Chronicle of a War Foretold: The Macroeconomic Effects of Anticipated Defense Spending Shocks *

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Abstract

We identify US defense news shocks as shocks that best explain future movements in defense spending over a five-year horizon and are orthogonal to current defense spending. Our identified shocks are strongly correlated with the Ramey (2011) news shocks, but explain a larger share of macroeconomic fluctuations and have significant demand effects. Fiscal news induces significant and persistent increases in output, consumption, investment, hours and the interest rate. Standard DSGE models fail to produce such a pattern. We propose a sticky price model with variable capital utilization, capital adjustment costs, and rule-of-thumb consumers that replicates the empirical findings and allows us to test the validity of our methodology for extracting anticipated fiscal shocks from the data.

JEL classification: E62, E65, H30

Key words: SVAR, maximum forecast error variance, defense news shocks, DSGE model

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1 Introduction

As Horace (65 BC-8 BC) explains "Life is largely a matter of expectation." After the seminal works of Beaudry and Portier (2007) and Jaimovich and Rebelo (2009), economists seem to agree that macroeconomic fluctuations may be driven by changes in expectations rather than current economic conditions and that agents react to changes in exogenous fundamentals before such changes materialize. Schmitt-Grohé and Uribe (2012) show that anticipated shocks account for about half of aggregate fluctuations in the US.

It is usually difficult to measure news but in some cases researchers were able to identify news by using the timing of specific events. Such strategy is available when trying to identify fiscal changes.[1] Ramey (2011) constructs two measures of news about changes in military spending. The first uses narrative evidence (based on information in the Business Week and other newspapers) to construct an estimate of the change in the expected present value of government spending. The second is constructed using the Survey of Professional Forecasters, and estimated changes in government spending are measured as the difference between actual government spending growth and the forecast of government growth made one quarter earlier. Ramey (2011) shows that VAR shocks incorrectly capture the timing of the news. Thus, inference about dynamic fiscal multipliers,[2] or the effects of fiscal news in the macroeconomy are likely to be biased.

In this paper, we propose an alternative methodology to identify fiscal news in the data which is easier to implement and can be used in situations where narrative evidence is unavailable: Defense news shocks are the shocks that best explain future movements in defense spending over a horizon of five years and that are orthogonal to current defense spending, as in Barsky and Sims (2011).[3] Our

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[1] Mertens and Ravn (2012) also categorize tax changes in the US as anticipated or unanticipated depending on the difference of the announcement and implementation date using narrative evidence of tax changes provided by Romer and Romer (2010).

[2] Along these lines, Forni and Gambetti (2011), Leeper et al. (2012), and Leeper et al. (2013) have shown that, because of the existence of legislative and implementation lags, private agents receive signals about future changes in governments spending before these changes take actually place, thus casting doubts on the evidence of previous SVAR literature on fiscal shocks as VAR representations are likely to be non-fundamental.

[3] Barsky and Sims (2011) used this identification approach to identify news shocks about future total factor productivity.

identified defense news shocks are strongly correlated with the Ramey (2011) news shocks, but they explain a much larger fraction of the variability in all real variables at business cycle frequencies. Also, they have a significant and more positive effect in the economy. In particular, anticipated fiscal shocks induce a significant and persistent increase in output, consumption, investment, hours and the interest rate. Hence, the component of the shock identified using the maximum forecast error variance methodology (henceforth MFEV) that is independent of the Ramey shock series contains important information on future defense spending. We illustrate further this point by showing that the Ramey news series is missing important information about fiscal news in the beginning of the 1950s, the end of 1970s and the mid 1990s.

Standard models are incapable of generating significant demand effects from defense spending news. In fact, in these models consumption falls after a news shock and output reacts less strongly. We have augmented a standard New Keynesian DSGE model with (a) variable capital utilization and capital adjustment costs and (b) rule of thumb consumers in order to generate theoretical responses to fiscal news that match the data. We use the model to simulate data and employ our proposed identification scheme in the simulated data to estimate the theoretical impulse responses and show that our proposed methodology recovers accurately the true shocks.

Several other studies analyze the macroeconomic effects of anticipated government spending shocks. Mertens and Ravn (2010), for example, use a DSGE model to derive a fiscal SVAR estimator that is applicable when shocks are permanent and anticipated and use it with US data. Our framework is less restrictive since it can deal with temporary fiscal shocks and uses medium-run rather than long-run constraints to identify them. Leeper et al. (2012) identify two types of fiscal news concerning government spending and tax policies. They identify government spending news using the Survey of Professional Forecasters and map the reduced-form estimates of news into a DSGE framework. They find that fiscal news is a time-varying process and incorrectly assuming time-invariant processes to model news might be misleading. Gambetti (2012) assesses the information content of government spending news constructed as the difference between the forecast of government spending growth over the next three quarters made by the agents at time t

(measured with the Survey of Professional Forecasters) and the forecast of the same variable made at time $t - 1$. He finds that the identified government spending news shock in a VAR generates Keynesian type of effects, increasing output and consumption and real wages before the actual increase in spending but crowding out private investment.

The remainder of the paper is organized as follows. Section 2 describes the econometric framework. Section 3 presents the main empirical results and in section 4 we examine their sensitivity to changes in the model specification. In Section 5 we present the theoretical model and in Section 6 we report results from testing our empirical methodology on simulated data and Section 7 concludes.

2   Econometric Strategy

2.1   Data

The data covers the period from 1947:Q1 to 2008:Q4. Recent work by Leeper et al. (2013) and Ramey (2011) has discussed the issue of missing information with respect to defense news events and how it can undermine identification in SVAR's. One efficient way to address this problem is by directly adding more information to the VAR, as in Sims (2012) and Forni and Gambetti (2011). Thus, together with real per capita defense spending, we also include in the VAR the Ramey (2011) measure of defense news shocks.[4] Apart from enabling us to alleviate the missing information problem, the inclusion of this series allows us to check how the news series we extract correlates with the latter series and to compare the effects of our shock with the effects of Ramey's news shock.

In addition to the defense spending variable and the Ramey (2011) news series, we also include in the VAR output, hours, consumption , and investment, all in real per capita terms, as well as the real manufacturing wage, the Barro and Redlick (2011) average marginal tax rate, the interest

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[4]This the narrative-based series Ramey constructed from newspaper archives.

rate on 3 month T-bills, and CPI inflation. The data comes from Ramey's website.[5]

2.2 Identifying Defense News Shocks

The defense news shock is identified as the shock that best explains future movements in defense spending over a horizon of five years and that is orthogonal to current defense spending. To obtain such shock we need to find the linear combination of VAR innovations contemporaneously uncorrelated with current defense spending which maximally contributes to defense spending's future forecast error variance as in Barsky and Sims (2011). The orthogonality restriction relative to defense spending is important since it requires the identified shock to have no contemporaneous effect on defense spending.

Let y_t be a kx1 vector of observables of length T. Let the reduced form moving average representation in the levels of the observables be:

$$y_t = B(L)u_t \tag{1}$$

where $B(L)$ is a kxk matrix polynomial in the lag operator, L, and u_t is the kx1 vector of reduced-form innovations. We assume that reduced-form innovations and structural shocks, ε_t, are linked by

$$u_t = A\varepsilon_t \tag{2}$$

Equations (1) and (2) imply

$$y_t = C(L)\varepsilon_t \tag{3}$$

where $C(L) = B(L)A$ and $\varepsilon_t = A^{-1}u_t$. The matrix A must satisfy $AA' = \Sigma$, where Σ is the variance-covariance matrix of reduced-form innovations. There are, however, an infinite number of

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[5]http://weber.ucsd.edu/ vramey/

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A's that satisfy the restriction. For some arbitrary orthogonalization, $\widetilde{A}$ (for example, the Choleski decomposition), the space of permissible impact matrices can be written as $\widetilde{A}D$, where D is a k x k orthonormal matrix ($D' = D^{-1}$, which entails $D'D = DD' = I$).

The h step ahead forecast error is

$$y_{t+h} - E_t y_{t+h} = \sum_{\tau=0}^{h} B_\tau \widetilde{A} D \varepsilon_{t+h-\tau} \tag{4}$$

where B_τ is the matrix of moving average coefficients at horizon τ. The contribution to the forecast error variance of variable i attributable to structural shock j at horizon h is

$$\Omega_{i,j} = \sum_{\tau=0}^{h} B_{i,\tau} \widetilde{A} \gamma \gamma' \widetilde{A}' B'_{i,\tau} \tag{5}$$

where γ is the jth column of D, $\widetilde{A}\gamma$ is a kx1 vector corresponding with the jth column of a possible orthogonalization, and $B_{i,\tau}$ represents the ith row of the matrix of moving average coefficients at horizon τ. We put defense spending in the first position in the system, and index the defense news shock as 1. Our identification procedure requires finding the γ which maximizes the sum of contributions to the forecast error variance of defense spending from horizon 0 to horizon H (the truncation horizon), subject to the restriction that these shocks have no contemporaneous effect on defense spending. Formally, we need to solve the following optimization problem

$$\gamma^* = \underset{\gamma}{\operatorname{argmax}} \sum_{h=0}^{H} \Omega_{1,1}(h) = \sum_{h=0}^{H} \sum_{\tau=0}^{h} B_{1,\tau} \widetilde{A} \gamma \gamma' \widetilde{A}' B'_{1,\tau} \tag{6}$$

$$\text{subject to} \qquad \widetilde{A}(1,j) = 0 \quad \forall j > 1 \tag{7}$$

$$\gamma(1,1) = 0 \tag{8}$$

$$\gamma'\gamma = 1 \tag{9}$$

The first two constraints impose on the identified news shock to have no contemporaneous effect on defense spending. The third restriction ensures that γ is a column vector belonging to an orthonormal matrix. This normalization implies that the identified shocks have unit variance.

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In the benchmark set up $H=20$ quarters. Hence, the defense news shock we identify is the shock that is orthogonal to defense spending and which maximally explains future variation in defense spending over a horizon of five years. The lag of the model is set to 4 which is a midway between what standard criteria suggest (The Akaike criteria favors six lags, the Hannan-Quinn information and Schwartz criteria favor two lags, and the likelihood ratio test statistic chooses eight lags). We examine the robustness of our results to alternative lag lengths and alternative H in Section 4.

3   Empirical Evidence

3.1   Identified News Shocks and Ramey News Shocks

Figure 1 shows the time series of identified (MFEV) news and the Ramey news shocks. The Ramey news shock is identified as the innovation in the Ramey news variable orthogonalized with respect to current defense spending.[6] To make the figure more readable, we present a one year backward looking average of the shock series. Shaded areas represent the war periods.

The two shock series are highly correlated with a contemporaneous correlation of 0.85. It is apparent that our news shock series captures important defense news events, such as the Korean war, Vietnam war, the Carter-Reagan buildup that began in the early 1980's, and the fall of the Berlin wall at the end of the 1980's. All of these events are also accounted for in the series of Ramey (2011). However, as we shall see in the next section, while strongly correlated, these two series have significantly different impacts on macroeconomic variables.

3.2   Impulse Responses

Figure 2a shows the estimated impulse responses of all the variables to a positive one standard deviation defense news shock from the benchmark VAR, with the dashed lines representing 2.5th and 97.5th percentile confidence bands. These bands are constructed from a residual based bootstrap

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[6]It is important to add this orthogonalization restriction since its omission implies that the Ramey news shock has a significant impact effect on defense spending.

procedure repeated 2000 times.[7]

Following a positive defense news shock, defense spending does not change on impact, by construction, and then grows gradually peaking after 7 quarters at 3.9%. Output, investment, consumption, and hours all increase on impact, with the responses being statistically significant at 0.35%, 0.82%, 0.32%, 0.32%, respectively. The peak response of output occurs after 3 quarters reaching 0.59%, reflecting a multiplier of 4.27.[8] Output and hours have a hump-shaped response that dies off after three years; consumption and investment responses return to zero after a year and a half.

It is also apparent that the real wage declines significantly following the news shock. Given that the real wage is measured as the product wage in the manufacturing sector rather than the consumption wage, this result can be interpreted along the lines of Ramey and Shapiro (1998) who showed that the relative price of manufactured goods rises significantly during a defense buildup and, thus, product wages in these industries can fall at the same time that the consumption wage is unchanged or rising. The news shock also raises the average marginal income tax rate, inflation and interest rates. Note that the tax rate increases in a gradual manner reflecting the notion that defense news shocks foretell future increases in both defense spending and tax rates.

Figure 2b shows the estimated impulse responses to a positive one standard deviation shock to the Ramey news variable. Two important differences stand out. First, our identified news shock has a larger effect on defense spending: the peak response of spending following the Ramey news shock is 3.3% compared to 3.9% following our news shock. Second, the responses of all the macro variables are significantly weaker. For example, the peak response of output occurs after 5 quarters, generating a multiplier of 1.13. On the other hand, the responses of hours are insignificant at all horizons. Furthermore, the responses of investment, consumption, and interest rates, though not

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[7]We use the Hall confidence interval (see Hall (1992)) which attains the nominal confidence content, at least asymptotically, under general conditions and has relatively good small sample properties as shown by Kilian (1999). We have also confirmed that our results are robust to using confidence bands derived from the bias-corrected bootstrap procedure of Kilian (1998).

[8]The multiplier is computed as the product of the ratio of the impulse responses of output and defense spending at the 3 quarter horizon and the average ratio of nominal GDP to nominal defense spending over the sample period.

significant, have signs which are the opposite of those obtained with our news series.

3.3   Forecast Error Variance Decomposition

Figure 3 shows the share of the forecast error variance of the endogenous variables attributable to our defense news shocks and the Ramey news shock. In general, our news shock explains a larger share of the forecast error variance of all variables. For example, it explains 54% of the variation in defense spending at the three year horizon compared to 38% for the Ramey news shock. Moreover, our news shock explains 70% of the variation in the Ramey news variable on impact. This indicates that our identified news shock is strongly related to Ramey's news shock though it appears to contain more information about future defense spending.

In addition to the defense spending variable, our MFEV news shock accounts for a much larger share of the forecast error variance of all other variables: It explains 23% and 28% of output and hours variation at the one year horizon, respectively, compared to 2% and 0% explained by Ramey's news shock; and a much bigger share of the variation in the nominal variables and the Barro and Redlick (2011) average marginal tax rate. In particular, our news shocks explains 21% of the variation in inflation at the three quarter horizon and 22% of the variation in the tax rate at the two year horizon, compared to 9% and 4% of the Ramey news shock, respectively. Furthermore, our news shock explains 13% of the variation in interest rates at the two year horizon, compared to zero in the case of Ramey's news shock.

To examine whether the differences between the contributions of the MFEV news shock and the Ramey news shock to the variables' variation are statistically significant, we estimated for all variables the p-value for the null hypothesis that the difference between the contribution the MFEV news shock and the Ramey news does not exceed zero. Each estimated p-value was obtained as the proportion of bootstrap values of the contribution difference of the two shocks not exceeding zero.[9] Our estimated p-values indicate that the differences are generally significant. Table 1 presents these results. To be concise, we focus on the horizon for which the point estimate of the contribution

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[9]As noted in Lutkepohl (2005) on p. 712, this estimation procedure will yield p-value estimates that are consistent under general assumptions.

difference is maximal. P-values are sufficiently low for most variables: The contribution differences for defense spending, output, hours, the Barro and Redlick (2011) average marginal tax rate, and investment appear to be highly significant with p-values of 0%, 2.2%, 1.1%, 3.2%, and 6.1%, respectively, and those corresponding to inflation and consumption are moderately significant with p-values of 10.6% and 12.5%, respectively. The zero p-value for the null hypothesis that the difference between the contribution of our news shock and the Ramey news shock to the defense spending variation is not positive strongly indicates that our news shock contains relatively more information about future defense spending.

3.4 The Additional Information Content in the MFEV News Shock Series

The results presented thus far have established that there is valuable information contained in our MFEV news series that is absent from the narrative-based Ramey (2011) shock series. To further illustrate the important difference between the two shocks, we run an exercise in which we projected our MFEV shock series onto the shock to the Ramey (2011) news series and collected the residual, and then projected all of the other variables in the VAR onto their own lags and the current and lagged values of the residual from the first step and estimated the impulse responses of the variables to the residual.[10]

The first step residual is shown in Figure 4, along with shaded areas that represent the dates at which the Ramey series is uninformative, i.e., contains zeroes. It is apparent that the mid-1990s deficit reducing Clinton era and the Obama election period are captured by very large negative realizations of our shock that are not accounted for by Ramey's narrative-based approach. Furthermore, there are various other large shocks that our identification method captures but are not accounted for by the narrative approach, e.g., the very large late 1952 shock (third largest overall)

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[10]We thank Karel Mertens for suggesting us this exercise. We excluded Ramey's series from the estimation undertaken in the second step so as to avoid collinearity resulting from the fact that the first step residual is a linear combination of all lagged variables. Since the first step residual is orthogonal by construction to Ramey's series, thus, rendering the inclusion of Ramey's series redundant, we proceeded with the second step estimation without the Ramey series.

which can be associated with the Eisenhower election; the very large shock at the end of 1980 (second largest overall) when Reagan got elected; and the largest shock of the series that took place in the second quarter of 1978 and can be associated with the Saur Revolution which signified the onset of communism in Afghanistan and preluded the 1979 Soviet war in Afghanistan.

The impulse responses to the first step residual are shown in Figure 5: the MFEV news shock component that is independent from the Ramey (2011) shock has a significant effect on future defense spending as well as on all real and nominal variables. More specifically, it raises the real aggregates, inflation, interest rates, and taxes, and starts to have a significant effect on defense spending after six quarters.[11] The peak effect on defense spending is also economically significant at nearly 2%, indicating that there is additional information about future defense spending beyond that contained in the narrative-based series of Ramey. Taken together, the results of this section suggest that while the narrative approach is informative, it can only capture part of the news present in the data and is therefore inferior to our MFEV identification method which can do a better job of picking the vast information content available in the data.

4   Robustness

This section addresses five potentially important issues regarding the analysis undertaken in the previous section. The first is the concern that assuming different lag specifications or alternative truncation horizons for the MFEV optimization problem may produce different results. The second issue pertains to the potential effect that altering the sample period, such that either the World War II period is included or the Korean War period is excluded, may have on the benchmark results. The third issue we examine is whether our shock is correlated with the identified defense shock of Fisher and Peters (2011) which corresponds to the innovation to the accumulated excess returns

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[11]We have confirmed that the residual is not correlated with other macroeconomic shocks identified in the literature, such as the Romer and Romer (2004) monetary policy shock, the Romer and Romer (2010) tax shock measure, shock to the real price of oil, and the shock to uncertainty used in Bloom (2009). That our residual is not correlated with monetary policy shocks is especially important given the strong effect it has on interest rates. These results are availble upon request from the authors.

of large US military contractors. The fourth issue we address is whether our results are robust to excluding the Ramey (2011) news series from the VAR, which is important to confirm given that narrative-based defense news measures are generally unavailable for most countries. Finally, we confirm that our results are not driven by a positive correlation of our identified shock with other structural disturbances that are identified in the literature as potential drivers of business cycle fluctuations.[12]

4.1   VAR Lags and the Truncation Horizon

Figure 6a shows the impulse responses obtained with lag lengths, from 3 to 6. As evident, the impulse responses to all of the variables are in general similar both qualitatively and quantitatively. The only noticeable difference is in the response of the Barro and Redlick (2011) income tax rate which is weaker and negative on impact for the model with 6 lags. Figure 6b displays the responses for four separate horizons, $H = 10$, 20 (benchmark), 30, and 40. The results are similar for all horizons.

4.2   Changing the Sample

Figures 7a and 7b correspond to Figures 2a and 2b with the only difference being that now the VAR is estimated using the larger sample period of 1939:Q2-2008:Q4. Including the World War II period introduces additional large fiscal events that are relatively much larger in magnitude (See also Ramey (2011)).

   It is apparent that, by and large, the results are qualitatively unchanged for both news shocks, with the exception of the responses of investment which falls after our news shock in the extended sample. While the point estimate impact effect on investment is still positive, investment starts to decline much sooner as compared to the benchmark sample though the decline becomes significant only after 6 quarters.

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[12]We have also tried a battery of sensitivity tests regarding the number of variables in the VAR and their ordering: Our results are insensitive to such changes and we do not present them here for economy of space.

Quantitatively responses are stronger than in the previous section and the MFEV news shock still generates much stronger responses than the Ramey news shock. The peak effects on output and hours are twice as large as before and the peak response of defense spending is 5.7% following our news shock compared to 2.9% following the Ramey news shock. These differences are most likely related to the very large fiscal news events that took place in the World War II period and are seen to have a noticeable effect on the responses of output and hours.

Perotti (2007) argues that the Korean War was unusually large and it should be excluded from the analysis of the effects of government spending. Figures 8a and 8b present responses estimated using the smaller sample period of 1955:Q1-2008:Q4. The results are unchanged: our news shock continues to generate significant demand effects that are stronger than the Ramey news shock effects.

4.3 Relation of News Shocks to the Fisher and Peters (2011) Defense Shock Series

Fisher and Peters (2011) have recently identified government spending shocks as the innovations to the accumulated excess returns of large US military contractors. Figures 9a and 9b plot the responses of the economy to a news shocks identified with our and Ramey's approach, when the VAR includes the Fisher and Peters (2011) excess return series.

The main results are robust to adding the excess return series to the VAR. Yet, an interesting result emerges with respect to the added excess returns variable. While our news shock significantly increases the excess returns of large defense contractors, the Ramey news shock has an insignificant effect on this variable. Thus, our methodology might recover shocks which contain more information about future fiscal policy relative to the Ramey news series.

4.4 Excluding the Ramey (2011) News Series

Given that narrative-based news shock measures are often unavailable for most countries, it is important to alleviate the concern that our empirical results are driven by our inclusion of the Ramey (2011) news series and that the applicability of our method is limited to economies for which such measures are available. To this end, we applied our methodology to a VAR that excludes the Ramey (2011) news series. The results of this exercise are presented in Figure 10. It is apparent that the main results remain unchanged: the identified news shock continues to raise the real aggregates, inflation, interest rates, and taxes, with defense spending following a delayed and gradual rise after the news shock realizes.

4.5 Cross-Correlations with Other Structural Disturbances

An additional concern that may arise from the benchmark results is that the identified MFEV news shock is correlated with other structural disturbances. To address this concern, we computed the correlation between the identified MFEV news shock and up to four lags and leads of the Romer and Romer (2004) monetary policy shock measure, Romer and Romer (2010) tax shock measure, shock to the real price of oil, the TFP news shock from Barsky and Sims (2011), and the shock to uncertainty used in Bloom (2009) which is based on stock market volatility. Apart from the Barsky and Sims (2011) TFP news shock series which was used in its raw form, all other shocks were constructed as the residuals of univariate regressions of each of the four variables on four lags.

In Figure 11 we plot contemporaneous and lead and lag correlations between the MFEV news shocks and the other five shocks we consider, together with the corresponding 95% asymptotic confidence intervals. The results indicate that the cross-correlations are small and insignificant, with all correlations being lower than 19% in absolute value. Thus, the fact that our shock is well identified and it has significant effects on output, consumption, investment, and hours relative to Ramey's news cannot be driven by mixing disturbances when using our identification approach. .

5 Anticipated Defense Spending Shocks in a DSGE Model

It is easy to show that a standard flexible, or sticky price DSGE model cannot replicate the empirical impulse responses with respect to defense news shocks. Both models fail to match qualitatively and quantitatively the responses present in the data. For standard DSGE models, even under the assumption of sticky prices, consumption reacts negatively in the impact period of the anticipated shock and the responses of the real variables fall short of the empirical impulse responses quantitatively.

Clearly, many mechanisms having been proposed for inducing positive responses of consumption after government spending shocks and for propagating news shocks in DSGE models in the literature. Various theoretical models have been suggested for generating increases in consumption after a fiscal expansion. These mechanisms include: (a) consumption and hours' complementarity in the utility function (see Monacelli and Perotti (2008), Hall (2009), Christiano et al. (2011) and Nakamura and Steinsson (2011)); (b) a lax monetary policy (see Canova and Pappa (2011), Christiano et al. (2011) and Erceg and Linde (2013)); (c) rule-of-thumb consumers (see Gali et al. (2007)); (d) deep habits (see Mertens and Ravn (2012)); (e) spending reversals (see Muller et al. (2009)) and (g) home production (see Gnocchi (2013)). On the other hand, the 'News Driven Business Cycles' literature has focused on the problem of generating intuitive news driven business cycles. Several modifications of the standard model have been suggested for propagating TFP news shocks:[13] (a) making consumption or leisure an inferior good (see, Eusepi and Preston (2009)); (b) using wealth in the utility function (Karnizova (2012)); (c) allowing for sticky prices and accommodative monetary policy (see Christiano et al. (2010), Khan and Tsoukalas (2012), Blanchard et al. (2009) among others) ; (d) adopting a multi-sector structure (see, Beaudry and Portier (2007)); (e) introducing investment adjustment costs and variable capital utilization (see Jaimovich and Rebelo (2009)) and (f) introducing search and matching frictions (see, Den Haan and Kaltenbrunner (2009)).

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[13]Beaudry and Portier (2013) provide an extensive literature review on the topic.

We have played with combinations of the different suggested mechanism in order to be able to replicate the empirical findings. We introduce two modifications to the standard sticky price model in order to bring its predictions closer to the data: (a) introducing variable capacity utilization in the production function as in Jaimovich and Rebelo (2009);[14] and (b) introducing rule of thumb consumers, assuming that 33% of the population does not have access to capital markets and simply consumes its disposable income. Next we present briefly the model and describe the theoretical responses to fiscal news shocks.

5.1 A Theoretical Model

The economy is inhabited by two types of households, optimizers and rule of thumb consumers. The problem of the optimizers is given below.

Optimizing Households

There is a share $1 - \lambda$ of optimizers that derive utility from private consumption, C_t^o and leisure, $1 - N_t^o$. At time 0 they choose sequences for consumption, labor supply, capital to be used next period K_{t+1}, nominal state-contingent bonds, D_{t+1} and government bonds, B_{t+1} to maximize their expected discounted utility:

$$E_0 \sum_{t=0}^{\infty} \beta^t u(C_t^o, N_t^o) = E_0 \sum_{t=0}^{\infty} \beta^t \frac{\left[C_t^o(1 - N_t^o)^{1-\phi}\right]^{1-\sigma} - 1}{1 - \sigma} \tag{10}$$

where $0 < \beta < 1$, and $\sigma > 0$. Here β is the subjective discount factor and σ a risk aversion parameter. Available time each period is normalized at unity. The financially unconstrained household maximizes utility subject to the sequence of budget constraints:

$$P_t(C_t^o + I_t) + E_t\{Q_{t,t+1}D_{t+1}\} + R_t^{-1}B_{t+1} \leq \tag{11}$$

$$(1 - \tau_t^l)P_t w_t N_t^o + [r_t - \tau^k(r_t - \delta(U_t))]P_t K_t + D_t + B_t + \Xi_t$$

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[14]Following Burnside and Eichenbaum (1996) we assume that production depends on effective utilized capital and that capital depreciation depends negatively of the capital utilization rate.

where $(1-\tau_t^l)P_t w_t N_t^o$, is the after tax nominal labor income, $[r_t - \tau^k(r_t - \delta(U_t))]P_t K_t$ is the after tax nominal capital income (allowing for depreciation), Ξ_t, are nominal profits from the firms (which are owned by consumers), and T_t are lump-sum taxes.

We assume complete private financial markets: D_{t+1} is the holdings of the state-contingent nominal bond that pays one unit of currency in period $t+1$ if a specified state is realized and $Q_{t,t+1}$ is the period-t price of such bonds, and R_t the gross return of a government bond B_t. Private capital accumulates according to:

$$K_{t+1} = I_t + (1 - \delta(U_t))K_t - \nu\left(\frac{K_{t+1}}{K_t}\right)K_t \qquad (12)$$

Following Burnside and Eichenbaum (1996), we assume that production depends on effective utilized capital and that capital depreciation depends positively on the capital utilization rate:

$$\delta(U_t) = \psi U_t^\phi \qquad (13)$$

where $\psi, \phi > 0$. The parameter ϕ in equation (13) determines the effect of utilization on the rate of depreciation of capital. When $\phi > 0$, $\frac{\partial \delta}{\partial U} > 0$, whereas when $\phi = 0$, capital utilization does not affect the rate at which capital depreciates.

and the function ν is parameterized as:

$$\nu\left(\frac{K_{t+1}}{K_t}\right) = \frac{b}{2}\left[\frac{K_{t+1} - (1-\delta)K_t}{K_t} - \delta(1)\right]^2 \qquad (14)$$

where b determines the size of the adjustment costs. Since optimizers own and supply capital to the firms, they bear the adjustment costs.

Financially constrained households

The remaining fraction of households, λ, are financially constrained. Rule-of-thumb households fully consume their current labor income. They cannot smooth their consumption in the face of

fluctuations in labor income and intertemporally substitute in response to changes in interest rates. Their period utility is the of the same form as for optimizers and its given by (10). And their budget constrained is given by:

$$P_t C_t^r = (1 - \tau_t^l) P_t w_t N_t^r \tag{15}$$

Aggregation

Aggregate consumption and hours are given by a weighted average of the corresponding variables for each consumer type. That is,

$$C_t = (1 - \lambda) C_t^o + \lambda C_t^r \tag{16}$$

and

$$N_t = (1 - \lambda) N_t^o + \lambda N_t^r \tag{17}$$

Firms

Firm j produces output according to:

$$Y_t(j) = (Z_t N_t(j))^{1-\alpha} (U_t(j) K_t(j))^{\alpha} \tag{18}$$

where $U_t(j) K_t(j)$ and $N_t(j)$ are private effective capital and labor inputs hired by firm j, and Z_t is an aggregate technology shock. We assume that firms are perfectly competitive in the input markets: they minimize costs by choosing private inputs, taking wages and the rental rate of capital as given. Since firms are identical, they all choose the same amount of inputs and cost minimization implies

$$\frac{U_t K_t}{N_t} = \frac{\alpha}{(1 - \alpha)} \frac{w_t}{r_t} \tag{19}$$

Equation (19) and the production function imply that the common (nominal) marginal costs is given by:

$$MC_t = \frac{1}{\Upsilon} Z_t^{\alpha-1} w_t^{1-\alpha} r_t^{\alpha} P_t \tag{20}$$

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where $\Upsilon = \alpha^\alpha (1-\alpha)^{1-\alpha}$.

In the goods market firms are monopolistic competitors. The strategy firms use to set prices depends on whether prices are sticky or flexible. In the former case we use the standard Calvo (1983) setting. That is, at each point in time each domestic producer is allowed to reset her price with a constant probability, $(1-\gamma)$, independently of the time elapsed since the last adjustment. When a producer receives a signal to change her price, she chooses her new price, P_t^*, to maximize:

$$\max_{P_t^*(j)} E_t \sum_{k=0}^{\infty} \gamma^k Q_{t+k+1,t+k}(P_t^* - MC_{t+k})Y_{t+k}(j) \tag{21}$$

Optimization implies

$$\sum_{k=0}^{\infty} \gamma^k E_t \{Q_{t+k+1,t+k}Y_{t+k}(j)(P_t^* - \frac{\varepsilon}{\varepsilon-1}\frac{1}{1-\tau^\varepsilon}MC_{t+k})\} = 0 \tag{22}$$

where $\tau^\varepsilon = -(\varepsilon-1)^{-1}$ is a subsidy that, in equilibrium, eliminates the monopolistic competitive distortion. Given the Calvo pricing assumption, the evolution of the aggregate price index is:

$$P_t = [\gamma P_{t-1}^{1-\varepsilon} + (1-\gamma)P_t^{*1-\varepsilon}]^{\frac{1}{1-\varepsilon}} \tag{23}$$

Fiscal and Monetary Policy

Government's income consists of tax revenues minus the subsidies to the firms and the proceeds from new debt issue; expenditures consist of government purchases and repayment of debt. The government budget constraint is:

$$P_t G_t - \tau^\varepsilon P_t Y_t - \tau_t^l w_t P_t N_t - \tau^k(r_t - \delta(U_t))P_t K_t - P_t T_t + B_t = R_t^{-1}B_{t+1} \tag{24}$$

We also assume that the government takes market prices, private hours and private capital as given, and that B_t endogenously adjusts to ensure that the budget constraint is satisfied. To ensure determinacy of equilibria and a non-explosive solution for debt (see, e.g., Leeper (1991)),

we assume a debt targeting rule of the form:

$$\tau_t^l = \overline{\tau_l} \exp(\zeta_b(b_t - \overline{b})) \tag{25}$$

where $b_t = \frac{B_t}{GDP_t}$ and ζ_b measures the degree of aversion of fiscal policy to debt deviations from target, $\overline{b}$. When ζ_b is very high, the model delivers results which are similar to those obtained in a model where the government balances its budget every period.

Finally, there is an independent monetary authority which sets the nominal interest rate as a function of current inflation according to the rule:

$$R_t = \overline{R} \exp(\zeta_\pi \pi_t + \epsilon_t^R) \tag{26}$$

where ϵ_t^R is a monetary policy shock.

Resource Constraint

Aggregate production must equal the demand for goods from the private and public sector:

$$Y_t = C_t + I_t + G_t \tag{27}$$

5.2   Introducing Anticipated Government Spending Shocks

The government spending shock is driven by anticipated innovations. We study a formulation with one-quarter anticipated shocks. Thus, government spending in log deviations from steady state evolves according to:

$$g_t = \rho g_{t-1} + \varepsilon_{g,t-j} + \varepsilon_{g0,t} \tag{28}$$

$$\varepsilon_{g,t} = \rho_g \varepsilon_{g,t-1} \tag{29}$$

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Here $\varepsilon_{g,t}$ denotes the anticipated portion of the news and $\varepsilon_{g0,t}$ is the unanticipated portion of the news. $j \geq 1$ represents the anticipation lag, i.e. the delay between the announcement of news and the period in which the future spending change is expected to occur. We set $\rho = 0$, $\rho_g = 0.85$, and $j = 1$ in our quantitative exercise.

5.3 Parametrization

We solve the model by approximating the equilibrium conditions around the flexible price non-stochastic steady state. The parameterizations we use is standard and is summarized in Table 2. The size of the steady state government spending to GDP ratio is set to match the average value of military spending to GDP in our sample. The Taylor rule and debt coefficients are set to guarantee a determined solution for all the different models we consider.[15] We assume equal tax rates for capital and labor in the economy and the debt to GDP ratio is set to match the average debt to GDP ratio in the US in our sample. We set the share of rule of thumb consumers equal 33%. The rest of the parameter values are pretty standard.

5.4 Theoretical impulse responses

Figure 12 presents the responses of the economy to anticipated changes in military spending. Continuous lines represent the responses of our model while dashed lines depict the responses of the standard sticky price model (NK model) and dotted lines the responses of a standard DSGE model with flexible prices (RBC model) to the shock.[16] Our proposed model captures well the dynamics with respect to fiscal news. It matches the empirical response of consumption whereas the other two standard models fail to do so and it generates significant responses to fiscal news relative to the standard RBC model. Relative to the standard NK model, the responses of the modified economy to the anticipated shock are more persistent. Output, consumption and labor increase for more than a year after the news. Investment declines at a slower pace relative to

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[15]Note that the indeterminacy of equilibria is a very common phenomenon in economies with news shocks.

[16]In the NK and RBC models utilization does not vary in response to the shocks and the rule of thumb consumers share is set to zero.

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the standard NK model, while the real wage is not reacting much initially and increases with a delay. Finally, the nominal interest and inflation (not shown in the picture since its responses are proportional to the responses of the nominal rate) increase persistently after the shock. Thus, apart from the responses of the real wage, the model captures reasonably well the dynamics of the real variables in response to fiscal news.[17] Given that the responses of the real wage in the data changed with the sample, we prefer not to change the model specification in order to change this result.

5.4.1 Discussion of the propagation mechanism and alternatives

In this subsection we investigate the importance of the different assumptions we have incorporated in the model for the transmission of fiscal news shocks. We start by investigating whether the nominal part of the model is necessary for our analysis. The first column of Figure 13 presents responses when we assume flexible prices in our benchmark economy. As it is apparent, real responses under flexible prices are weak due to the absence of the demand effect that propagates the effects of the fiscal news in the economy by increasing labor demand and real wages and, hence, the consumption of rule of thumbs and consequently aggregate consumption.

In order to obtain increases in private consumption after fiscal news we have introduced a share of financially constrained consumers in the model economy. Alternatively, we could have assumed complementarities between consumption and leisure by adopting the preference specification in Jaimovich and Rebelo (2009). We perform this exercise in the second column of Figure 13. All real variables react to the shock with the same sign as in our benchmark specification, apart from the real wage that is now falling after a fiscal news shock and the nominal interest rate that is counterfactually falling. Responses for this model are quantitative smaller for the adopted calibration, but the major drawback for using this model is that it does not fit the responses of the economy to a monetary policy shock and for that reason we have decided to use the model with rule of thumb consumers as our benchmark.

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[17]In simulations that we do not present here for economy of space we show that the model is consistent with the responses to other shocks such as contemporaneous and news TFP shocks and contemporaneous and news investment specific shocks and monetary policy shocks.

Turning to rule of thumb consumers, the behavior of those households is, by definition, insulated from movements in real interest rates. Moreover, since these agents consume their disposable income and since in the presence of sticky prices, their income is increased through the increases in the real wage induced by the increased labor demand and the increase in tax revenues when the shock arrives, those agents will increase consumption after the fiscal news shock. As the third column of Figure 13 shows the presence of financially constrained individuals guarantees an increase in consumption on impact after the shock, and propagates the effects of fiscal news in the economy.

Also variable capital utilization and adjustment costs are important for generating persistence responses to fiscal news, as seen in the first column of Figure 14. In the absence of variable capital utilization and capital adjustment costs, firms miss an additional margin to react to the increased demand generated by the expected shock and are constrained to increase more labor demand. This results in higher increases in wages which translates into higher increases in consumption by rule of thumb consumers. At the same time, investment is crowded out by the increase in private consumption and increases by a smaller amount relative to the benchmark model. Overall, the demand effects of the shock become even stronger. Yet, the responses to the shock of all variables are much less persistent.

5.4.2 Other Assumptions that Help Propagate Fiscal News Shocks

Evans and Karras (1998) estimate private consumption and military spending to be complements and at the same time estimate the share of financially constrained individuals to be 30% in the US. We investigate how the assumption of financially constrained individuals coupled with complementarity of military spending and private consumption affect the dynamics of the model economy by introducing military spending directly in the utility function. The responses of the modified economy are presented in the second column of Figure 14. Assuming complementarity between military and private spending enhances the propagation mechanism of anticipated shocks and helps the model fit better the data.

Finally, many authors have shown (see, e.g., Canova and Pappa (2011)) that the interaction

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between fiscal and monetary policy is crucial for the propagation of fiscal shocks. In the third column of Figure 14 we plot responses of the model economy when we assume a lower coefficient for the Taylor rule in (26) - setting $\zeta_\pi = 1$. A laxer monetary policy does indeed allow for stronger demand effects from fiscal news shocks.

6 A Test of our Methodology

In this section we test our methodology through the lens of our model. To this end, we simulate series from our model and use our identification strategy in these series in order to see whether we can recover the true shocks. In particular, we simulate 2000 sets of data with 248 observations each using as the data generating process the model of Section 5.1. For each simulation, we apply our identification method on the artificial data and include in the Monte Carlo VAR the same variables that we used in the empirical exercise.[18] The two structural shocks in the model are the unanticipated and anticipated defense spending shocks, which we draw from the normal distribution. To avoid singularity, we attach eight measurement errors to all variables in the model apart from defense spending, all of which are also drawn from normal distributions. The standard deviations of the two defense shocks and the measurement errors are presented in Table 3.

Figure 15 depicts both the theoretical and estimated impulse responses averaged over the simulations to a defense news shock. The theoretical responses are represented by the solid lines and the average estimated responses over the simulations are depicted by the dashed lines, with the dotted lines depicting the 2.5th and 97.5th percentiles of the distribution of estimated impulse responses. It is apparent that the estimated empirical impulse responses are generally unbiased and capture the dynamics of the variables following the news shock quite well. The unbiasedness of the estimated responses of the variables coupled with the observation that the lower bands of

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[18]The only difference from the empirical VAR is that we do not include a narrative-based news measure because our theoretical model does not contain a natural counterpart to the Ramey (2011) news series. Nevertheless, we have confirmed that the simulation results are generally insensitive to adding a variable that is equal to the true news shock series and some reasonably calibrated measurement error that could proxy for the Ramey news.

the confidence intervals are significantly above zero are very encouraging.

Table 4 reports the average correlation between the identified defense news shock and the true defense news shock across simulations, along with 95% confidence interval bands. The average correlation between the identified defense news shock and the true defense news shock across simulations is 0.84. Moreover, 2.5th and 97.5h percentile correlations are 0.78 and 0.88, respectively. Taken together, the results of this section demonstrate that our identification method is suitable for identifying defense spending news shocks.

7   Conclusion

We show that news about military spending do affect significantly aggregate demand and explain a significant fraction of output fluctuations. In contrast with Ramey (2011), fiscal news generate significant Keynesian type of effects in the economy, increasing persistently output, consumption, investment, hours, the interest rate and inflation.

We propose a DSGE model that can explain some of the facts we have revealed and use it to test our methodology. Our empirical strategy for identifying fiscal news shocks passes the test in simulated data. We are able to show that identifying fiscal news shocks as shocks that explain future movements in defense spending over a five-year horizon and that are orthogonal to current spending in simulated data recovers the true fiscal news shocks.

Our results are useful to both academics and policymakers. First, we propose a new methodology for the identification of news about fiscal policy changes. It is objective and does not require the readings of newspapers sources and, as a result, can be applied for countries with weak or no newspaper archives. Second, we have shown that our approach captures better information about future military spending increases relative to Ramey (2011) approach. Third, we show that the presence of rigidities and financially constrained individuals are key assumptions for matching the empirical findings. Financial frictions matter for aggregate fluctuations, even when the latter are induced by news shocks. Finally, according to our estimates, news about future changes in military

spending account for a non-negligible share of output fluctuations at business cycle frequencies. Since anticipation effects are estimated to be significant and economically important, policymakers should be cautious in announcing policy changes that can affect agents' expectations about future government spending. Or reversing this argument, policymakers can use policy announcements as a tool for responding to the cycle when constrained by budgetary or other types of restrictions.

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Table 1: **The Difference Between the Forecast Error Variance Contributions of MFEV and Ramey News Shocks: Statistical Significance**

Variable	Contribution Difference (%)	Horizon	P-Value (%)
Defense Spending	16	12	0
Output	21	3	2.2
Consumption	16	1	12.5
Investment	15	1	6.1
Real Wage	5	5	24.6
Tax Rate	17	9	3.2
Hours	28	5	1.1
Interest Rate	13	10	15.4
Inflation	11	3	10.6

Notes: This table presents the p-values for the null hypothesis that the difference between the contribution of the MFEV news shock and the Ramey news shock to the corresponding variable's variation is not positive. The horizon for which the p-value is computed is the one at which the point estimate of the contribution difference is maximal. The second column depicts the maximal point estimate difference between the two shocks' contributions to the corresponding variable's variation, and the third column gives the corresponding horizon. Each estimated p-value was obtained as the proportion of bootstrap values of the contribution difference of the two shocks not exceeding zero.

Table 2: **Parameter values**

β	discount factor	0.99
B/Y	steady state debt to output ratio	0.55
σ	risk aversion coefficient	2
ϕ	preference parameter	0.7
b	adjustment cost parameter	15
δ	capital depreciation rate	0.025
α	capital share	0.36
τ^l	average labor tax rate	0.3
τ^k	average capital tax rate	0.3
G/Y	steady state G/Y ratio	0.07
ζ_π	Taylor's coefficient	1.1
ζ_b	coefficient on debt rule	2
γ	degree of price stickiness	0.75
$\frac{\varepsilon}{\varepsilon-1}$	steady state markup	7.88
λ	rule of thumb consumers	0.3
ϕ_u	elasticity of depreciation to changes in utilization	1.40

Table 3: **Monte Carlo Experiment: DSGE Model Shock Standard Deviations**

Shock	Standard Deviation
Unanticipated Defense Shock	0.03
Anticipated Defense Shock	0.03
Measurement Errors	0.01

Notes: This table reports the standard deviations of the shocks used to generate the data in the Monte Carlo experiment of Section 6.

Table 4: **Monte Carlo Correlations**

Mean	2.5th and 97.5th Percentiles
0.84	[0.78,0.88]

Notes: This table reports the correlations between the MFEV shock and the narrative-based shock and the true defense shock series, computed from 2000 Monte Carlo simulations of the model of Section 5.1. The MFEV shock was identified using the empirical MFEV identification method and the narrative-based shock is the VAR innovation in the artificially constructed narrative-based news shock measure constructed by adding a measurement error to the true news shock series. The benchmark case pertain to a Monte Carlo exercise in which the narrative-based series was included in the VAR, whereas the second row corresponds to the exercise in which this series was excluded from the VAR.

Figure 1: **MFEV News Shock and Ramey News Shock Time Series**.
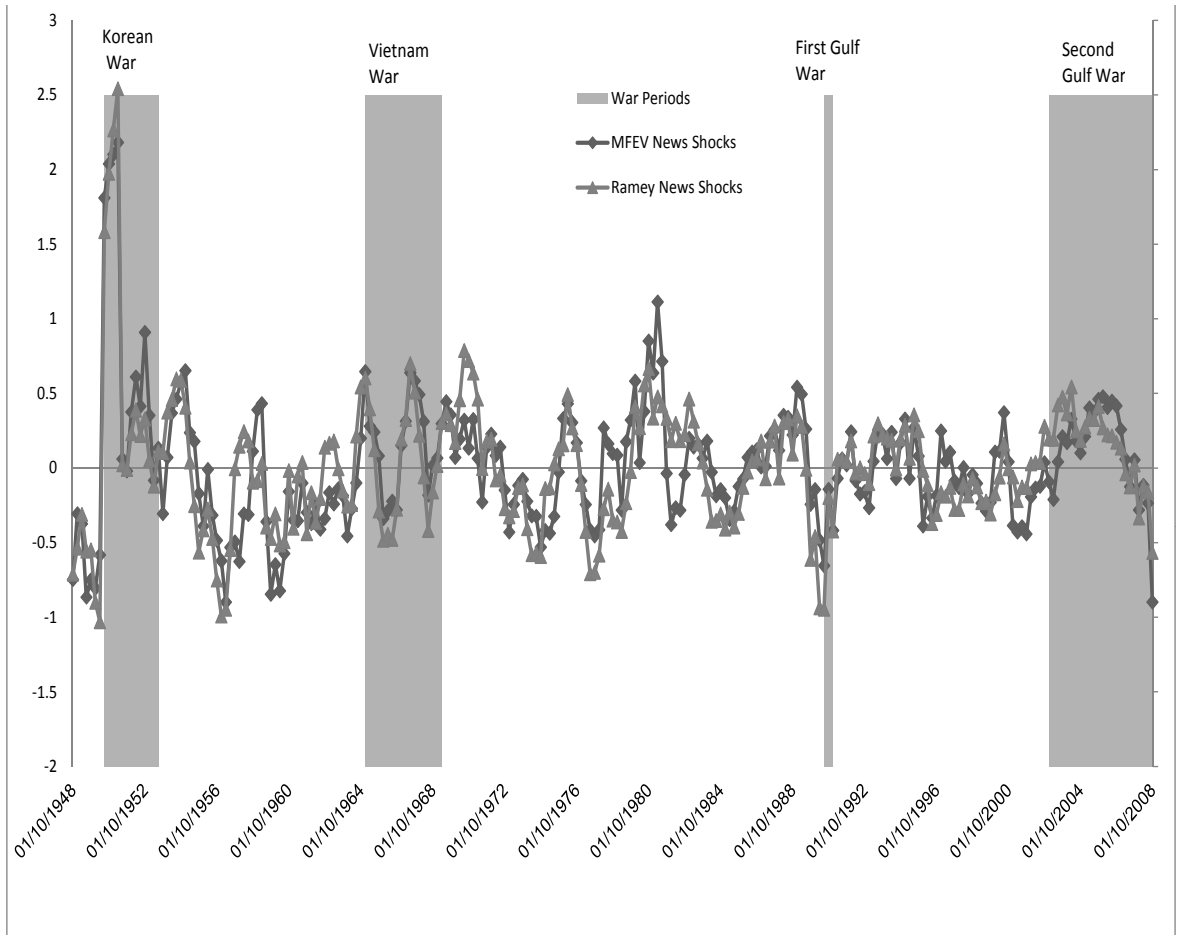
Notes: U.S. war periods are represented by the shaded areas. Plotted is a one year backward looking average of the shock series $\varepsilon_t^s = (\varepsilon_{t-3} + \varepsilon_{t-2} + \varepsilon_{t-1} + \varepsilon_t)/4$. The series begin in 1948:Q4 and end in 2008:Q4.

Figure 2: **Benchmark VAR: (a) Impulse Responses to MFEV News Shock; (b) Impulse Responses to Ramey News Shock**
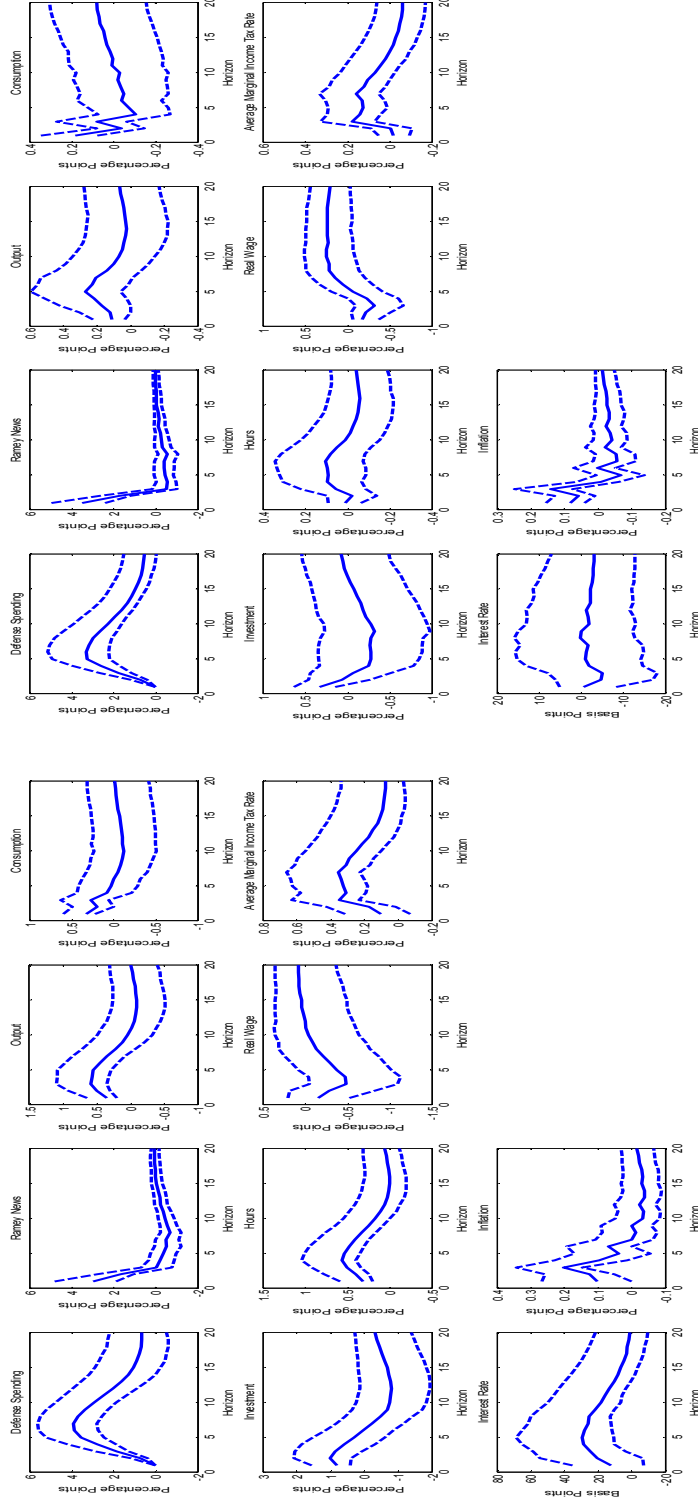
(a) **Impulse responses to a one standard deviation MFEV (b) Impulse responses to a one standard deviation Ramey News Shock.**

Notes: Panel (a): The impulse responses were obtained from applying the MFEV method explained in section 2 on the benchmark VAR. Dashed lines represent 2.5th and 97.5th percentile Hall (1992) confidence bands generated from a residual based bootstrap procedure repeated 2000 times. Panel (b): The impulse response are with respect to the shock to the Ramey news variable orthogonalized with respect to current defense spending. Dashed lines represent 2.5th and 97.5th percentile Hall (1992) confidence bands generated from a residual based bootstrap procedure repeated 2000 times.

Figure 3: **The Share of Forecast Error Variance Attributable to MFEV News Shocks and Ramey's News Shocks**.
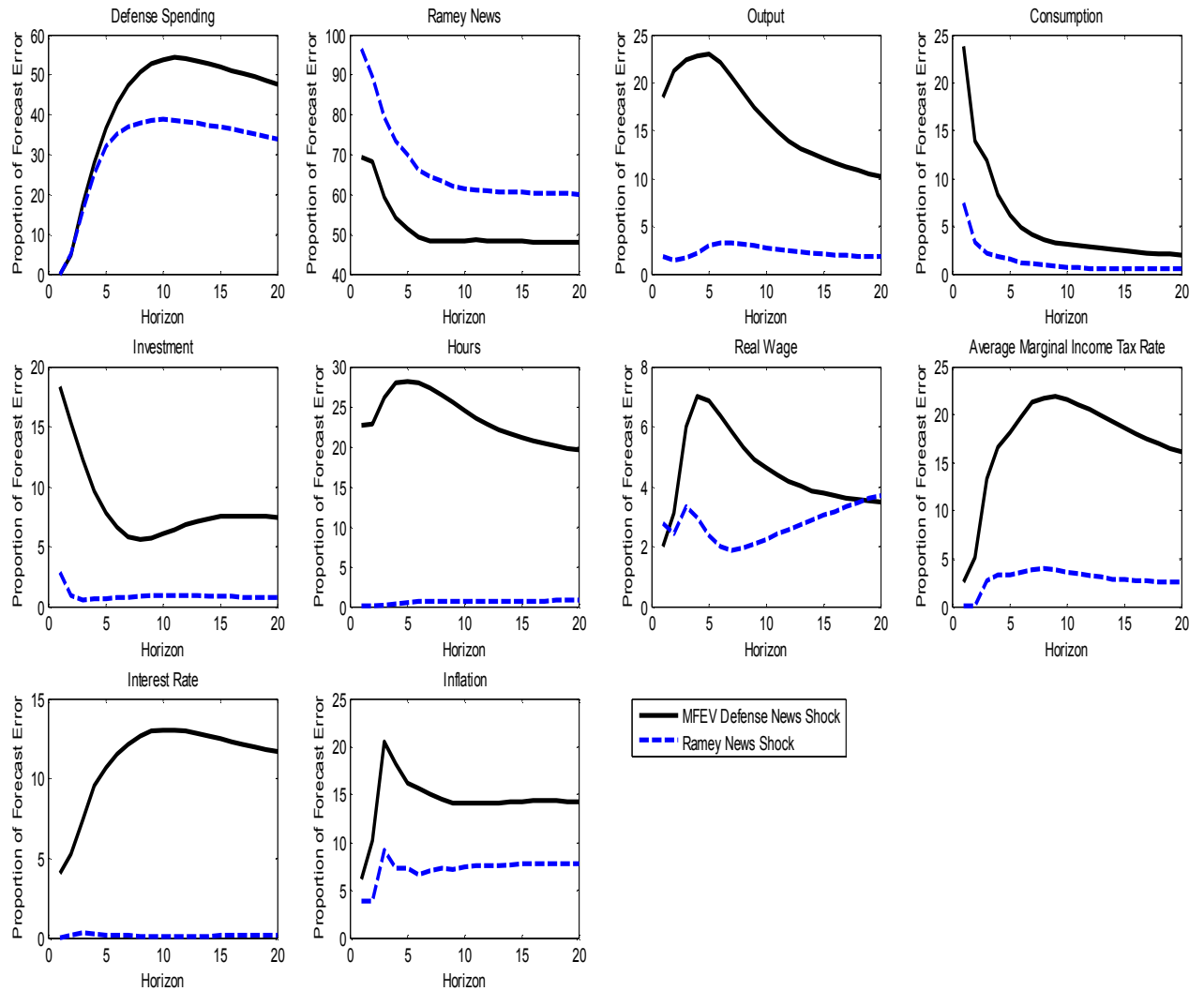
Notes: The MFEV news shock corresponds to that from figure 2a whereas the Ramey news shock corresponds to that from figure 2b.

Figure 4: **MFEV News Shock Orthogonalized with resect to Ramey's Shock** .

Notes: Periods in which the Ramey (2011) series contains zeros are represented by the shaded areas. Plotted is the residual obtained from projecting the MFEV news shock series onto the Ramey shock series. The residual is normalized by its standard deviation such that the y-axis is in terms of the residual's standard deviations units. The series begins in 1948:Q1 and ends in 2008:Q4.

Figure 5: **Impulse responses to a one standard deviation Defense News Shock Orthogonalized with respect to Ramey's Shock (solid lines).**
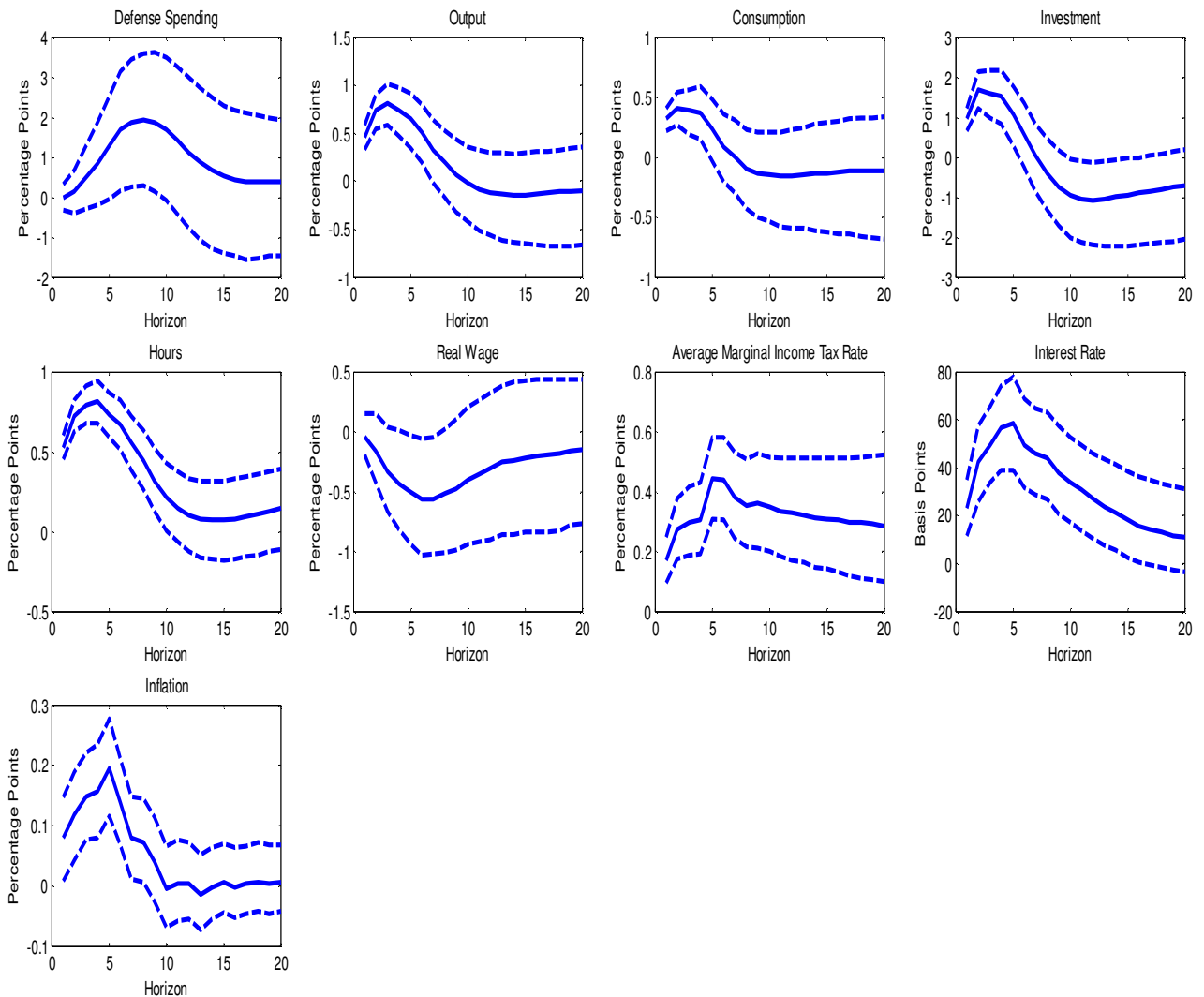
Notes: The impulse responses were obtained from projecting the variables in the benchmark VAR onto their own lags and the current and lagged values of the residual obtained from projecting the MFEV news shock series onto Ramey's shock series. Ramey's series is excluded from the former projection so as to avoid colinearity and four lags of the variables and the residual are included. Dashed lines represent 2.5st and 97.5th percentile Hall (1992) confidence bands generated from a residual based bootstrap procedure repeated 2000 times. Horizon is in quarters.

Figure 6: **Robustness: (a) VAR lags; (b) Truncation horizon**
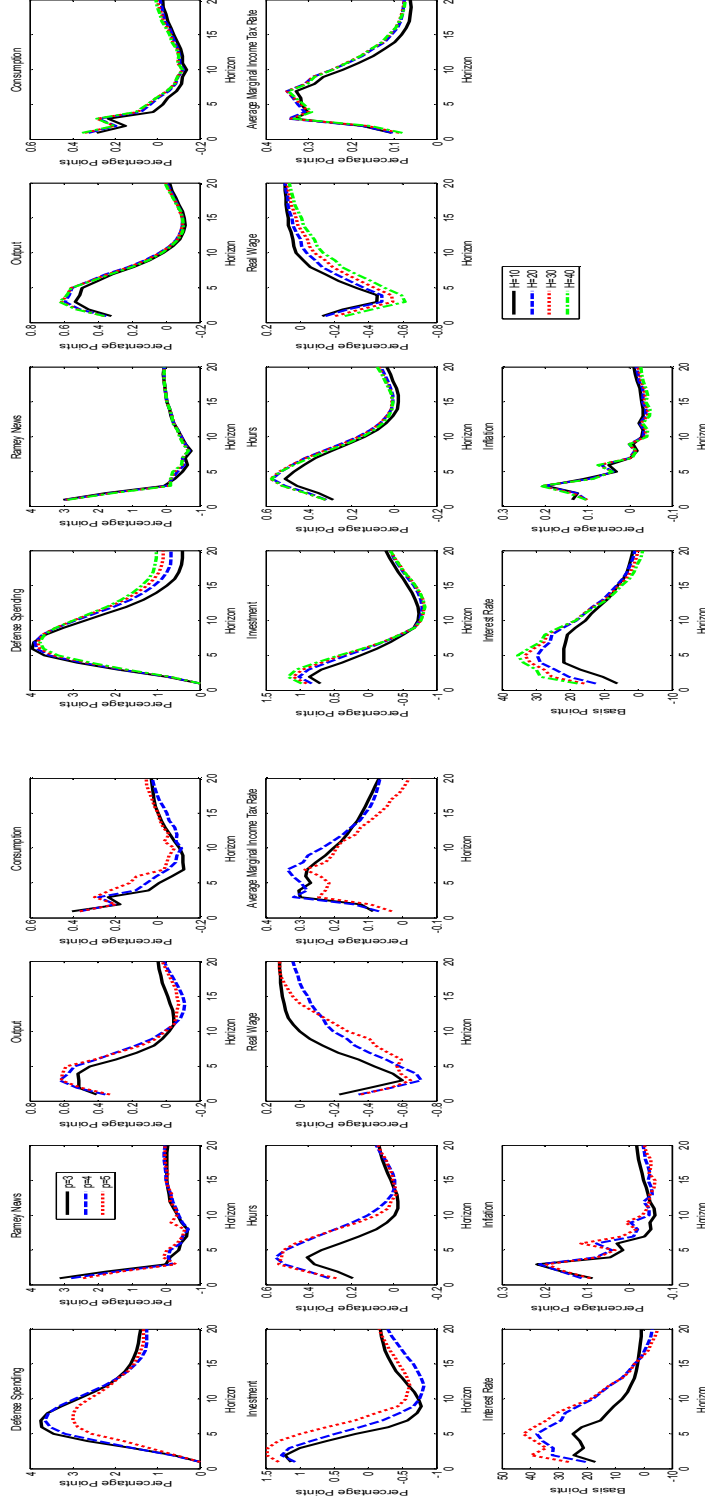
(a) **Impulse responses to a one standard deviation Defense News Shock: robustness to different lag structures.**

(b) **Impulse responses to a one standard deviation Defense news shock: robustness to different truncation horizons.**

Notes: Panel (a): The solid, dashed, dotted and dash-dotted lines are the estimated impulse responses to the defense news shock from a VAR with 3, 4, 5, and 6 lags, respectively. Panel (b): The solid, dashed, dotted and dash-dotted lines are the estimated impulse responses to the defense news shock from a VAR with a truncation horizon, H, equal to 10, 20, 30, and 40 periods, respectively.

Figure 7: **Larger Sample (1939-2008): (a) Impulse Responses to MFEV News Shock; (b) Impulse Responses to Ramey News Shock**
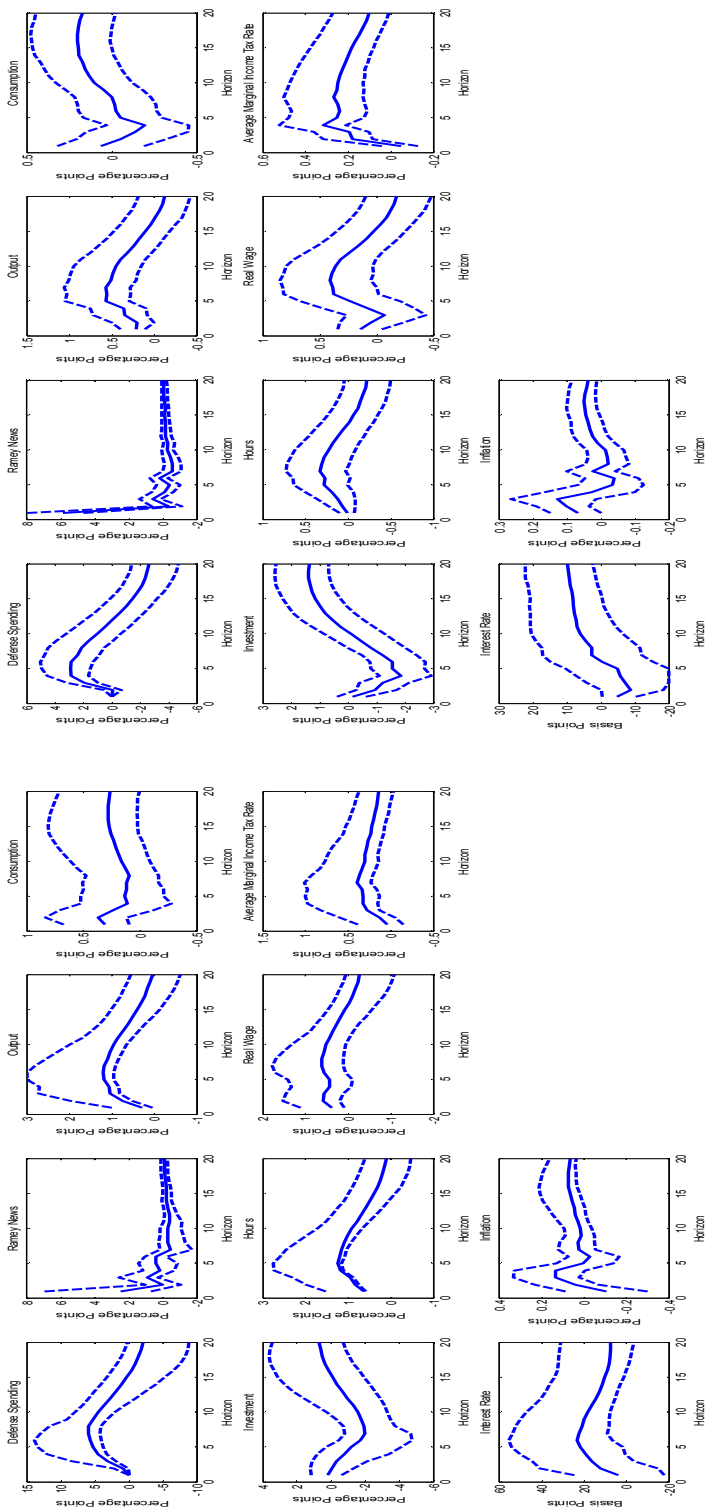
(a) **Impulse responses to a one standard deviation MFEV** (b) **Impulse responses to a one standard deviation Ramey News Shock.**

Notes: Panel (a): The impulse responses were obtained from applying the MFEV method explained in section 2 on the benchmark VAR using the sample period 1939:Q2-2008:Q4. Dashed lines represent 2.5th and 97.5th percentile Hall (1992) confidence bands generated from a residual based bootstrap procedure repeated 2000 times. Panel (b): The impulse response are with respect to the shock to the Ramey news variable orthogonalized with respect to current defense spending, using the sample period of 1939:Q2-2008:Q1. Dashed lines represent 2.5th and 97.5th percentile Hall (1992) confidence bands generated from a residual based bootstrap procedure repeated 2000 times.

Figure 8: **Post-Korea War Sample (1955-2008): (a) Impulse Responses to MFEV News Shock; (b) Impulse Responses to Ramey News Shock**
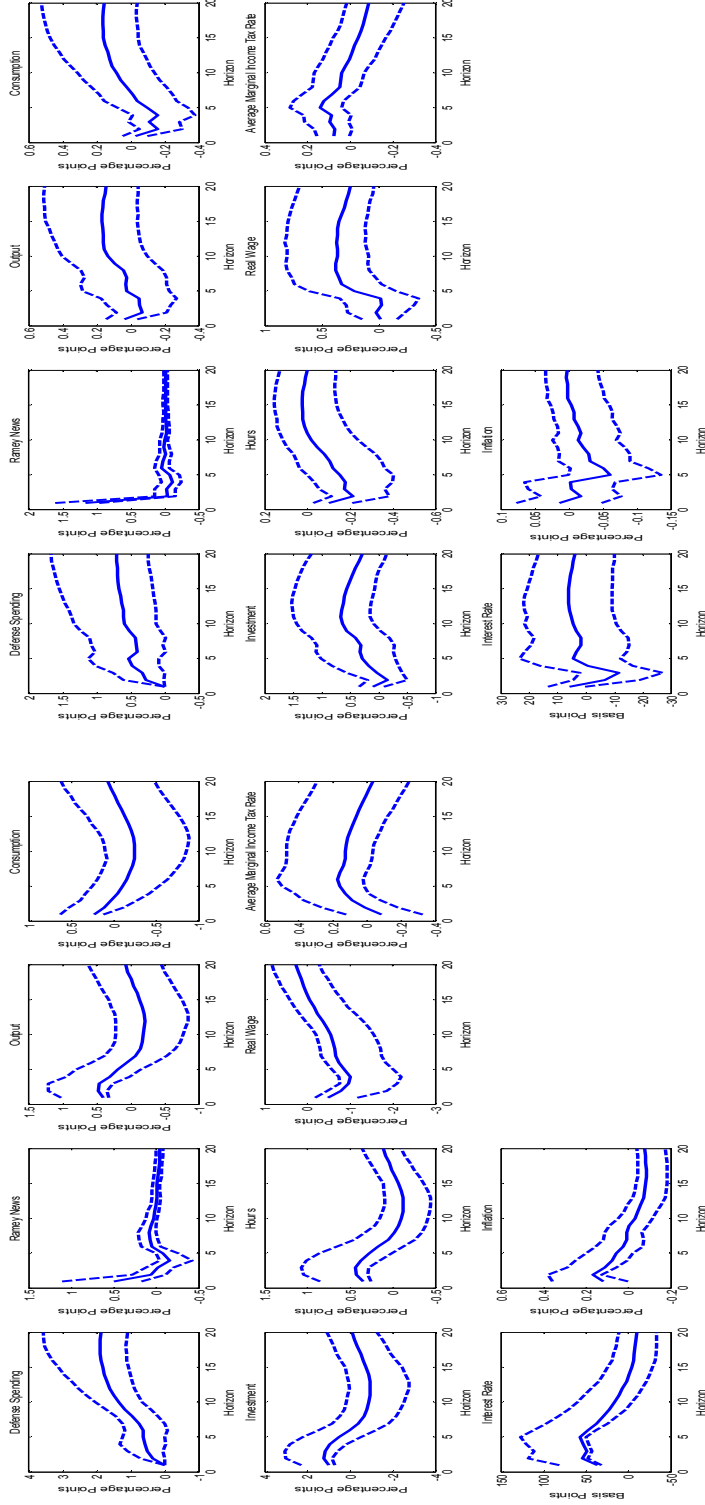
(a) **Impulse responses to a one standard deviation MFEV (b) Impulse responses to a one standard deviation Ramey News Shock.**

Notes: Panel (a): The impulse responses were obtained from applying the MFEV method explained in section 2 on the benchmark VAR using the sample period 1955:Q1-2008:Q4. Dashed lines represent 2.5th and 97.5th percentile Hall (1992) confidence bands generated from a residual based bootstrap procedure repeated 2000 times. Panel (b): The impulse response are with respect to the shock to the Ramey news variable orthogonalized with respect to current defense spending, using the sample period of 1955:Q1-2008:Q1. Dashed lines represent 2.5th and 97.5th percentile Hall (1992) confidence bands generated from a residual based bootstrap procedure repeated 2000 times.

Figure 9: **VAR with the** Fisher and Peters (2011) **Defense Shock Series: (a) Impulse Responses to MFEV News Shock; (b) Impulse Responses to Ramey News Shock**
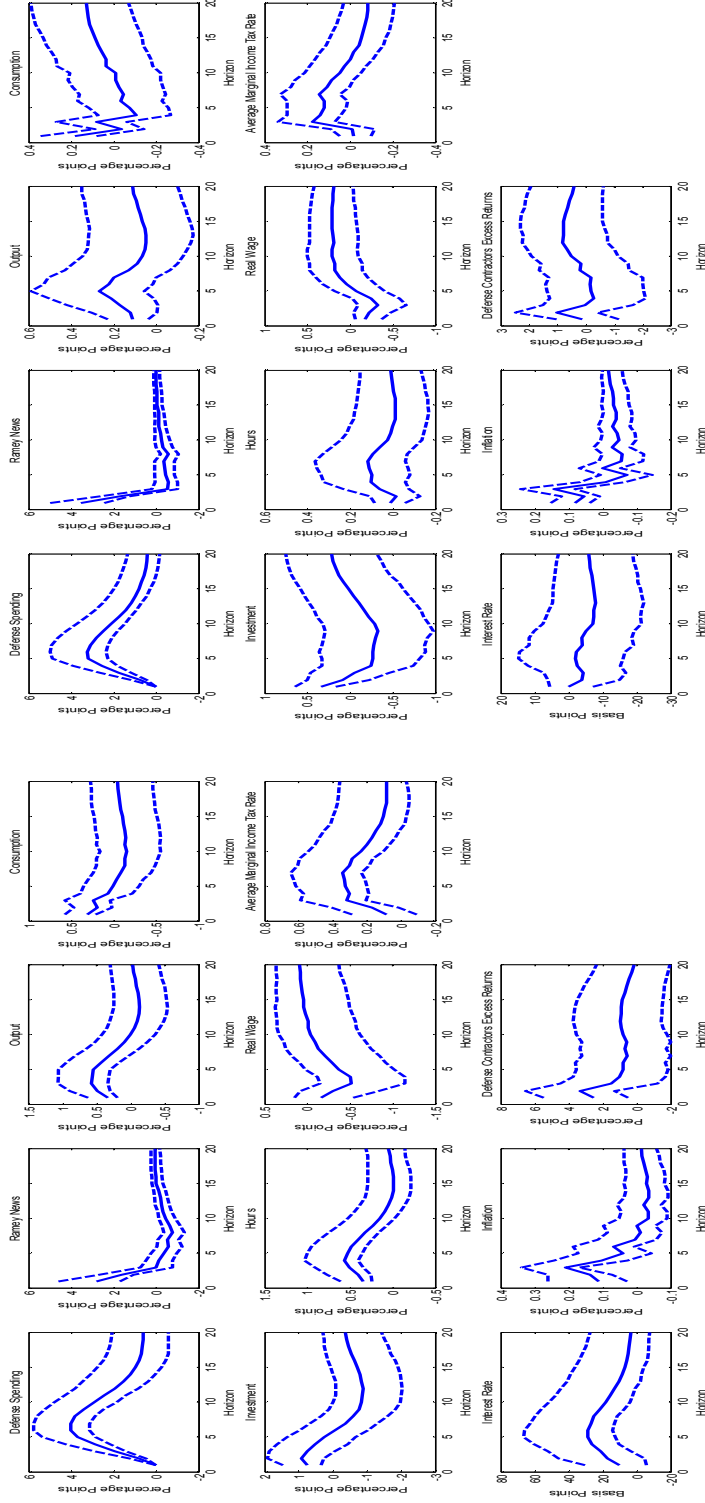
(a) **Impulse responses to a one standard deviation MFEV (b) Impulse responses to a one standard deviation Ramey News Shock.**

Notes: Panel (a): The impulse responses were obtained from applying the MFEV method explained in section 2 on a VAR that includes the Fisher and Peters (2011) Defense Shock Series. Dashed lines represent 2.5th and 97.5th percentile Hall (1992) confidence bands generated from a residual based bootstrap procedure repeated 2000 times. Panel (b): The impulse response are with respect to the shock to the Ramey news variable orthogonalized with respect to current defense spending, via a VAR that includes the Fisher and Peters (2011) defense shock series. Dashed lines represent 2.5th and 97.5th percentile Hall (1992) confidence bands generated from a residual based bootstrap procedure repeated 2000 times.

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Figure 10: **VAR Without the** Ramey (2011) **Series: Impulse responses to a one standard deviation Defense News Shock (solid lines).**
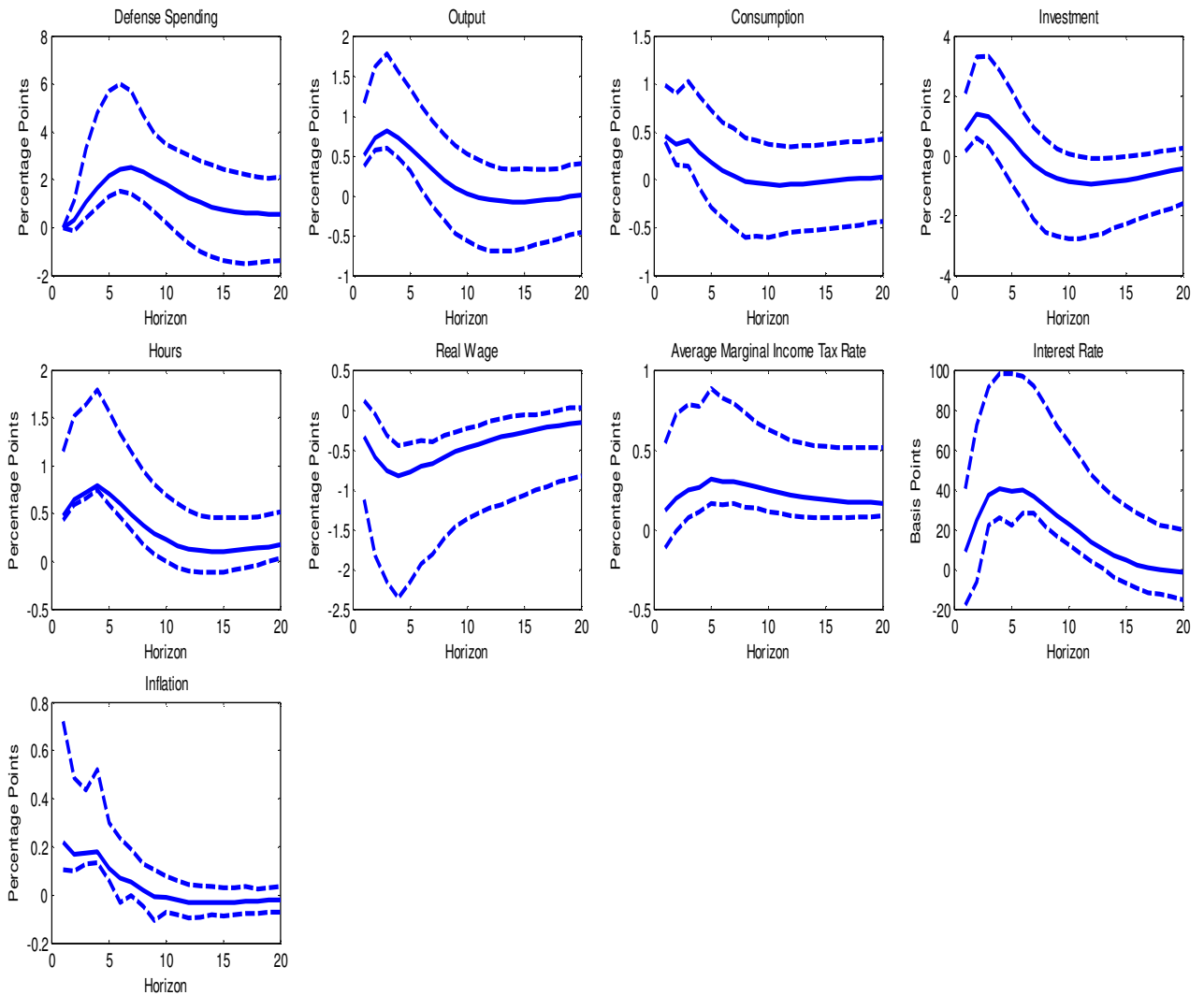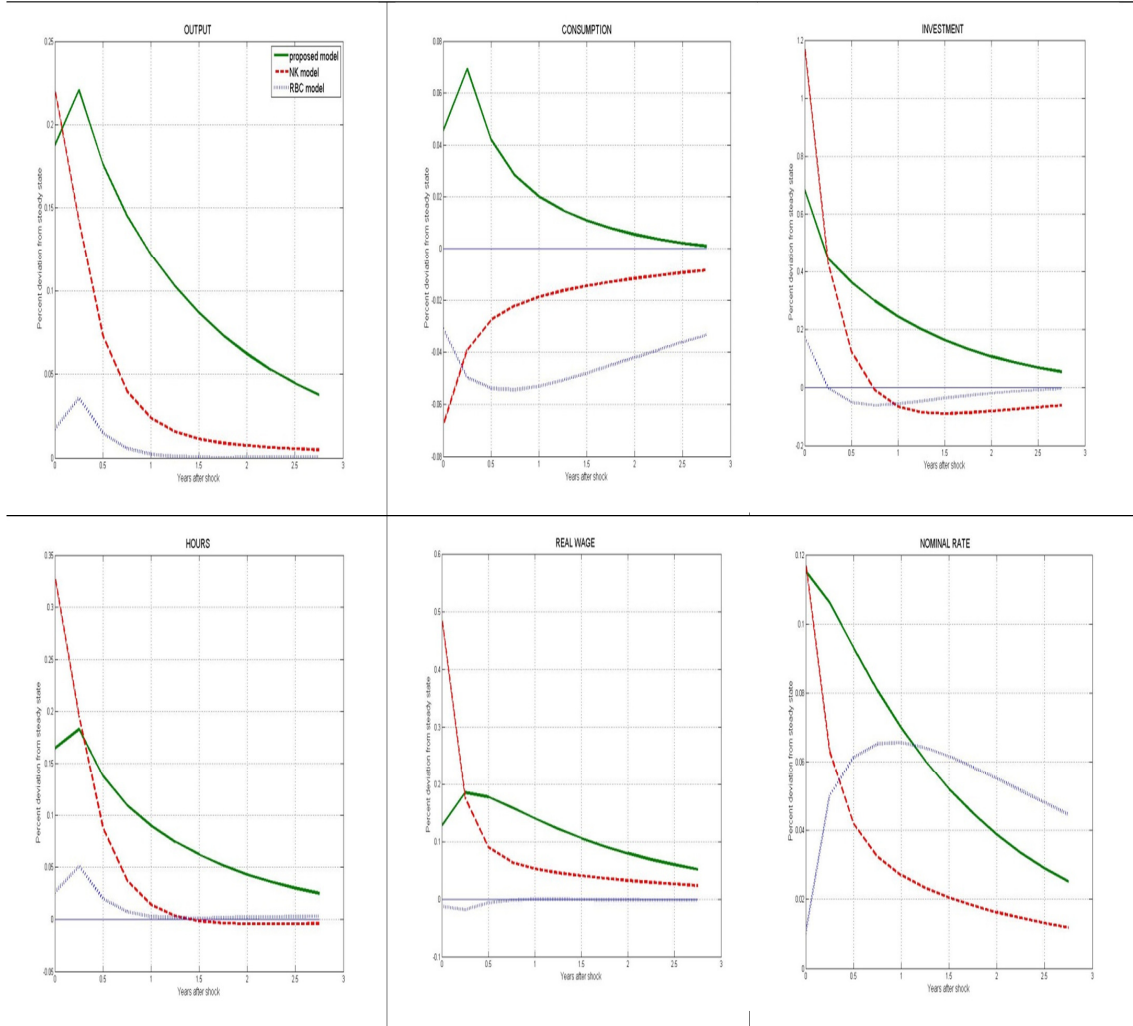

Notes: The impulse responses were obtained from applying the MFEV method explained in section 2 on a VAR that excludes the Ramey (2011) news series. Dashed lines represent 2.5th and 97.5th percentile Hall (1992) confidence bands generated from a residual based bootstrap procedure repeated 2000 times. Horizon is in quarters.

Figure 11: **The Cross-Correlation between the MFEV News Shock and Lags/Leads of Other Structural Shocks**.
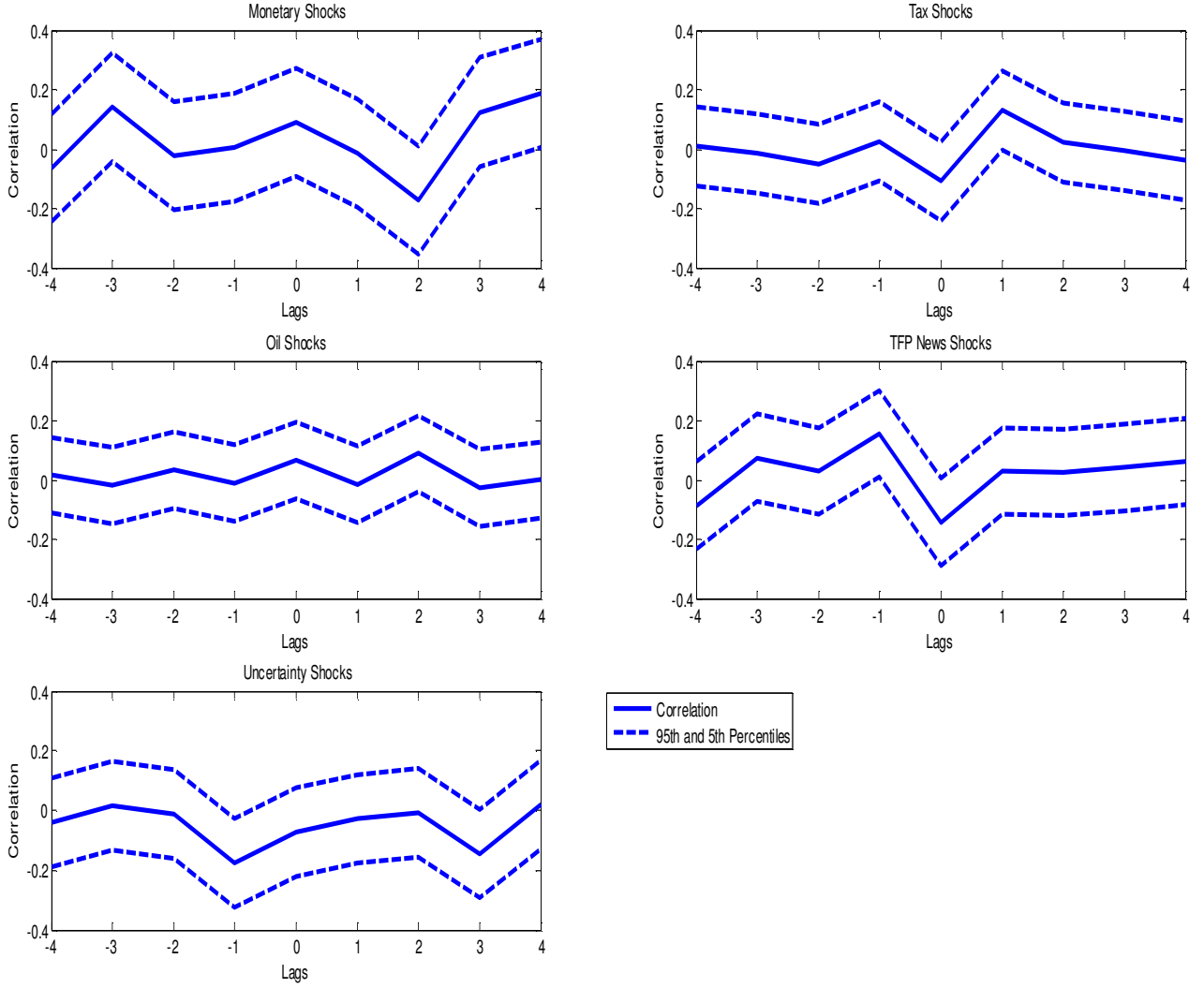
Notes: The solid line is the cross-correlation and the dashed lines represent the 95% asymptotic confidence interval. The other shocks are the Romer and Romer (2004) monetary policy shock measure, Romer and Romer (2010) tax shock measure, shock to the real price of oil, the TFP news shock from Barsky and Sims (2011), and the shock to the uncertainty measure used in Bloom (2009) which is based on stock market volatility and corresponds to Figure 1 in his paper. Apart from the Barsky and Sims (2011) TFP news shock series which was used in its raw form, all other shocks were constructed as the residuals of univariate regressions of each of the four variables on four lags.

Figure 12: **Theoretical Model: Responses to an Anticipated Shock**.
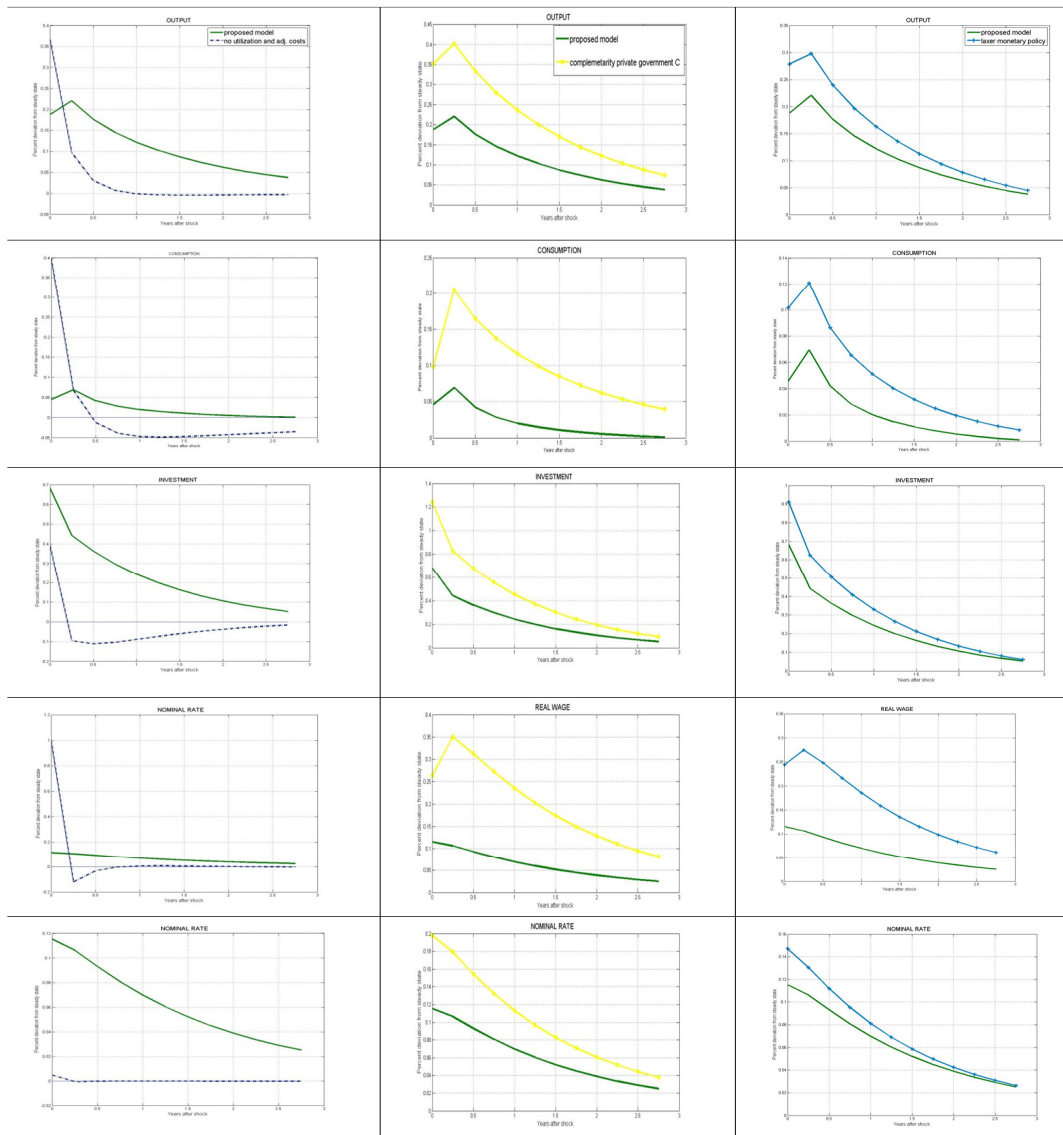

Notes: The Responses were obtained from the model of Section 5.1, where the solid lines represent the responses of our model, dotted lines depict the responses of the standard sticky price model (NK model), and dashed lines the responses of a standard DSGE model with flexible prices (RBC model) to the shock.

Figure 13: **Theoretical Model: Quantification of the Propagation Mechanisms Induced by Sticky Prices, Jaimovich and Rebelo (2009) Preferences, and Rule of Thumb Consumers**.
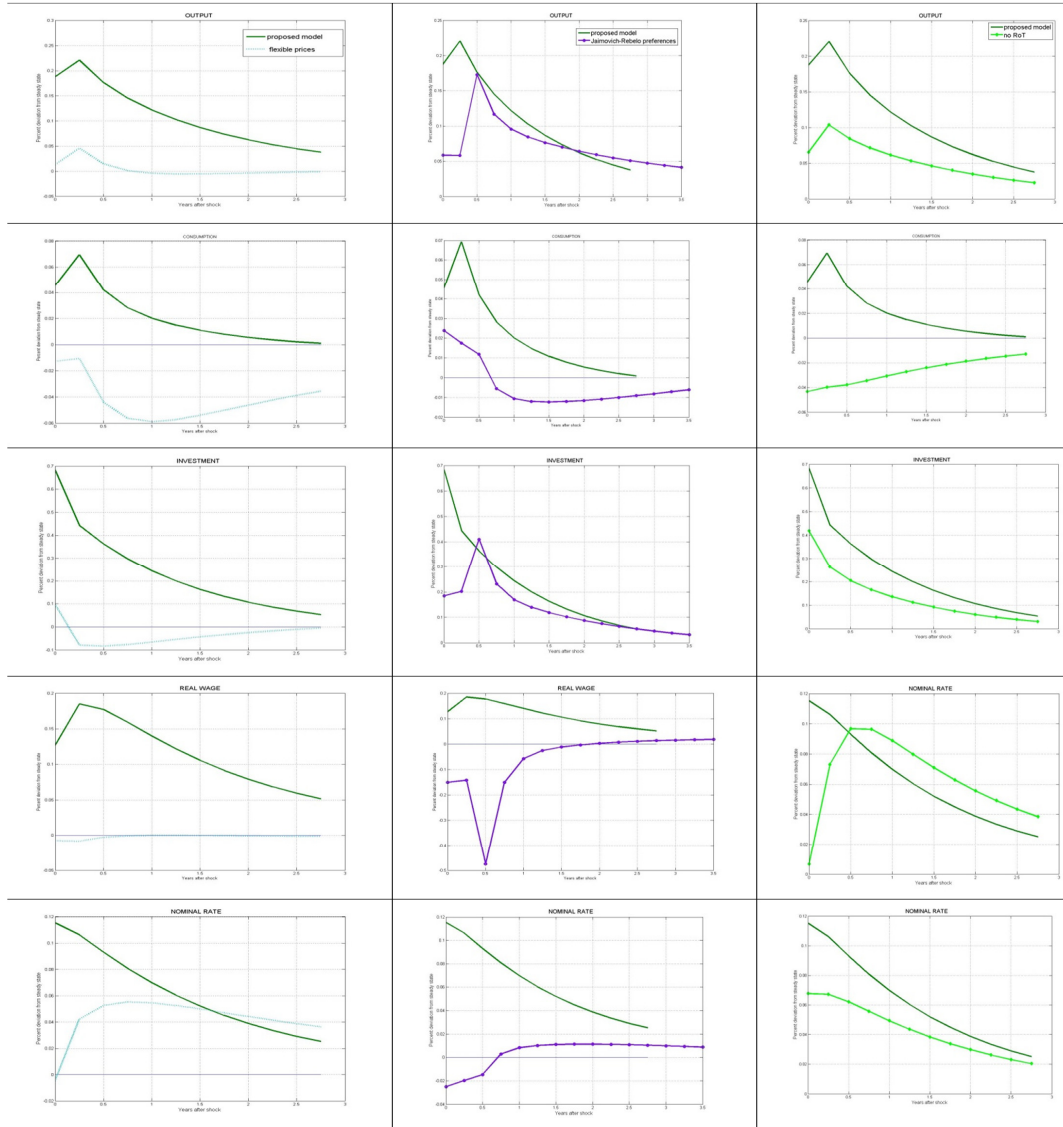

Notes: The Responses were obtained from the model of Section 5.1, where each column corresponds to a model in which the relevant feature is absent from the model.

Figure 14: **Theoretical Model: Quantification of the Propagation Mechanisms Induced by Variable Capital Utilization and Adjustment Costs, Military and Private Spending Complementarity, and Laxer Monetary Policy**.

Notes: The Responses were obtained from the model of Section 5.1, where each column corresponds to a model in which the relevant feature is absent from the model.

Figure 15: **Monte Carlo Evidence: Estimated Impulse Responses to Identified News Shock**.
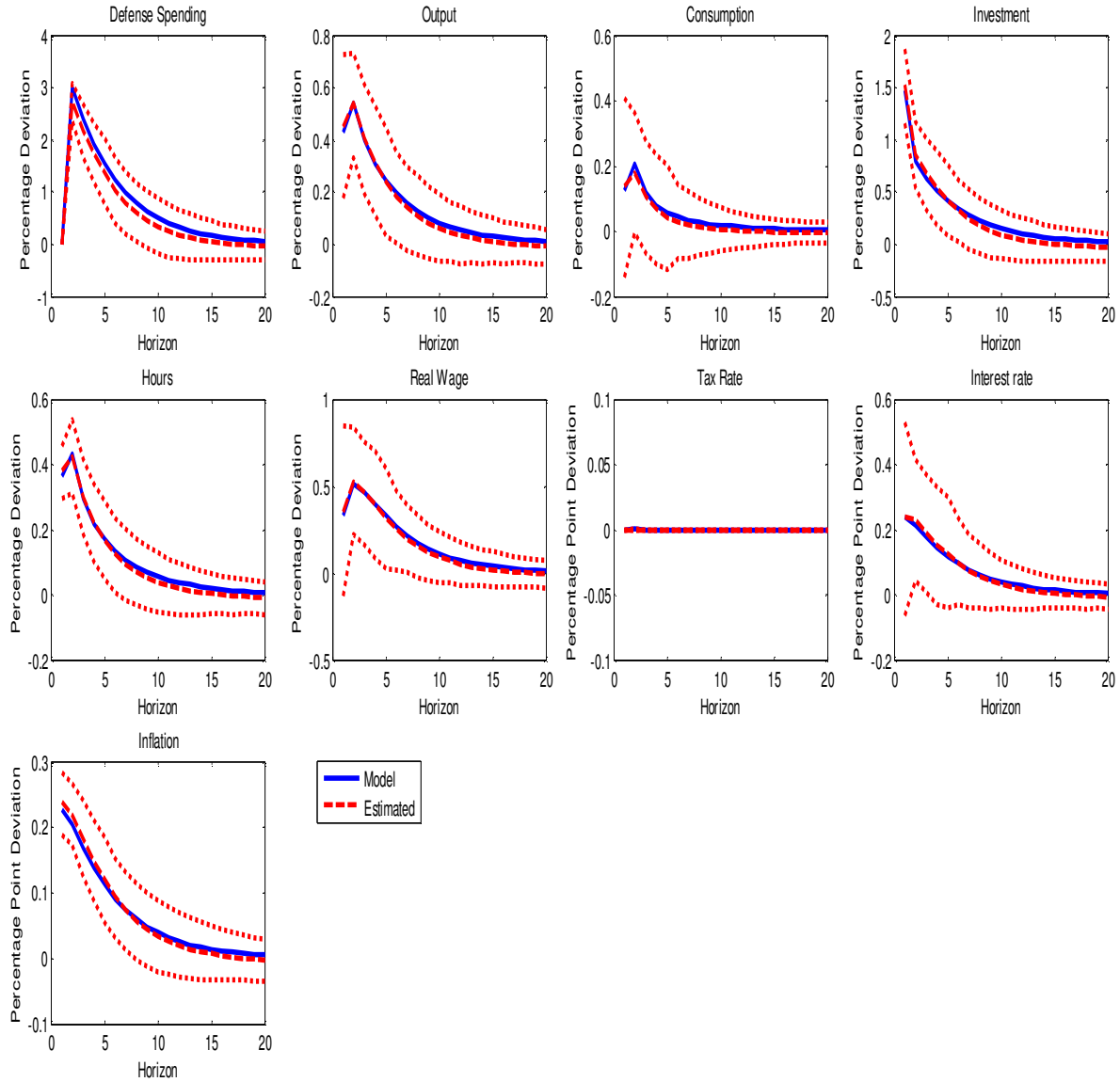
Notes: The figures are based on 2000 Monte Carlo simulations of the model of Section 5.1 where in each simulation the MFEV shock was identified using the empirical MFEV identification method. The solid line represents the true model impulse responses, the dashed line is the average estimated impulse response to the MFEV shock across Monte Carlo replications, and the dotted lines are the 97.5th and 2.5th estimated percentiles.

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