in Table 3 of Ramey and Zubairy (2018)). They point that this result could be due to low variation in the Ramey's news about future defense spending after WWII. We attempt to overcome this potential problem by employing alternative identification strategies that display grater variation and reach similar conclusions.

following model:

$$\boldsymbol{x}_t = \left(1 - H^{AG}_{t-1}\right) \boldsymbol{C}_B(L)\boldsymbol{x}_{t-1} + H^{AG}_{t-1}\boldsymbol{C}_R\boldsymbol{x}_{t-1} + \boldsymbol{e}_t \tag{2}$$

$$H^{AG}_t = \frac{exp(-\gamma z_t)}{1 + exp(-\gamma z_t)} \tag{3}$$

$$\boldsymbol{e}_t \sim \mathcal{N}\left(0, \boldsymbol{\Omega}_B\left(1 - H^{AG}_{t-1}\right) + \boldsymbol{\Omega}_R\left(H^{AG}_{t-1}\right)\right) \tag{4}$$

$$var(z_t) = 1\ ,\ E(z_t) = 0 \tag{5}$$

where $\boldsymbol{x}_t$ is the same vector of variables as defined above. The model allows for a differential impact of the government spending shock both contemporaneously (through matrices $\boldsymbol{\Omega}_B$ and $\boldsymbol{\Omega}_R$) and dynamically (through matrices $\boldsymbol{C}_B(L)$ and $\boldsymbol{C}_R(L)$) during booms and recessions. The transition between these two states is governed by a logistic function H^{AG}_t that depends on the variable z_t, which is defined as the centered moving average (MA) of order 7 of the growth rate of real GDP.

Despite an apparently similar framework, the results generated by the two different estimation approaches (the model described by equation 1) are very different: Auerbach and Gorodnichenko (2012) find that a government spending shock that occurs during a time of R has a positive and larger effect than the same shock occurring during a time of B.

Why do similar estimation methods yield such contrasting results? The answer to this question rests on the information used to determine the current state of the economy. Equation 2 uses a continuous variable determined by a centered MA of the growth rate of real GDP, while equation 6 includes a binary variable that follows the NBER definition of recession.[38] Constructing H^{AG}_{t-1} in equation 2 in such a way has potentially important implications. By using a centered MA of order j (a two-sided MA filter), at any given period of time, we are making use of future developments in GDP to inform about the current state of the economy. For example, in period t, whether the economy is in recession or expansion will be determined by information up to period $t + (j - 1)/2$. In the event of an incoming change in the business cycle (e.g. from an expansion to a recession), we could potentially be mislabelling the current state of the economy.

In order to determine whether the nature of the two-sided MA filter can explain the differences between the two sets of results, we replicate the benchmark analysis in Auerbach and Gorodnichenko (2012) for different sizes of the centered MA of the growth rate of real GDP. Figure 9 shows the responses of GDP and government spending to a

[38] When we redefine H^{AG}_{t-1} in equation 2 to be a dummy variable, the results are qualitatively similar.

positive shock to the latter during times of B and R when varying the size of the MA from 5 up to 19. The results suggest that the impact of the shock on GDP does depend on the size of the MA filter: using a high-order MA (i.e. using more information that has not yet occurred) reduces the effect of the shock during times of B (with the effect even becoming negative in the medium run) and augments it during times of R. When the size of the benchmark specification in Auerbach and Gorodnichenko (2012) (a MA of order 7) is reduced to a MA of order 5, the results become qualitatively the same as those described earlier in this paper: a government spending shock has a positive effect on GDP during times of B and a negative effect during times of R.

Next, we analyse how the results in Auerbach and Gorodnichenko (2012) would be affected if the centered MA were substituted by a one-sided MA filter (i.e. keeping the length of the MA filter constant, but altering its symmetry). Figure 10 shows the responses to a government spending shock when we use (i) the benchmark specification (centered MA of order 7), (ii) a one-sided MA filter of order 7 that only uses past information and (iii) a one-sided MA filter that exclusively uses future information.[39] The results confirm that, when not using information about the future (i.e. when the MA is only backward-looking), the response of output becomes more similar to those obtained from equations 6 and 10: a government spending shock has positive effects during a period of B, but negative ones during a period of R (while the opposite is true when a forward-looking MA filter is used).

We conclude that the differences between the results presented in this paper and those in Auerbach and Gorodnichenko (2012) respond to the information used to explain changes in the state of the economy.[40]

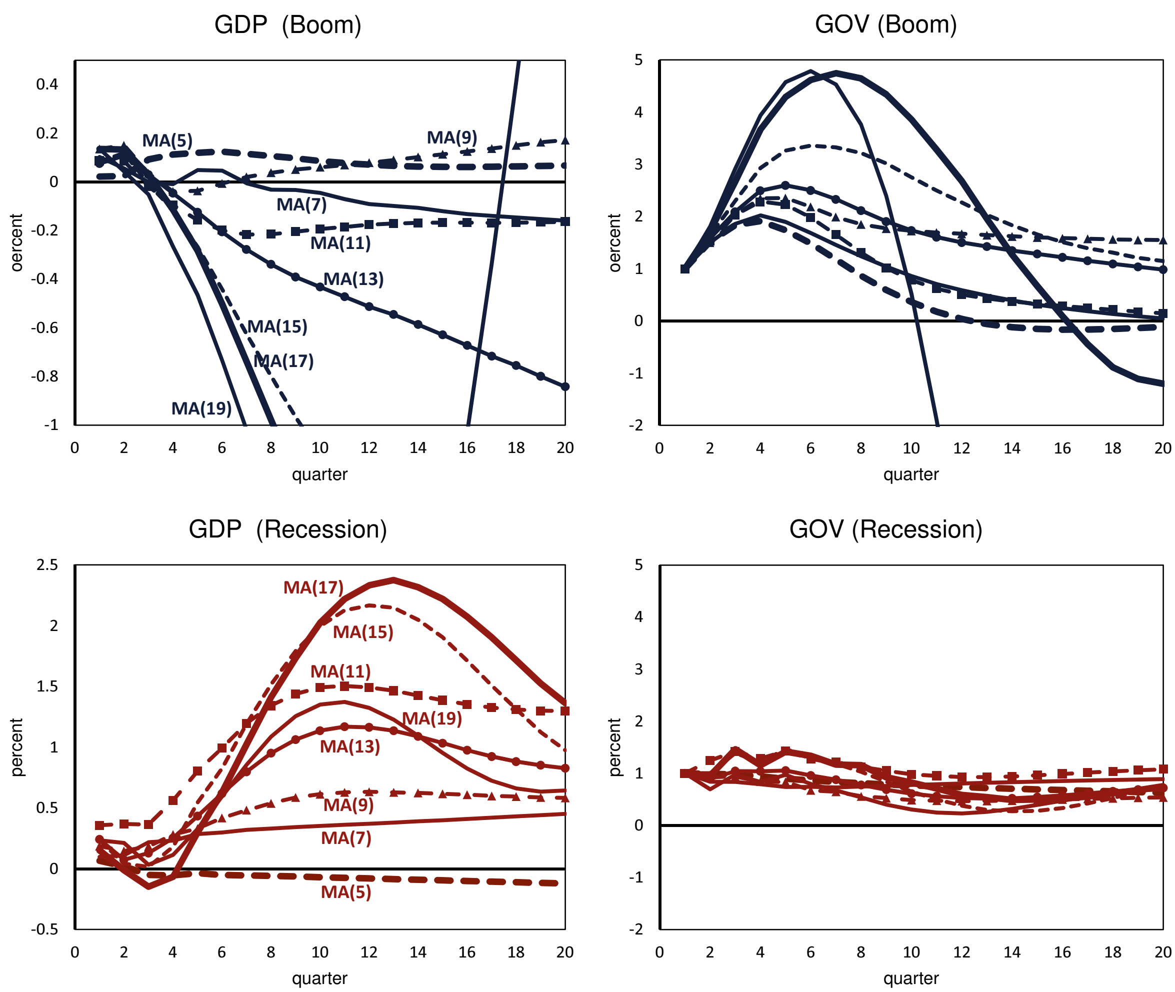
4 Fiscal policy during periods of high uncertainty

This section investigates the potential non-linear effects of government spending when the economy switches between periods of HU and LU.

[39]Cases in between these two extremes (e.g a MA(7) filter that uses information from the last two quarters and the next four quarters) support the same conclusions.

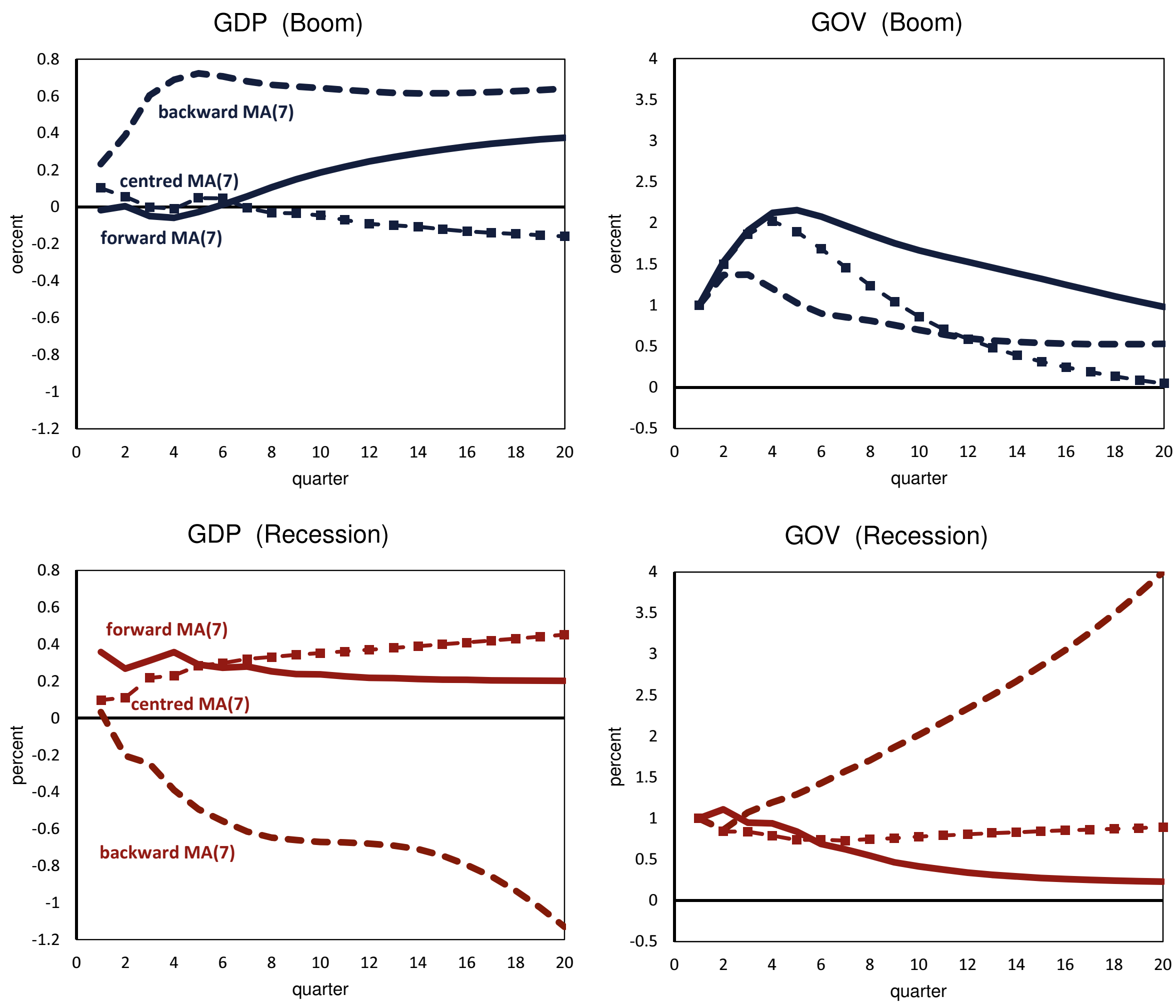
[40]Bognanni (2012) uses a Markov-switching VAR where the probability of recession is estimated period by period, and finds that the effect of a government spending shock on activity is smaller during periods of R than B.

Figure 9: Responses during times of R and B using the Auerbach and Gorodnichenko (2012) framework and a two-sided MA filter



The top panel (in blue) shows responses to a government spending shock during times of boom. The bottom panel (in red) shows responses during times of recession. Note that the graphs in the left column have a different scale to facilitate their readability. The responses are computed using the strategy described in Auerbach and Gorodnichenko (2012) but with variations in the size of the centered moving average of the growth rate of real GDP used to provide information about changes in the regime.

Figure 10: Responses during times of R and B using the Auerbach and Gorodnichenko (2012) framework and a one-sided MA filter



The top panel (in blue) shows responses to a government spending shock during times of boom. The bottom panel (in red) shows responses during times of recession. The responses are computed using the strategy described in Auerbach and Gorodnichenko (2012) but with variations made to the centering of the moving average (MA) of the growth rate of real GDP used to provide information about changes in the regime. Forward MA(7) is a one-sided MA filter of order 7 using future information only; backward MA(7) is a one-sided MA filter of order 7 using exclusively past information.

4.1 Defining of periods of HU

To define periods of HU we follow the methodology and data described in Bloom (2009). Bloom (2009) constructs a monthly measure of uncertainty using the VXO index of implied volatility from 1986 onwards and using the actual monthly return volatilities of the SP500 index between 1962 and 1986.[41] We extend these estimates back to 1947. Major uncertainty events are selected as those months which have a stock market volatility of 1.65 standard deviations above a Hodrick-Prescott trend (with a smoothing coefficient of 129,600). Since our sample has a quarterly frequency, we consider periods of HU to be those quarters containing any of the monthly events described above.[42] Periods of LU are defined as the rest of the quarters.

Figure 1 shows the episodes of HU in our sample, which amount to 36 quarters, with an average period of elevated uncertainty lasting for around 2 quarters.

Following the discussion in Bloom (2009), our measure of uncertainty is not expected to be caused by macroeconomic developments. However, a potential problem may arise if our measure of uncertainty and other macroeconomic variables of interest are jointly determined. While we cannot formally test the exogeneity of our episodes of HU, we can test wether they can be predicted by past (or current) information. We follow Mertens and Ravn (2012) and Cloyne (2013)in implementing two tests of predictability of our episodes. The first one is a linear estimation of our measure of HU on lags of different variables (i.e. a Granger causality test).[43] The second method is a non-linear estimation using a probit model. In both cases we test the joint significance of the explanatory variables as an analysis of the predictability of the HU measure.[44] Our set of explanatory variables contains four lags of GDP, government spending, tax revenues, consumption investment, employment, wages, firm profits, prices, interest rates and oil prices.[45] The results of the tests for different groups of these variables are shown in columns 1-5 of Panel A in Table 1. The hypothesis that the past values of the considered variables can help in predicting the occurrence of episodes of high uncertainty is clearly rejected in the data, both in the linear and non-linear models. Panel B of Table 1

[41]The adequacy of stock market volatility as a measure of uncertainty is also documented in Bloom et al. (2007).

[42]The results are very similar when we consider quarterly volatility (instead of monthly) and pick up the periods with unusually high values.

[43]Since our measure of HU is a binary variable, we are in fact estimating a linear probability model and testing whether past information for the considered variables can affect the probability of occurrence of a HU event.

[44]In the linear case we use an F-statistic for the joint significance of the explanatory variables. In the probit model, we construct a likelihood ratio.

[45]The estimations also contain four lags of the dependent variable, a constant and a quadratic trend. The exclusion of any of these elements does not affect the results.

show the results to similar estimations when adding the current values of explanatory variables. The results seem to suggest that not even the contemporaneous values of the considered values can significantly help in predicting episodes of HU.

Table 1: Tests of predictability of uncertainty

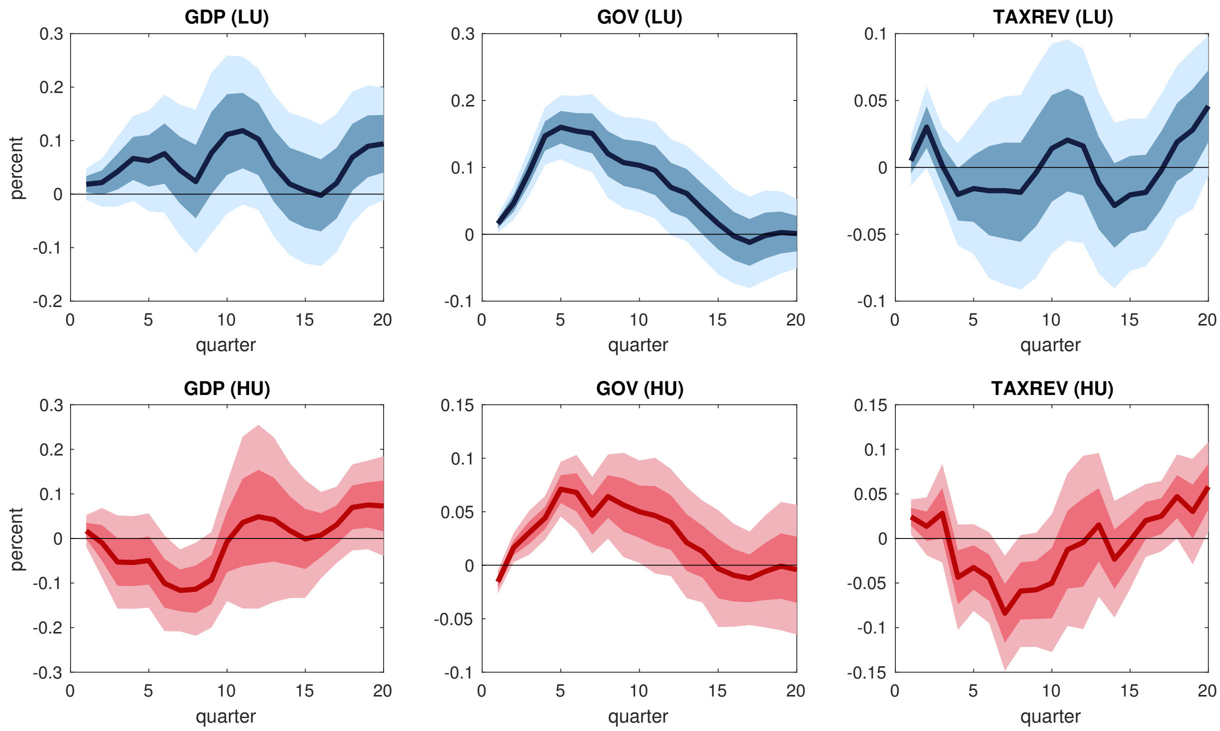
	(1) *GDP*	(2) *fiscal*	(3) *macro*	(4) *nominal*	(5) *all*
Panel A:					
linear estim. (F test)	0.35 (0.85)	0.38 (0.93)	0.53 (0.95)	1.02 (0.43)	0.67 (0.94)
non-linear estim. (LR test)	1.9 (0.75)	3.68 (0.88)	9.72 (0.97)	10.53 (0.57)	33.49 (0.88)
Panel B:					
linear estim. (F test)	0.74 (0.59)	0.82 (0.61)	0.59 (0.94)	0.96 (0.50)	0.78 (0.86)
non-linear estim. (LR test)	4.32 (0.50)	7.95 (0.63)	13.74 (0.97)	12.11 (0.67)	51.58 (0.61)

Note: This table shows the results of tests of predictability of the uncertainty dummy variable using information from various set of variables (displayed in columns). Panel A presents tests using regressions with four lags of the explanatory and dependent variables and Panel B also includes contemporaneous regressors. The linear estimation shows the results of an F test measuring the relevance of sets of variables 1-5 in predicting episodes of uncertainty (Granger causality tests). The non-linear estimation presents the results of likelihood ratio tests of a probit models that include the explanatory variables in columns 1-5 against a model that does not include them. The set of variables in columns 1-5 are lags (and contemporaneous values in the case of Panel B) of GDP (column 1); government spending and tax revenues (column 2), consumption, investment, employment, wages, and firms profits (column 3); GDP deflator, interest rates (3-month Treasury bill) and oil prices (measured by the West Texas Intermediate price) (column 4); and all variables together (column 5). All explanatory variables are expressed in logarithms (except the interest rate) and in real per capita terms (except the nominal variables in column 4). All regressions include a constant and linear and quadratic trends. Each cell in the table shows the value of the F/Likelihood Ratio tests. The p-value associated with each test is showed in brackets (higher values indicate failure to reject the hypothesis that the variables in each regression contain no information for explaining episodes of uncertainty).

In view of these results, and given that the episodes of HU are very short (less than two quarters, on average) we modify the timing of the states in equation 1 by substituting H_{t-1} by H_t to better reflect the effect of the shock during periods of HU.[46]

[46]We test the sensitivity of the results to the timing of H_t in the robustness section below.

Figure 11: Responses to government spending shocks in HU and LU (Ramey news)



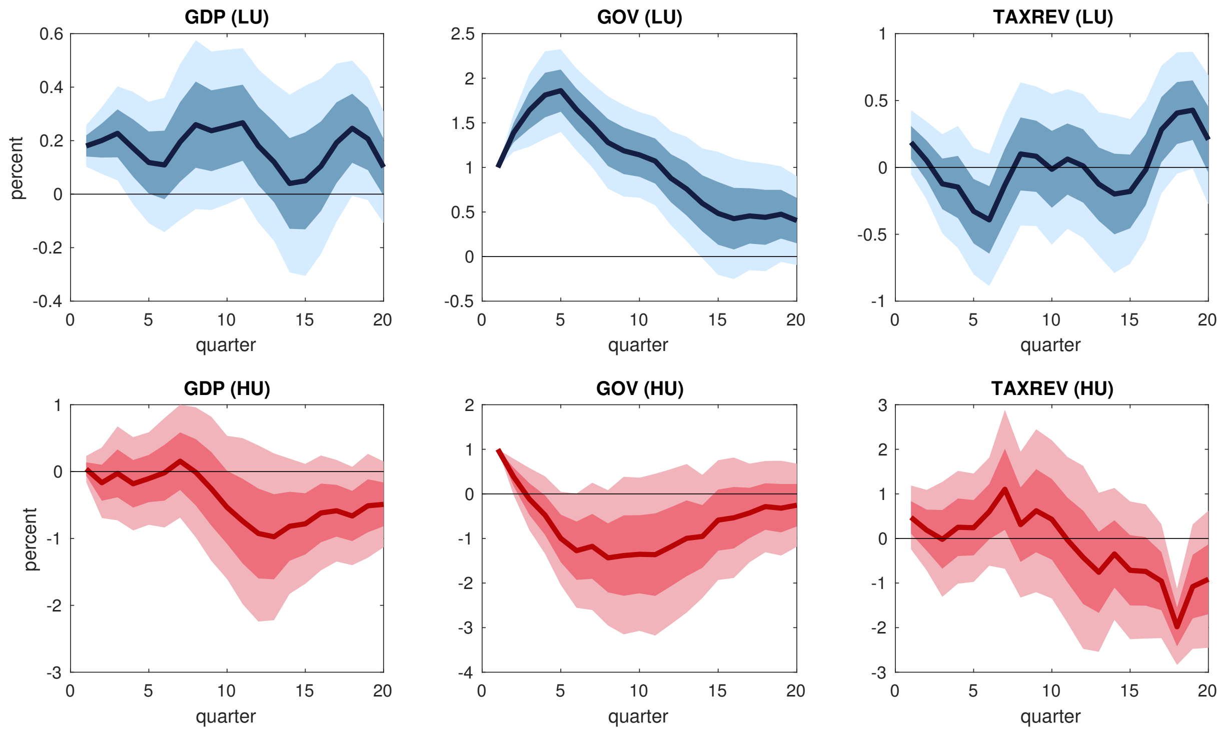
The top panel (in blue) shows responses to a government spending shock (identified with news about future defense spending) during times of low uncertainty. The bottom panel (in red) shows responses during times of high uncertainty. The 68% and 95% confidence bands are computed using Newey-West standard errors.

4.2 Results

Figure 11 shows the responses to a government spending shock identified using news about future defense spending both during times of LU (upper panel) and during HU (bottom panel). An increase in government spending during LU triggers a positive response of output (although estimates are associated with relatively high confidence bands). The 1-year cumulative multiplier is estimated to be around 0.5. When the same shock takes place during periods of HU the effect of output is negative until the 10th quarter. The 1-year cumulative multiplier is -1.3.

Figure 12 repeats the same exercise but identifying the shocks using the Blanchard-Perotti approach. During times of LU, a shock to government spending increases output throughout the considered horizon. This effect is significantly different from 0 during the first year, with an average multiplier of 0.3 during this time. On the contrary, when the shock occurring during periods of HU, output does not significantly respond to the

Figure 12: Responses to government spending shocks in HU and LU (Blanchard-Perotti)



The top panel (in blue) shows responses to a government spending shock (identified using exclusion restrictions) during times of low uncertainty. The bottom panel (in red) shows responses during times of high uncertainty. The 68% and 95% confidence bands are computed using Newey-West standard errors.

increase in government spending, in fact, it contracts after the second year.[47]

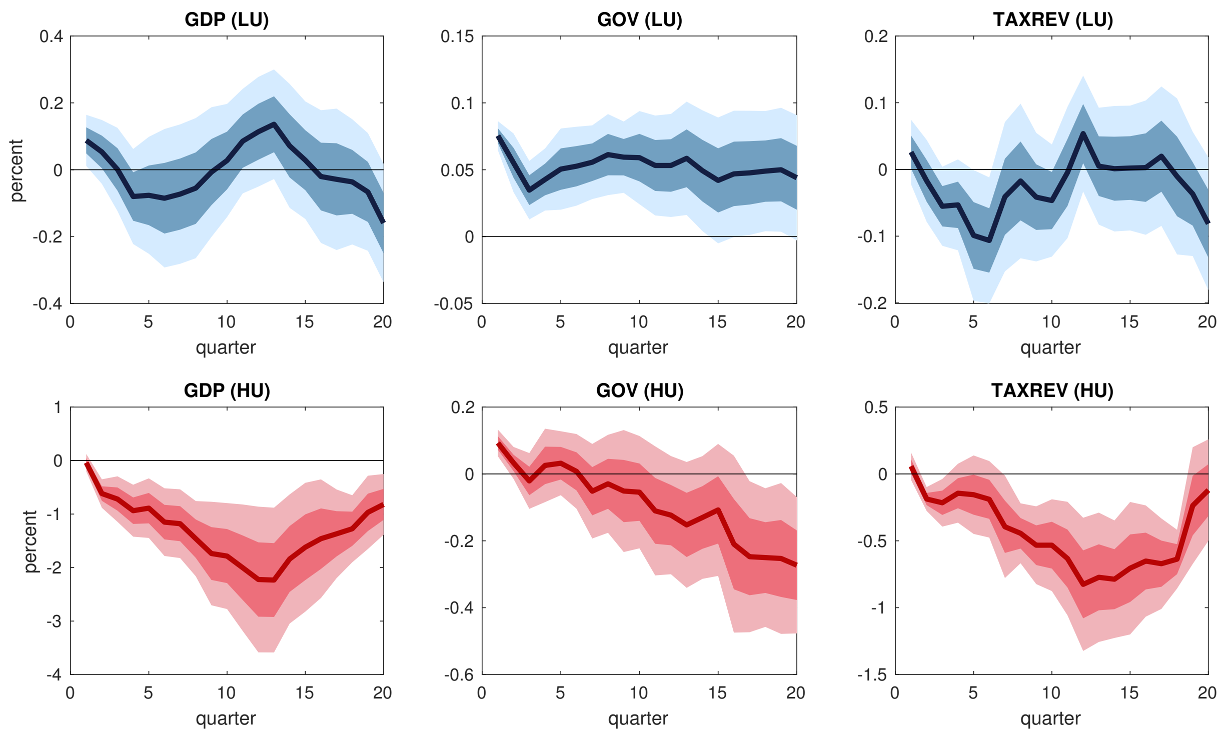
Lastly, Figure 13 shows the results when identifying government spending shocks using forecast errors. In this case, the response of output to an increase in spending is positive and significant upon impact, but fluctuates around 0 afterwards.[48] A government spending shock hitting the economy during times of HU triggers a significant, persistent and negative effect on output which lasts for three years.

Although the dynamic impact varies from specification to specification, all three identification methods seem to suggest that output expands after a government spending shock in periods of LU (at least in the short run). However that effect is negative or not significant when the shock occurs during times of HU.

[47]Note that government spending also decreases after the first year.

[48]The impact multiplier is estimated to be 1.3, with a 1-year cumulative multiplier slightly above 0.3. Note than in the linear case showed in the bottom panel of Figure A1 and in Ramey (2011a), output tends to contract in the medium run after a positive government spending shock.

Figure 13: Responses to government spending shocks in HU and LU (forecast errors)



The top panel (in blue) shows responses to a government spending shock (identified using forecast errors) during times of low uncertainty. The bottom panel (in red) shows responses during times of high uncertainty. The 68% and 95% confidence bands are computed using Newey-West standard errors.

4.3 Robustness

This subsection investigates the robustness of the benchmark results obtained above for the cases of LU and HU. In particular, we propose alternative definitions of HU, compute responses using a SVAR, and test the sensitivity of the results to the inclusion of further control variables and changes in the main specification.

Alternative definition of high uncertainty The measure of uncertainty employed so far is based on the (implied) stock market volatility as in Bloom (2009). One potential concern is that the impact of uncertainty on the effect of fiscal policy could be due to the specific nature of this measure of uncertainty.[49] Figure14 shows how different the responses are when using alternative methods to define periods of HU. The first alternative (dashed lines in Figure14) follows Bloom (2009) and uses implied stock market volatility but at quarterly frequency. A second alternative (pointed lines) employs the same variable lagged one period (i.e. the variable H is expressed in $t-1$ as in equation 1). Lastly, we use the Geopolitical Risk Index as described in Caldara and Iacoviello (2017).[50]

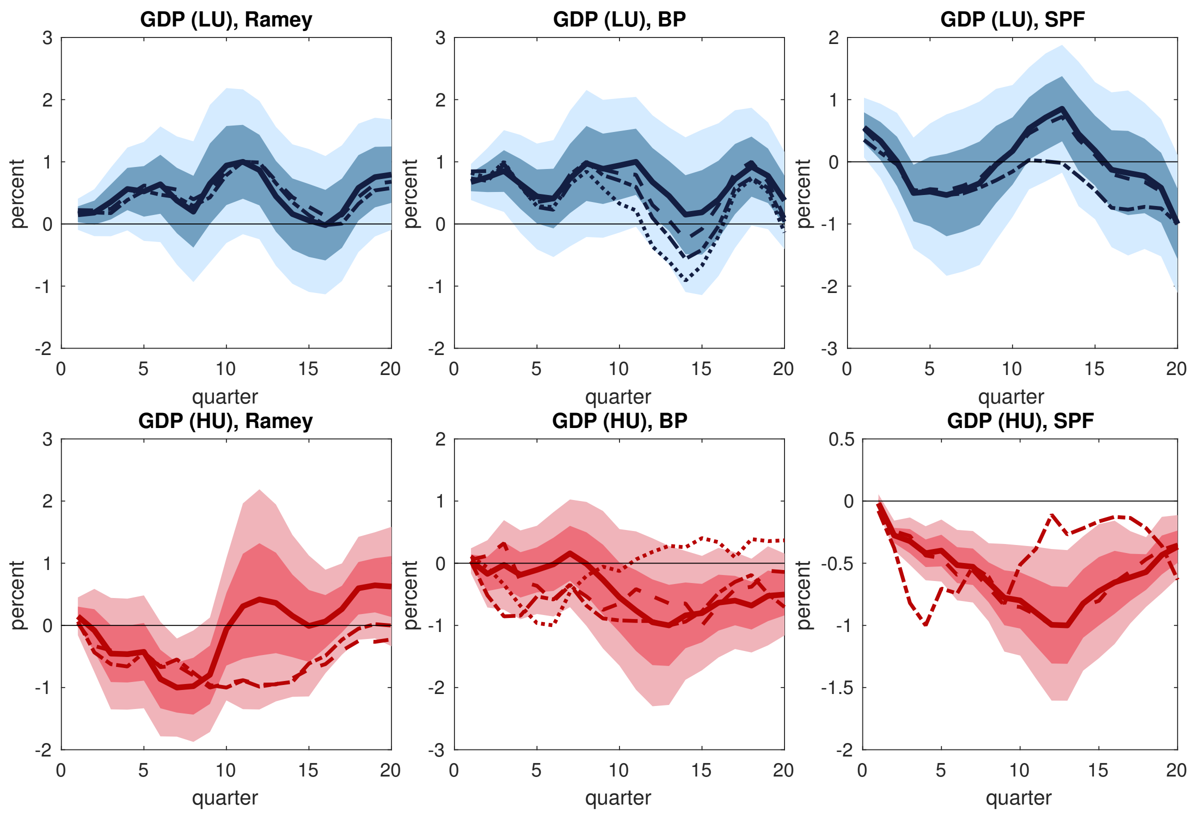
In all these cases, the response of output (and the rest of variables) seem to follow a qualitatively similar pattern to the benchmark estimations regardless of the method employed to construct the episodes of HU. During periods of LU government spending shocks stimulate output (in the case of the identification using forecast errors, this only occurs upon impact). During times of HU, the same shock seems to have contractionary effects which are more persistent than those in the benchmark estimations.

FigureB6 in the Online Appendix shows the results when using an alternative measure of uncertainty based on Jurado et al. (2015). The authors estimate h-periods ahead macroeconomic uncertainty by looking at an aggregation of the conditional volatility of the unforecastable component of several variables. This measure of uncertainty is only available since 1960q3. We employ the aggregate measures of uncertainty of $h = 12$ and

[49]For example, changes in the distribution of dividends may have an effect on the definition of events of high uncertainty.

[50]Caldara and Iacoviello (2017) construct a measure of uncertainty related to geopolitical risk by counting the number of articles that contain words related to geopolitical tensions in international newspapers. We follow the methodology described in Section 2 and define quarters of high uncertainty as quarters containing any month with an unusually high value of the geopolitical risk measure (1.65 standard deviations above a Hodrick-Prescott trend). This measure is significantly correlated to the benchmark series based on Bloom (2009), with a coefficient of correlation of 75%. An alternative measure of uncertainty based on word counting can be found in the Economic Policy Uncertainty Index, as described in Baker et al. (2016). The response of output to a shock in government spending when HU is defined according to this measure is negative when the shocks are identified using Ramey's series or forecast errors (the responses are not significantly different from 0 when using the Blanchard-Perotti identification).

Figure 14: Robustness to different specifications of high uncertainty



The top panel (in blue) shows responses to a government spending shock during times of low uncertainty. The bottom panel (in red) shows responses during times of high uncertainty. Left column displays the output response when government spending shocks are identified using Ramey news about defense spending. In the middle column, shocks are identified using a Blanchard-Perotti approach. In the right column, shocks are identified as forecast errors in government spending. Solid lines refer to estimations using the benchmark definition of HU. Dashed lines indicate responses using an alternative definition using quarter volatility. Pointed lines (only in middle column graphs) uses the same definition but the variable H_t is lagged one period (as in equation 1). Dash-point lines refer to responses using a definition of HU based on the Geopolitical Risk Indicador. The 68% and 95% confidence bands are computed using Newey-West standard errors.

$h = 3$ periods ahead). This indicator has a much lower correlation to our own measure (for the case of $h = 12$, the correlation is 26%). The results under the Blanchard-Perroti and the forecast errors identification schemes suggest that output expands in the short run after a shock during LU and contracts during HU (but less clearly when considering alternative specifications). Using the Ramey's news of future defense spending, we find that the shock has not significant effects during LU, but seems to reduce output in medium run during HU.[51]

Computing responses using a non-linear SVAR. Following Subsection 3.3 and the details explained in Appendix B, we now compute the responses to a government spending shock using a non-linear SVAR. In the first case (Figure15) we identify the shocks using the Blanchard-Perotti approach. The estimates (solid lines) indicate that output expands significantly after an increase in government spending that occurs during times of LU (the average multiplier during the first year is 0.6). On the contrary, this shock has a significant and negative effect on output when it hits the economy during times of HU (the multiplier averages to 1.3 during the first four periods).[52]

When using the news about future defense spending to identify exogenous variation in government spending, we find that output declines significantly after an increase in government spending during periods of HU (Figure15).[53]

A similar pattern obtains when identifying the shocks using forecast errors (see Online Appendix). AsFigureB7 shows, government spending only stimulates output upon impact during times of LU (with a no clear effect afterwards) but it significantly contracts it when the shock occurs in times of HU.

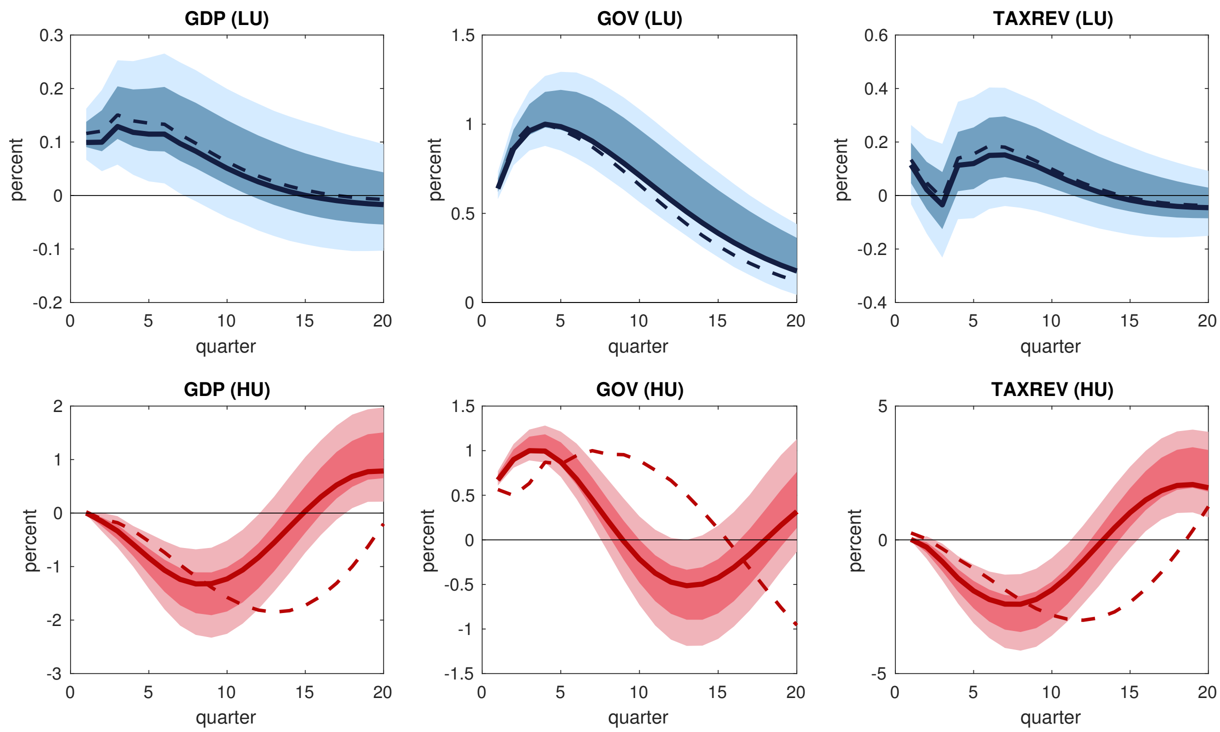
As noted earlier, the responses from a non-linear SVAR must be interpreted with caution (since the regime is fixed during the response horizon), particularly so in the case of short events such as episodes of HU. However, the evidence seems to suggest that at least in the short run (when these estimates are more reliable, due to a lower probability of a regime change), government spending shocks contract output when occurring during times of HU.

[51]In any case, the results when using the Jurado et al. (2015) must be interpreted with care due to a reduced sample.

[52]The results are very similar until the second year when identifying government spending shocks from a nonlinear process (dashed lines in Figure15).

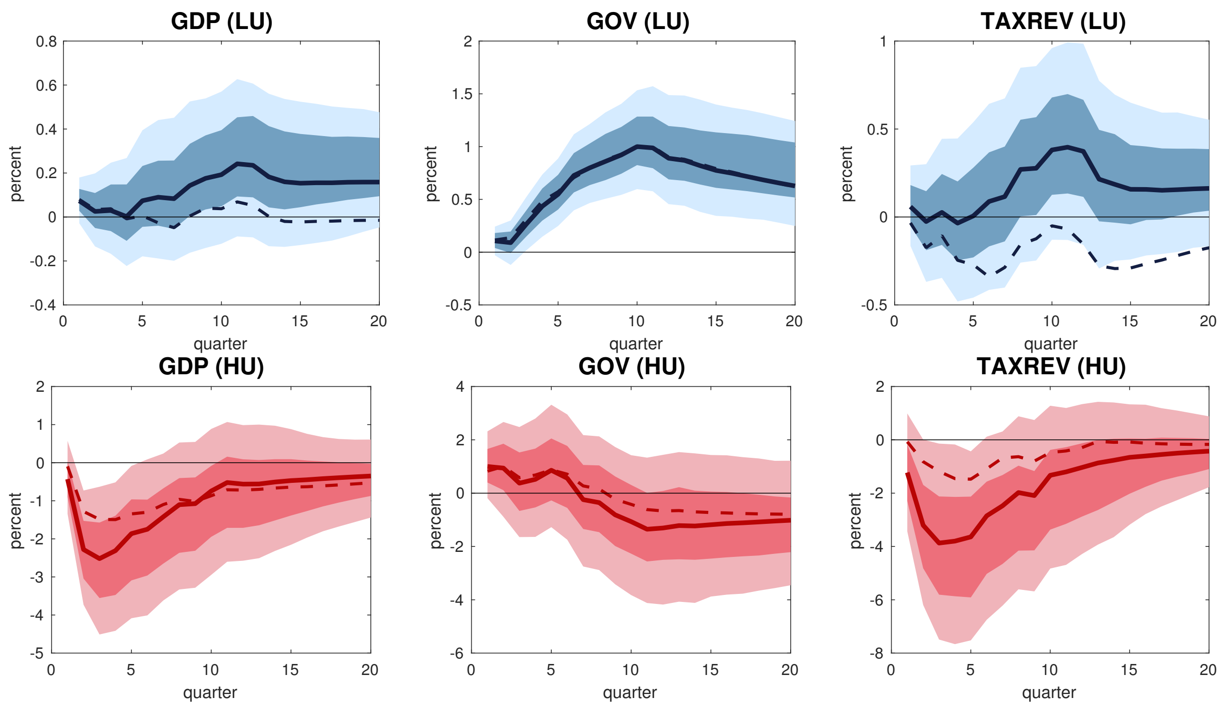
[53]The effect on output during times of LU seems to be not significant after impact when considering the full sample (1947-2016q) although the effects are positive when the sample stops before the Great Recession.

Figure 15: Responses using a non-linear SVAR in HU and LU (Blanchard-Perotti)



The top panel (in blue) shows responses to a government spending shock (identified using exclusion restrictions) during times of low uncertainty. The bottom panel (in red) shows responses during times of high uncertainty. Solid lines represent the estimations when government spending is assumed to be a linear process. Dashed lines represent the estimations when the shocks are identified using a non-linear process for government spending. The 68% and 95% confidence bands are computed using a non-parametric bootstrap.

Figure 16: Responses using a non-linear SVAR in HU and LU (Ramey)



The top panel (in blue) shows responses to a government spending shock (identified using news about future defense spending) during times of low uncertainty. The bottom panel (in red) shows responses during times of high uncertainty. Solid lines refer to specifications using a sample from 1947q1-2007q3, dashed lines indicate the responses of estimations using the full sample (1947q1-2016q4). The 68% and 95% confidence bands are computed using a non-parametric bootstrap.

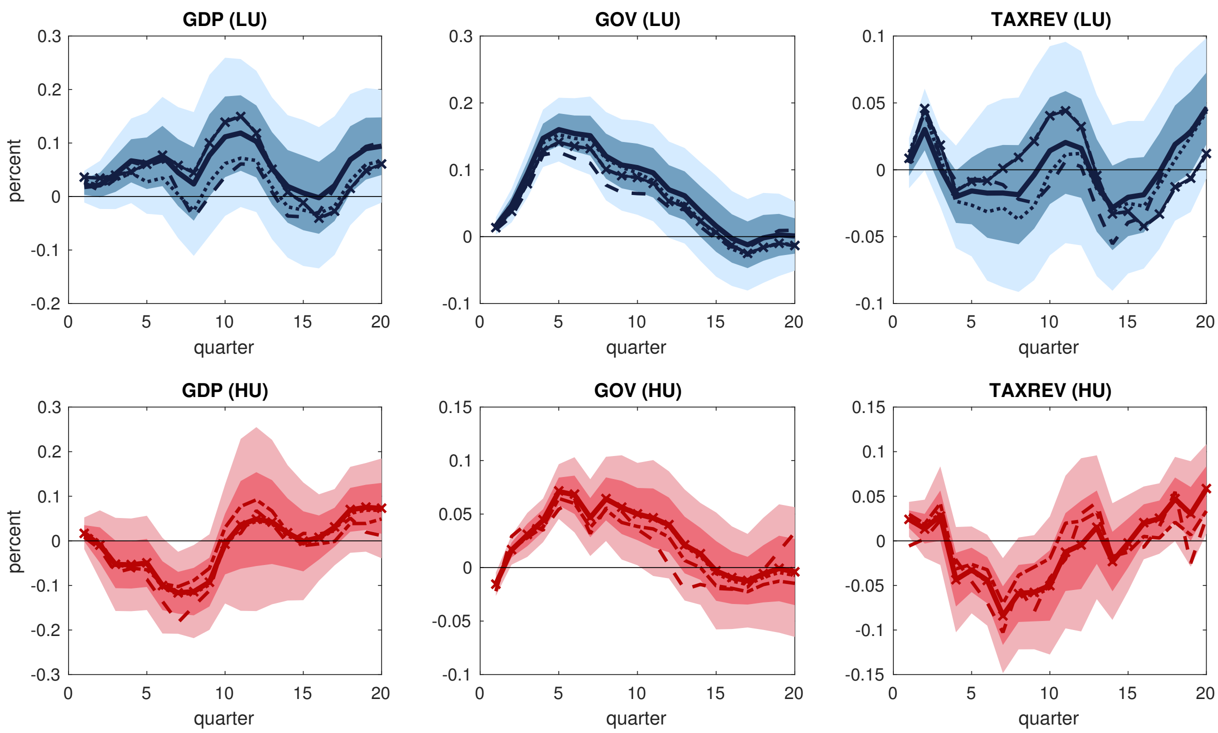
Further controls. In this section we test whether the absence of potentially important variables can bias the results of the estimates (focusing on the identification based on the Ramey's news). The results are shown in Figure 17. In a first exercise (dashed lines in Figure 17), we include additional variables that can show a particularly different behavior during times of HU and potential bias the results: SP500 stock level, interest rates, oil prices and the GDP deflator. In a second exercise (pointed lines) we include past values of the variable that acts as time-varying intercept (H_t); in this way, we minimize even further the potential dynamic effect that a given regime can have in the response of the variables *beyond* the effect arising from the government spending shock. When using Ramey's news about future defense spending in this setting there can be two sources of concern: i) much of the variation in this variable arises from few war episodes and ii) these episodes may be related to both military spending and increases in uncertainty. To reduce these sources of concern, in our third robustness exercise (in dash-point lines), we incorporate the three Ramey-Shapiro dates of war events as dummy variables in periods t, $t-1$ and $t-2$ when estimating equation 1.[54]

In all these robustness checks, the responses of output to a government spending shock during times of LU and HU are remarkably similar (particular during the short run) to those from the benchmark specifications. These exercises attenuates the concerns that our estimations may suffer from omitted variable bias from the lack of sufficient controls or because of an inadequate control that the impact that a given regime has on the variables of interest.

Alternative specifications. We now explore the robustness of the results to alternative specifications, The results, employing our three identification approaches, are shown in Figure 18. In a first exercise (solid lines in Figure 18), we use federal instead of total government spending and tax revenues. Secondly, we limit the sample to 1980q1 to 2016q4 (dashed lines). This is an interesting exercise, because it attenuates the concerns that uncertainty may be too much related to war episodes such as the Korean or Vietnam wars. Additionally, it allows our measure of HU to rely almost exclusively on implied volatility from the VXO. In a third and fourth tests (pointed and dash-point lines) we explore the sensitivity of the results to a larger dynamic structure, using 6 and 8 lags (respectively) of the variables of interest. Lastly (cross markers), we include non-linear trends. In general, results are similar to the benchmark specifications.

[54]In our sample these dates refer to the Korean war, Vietnam War and the Soviet invasion of Afghanistan (Ramey and Shapiro (1998)); we augment them with 9/11 following Ramey (2011a). We also perform a fourth robustness exercise when the Ramey-Shapiro dates included only during $t-1$ and $t-2$ (cross-markers lines in Figure 17).

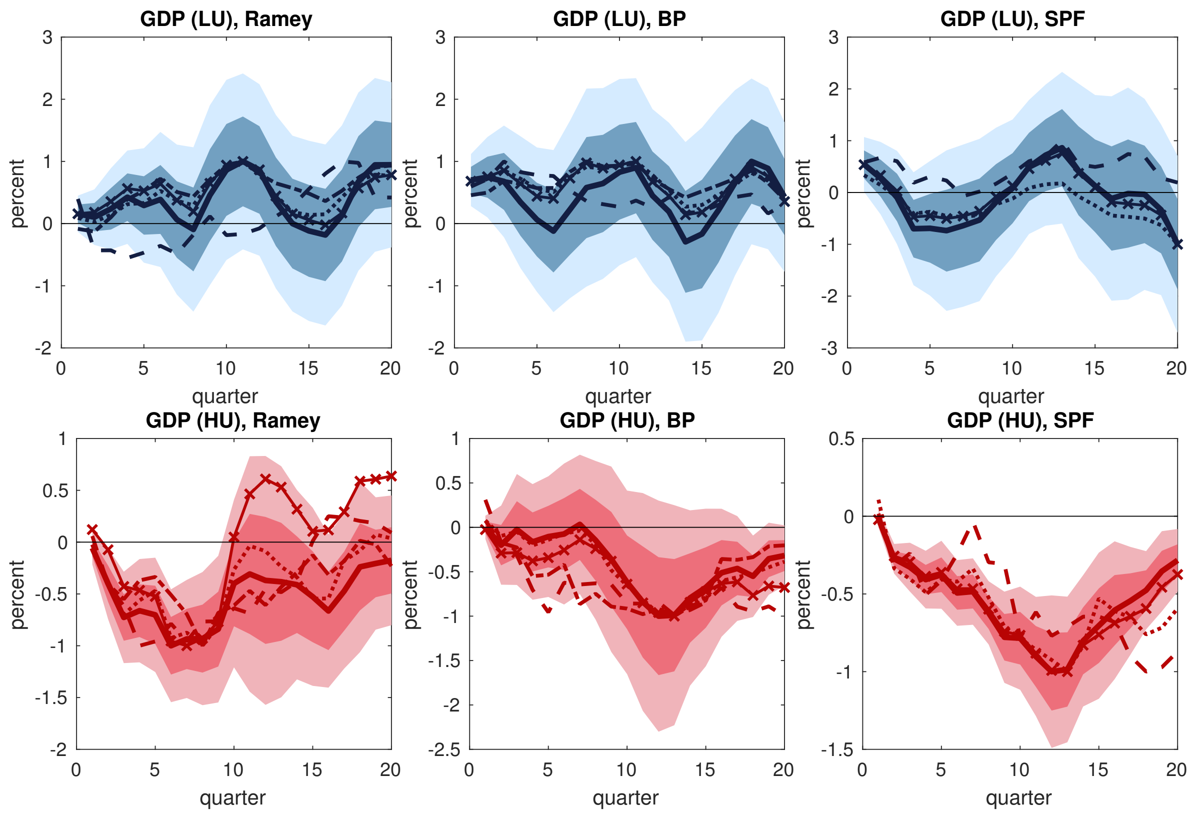
Figure 17: Robustness to the inclusion of additional controls in HU and LU specifications (Ramey news)



The top panel (in blue) shows responses to a government spending shock (identified using news about future defense spending) during times of low uncertainty. The bottom panel (in red) shows responses during times of high uncertainty. Solid lines refer to the benchmark estimations. Dashed lines show responses when including additional controls (gdp deflator, SP500 stock, interest rates, oil prices). Pointed lines refer to estimations that include lagged dummies (H_t) in addition to intercept. Dash-point lines show the responses when including the Ramey-Shapiro dates in periods t, $t-1$ and $t-2$. Cross markers lines show the same responses with the Ramey-Shapiro dates included only during $t-1$ and $t-2$. The 68% and 95% confidence bands are computed using Newey-West standard errors.

During periods of LU, output tends to react positively in the short run (becoming not significant after the first year).[55] During episodes of HU, the reaction of output to a government spending increase is negative.

Figure 18: Robustness to alternative specifications during HU and LU specifications



The top panel (in blue) shows responses to a government spending shock (identified using exclusion restrictions) during times of low uncertainty. The bottom panel (in red) shows responses during times of high uncertainty. Left column displays the output response when government spending shocks are identified using Ramey news about defense spending. In the middle column, shocks are identified using a Blanchard-Perotti approach. In the right column, shocks are identified as forecast errors in government spending. Solid lines refer specifications with federal government spending and tax revenues instead of total (which includes state and local components). Dashed show the results when restricting the sample to 1980q1-2016q4. Pointed lines refer to specifications with a polynomial order of 6 in equation 1. Dash-point lines (not in forecast error specification due to few degrees of freedom) employ a polynomial order of 8. Cross-markers show estimates that include non linear trends. The 68% and 95% confidence bands are computed using Newey-West standard errors for the specification in solid lines.

[55]With the exception of the case when the sample is restricted to start in 1980 and we identify shocks using Ramey's news: under this scenario the response of output during LU periods s slightly negative and not significantly different from zero.

4.4 Exploring a potential mechanism

Why do high levels of uncertainty or a recessionary economy affect the impact of exogenous changes in government spending? The above analysis suggests that there is a mechanism that operates differently when the economy is in a state of HU (or R). In this subsection, we consider the role of a change in confidence as the device inducing the differing responses in the empirical analysis.[56]

We interpret a shift from times of LU to HU as a deterioration in the information set available to agents.[57] In a context of scarce information, households may become more cautious, rendering their confidence sensitive to signals that may confirm their pessimism about their future income levels.

In such a situation, an increase in government spending could serve to corroborate the idea that the productivity of the economy was low, triggering a shift to pessimism among households. The likely result of the deterioration in households' confidence would be that consumption would decrease in view of potentially low levels of income, triggering a contractionary effect on the overall economy. This mechanism would be theoretically supported buy agents that display ambiguity averse preferences as in Ilut and Schneider (2014). Such preferences imply that during times of HU agents cannot correctly assign probabilities to all relevant scenarios, behaving *as if* they evaluate potential future outcomes using a worse case set of probabilities.

To support this conjecture, we analyze the responses of some relevant variables to a government spending shock.[58] Figure 19 shows the responses of our variables of interest (output, government spending and tax revenues), together with new variables introduced simultaneously (measures of confidence, consumption and interest rates)[59].

[56]We focus on a mechanism that acts differently during times of HU and times of LU (rather than during times of B and times of R). Although uncertainty could be endogenously generated during R (see Bloom (2014) for a discussion), the definition of periods of HU here is mostly based on exogenous events (Bloom (2009)), which makes uncertainty a better candidate with which to explain the above results. Since periods of HU and R do not always overlap, we could test which is the ultimate driving force behind the differing responses observed above (heightened uncertainty or a slack economy). Unfortunately, the data are too scarce for us to draw conclusive results on this.

[57]This can be due to scarce information or a reduction in its accuracy. As defined by Frank Knight (1921), uncertainty is found in situations where agents cannot attach probability distributions to some events. This represents the inability of agents to form accurate predictions about, for example, the level of productivity in the economy or the income levels expected by households.

[58]We use narrative identification based on Ramey's news about defense spending. Following Burnside et al. (2004) and Ramey (2011a), we use the fixed set of variables $\boldsymbol{x}_t$ described above and rotate the new variables of interest into the analysis.

[59]The details of these variables can be found in Appendix A. The sample is restricted to 1967q1-2007q4 due to data availability. For this reason, we construct the responses using the SVAR as shown in Section 4.3 (the point estimations when using local projections are less precise and show a more erratic behavior due to a smaller sample although the main messages of this subsection are similar).

Similar to what was explored before, output has a positive reaction to a government spending increase during times of LU, but it falls when the shock occurs during episodes of HU.

Now we turn our attention to the response of confidence. We measure this variable by using the Consumer Confidence Index (CCI) elaborated by the Conference Board.[60]

As Figure 19 shows (first graphs in second and fourth rows), Confidence react positively to a government spending shock when it takes place during a time of LU, but decrease when shocks occur during times of HU. As hypothesized earlier in this section, this evidence seems compatible with a shift to pessimism during uncertain times, since government spending shocks lower the confidence of agents if they occur during times of heightened uncertainty, while they boost their confidence during normal times.

This shift towards pessimism translates into a higher demand for precautionary savings by households. Figure 19 (middle graphs in second and fourth rows) shows a significant reduction in consumption in response to government spending shocks during times of HU. The last column of Figure 19 (second and fourth rows) shows the response of interest rates to a government spending shock. As could be expected from the response of the monetary authority to developments in inflation, the interest rate declines after a shock during a time of HU (while reacts positively to a shock that occurs in a time of LU).

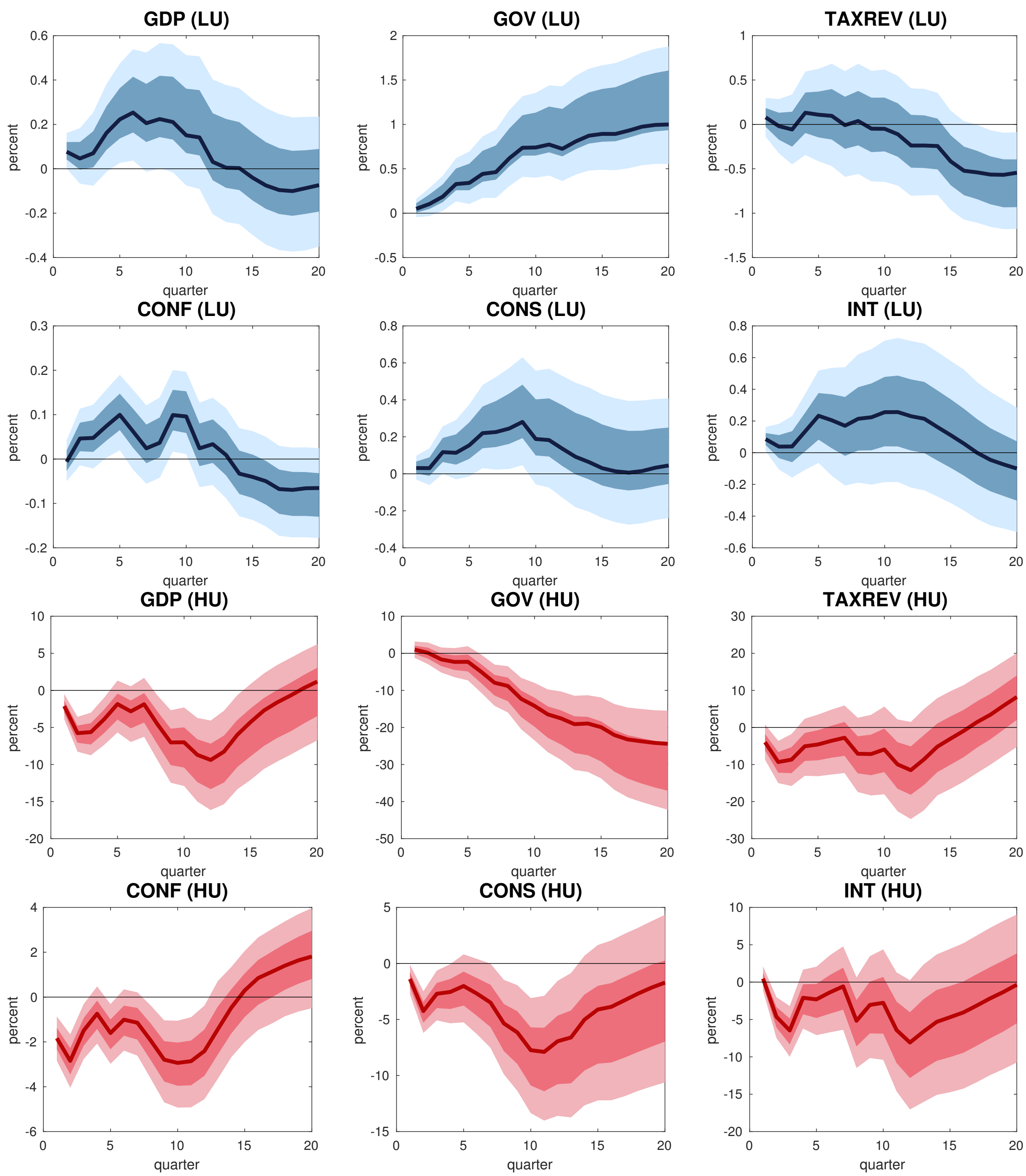
5 Conclusions

The effect of government spending is likely to depend on features of the economy that evolve over time. In this paper, we study whether the effects of changes in government spending remain the same across states of the economy. In particular, we empirically characterize how changes in government spending may differ across states of high (HU) and low (LU) uncertainty and across recessions (R) and booms (B).

Our results suggest that the impact of government spending shocks on output is positive during times of LU or B and negative during times of HU or R. We find that households' confidence is a key variable for interpreting these results, as agents become more pessimistic when a positive government spending shock confirms their views on the state of the economy.

[60]The CCI measures consumer confidence by using the monthly responses of 5,000 US households to questions on their current and expected (within the next six months) business, family income and employment conditions. The CCI is computed as the proportion of participants that respond positively to these questions. Data for this variable is available from 1967q1 onwards.

Figure 19: Exploring a potential mechanism during times of HU and LU (Ramey identification in a SVAR).



The top panel (in blue) shows responses to a government spending shock (identified using news about future defense spending) during times of low uncertainty. The bottom panel (in red) shows responses during times of high uncertainty. Sample is restricted to 1967q1-2007q4. The 68% and 95% confidence bands are computed using a non-parametric bootstrap.

Other studies in the literature (such as Auerbach and Gorodnichenko (2012)) produce contrasting results. We explore these differences by highlighting the importance of the information used to determine the state of the business cycle.

The results documented here provoke new research questions. For example, we have seen that output contracts after a positive government spending shock if that shock happens during a time of HU or R. It would be interesting to identify whether it is HU, R or a combination of both that is causing this effect. This would require a comparison between a shock that happens in a time of HU and B and a shock that happens during a time of LU and R. However, the data are not informative enough for this, since there are just a few events with these characteristics, insufficient for us to obtain robust results. More empirical evidence is required to help us shed light on this question.

It is also necessary to understand the mechanism causing these differing impacts of government spending on the economy. Here we have highlighted the importance of households' confidence in explaining the results. A detailed theoretical framework that can explain such nonlinear effects would be crucial for evaluating the consequences of public policies.

We have focused our attention on uncertainty that has an arguably exogenous origin (e.g. war, terror). However, uncertainty can be generated by endogenous causes, for example by policy itself (see Baker et al. (2016), Fernández-Villaverde et al. (2015) or Bi et al. (2013)).[61] Whether and how this source of fiscal uncertainty can affect real activity are questions left for future research.

[61]Uncertainty derived from fiscal policy has received attention from the media. See, for example, The Economist (16/11/2013):"*Governments, however, are still breeding fears about the future. The most glaring form of uncertainty in the rich world is fiscal. [...] This is self-imposed uncertainty. If the fiscal path were a little clearer, the reduction in uncertainty should spur investment and output, which in turn should improve the fiscal picture.*"

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Appendix

A. Data

The following data are obtained from the BEA's NIPA tables: **Output** is Gross Domestic Product from Table 1.1.5 (line 1). **Total Government Spending** is Government Consumption Expenditures and Gross Investment from Table 3.9.5 (line 1). **Federal Government Spending** is Federal Government Consumption Expenditures and Gross Investment from Table 3.9.5 (line 9). **Total Tax Revenues** are Current Receipts from Table 3.1 (line 1). **Federal Tax Revenues** are Federal Current Tax Receipts from Table 3.2 (line 2) plus Contributions for Government Social Insurance from Table 3.2 (line 11) minus Taxes on Corporate Income taxes from Federal Reserve Banks from Table 3.2 (line 8). **Consumption** is Personal Consumption Expenditures from Table 1.1.5 (line 2). **Investment** is Gross Private Domestic Investmen from Table 1.1.5 (line 7). **Wages** is Compensation of Employees, Paid - Wages and Salaries, retrieved from FRED, Federal Reserve Bank of St. Louis. **Corporate profits**: Corporate Profits After Tax (without IVA and CCAdj), retrieved from FRED, Federal Reserve Bank of St. Louis. All these variables are expressed in real terms, deflated by the GDP deflator from Table 1.1.9 (line 1), and in per capita terms (divided by Total Population: All Ages including Armed Forces Overseas, from U.S. Bureau of the Census since 1952, extended for the period 1947q1-1951q4 using following Ramey and Zubairy (2018)).

Data from other sources: **Employment** is All Employees, Total Nonfarm Payrolls form the U.S. Bureau of Labor Statistics (converted to real per capita terms as detailed before). **Unemployment rate** is the Civilian Unemployment Rate from the U.S. Bureau of Labor Statistics. Consumer Confidence Index. Source: Conference Board (obtained via Thomson Reuters Datastream). **Interest rates** is the 3-Month Treasury Bill (Secondary Market Rate). Source: Board of Governors of the Federal Reserve System. **Ramey's news** is the military news about future defense spending from Ramey and Zubairy (2018), divided by previous quarter nominal GDP. The **government spending shocks based on forecast errors** are constructed in Ramey (2011a), using data from the Survey of Professional Forecasters. **SP500 returns** is the average monthly returns from the S&P Dow Jones Indices LLC, retrieved from FRED, Federal Reserve Bank of St. Louis). **Volatility** is the VXO index (monthly average of daily values) since 1982 (from CBOE) and the realized volatility (monthly standard deviation) from the SP500 returns, following Bloom (2009). **Oil price** is West Texas Intermediate (WTI), spot crude oil price (Federal Reserve Bank of St. Louis). The **Geopolitical Risk Index** (GPR) is the overall historical GPR index explained in

Caldara and Iacoviello (2017). The **Economic Policy Uncertainty Index** (EPU) is the overall historical EPU index explained in Baker et al. (2016). The **macroeconomic uncertainty index** from Jurado et al. (2015) refers tot he 3 and 12 months ahead.

B. Computing responses using a non-linear VAR

This appendix explains how to incorporate the two alternative identification schemes (Blanchard-Perotti and Ramey's news about future defense spending) in a non-linear SVAR used in the robustness tests in Sections 3 and 4.

i) Implementing the Blanchard-Perotti approach

To capture the potentially different contemporaneous and dynamic responses of the variables to government spending shocks, we estimate an otherwise standard SVAR with dummy variables that provide information about the change in economic conditions (from times of LU to HU or between R and B):

$$\boldsymbol{x}_t = \boldsymbol{B}_L(L)\boldsymbol{x}_{t-1} + \left(\boldsymbol{B}_H(L) - H_{t-1}\boldsymbol{B}_L(L)\right)\boldsymbol{x}_{t-1} + \boldsymbol{e}_t \tag{6}$$

$$\boldsymbol{e}_t = \boldsymbol{D}_t\boldsymbol{\varepsilon}_t \tag{7}$$

$$\boldsymbol{D}_t = \left(\boldsymbol{D}_L + \boldsymbol{D}_H H_{t-1}\right) \tag{8}$$

where $\boldsymbol{x}_t = [g_t, y_t, tr_t]'$ and $\boldsymbol{e}_t \sim \mathcal{N}(0, \boldsymbol{D}_t\boldsymbol{D}_t')$ is a vector of residuals which are linear combinations of the structural shocks $\boldsymbol{\varepsilon}_t \sim \mathcal{N}(0, \boldsymbol{I})$. $\boldsymbol{B}(L) = (\boldsymbol{I} - \boldsymbol{B}_1 L - \boldsymbol{B}_2 L^2 \ldots \boldsymbol{B}_p L^p)$ represents a lag polynomial of order p.[62]

H_t is a dummy variable that takes a value of one during periods of HU (or R, depending on the analysis).[63] When $H_t = 0$, the dynamic lagged variables affect the system through $\boldsymbol{B}_L(L)$, and when $H_t = 1$ through $\boldsymbol{B}_H(L)$, allowing for a potentially different dynamic response in the system. The contemporaneous response matrix $\boldsymbol{D}_t$ is also allowed to be state-dependent, changing during periods of LU or B (matrix $\boldsymbol{D}_L$) and periods of HU or R (matrix $\boldsymbol{D}_H$). The specification also includes a state-varying constant and a quadratic trend (as emphasised in Francis and Ramey (2009)).

In the framework of this subsection, exogenous shocks to government spending are identified using an exclusion restriction: government spending does not react contemporaneously to other structural shocks. To implement this restriction, the matrix $\boldsymbol{D}_t$

[62] We set $p = 4$ following Blanchard and Perotti (2002) and Ramey (2011a).

[63] We follow Auerbach and Gorodnichenko (2012)) in using H_{t-1} (as opposed to using H_t) to avoid contemporaneous feedback from fiscal policies into the state of the economy. Our results are, however, similar regardless of which specification we use.

is obtained from a Choleski decomposition of the variance-covariance matrix of the relevant residuals from equation 6, where government spending is ordered first.

To prevent the nonlinearities that are present in equation 6 from altering the original Blanchard-Perotti identification assumption, we impose 0 coefficients on the matrix $\boldsymbol{B}_1(L) = \boldsymbol{B}_H(L) - \boldsymbol{B}_L(L)$ for the government equation. Therefore, government spending shocks ε_t^g are identified, in line with Blanchard and Perotti (2002), from:

$$g_t = \sum_{j=1}^{p} \boldsymbol{\beta}_{0,j}^{g} \boldsymbol{x}_{t-j} + \varepsilon_t^g$$

In an alternative specification, we allow for the shocks to be identified using a non-linear process for government spending (i.e., without imposing 0 restrictions on matrix $\boldsymbol{B}_1(L)$).

Note that when we do not allow for differential responses due to changing economic distinctions, i.e. $H_t = 0$ for all periods, equation 6 reduces to a standard linear SVAR model:

$$\boldsymbol{x}_t = \boldsymbol{B}(L)\boldsymbol{x}_{t-1} + \boldsymbol{D}\boldsymbol{\varepsilon}_t \tag{9}$$

ii) Identification with news about future defense spending

In this subsection, we describe how we compute the responses to government spending shocks in a non-linear VAR where the shocks are identified using the measure of news about future government spending (as a percentage of GDP) described in Ramey (2011a).

We estimate a VAR that explicitly incorporates the structural shocks to government spending, namely ε_t^{Ramey}, or news about defense spending:

$$\boldsymbol{x}_t = \boldsymbol{B}(L)\boldsymbol{x}_{t-1} + H_{t-1}\boldsymbol{C}(L)\varepsilon_t^{Ramey} + (1 - H_{t-1})\boldsymbol{D}(L)\varepsilon_t^{Ramey} + \boldsymbol{\xi}_t \tag{10}$$

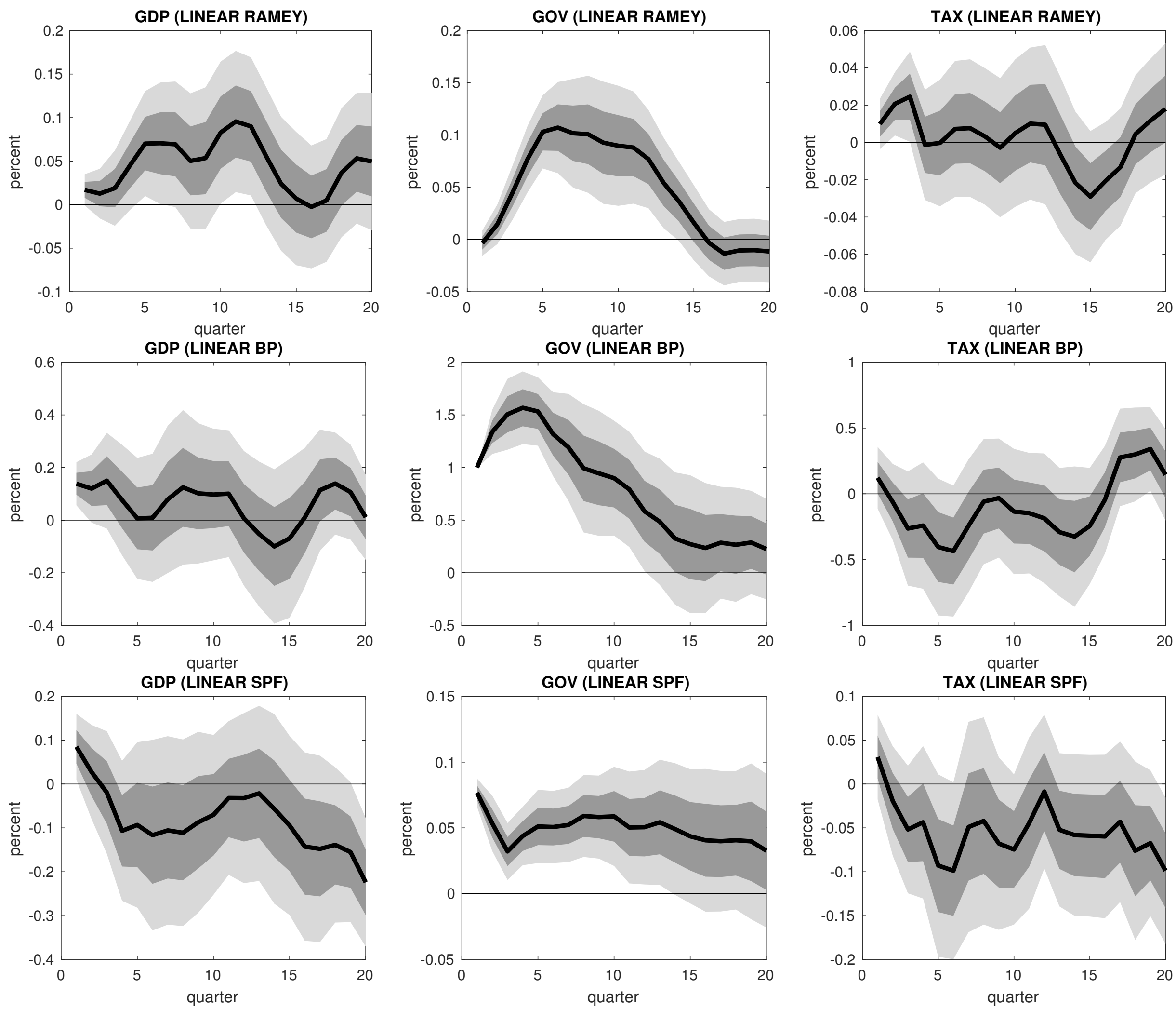
As before, $\boldsymbol{B}(L)$ is a lag polynomial of order p and $\boldsymbol{C}(L)$ and $\boldsymbol{D}(L)$ are lag polynomials of order q.[64] $\boldsymbol{\xi}_t$ is a residual with normal distribution. As in equation 6, the above model allows for government spending shocks to have differential effects, both dynamically and on impact, depending on the evolution of features of the economy controlled by H_t.[65] However, the key difference from the model in equation 6 is that the structural shocks ε_t^{Ramey} are now assumed to be observable variables.

[64] Following similar studies such as Romer and Romer (2010), we set $q = 12$.

[65] When H_t takes a value of 1, the contemporaneous and dynamic effects of the shock ε_t^{Ramey} are given by the matrix $\boldsymbol{C}(L)$. Conversely, when $H_t = 0$ these effects are controlled by the matrix $\boldsymbol{D}(L)$.

C. Appendix Figures

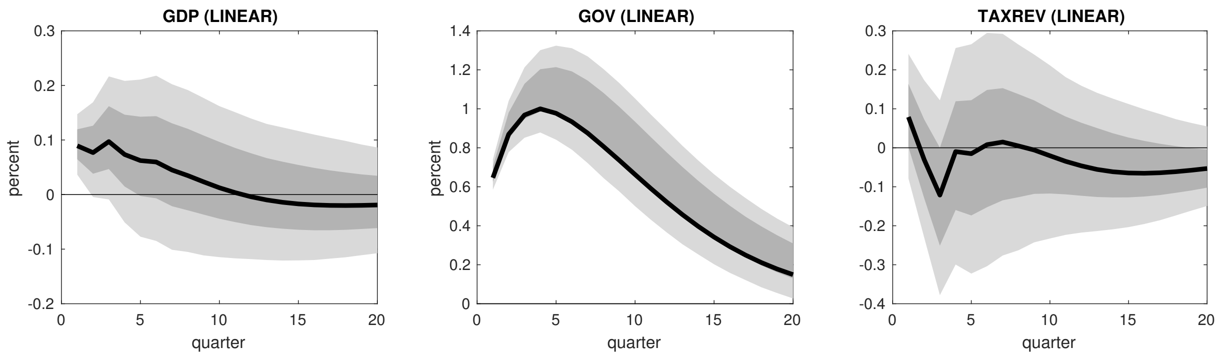
Figure A1: Responses to government spending shocks under different identification schemes



Responses of output, government spending and tax revenues to exogenous government spending shocks identified using Ramey news about future defense spending (first row), a Blanchard-Perotti approach (second row) and forecast errors (third row). The 68% and 95% confidence bands are computed using a using Newey-West standard errors.

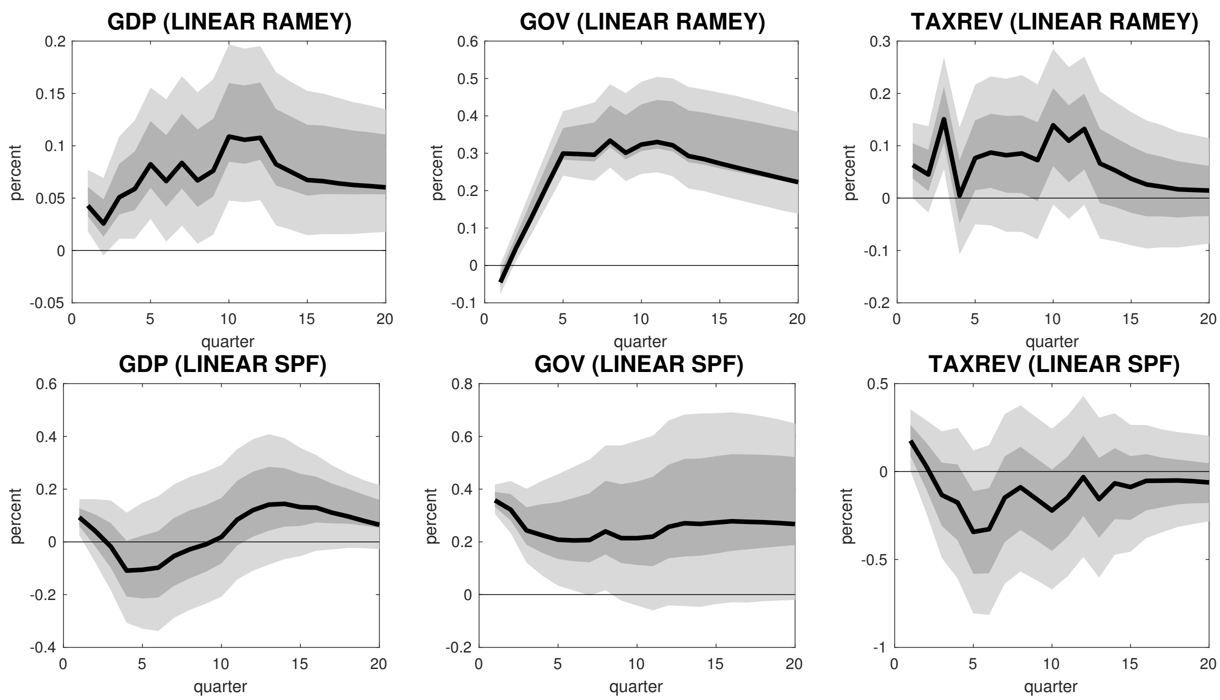
Online Appendix

Figure B1: Responses to government spending shocks using a SVAR and Blanchard-Perotti identification



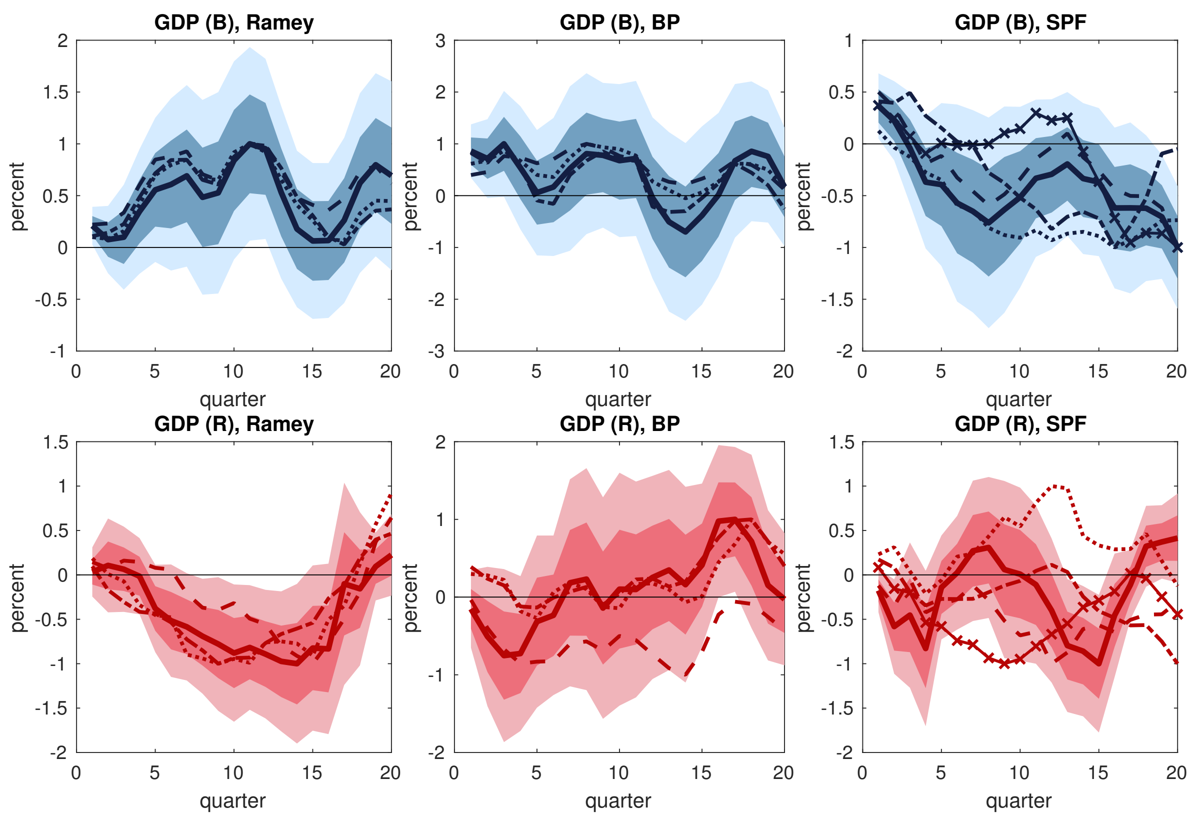
Responses to exogenous a government spending shock identified using a Blanchard-Perotti approach The 68% and 95% confidence bands are computed using a non-parametric bootstrap.

Figure B2: Responses to government spending shocks using a SVAR under different identification schemes



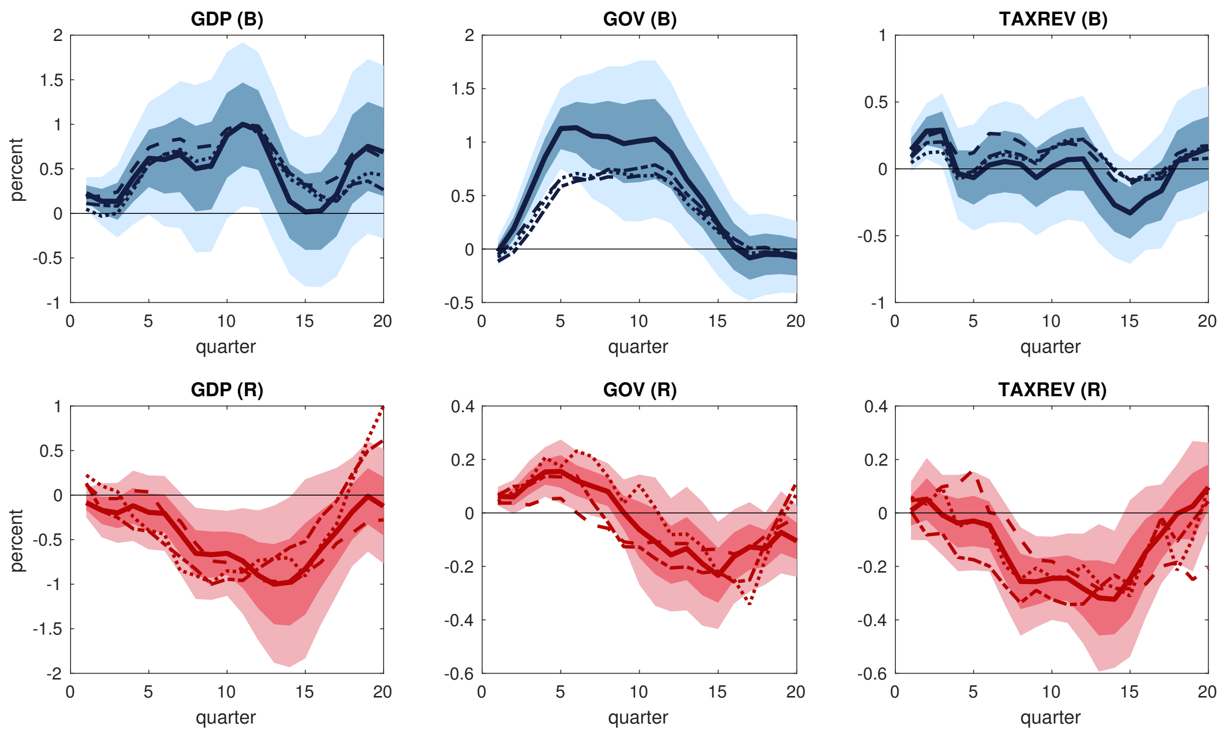
Responses to exogenous government spending shocks identified using Ramey news about future defense spending (first row), and forecast errors (second row). The 68% and 95% confidence bands are computed using a non-parametric bootstrap.

Figure B3: Robustness to different specifications of recession (different identification schemes)



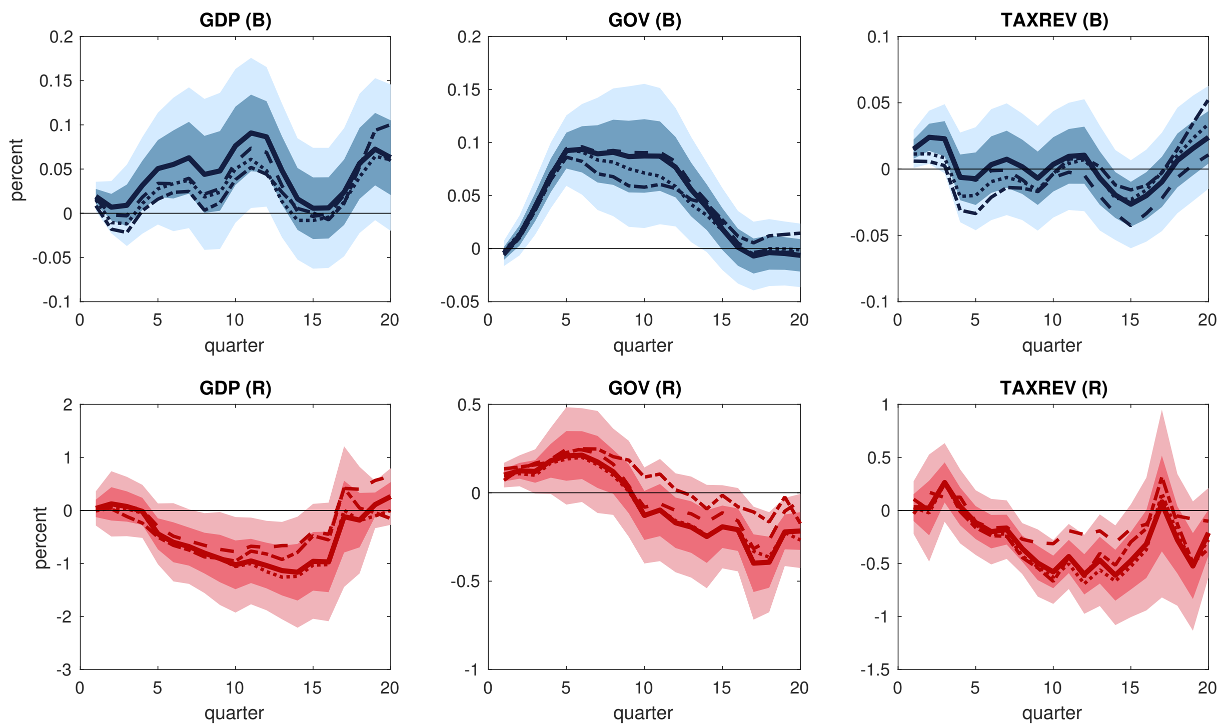
The top panel (in blue) shows responses to a government spending shock during times of boom. The bottom panel (in red) shows responses during times of recession. Left column displays the output response when government spending shocks are identified using Ramey news about defense spending. In the middle column, shocks are identified using a Blanchard-Perotti approach. In the right column, shocks are identified as forecast errors in government spending. Solid lines refer to the benchmark specification (recessions defined as two consecutive quarters of negative output growth). Dashed lines refer to specifications with recessions defined by the NBER. Pointed lines display the results when recessions are defined as periods with an unemployment rate above 6.5. Dash-point lines refer to specifications with recessions defined as periods with unemployment rate higher than one standard deviation above the sample average. Cross-markers line (only in right-hand-side column) defined recessions as periods with negative growth rate of capacity utilization. The 68% and 95% confidence bands are computed using Newey-West standard errors.

Figure B4: Robustness to the changes in the timing of the state dummy (Ramey news)



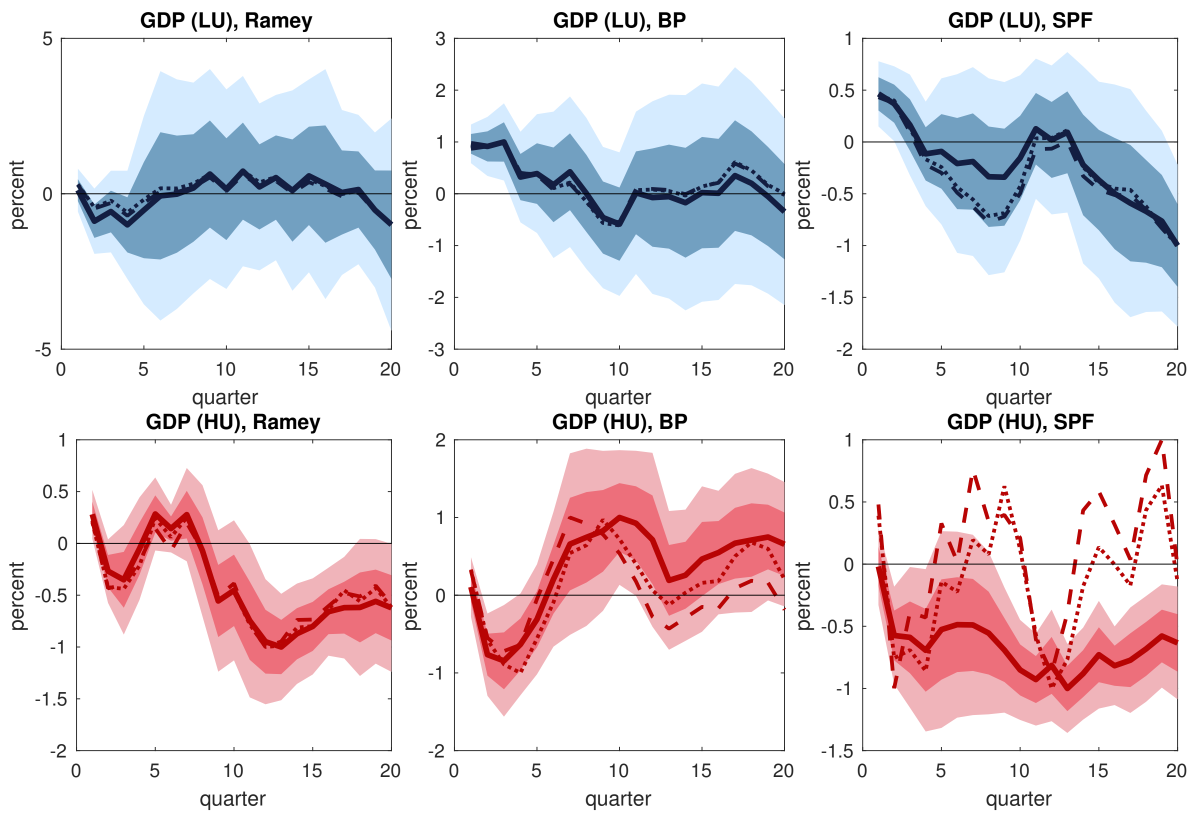
The top panel (in blue) shows responses to a government spending shock (identified with news about future defense spending) during times of boom. The bottom panel (in red) shows responses during times of recession. These results mirror those in Figure 5 with the only difference that H_{t-1} in equation 1 is substituted by H_t. Solid lines refer to the benchmark specification (recessions defined as two consecutive quarters of negative output growth). Dashed lines refer to specifications with recessions defined by the NBER. Pointed lines display the results when recessions are defined as periods with an unemployment rate above 6.5. Dash-point lines refer to specifications with recessions defined as periods with unemployment rate higher than one standard deviation above the sample average. The 68% and 95% confidence bands are computed using Newey-West standard errors.

Figure B5: Robustness to alternative especifications using R and B (Ramey news)



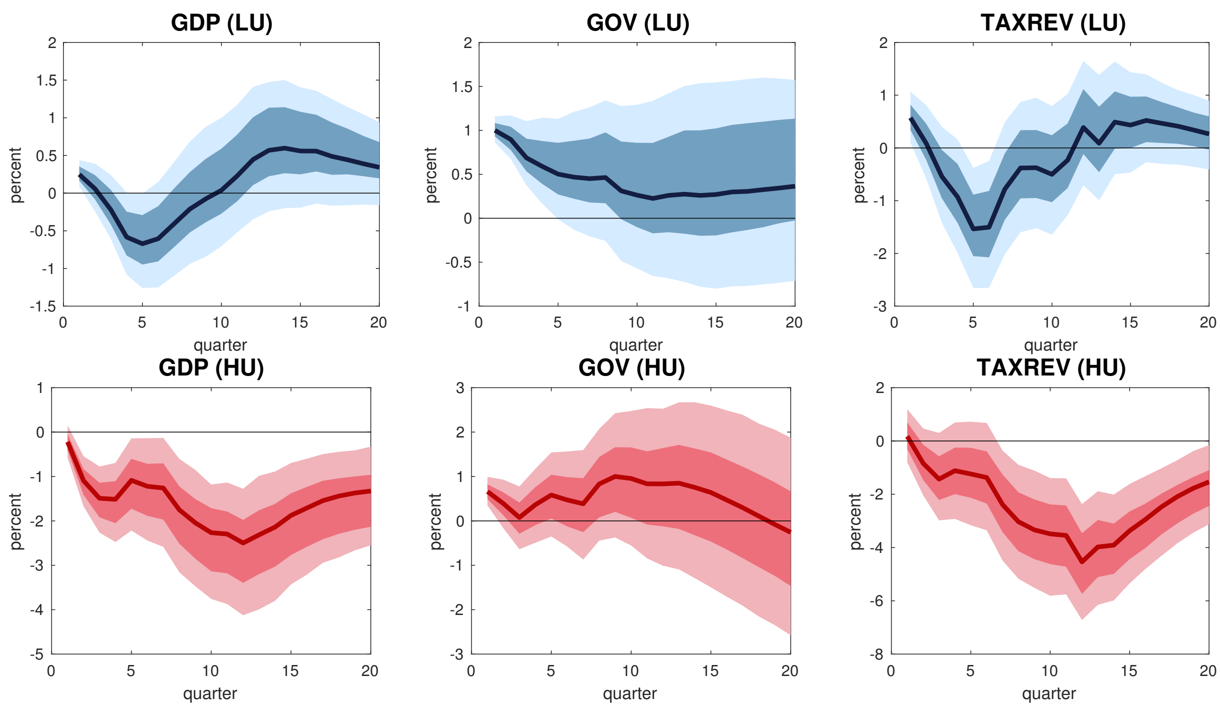
The top panel (in blue) shows responses to a government spending shock (identified with news about future defense spending) during times of boom. The bottom panel (in red) shows responses during times of recession. Solid lines refer to benchmark estimates. Dashed lines refer to specifications with federal government spending and tax revenues instead of total (which includes state and local components). Pointed lines refer to specifications with a polynomial order of 6 in equation 1. Dash-point refer to specifications with a polynomial order of 8 in equation 1. The 68% and 95% confidence bands are computed using Newey-West standard errors.

Figure B6: Alternative definitions of high uncertainty (Ramey news)



The top panel (in blue) shows responses to a government spending shock during times of low uncertainty. The bottom panel (in red) shows responses during times of high uncertainty. Left column displays the output response when government spending shocks are identified using Ramey news about defense spending. In the middle column, shocks are identified using a Blanchard-Perotti approach. In the right column, shocks are identified as forecast errors in government spending. Solid lines refer to estimations with a definition of HU based on Jurado et al. (2015) 12 periods ahead when he variable H_t is lagged one period (as in equation 1. Dashed lines display the responses using the same approach but when he variable H_t refers to time t (contemporaneous to the shock). Pointed lines use the same measure from Jurado et al. (2015) when uncertainty is measured 3 months ahead.The 68% and 95% confidence bands are computed using Newey-West standard errors.

Figure B7: Responses using a non-linear SVAR in HU and LU (forecast errors)



The top panel (in blue) shows responses to a government spending shock (identified using exclusion restrictions) during times of low uncertainty. The bottom panel (in red) shows responses during times of high uncertainty. The 68% and 95% confidence bands are computed using a non-parametric bootstrap.