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

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Abstract

We identify news shocks to U.S. defense spending as the shocks that best explain future movements in defense spending over a five-year horizon and are orthogonal to current defense spending. Our identified shocks, though correlated with the Ramey (2011) news shocks, explain a larger share of macroeconomic fluctuations and produce significant demand effects. News about increases in defense spending induces significant and persistent increases in output, hours worked, inflation and the interest rate, and significant increases in investment, consumption and the excess returns of defense contractors on impact.

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

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There has recently been a renewed interest in theories of expectation-driven business cycles, focusing in particular on the effects of news shocks: shocks which are realised and observed before they materialise. These types of shocks are of particular importance for fiscal variables, where there is a natural lag between policy decisions and implementation. Studies which attempt to measure the effects of news shocks empirically have so far used narrative identification of expectational shocks, which is particularly time-consuming to implement, and requires the availability of detailed historical records. 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.

Beaudry and Portier (2006) and Jaimovich and Rebelo (2009) present theoretical models in which news about future productivity is a primary source of business cycle fluctuations. Beaudry and Portier (2006) were the first to provide empirical evidence in favor of this hypothesis in the context of structural VARs.[1] Schmitt-Grohé and Uribe (2012) estimate a DSGE model with flexible prices, which incorporates news about future technology, preference, government spending and markup shocks, and show that anticipated shocks account for around half of aggregate fluctuations in the U.S.

By its nature, measuring news in the data can be difficult, but in recent years some studies have identified news by using the timing of specific events, in particular in the context of fiscal changes. Ramey (2011) constructs two measures of news about changes in defense 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: changes in government spending are measured as the difference between actual government spending growth and the one-quarter-ahead forecast of government spending growth.[2] Ramey (2011)

[1] More recently, Ben Zeev and Khan (2015) and Ben Zeev (2015) have provided structural VAR-based evidence that investment-specific technology news shocks are the main force behind business cycles.

[2] Mertens and Ravn (2012) also categorise tax changes in the U.S. as anticipated or unanticipated de-

shows that VAR shocks incorrectly capture the timing of the news. Thus, inference about dynamic fiscal multipliers, or the effects of fiscal news in the macroeconomy, are likely to be biased.[3]

Applying Barsky and Sims (2011) methodology to defense spending, we identify defense news shocks as the shocks that best explain future movements in defense spending over a horizon of five years, and that are orthogonal to current defense spending. Our identified defense news shocks are correlated with the Ramey (2011) news shocks, but explain a much larger fraction of the variability in all real variables at business cycle frequencies. They also generate more significant demand effects. In particular, anticipated increases in defense spending induce a significant and persistent increase in output, hours worked, the interest rate and inflation, and significant impact responses of consumption and investment. Moreover, the shock identified using our methodology significantly increases the excess returns of large defense contractors while Ramey's news shock does not. These results suggest that the component of the shock identified using our maximum forecast error variance methodology (henceforth MFEV) contains important information on future defense spending.

To get a better understanding of the differences between the MFEV and Ramey's news shocks, we resort to historical evidence. We make note of the historical events that match our identified news shocks, and characterise the mismatch between our defense news series and Ramey's news shocks. The analysis reveals that, despite the positive correlation, the two series are different. All the exercises we have performed suggest that using our methodology we exctract defense news that were not reported in the newspapers and, hence, it is not

pending on the difference between the announcement and implementation date using narrative evidence of tax changes provided by Romer and Romer (2010).

[3]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 actually take place, thus casting doubts on the evidence of previous SVAR-based studies on fiscal shocks, in particular because VAR representations are likely to be non-fundamental. For an alternative view on the fiscal foresight problem in SVARs see Perotti (2014).

surprising that the economic consequences of the MFEV and the Ramey news shocks are different.

For our identification procedure to be valid, the government spending series should be exogenous. Clearly, defense spending is largely exogenous, and for that reason we do not apply our methodology to other non-defense components of government spending. Nonetheless, we perform additional exercises to show that our identified shock is valid, and that, even in the unlikely case that there is a fiscal rule relating defense spending to economic fluctuations, the extracted MFEV shock is not mixed with other typical demand or supply shocks.

Another important concern is that the defense spending news shocks may capture the effects of total factor productivity (TFP) news shocks. To address this concern, we include TFP in our benchmark model and later implement an extended estimation algorithm that effectively removes the potential correlation between defense news shock and current TFP or TFP news. In particular, we develop an extension to our baseline identification method in which the defense news shock is identified as the shock that maximally explains the difference between the sums of the contributions to the five-year variation in defense spending and in TFP, and is orthogonal to both current defense spending and current TFP. Results from this exercise indicate that the potential of defense news shocks to generate business cycle fluctuations is not driven by a spurious correlation with TFP 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 apply it to U.S. data. Our framework is less restrictive since it can deal with temporary fiscal shocks and uses medium-run, rather than long-run, restrictions for identification. 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. Forni and Gambetti (2014) assesses the information content of government spending news constructed as the difference between the current forecast of government spending growth over the following three quarters, measured with the Survey of Professional Forecasters, and the forecast of the same variable made one quarter earlier. He finds that the identified government spending news shock 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 organised as follows. Section 1 describes the econometric framework. Section 2 presents the main empirical results and Section 3 records historical events that match the MFEV news shocks series. Section 4 provides the results of several robustness checks and extensions, and Section 5 concludes.

1 Econometric Strategy

1.1 Data

The data cover the period 1947:Q1 to 2007:Q4.[4] We include in the VAR: defense spending, output, hours worked, consumption and investment, all in real per-capita terms, as well as the real manufacturing wage, the Romer and Romer (2010) narrative series of tax changes, the interest rate on 3 month T-bills, and CPI inflation.[5] We also include in the benchmark

[4]Although Ramey has updated her defense news series up to 2013:q4, we stop the sample at 2007q4 since many of the variables included in the VAR in the following sections of the analysis, such as the Romer and Romer tax series, the Mertens and Ravn tax changes, and the excess returns of military contractors are not available for the extended sample.

[5]Note that we use the total tax changes of Romer and Romer (2010), which includes both endogenous and exogenous tax changes. Ramey (2011) uses the Barro and Redlick (2011) average marginal tax rate series in her VAR. Given that this series is annual, she assumes no tax changes take place within the fiscal year. We therefore found the Romer and Romer (2010) tax series more appropriate for our analysis. It is

VAR a measure of TFP, to ensure that our identified shock is not related to TFP movements. For the TFP series, we use the real-time, quarterly series on TFP for the U.S. business sector, adjusted for variations in factor utilization (labor effort and capital's workweek), constructed by Fernald (2012).[6]

Both Leeper et al. (2013) and Ramey (2011) discuss the issue of missing information with respect to defense news events, and how it can undermine the identification of shocks in SVARs. 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) narrative-based measure of defense news shocks and the accumulated excess returns of large U.S. defense contractors series from the Fisher and Peters (2011) Defense Shock Series.[7] The former series adds direct information about news in defense spending, while the latter is a proxy for changes in expectations about defense spending. Apart from adding additional information to the VAR, the inclusion of these series allows us to check the correlation between the news series we extract and the series of Ramey (2011), and to compare the effects of the different identified news shocks within the same VAR.

1.2 Identifying Defense News Shocks

Our identification strategy relies on "medium-run" constraints and builds on Uhlig (2003) and Barsky and Sims (2011). 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. Our underlying identifying assumption is that the

also important to note that including this series in the VAR rather than the Barro and Redlick (2011) tax series lowers the contribution of our news shocks to output fluctuations by 40%; that is, using the Barro and Redlick (2011) series might be misleading regarding the importance of defense news shocks for explaining business cycle fluctuations.

[6]The majority of the data is taken from Ramey's website: http://weber.ucsd.edu/ vramey/. The TFP series are available from Fernald's website: http://www.frbsf.org/economics/economists/sta.php?jfernald.

[7]We thank Jonas Fisher for providing us with this data.

defense news shock is the only current shock that affects future defense spending. This assumption is consistent with the reasonable notion that defense spending does not respond to other economic variables, which implies that it is driven by only two shocks, one being the traditional unanticipated defense shock which moves defense spending on impact and the other being the defense news shock which moves defense spending with a lag. An example of a process that would satisfy this condition is:

$$DF_t = \rho DF_{t-1} + \varphi_1 \varepsilon_t^{sdf} + \varphi_2 \varepsilon_{t-s}^{dfnews} \tag{1}$$

where $0 < \rho < 1$, $\varphi_1, \varphi_2 > 0$, ε^{sdf} and ε^{dfnews} are the surprise and anticipated innovations in defense spending, respectively, and the news shock is realised $s > 0$ periods in advance. Equation (1) implies that a univariate model is unable to recover the impact of the news shock, since a news shock that occurs today has an effect on defense in the j-ahead period, leaving current defense spending unchanged. However, other variables may react instantaneously to the news shock, since rational expectations induce agents to react in advance to future anticipated shocks in order to maximise lifetime utility. Hence, we identify the effect of the news shock by employing a multivariate VAR model, which includes variables that react to the news shock on impact. We therefore consider a VAR that includes defense spending together with other macroeconomic variables and use the resulting reduced-form VAR innovations to search for the structural shock that is i) contemporaneously orthogonal to defense spending and that ii) maximally explains the future variation in defense spending over some finite horizon.

Specifically, let y_t denote a $k \text{x} 1$ vector of observables of length T. For much of our analysis this will be: U.S. defense spending, Ramey's news shocks, output, consumption, investment, hours, the real wage, the Romer and Romer tax changes, the interest rate, inflation, TFP and defense contractors' excess returns. Let the VAR in the observables be given by

$$y_t = F_1 y_{t-1} + F_2 y_{t-2} + ... + F_p y_{t-p} + F_c + u_t \tag{2}$$

where F_i are $k \,\mathrm{x}\, k$ matrices, p denotes the number of lags, F_c is a $k \,\mathrm{x}\, 1$ vector of constants, and u_t is the $k \,\mathrm{x}\, 1$ vector of reduced-form innovations with variance-covariance matrix Σ. The moving average representation of this k-variable VAR is:

$$y_t = B(L)u_t \tag{3}$$

where $B(L)$ is a $k \,\mathrm{x}\, k$ matrix polynomial in the lag operator, L. To identify the structural shocks, ε_t, we assume that there exists a linear relationship, $u_t = A\varepsilon_t$, where A is the impact matrix. Hence the structural representation of the VAR is:

$$y_t = C(L)\varepsilon_t \tag{4}$$

where $C(L) = B(L)A$ and $\varepsilon_t = A^{-1}u_t$. The matrix A must satisfy $AA' = \Sigma$. For any arbitrary orthogonalization, $\widetilde{A}$, satisfying this restriction, such as the Choleski decomposition, the infinite space of permissible impact matrices can be written as $\widetilde{A}D$, where D is any $k \,\mathrm{x}\, k$ orthonormal matrix, satisfying $D'D = DD' = I$.

The h-step ahead forecast error is defined as:

$$y_{t+h} - E_t y_{t+h} = \sum_{\tau=0}^{h} B_\tau \widetilde{A} D \varepsilon_{t+h-\tau} \tag{5}$$

where B_τ is the matrix of moving average coefficients at horizon τ. Since the elements of ε_t are independent, this equation illustrates that the forecast error variance of a particular variable i at horizon h is the sum of the contributions of the k structural shocks. Let $\Theta_{i,j}(h)$

denote the contribution of shock j to the forecast error variance of variable i at horizon h:

$$\Theta_{i,j} = \sum_{\tau=0}^{h} B_{i,\tau} \widetilde{A} \gamma \gamma' \widetilde{A}' B'_{i,\tau} \tag{6}$$

where γ is the jth column of D, $\widetilde{A}\gamma$ is a kx1 vector which represents the vector of impact effects of shock j, and $B_{i,\tau}$ represents the ith row of the matrix of moving average coefficients at horizon τ. The assumption that only two shocks, surprise and news, affect defense spending implies:

$$\frac{\Theta_{1,sdf}(h) + \Theta_{1,dfnews}(h)}{\sum_{\tau=0}^{h} B_{1,\tau} \Sigma B'_{1,\tau}} = 1 \qquad \forall\, h. \tag{7}$$

where, letting defense spending occupy the first position in the VAR, $\sum_{\tau=0}^{h} B_{1,\tau} \Sigma B'_{1,\tau}$ represents the forecast error variance of defense spending at horizon h.

We identify the unexpected defense innovation ε_t^{sdf} as the reduced-form VAR innovation in defense spending.[8] The news shock $\varepsilon_{t-s}^{dfnews}$ is the true news about future changes in defense spending s periods ahead. Without loss of generality, we assume the second structural shock is the news shock, and, thus, the second column of $\widetilde{A}D$ is its impact vector. In practice, Restriction (7) is unlikely to hold at all horizons in a multivariate VAR model. Hence, as suggested by Barsky and Sims (2011), we select the second column of the impact matrix $\widetilde{A}D$ that comes as close as possible to making Equation (7) hold over a finite set of horizons. In particular, we choose the second column of D, denoted by the vector γ, such that this second shock maximises the forecast error variance of the defense spending variable over horizon H that is left unexplained after the contribution of the unanticipated defense shock is accounted for. In other words, our identification procedure requires finding the γ which maximises the sum of contributions to the forecast error variance of defense spending from

[8]Note that this corresponds to the first structural shock identified by a Cholesky decomposition, and so the impact vector of this shock is simply the first column of the Cholesky factor $\widetilde{A}$.

horizon 0 to horizon H, subject to the restriction that these shocks have no contemporaneous effect on defense spending.

Formally, we solve the following optimization problem:

$$\gamma^* = \underset{\gamma}{\operatorname{argmax}} \sum_{h=0}^{H} \Theta_{1,2}(h) \tag{8}$$

$$\text{subject to } \gamma(1) = 0 \tag{9}$$

$$\gamma'\gamma = 1 \tag{10}$$

Restriction (9) ensures that defense spending does not respond contemporaneously to news shocks, while Restriction (10) implies that γ is a column vector that belongs to an orthonormal matrix D.

We set $H = 20$ quarters and $p = 4$ lags in our benchmark specification and examine the robustness of our results to alternative lag lengths and truncation horizons in the Online Appendix.[9]

2 Results

2.1 Impulse Responses

Figure 1a shows the estimated impulse responses of all variables to a one standard deviation positive defense news shock from the benchmark VAR.[10] All responses should be interpreted as deviations from steady state values.

[9]The Online Appendix is available at http://apps.eui.eu/Personal/Pappa/research.html.

[10] Dashed lines represent 2.5th and 97.5th percentile confidence bands. These bands are constructed from a residual-based bootstrap procedure with 2000 repetitions.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). Many studies in the literature report more narrow, 68% error bands. Although, for comparability with other studies, it would be useful to include the 68% error bands, we decided not to do so here for ease of presentation and also because there is no added information obtained from presenting the 68% bands.

In accordance with our identification assumptions, defense spending does not respond on impact to the positive news shock. In the subsequent periods it grows gradually, peaking after 6 quarters at around 4%. Output, investment, consumption and hours all increase on impact, with the responses being statistically significant at 0.24%, 0.63%, 0.26% and 0.2% respectively. The peak response of output comes after 3 quarters, reaching 0.36%. Following Mountford and Uhlig (2009), Uhlig (2010), Fisher (2010), and Owyang et al. (2013), we compute the output multiplier in the 6th quarter, when defense spending reaches its peak, as the ratio of the 6 quarter cumulative output response to the 6 quarter cumulative defense spending response, multiplied by the average ratio of nominal GDP to nominal defense spending over the sample period. In other words, $multiplier_Y \equiv \frac{\sum_{i=1}^{6} log(Y)_i}{\sum_{i=1}^{6} log(G)_i} \frac{Y}{G}$. In the baseline VAR, the cumulative output multiplier is 2.14.

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 build-up 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 Romer and Romer (2010) tax series marginally on impact and inflation and interest rates more significantly and persistently.

Finally, the shock induces a significant increase in the excess returns of large defense contractors, while it has an insignificant effect on TFP both on impact and at future periods. Since we have not imposed any restrictions on those series, their impulses imply: a) our identified shocks seems to capture news about future defense spending since they affect the valuation of the stocks of large defense contractors on impact and b) our defense news shock cannot be related to a positive TFP shock that we mislabel as a defense news shock.

2.2 Comparison with the Narrative-Based Ramey (2011) Shocks

2.2.1 Impulse Responses to Ramey (2011) Shocks

Figure 1b shows the estimated impulse responses to a positive one standard deviation shock to the Ramey news variable, identified as its VAR innovation orthogonalised with respect to defense spending. Three important differences stand out. First, our MFEV identified news shock has a larger effect on defense spending: the peak response of spending following the Ramey news shock, again after 6 quarters, is 3.48% compared to 3.99% following the MFEV news shock. Second, the responses of all the macro variables to the Ramey shock are noticeably weaker and barely significant. The cumulative output multiplier after 6 quarters is 1.3. The response of hours worked is also weaker at all horizons. The responses of investment and consumption are significantly positive on impact but quickly turn negative. The interest rate response is insignificant, and the response of inflation is weaker, although the dynamics are similar. Third, and most importantly, the Ramey news shock does not significantly affect the excess returns of large defense contractors, neither on impact nor with a lag. We interpret this as an indication that our identified shock contains more information of news about future defense spending than Ramey's shock series.

2.2.2 Comparison of Forecast Error Variance Decomposition

Figure 2 shows the share of the forecast error variance of the endogenous variables attributable to the MFEV 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 48% of the variation in defense spending at a three year horizon compared to 38% for the Ramey news shock. Moreover, our news shock explains 76% of the variation in the Ramey news variable on impact. This indicates that our identified news shock is related to Ramey's news shock, though it appears to have different economic effects.

In addition, our MFEV news shock accounts for 9% and 13% of variation in output and hours at a one year horizon, respectively, compared to 2% and 4% explained by Ramey's news shock, as well as a bigger share of the variation in the nominal variables. In particular, our news shocks explains 30% and 6% of the variation in inflation and interest rates at a one year horizon, respectively, compared to 11% and 1% accounted for by the Ramey news shock.

To examine whether these differences are statistically significant, we have estimated the p-value for the null hypothesis that the difference between the contribution of the MFEV news shock and the Ramey news shock to the variation in defense spending does not exceed zero.[11] We focus on the horizon at which the point estimate of this difference is maximal. The estimated p-value of 0.01 indicates that the difference is significant, strongly suggesting that our news shock contains relatively more information about future defense spending.

2.2.3 Excluding the Ramey (2011) News Series

An important contribution of our methodology is that it allows the estimation of the effects of defense news shocks even in the absence of narrative-based measures. Given that such measures are unavailable for most countries, and extremely time-consuming to produce, it is important to alleviate the concern that our empirical results are driven by the inclusion of the Ramey (2011) news series in the VAR, which would suggest that the applicability of our methodology is limited to economies for which such measures are available. To this end, we re-estimate our baseline VAR, excluding the Ramey (2011) news series. The results of this exercise are presented in Figure 3. While some responses are smaller, it is apparent that the main results remain qualitatively unchanged: the identified news shock continues to raise the real aggregates, as well as inflation and the interest rate, and it continues to significantly

[11] This p-value is estimated as the proportion of bootstrapped estimates of this difference not exceeding zero. As noted in Lutkepohl (2005), p. 712, this estimation procedure will yield p-value estimates that are consistent under general assumptions. Details of this exercise appear in the online appendix.

raise the excess returns of the large defense contractors, while having no significant effect on TFP.

The correlation between these identified MFEV news shocks with the benchmark shocks obtained in Section 2.1 is 0.55. This is a strong correlation, although there does appear to be a non-negligible wedge between the two identified shock series. While it is clear that including the Ramey (2011) series increases the importance of the shock in explaining the future variation in defense spending and, hence, improves identification, it is still evident that the effects of defense news do not change qualitatively with respect to the benchmark VAR.

The MFEV shock we recover can be thought of as having two components: one that is closely related to the Ramey news and corresponds to information that was available in the public sphere about future changes in defense spending and one that is unrelated to this information and the MFEV methodology is extracting by exploiting the Forecast error variance decomposition of defense spending. Ramey news may, or may not have actually been implemented. Instead, by construction, the MFEV news shocks relates to defense news that were all implemented but it is less clear whether they were in the public sphere. It could be that they were in the news and Ramey failed to captured them, or judged that were not relevant for forecasting future changes in defense. Although, Ramey news and MFEV shocks correlate, they are not identical and they seem to pick up different types of types of news.

The contemporaneous correlation of the MFEV shock extracted in the VAR without the Ramey series and the Ramey news is 0.26. This implies that using the MFEV methodology we are capturing part of the Ramey news even without including her series directly in the VAR. Thus, the two components of the MFEV shock are interrelated, but not identical and it is difficult to decompose the shock into the component related to the Ramey news and the component which is not captured by the newspaper readings.[12] In the next subsection, we try

[12]We have also confirmed the two shocks do not Granger cause each other, i.e., the relation between the

to isolate the component related to unreported news and analyze its economic consequences.

2.2.4 The Informational Content of MFEV Shocks

The exercises performed so far imply that the MFEV shocks contain more information relative to the Ramey news series. Since Ramey's news series is included in our benchmark VAR, we would like to examine directly what more our MFEV series captures, which is not captured by Ramey's news shocks. To do this, we project our MFEV shock series, identified in Section 2.1, onto the shock to the Ramey (2011) news series, identified in Section 2.2. The resulting residual (henceforth MFEVORT) represents the variations in the MFEV series which are orthogonal to the Ramey shocks. To study the effects of the MFEVORT series, we then project all of the other variables in the VAR onto their own lags and the current and lagged values of MFEVORT and estimate the impulse responses of the variables to changes in MFEVORT. [13]

The estimated impulse responses to MFEVORT are shown in Figure 4. Similar with the benchmark results, MFEVORT 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 has a significant effect on defense spending after five quarters. Relative to the MFEV shock, MFEVORT raises investment more persistently and lowers the real wage in a more pronounced and persistent manner. Finally, notice that MFEVROT has a much stronger and more persistent effect on the excess returns of large defense contractors. The significant effects of the artificial shock series on macroeconomic aggregates suggest that the component of defense news which is not captured by the Ramey news is important for determining the economic consequences of defense news in the data. Finally, notice that the

two shocks is a contemporaneous one rather than a lead-lag relation.

[13]We thank Karel Mertens for suggesting this exercise. We excluded Ramey's series from the estimation of these impulse responses so as to avoid collinearity resulting from the fact that MFEVORT is a linear combination of all lagged variables. Since MFEVORT is orthogonal to Ramey's series by construction, its inclusion would be redundant.

correlation of the MFEVORT shock and the MFEV shocks extracted from the VAR without the Ramey news of the previous subsection is 0.71. Hence, indeed the news which was not available in the public sphere is what drives the wedge between the Ramey's news and our MFEV shocks and brings additional info relative to the narrative series.

In an alternative exercise we present in the online appendix in order to save space, we have tried a different way of isolating the component of the MFEV news which does not relate to Rameys news. We have orthogonalised the MFEV shock of Section 2.2.3, i.e., extracted from the VAR without the Ramey news series as an endogenous variable, with respect to the Ramey news series and plot the impulse responses of the macro variables to this alternative orthogonalised shock that we call MFEVORT2 in the online appendix. Responses to MFEVORT2 are very similar and statistically indistinguishable from the responses to MFEVORT. The correlation between the two shocks is 0.73. Hence, both these two exercises suggest that the component of defense news that Rameys methodology fails to capture, either because of no available records in the public sphere, or because of human error when collecting the defense news, or of wrong judgment, increases much more private investment inducing stronger demand effects relative to the Ramey news. Taking it to the limit, one could claim that the kind of news Ramey does not capture seem to be related with news that stock market participants have since the excess returns of military contractors increase significantly and considerably in response to the component of news that Ramey fails to capture.[14]

[14] Another way of checking the informational content of the recovered shocks is to investigate how they relate with the revisions of federal spending forecasts from the Survey of Professional Forecasters (SPF). We construct the revision, between period $t-1$ and t, of expectations of growth in federal spending from period $t-1$ to period $t+3$, which is the longest horizon reported by the SPF. We then project this SPF-based news variable on four of its own lags and current and four lagged values of the MFEV, the MFEVORT and the Ramey news series. Figure 7 in the online appendix shows the response of the SPF-based news series to the two news shocks and the artificial MFEVORT measure. The SPF series all react on impact to the different news, although responses are not statistically significant.

2.3 The Effects of Unanticipated Defense Spending Shocks

Defense spending is not perfectly predicted by economic agents, despite fiscal foresight. In equation (1) we assume that defense spending is driven by two shocks, one being the defense news shock which moves defense spending with a delay and the other being the traditional unanticipated defense shock which moves defense spending on impact. In Figure 11 we plot the impulse responses from the benchmark VAR to the latter shock. Besides the large effect on defense spending itself, the unanticipated shock has a relatively small effect on the economy, in particular because it substantially crowds out private investment. One puzzling feature of the shock is that it raises TFP significantly on impact. Ben Zeev and Pappa (2015) show that this is due to the presence of measurement error in quarterly TFP series, and that if the TFP response is shut down the output multiplier is zero for unanticipated defense shocks. Another puzzling aspect that emerges from the figure is the positive response of the Ramey news series to the unanticipated shock, which becomes statistically significant after one quarter. It is worth noting that this response, albeit statistically significant, reflects a small contribution, of less than 5%, to the forecast error variance of the Ramey news series. Clearly, anticipated and unanticipated defense shocks have very different effects.

3 The Chronicle: MFEV Series and Historical Records

The previous sections have established that there is a lot of informational discrepancy between our identified defense news shocks and the news shocks of Ramey (2011). In this section we look at the two different shock series from a historical perspective, and try to identify the events which our shock series captures that Ramey (2011) fails to account for. In order to make the series comparable, since the MFEV series is continuous while Ramey's shocks are not, we generated a series that is equal to zero if the corresponding MFEV value is less than one standard deviation in absolute value, and is equal to the MFEV value otherwise.

This generated series is plotted against Ramey's original series in Figure 5, where both series are normalised by their respective standard deviations. The Ramey news and our generated series coincide at only 8 points: 1950:Q2, 1961:Q2, 1961:Q4, 1963:Q3, 1977:Q3, 1980:Q2, 1989:Q4 and 2002:Q1. Even for these events, the size of the shock recovered is very different. According to Ramey's series, the defense news shocks in 1950:Q2 is much larger than the identified MFEV shock, and for the rest of the events the size of the MFEV shock is larger than Ramey's shocks.

Moreover, in 32 cases Ramey (2011) identifies a news shock that the MFEV methodology fails to capture, and in 24 cases we recover a defense news shocks when the Ramey shock is zero. Some of this mismatch is due to the different timing of the shocks. In 5 cases the defense news shock according to the MFEV methodology occurs a few quarters before the Ramey shock. For example, Ramey (2011) identifies a defense news shock in the first quarter of 1981, when Ronald Reagan announced, on the 19th of February, that he planned to increase the military budget by 24.1%. Instead, the MFEV methodology identifies a shock in the last quarter of 1980, when Reagan was elected and, according to the Republican platform of the 1980 election, an increase in military spending was expected. Similarly, we recover a news shock in the first quarter of 1990, when tensions between Iraq and Kuwait were increasing and the Iraqi military began preparations at the border with Kuwait, while Ramey (2011) identifies a shock in the fourth quarter of 1990, based on the newspaper reports of U.S. intervention to defend Kuwait. These discrepancies suggest that the informational content of the two shock series is different and this drives the differences in their economic consequences.

Table 1 reports the quarters for which the MFEV shocks and the Ramey shocks give predictions of opposite signs, and the dates for which we identify a shock to defense spending while Ramey does not, as well as the size of those shocks in terms of standard deviations.

The third column of the table describes the historical events that could match our identified defense news shocks.[15]

We highlight some episodes for which it is clear that the MFEV series captures news about defense spending that Ramey fails to capture.[16] For example, in the second quarter of 1955 we identify a negative defense spending shock that can be associated with the conclusion of the Geneva Summit between the U.S., U.S.S.R., U.K., and France on July 23rd. The purpose of the summit was to bring together world leaders to begin discussions on peace. During the same quarter the Federal Republic of Germany (West Germany) also joined NATO. On the other hand, the positive shock in the third quarter of 1968 coincides with the U.S. pre-election period, in which Richard Nixon was the front-runner following a campaign in which he claimed to have a "secret plan" to end the Vietnam war. In the second quarter of 1970, Ramey (2011) recovers a negative defense news shock, based on reports that suggest that defense spending should be cut between 1970 and 1971, despite the fact that in that quarter Nixon announced the invasion of Cambodia. Instead, the MFEV methodology identifies a positive defense news shock in this quarter. Again, on April 30 1975, the Vietnam War ended and the MFEV shock takes a negative value in this quarter. On November 18 1981, President Reagan proposed renewed disarmament negotiations, to be called Strategic Arms Reduction Talks (START), and our MFEV series identifies a negative defense news shock in that period.

After contrasting our shocks with the historical evidence, it is clear that the MFEV news series capture relevant information that can be easily associated with defense news. Moreover, the extraction of the shocks is objective and needs no judgement calls, no keywords to be recovered and no ex ante historical record readings.

[15] The recovered events come from historical records in http://en.wikipedia.org/wiki/Years_in_the_United_States.

[16] In the Online Appendix we describe in detail all historical events associated with our defense news shocks.

4 Validity of Our Identification Procedure

The striking difference in the effects of our MFEV shock and Ramey's news shock is intriguing. Ramey (2011) acknowledges that the narrative approach might leave some information about anticipated shocks uncaptured and the comparison between historical data and our identified shocks in the previous section reinforces this statement. Hence, our methodology can be seen as complementary to her approach and easily applicable without referring to historical newspaper records.

Nonetheless, given the nature of our identification methodology, there can still be some concerns about the validity of our approach. In this section we try to address possible criticisms of our identification procedure and establish the validity of our results through a series of diagnostic checks. Firstly, as discussed above, our identification is based on the assumption that defense spending is driven only by its own anticipated and unanticipated shocks. If this does not hold, we might mislabel an endogenous reaction to other economic variables as a defense spending shock, and this could result in incorrect conclusions regarding the effects of defense spending shocks. One of the advantages of using defense spending, rather than other components of government spending, is that it is unlikely that defense spending has an endogenous component. After all, wars occur in response to socio-political events, and not as a reaction to business cycle conditions. To illustrate the validity of this idea, we test the exogeneity of defense spending by estimating its response to other types of shocks. Secondly, an implication of the violation of this assumption would be that the identified defense spending shocks are correlated with other types of shocks; to test this we calculate the correlations between our identified MFEV shocks and other economic shocks. Since TFP news shocks have been shown to have particularly important implications for macroeconomic fluctuations, we also extend our baseline estimation method to purge our identified defense spending news shocks of any possible correlation with TFP.

Finally, we present some further extensions of our baseline VAR to gauge the robustness of our results. In particular, we report the results for the VAR excluding Ramey's news shocks, check for potential omitted variables, and test the robustness to some alternative VAR specifications.

4.1 Exogeneity of Defense Spending

For our identification strategy to be valid, defense spending should be exogenous, meaning that it does not respond to other economic fluctuations. As discussed above, this is very likely to hold by the nature of defense spending. Nonetheless, to demonstrate the exogeneity of our series more formally, in Figure 6 we plot the responses of defense spending to different shocks that are considered to be important sources of business cycle fluctuations: the Romer and Romer (2004) monetary policy shock measure, the Romer and Romer (2010) exogenous tax shock measure,[17] a shock to the real price of oil, the TFP news shock and the unanticipated TFP shock from Barsky and Sims (2011), the innovation to the U.S. economic policy uncertainty index of Baker et al. (2012), and the unanticipated and anticipated tax shocks constructed by Mertens and Ravn (2012).[18] The response to each shock is estimated via individual regressions in which defense spending is projected onto four of its own lags and four lags of each shock series. The response of the defense spending series to these shocks is always insignificant. Defense spending appears to be exogenous and unrelated to shocks that affect the cycle.

[17]Romer and Romer (2010) provides two series of endogenous and exogenous tax changes whose sum produces the total tax changes series, which we use in the benchmark VAR. We use the exogenous tax changes series for this exercise.

[18]The Mertens and Ravn (2012) anticipated tax shock is effectively available in the form of 17 separate series, each corresponding to a different anticipation horizon at which the news shock took place. We sum these various series, thus producing a single series of tax news shocks, albeit with heterogeneous anticipation horizons. The results of both this section and the next section are unaffected by taking the separate series themselves instead.

4.2 The MFEV Shock and Other Structural Disturbances

Another implication of defense spending being endogenous to economic fluctuations would be that our identified MFEV news shocks capture the effects of other economic shocks. For example, suppose there is a defense spending rule which positively relates spending to past GDP. Then, a positive shock that raises current and future GDP would increase future defense spending and therefore, given our identification procedure, would be spuriously included in our MFEV shock. Given the observed significantly positive effect of the MFEV shock on output, a possible correlation between the MFEV shock and other expansionary shocks would imply that the multiplier, and the fraction of GDP volatility accounted for by the MFEV shock, would be overestimated. To address this concern, we first compute the response of defense news shocks to other shocks. Second we compute the correlation between the identified MFEV news shock and up to four lags and leads of the different macroeconomic shocks considered in Section 4.1[19].

In Figure 7 we plot the contemporaneous and lead and lag correlations between the MFEV news shocks and the other eight shocks we consider, together with the corresponding 95% asymptotic confidence intervals. The results indicate that the cross-correlations are small, with all correlations being lower than 19% in absolute value, and **mostly insignificant**. This suggests that our shock is well identified and the fact that it has significant effects on output, consumption, investment and hours is not due to mixing its effects with other disturbances.

4.3 Restricting the TFP Responses

Our benchmark results indicate that TFP does not respond significantly to the MFEV news shock. However, the fact that the responses are negative after the shock may raise the con-

[19]Since the results of the two exercises are similar we report here the results obtained from the second exercise to save space. The results from the first exercise are available upon request.

cern that our results are driven, in part, by this delayed effect on TFP. To alleviate this concern, we develop an alternative estimation algorithm that effectively removes any potential delayed effect that the identified defense news shock may have on TFP. In particular, we extend our baseline identification method, and identify the defense news shocks as the shock that maximises the difference between the contributions to the five-year variation in defense spending and in TFP, and is orthogonal to both current defense spending and current TFP. We also restrict the shock to have no effect on TFP on impact, to be consistent with the notion that our identified shock should have no relation to TFP at all horizons. This restriction effectively ensures that unanticipated TFP movements are not spuriously mixed with our shocks.

We put defense spending and TFP in the first and second positions in the VAR, respectively, and index the defense news shock as 2 in accordance with the notation in Section 1.2. As before, letting γ be the second column of D (corresponding to the defense news shock), the estimation of γ^* requires solving the following constrained maximization problem:

$$\gamma^* = \underset{\gamma}{\operatorname{argmax}} \left(\sum_{h=0}^{20} \Theta_{1,2}(h) - \sum_{h=0}^{20} \Theta_{2,2}(h) \right) \tag{11}$$

$$\text{subject to} \quad \gamma(1) = 0 \tag{12}$$

$$\gamma(2) = 0 \tag{13}$$

$$\gamma'\gamma = 1 \tag{14}$$

where restrictions (12) and (13) ensure that the identified shock is orthogonal to current TFP and defense spending, and restriction (14) ensures that the identified γ is a unit vector. Since this problem can no longer be reduced to an eigenvalue-eigenvector problem as in Uhlig (2003), we resort to using a numerical optimization procedure. In particular, for each draw from the posterior distribution of the reduced-form VAR parameters, we search over 10^7 random draws of unit vectors and choose the vector that maximises the objective function

(11). The specific steps are as follows: i) randomly draw a $(k-2)$x1 vector of NID(0,1) random variables and divide this vector by its norm to obtain a unit vector γ, ii) add two zeros to the first and second elements of γ and use the resulting vector to compute the value of the objective function, iii) repeat steps 1 and 2 10^7 times, iv) pick the vector γ^* that corresponds to the maximal value obtained in step 2. This is the identified column vector from which we compute the impulse responses and forecast error variance shares.

Figures 8a and 8b show the impulse responses and the forecast error variance shares, respectively, for the MFEV news shock identified from this extended estimation procedure, as well as the shock to the Ramey (2011) series, orthogonalised with respect to TFP and defense spending, and the benchmark MFEV news shock as identified in Section 1.2.[20] It is evident that TFP movements are not the driver of our results: the identified defense news shock continues to dominate the Ramey news shock in terms of its effects on the real aggregates, inflation, and interest rates. It is also apparent that it generates responses that are very similar to those produced by the benchmark MFEV news shock. Thus, we feel comfortable rejecting the possibility that TFP shocks are driving our results.

4.4 Other Omitted Variables

It may also be the case that we have omitted important variables from our exercises, which would again imply that our defense news shocks can be confused with other potential shocks that increase demand in the short run, and are associated with future increases in defense spending. In this subsection we present exercises considering some possible suspects.

Firstly, we augment our VAR with the spread between Aaa and Baa bond rates, to investigate whether our shock is spuriously correlated with a shock to risk. Whenever the spread between these two securities increases, the market believes there is higher probability

[20] Note that we restrict the Ramey news shock to be orthogonal to current TFP for comparison purposes, as the MFEV news shock from the extended identification procedure is also subject to this restriction.

of default for the riskier Baa rated bonds. The spread may also increase as a result of the Baa securities becoming less liquid, either as a result of their increased riskiness or because of stress in financial markets. Since there are a large number of firms involved in these measures, the spread provides a good indicator of economy-wide stress. By looking at this spread, therefore, we include a series that proxies for the overall state of the economy. Furthermore, Kang and Pflueger (2014) suggest that corporate bond yields reflect fear of debt deflation. Higher credit spreads reflect higher expected credit losses, and a higher risk premium due to the greater concentration of defaults.

The results from adding the Baa-Aaa spread series to the original VAR are shown in Figure 9. The credit spread has an insignificant response to our news shock, and other responses do not change significantly, so that our measure of news about defense spending does not appear to capture a risk factor that was omitted in the original VAR.

Furthermore, governments might change the composition of government spending. As a result, it could be that we observe significant effects from defenses news shock simply because another component of federal spending is changing and thus generating significant demand effects. We therefore include the non-defense spending series in our benchmark VAR.[21] Figure 10a rejects this hypothesis. In fact, there is a marginally significant and negative response of the non-defense spending component, which seems to be crowded out by the defense spending news shock. Hence, the significant macroeconomic effects of defense news cannot be attributed to the fact that the defense news shocks are correlated with positive innovations in non-defense spending.

Future increases in defense spending might be driven by positive innovations in investment specific technology. Given that a big proportion of defense spending is related to items that can be affected by investment specific shocks, in Figure 10b we present the impulse responses

[21] In exercises that we do not present here for economy of space, we also consider different components of government spending, in particular government consumption and investment.

when we add to the original VAR the ratio of the price of equipment and software investment and durable consumption to the price of nondurables and services consumptions (RPI). It is apparent that RPI does not react significantly to the identified shock at all horizons, and that the responses of other variables are not effected by including the RPI.

In our benchmark VAR we include TFP to ensure that our identified defense news is not related with TFP movements. Since in countries with weak or no newspaper archives it would be very challenging to construct reliable high-frequency series for TFP and since its important to establish that our defense news shocks are not TFP news shocks we also analyze whether our benchmark results are robust to the use of alternative TFP series such as the standard Solow residual in the benchmark VAR. We present the impulse responses of this alternative VAR in the Online Appendix. Both impulse responses to the defense news shock and the quantitative inference is robust to the use of the more accessible measure for TFP (i.e., the Solow residual).[22]

4.5 Other Robustness Checks

In addition to the exercises discussed above, we have examined the robustness of our results along the following dimensions: *i*) assuming different lag specifications or alternative truncation horizons for the MFEV optimization problem; *ii*) inclusion of a linear time trend in the benchmark VAR; *iii*) testing for non-linear effects of the news shocks in different business cycle and political regimes; and *iv*) relation of MFEVORT to other structural disturbances. The results of these checks, which are presented in the online appendix, indicate that our main results are robust to all of these changes.

[22] Whereas Fernald TFP series did not rise in response to the MFEV shock, the Solow residual does increase moderately; this rise is consistent with the expansionary implications of our shocks and the fact that factor utilization is not accounted for in the construction of the Solow residual.

5 Conclusion

In this paper we have developed a novel procedure for identifying defense spending news shocks. Relative to the existing literature, our methodology is objective and needs no judgement calls, no keywords to be recovered and no time-consuming ex ante historical record readings. As a result, it can be applied to countries with weak or no newspaper archives. We have shown that our approach captures richer information about future defense spending increases relative to the approach of Ramey (2011), by contrasting our shocks with real time events and announcements and ruling out the possibility that our shocks are related to other macroeconomic shocks.

Using our extracted shocks, we show that news about defense spending does significantly affect aggregate demand and explains a non-negligible fraction of output fluctuations. In contrast with Ramey (2011), MFEV-identified fiscal news generate significant Keynesian type effects on the economy. According to our estimates, news about future changes in defense spending account for a non-negligible share of output fluctuations at business cycle frequencies.

Our results are useful to both academics and policymakers. Since anticipation effects are estimated to be significant and economically important, it is important to include them in empirical studies of the effects of fiscal changes. Moreover, 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.

References

Baker, S. R., Bloom, N. and Davis, S. J.: 2012, Policy uncertainty: a new indicator, *CentrePiece - The Magazine for Economic Performance 362*, Centre for Economic Performance, LSE.

Barro, R. and Redlick, C.: 2011, Macroeconomic effects from government purchases and taxes, *The Quarterly Journal of Economics* **126**(1), 51–102.

Barsky, R. and Sims, E. R.: 2011, News shocks and business cycles, *Journal of Monetary Economics* **58**(3), 235–249.

Beaudry, P. and Portier, F.: 2006, Stock prices, news, and economic fluctuations, *American Economic Review* **96**(4), 1293–1307.

Ben Zeev, N.: 2015, What can we learn about news shocks from the late 1990's and early 2000's boom-bust period?, *Manuscript*, Ben-Gurion University.

Ben Zeev, N. and Khan, H.: 2015, Investment-Specific News Shocks and U.S. Business Cycles, *Journal of Money, Credit and Banking* **47**(7), 1239–1464.

Ben Zeev, N. and Pappa, E.: 2015, Multipliers of unexpected increases in defense spending: An empirical investigation, *Journal of Economic Dynamcis and Control (forthcoming)* .

Fernald, J.: 2012, A quarterly utilization-adjusted series on total factor productivity, *Technical report*, Federal Reserve Bank of San Francisco.

Fisher, J.: 2010, Comment on: Letting different views about business cycle compete, *in* D. Acemoglu, K. Rogoff and M. Woodford (eds), *NBER Macroeconomics Annual*, Vol. 24, University of Chicago Press, pp. 457–474.

Fisher, J. D. M. and Peters, R.: 2011, Using stock returns to identify government spending shocks, *Economic Journal* **120**(544), 414–436.

Forni, M. and Gambetti, L.: 2011, Fiscal foresight and the effects of government spending, *Manuscript*, Universitat Autonoma de Barcelona.

Forni, M. and Gambetti, L.: 2014, Government spending shocks in open economy VARs, *Working paper*, Universitat Autonoma de Barcelona.

Hall, P.: 1992, *The Bootstrap and Edgeworth Expansion*, Springer-Verlag.

Jaimovich, N. and Rebelo, S.: 2009, Can news about the future drive the business cycle?, *American Economic Review* **99**(4), 1097–1118.

Kang, J. and Pflueger, C. E.: 2014, Inflation risk in corporate bonds, *Journal of Finance, (forthcoming)* .

Kilian, L.: 1999, Finite-sample properties of percentile and percentile-t bootstrap confidence intervals for impulse responses, *The Review of Economics and Statistics* **81**(4), 652–660.

Leeper, E. M., Richter, A. W. and Walker, T. B.: 2012, Quantitative effects of fiscal foresight, *American Economic Journal: Economic Policy* **4**(2), 115–44.

Leeper, E. M., Walker, T. B. and Yang, S. S.: 2013, Fiscal foresight and information flows, *Econometrica* **81**(3), 1115–1145.

Lutkepohl, H.: 2005, *New introduction to multiple time series analysis*, Springer.

Mertens, K. and Ravn, M. O.: 2010, Measuring the impact of fiscal policy in the face of anticipation: A structural VAR approach, *The Economic Journal* **120**(544), 393–413.

Mertens, K. and Ravn, M. O.: 2012, Empirical evidence on the aggregate effects of anticipated and unanticipated us tax policy shocks, *American Economic Journal: Economic Policy* **4**(2), 145–81.

Mountford, A. and Uhlig, H.: 2009, What are the effects of fiscal policy shocks?, *Journal of Applied Econometrics* **24**(6), 960–992.

Owyang, M. T., Ramey, V. A. and Zubairy, S.: 2013, Are government spending multipliers greater during periods of slack? evidence from 20th century historical data, *American Economic Review, Papers and Proceedings* **103**(3), 129–134.

Perotti, R.: 2014, Defense Government Spending Is Contractionary, Civilian Government Spending Is Expansionary, *NBER Working Papers 20179*, National Bureau of Economic Research, Inc.

Ramey, V. A.: 2011, Identifying government spending shocks: It's all in the timing, *The Quarterly Journal of Economics* **126**(1), 1–50.

Ramey, V. A. and Shapiro, M. D.: 1998, Costly capital reallocation and the effects of government spending, *Carnegie-Rochester Conference Series on Public Policy* **48**(1), 145–194.

Romer, C. and Romer, D.: 2004, A new measure of monetary shocks: Derivation and implications, *American Economic Review* **94**(4), 1055–1084.

Romer, C. and Romer, D.: 2010, The macroeconomic effects of tax changes: Estimates based on a new measure of fiscal shocks, *American Economic Review* **100**(3), 763–801.

Schmitt-Grohé, S. and Uribe, M.: 2012, What's news in business cycle?, *Econometrica (forthcoming)* .

Sims, E. R.: 2012, News, non-invertibility, and structural VARs, *Advances in Econometrics (fortcoming)* .

Uhlig, H.: 2003, What moves real GNP?, *Unpublished manuscript*.

Uhlig, H.: 2010, Some fiscal calculus, *American Economic Review* **100**(2), 30–34.

Table 1: **Historical Narrative of MFEV News Shocks.**

Date	MFEV Shock	Ramey News Series	Historical Narrative
1948:Q2	-1.08	0.26	Pre-election period with clear advantage to democrats that support peace treaties.
1948:Q4	-2.31	0.26	Pre-election period with clear advantage to democrats that support peace treaties.
1955:Q2	-1.91	0	End of Geneva summit; West Germany joins NATO.
1959:Q3	-1.58	0	Opening of the American National Exhibition in Moscow.
1960:Q3	-2.06	0	Pre-election period for John F. Kennedy supporting peace.
1961:Q3	-1.03	0.12	August - Alliance for Progress founded by U.S.
1964:Q2	-1.30	0	April 20 - Lyndon Johnson in New York, and Nikita Khrushchev in Moscow, simultaneously announce plans to cut back production of materials for making nuclear weapons.
1968:Q3	1.38	0	Pre-election period for Richard Nixon supporting reinforcement of national defense.
1970:Q2	1.25	-0.06	April 29 - The U.S. invades Cambodia.
1970:Q3	1.01	0	September 5 - Vietnam War: Operation Jefferson Glenn.
1971:Q3	-1.16	0	August 15th, U.S. President Nixon announces 90-day freeze on wages, prices, and rents.
1975:Q2	-1.05	0	April 30 - Vietnam War: The Fall of Saigon.

Continued from previous page.

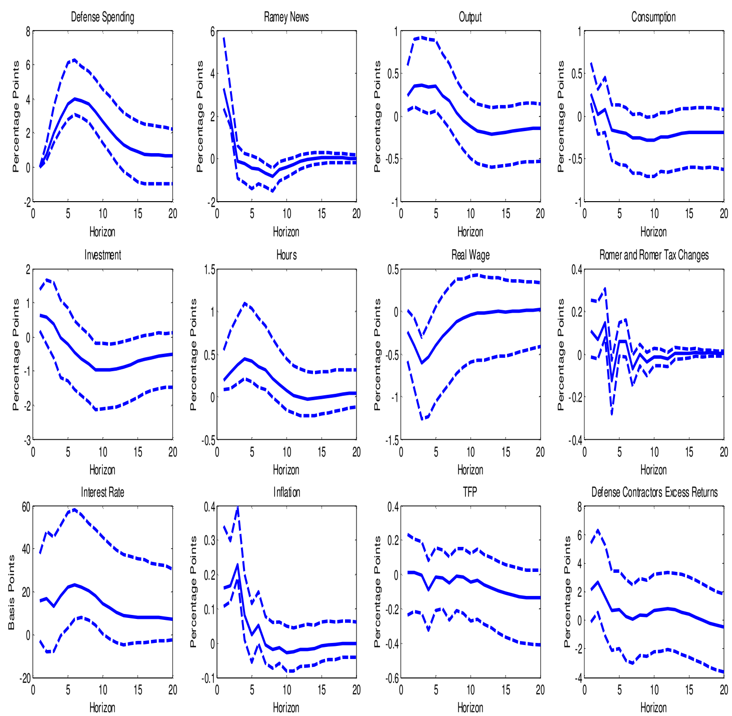
Date	MFEV Shock	Ramey News Series	Historical Narrative
1975:Q3	1.44	0	August 20 - NASA launches the Viking 1 planetary probe toward Mars.
1977:Q3	-1.06	-0.04	September 7 - Torrijos–Carter Treaties are signed.
1978:Q2	1.94	0	From May 19 through June, the U.S. provides support in rescue operations in Zaire.
1979:Q3	1.10	0	July 3 - Jimmy Carter signs first directive for secret aid to opponents of pro-Soviet regime in Kabul.
1980:Q2	-1.85	0	Pre-election period considered as realigning election: Carter as a peacemaker vs. Reaganomics.
1980:Q3	1.31	0	Pre-election of Ronald Reagan - polls suggest level of defense spending is low.
1980:Q4	2.03	0	Election of Ronald Reagan - plans for increases in defense spending in Republicans platform.
1981:Q4	-1.19	0	Strategic Arms Reduction Talks proposal by President Reagan.
1987:Q2	-1.03	0	"Tear down this wall!": Mikhail Gorbachev's glasnost and perestroika.
1988:Q2	1.51	0	Mid-March and April - Panama crisis.
1990:Q1	1.18	0	Increasing tensions between Iraq and Kuwait.

Continued from previous page.

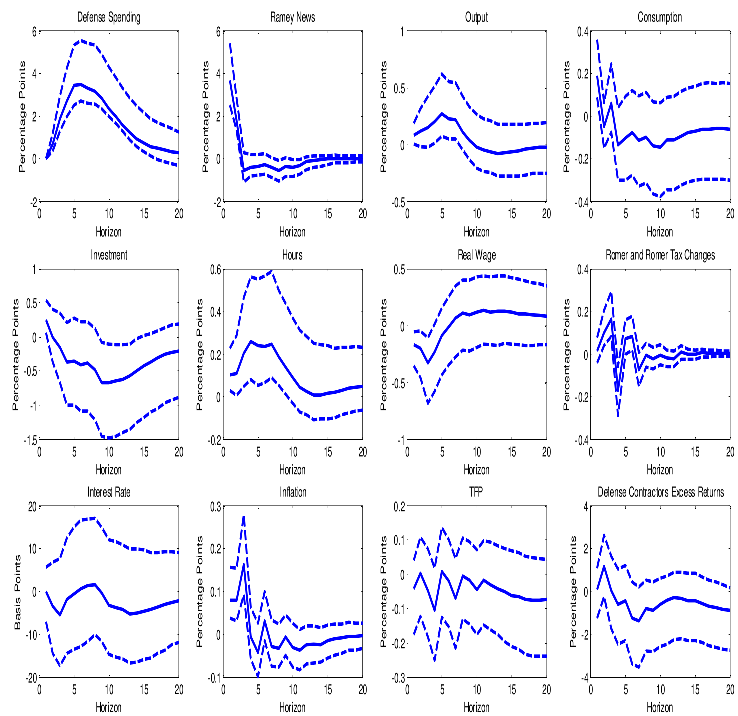
Date	MFEV Shock	Ramey News Series	Historical Narrative
1992:Q3	-1.49	0	Pre-election period with Clinton ahead of Bush, and democratic platform supporting defense conversion.
1996:Q3	-1.00	0	Democrats pre-election support military cuts; U.S. fails in its attempt to build support for military action against Iraq in the UN Security Council.
1999:Q3	-1.06	0	Ending of Kosovo War.
2001:Q2	-1.09	0	June 5 - Jim Jeffords leaves the Republican Party, giving Democrats control of the U.S. Senate.
2001:Q4	-1.04	0	The U.S. government indicts Moussaoui for involvement in September 11 attacks.

Notes: This Table reports the quarters for which the MFEV shocks and the Ramey shocks give predictions of opposite signs and the dates for which we identify a shock to defense spending while Ramey does not, as well as the size, in terms of standard deviations, of those shocks. The third column of the table describes the historical events that could match our identified defense news shocks.

Figure 1: **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 News Shock.



(b) Impulse responses to a one standard deviation Ramey News Shock.

Notes: The y-axis gives the percentage point deviation from the variable's steady state; the only exception is the interest rate response, for which the deviation is shown in terms of basis points. The horizon on the x-axis is in quarters. Panel (a): The impulse responses were obtained from applying the MFEV method explained in Section 1 on the benchmark VAR. Panel (b): The impulse response are with respect to the shock to the Ramey news variable orthogonalised 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 2: **The Share of Forecast Error Variance Attributable to MFEV News Shocks and Ramey's News Shocks.**

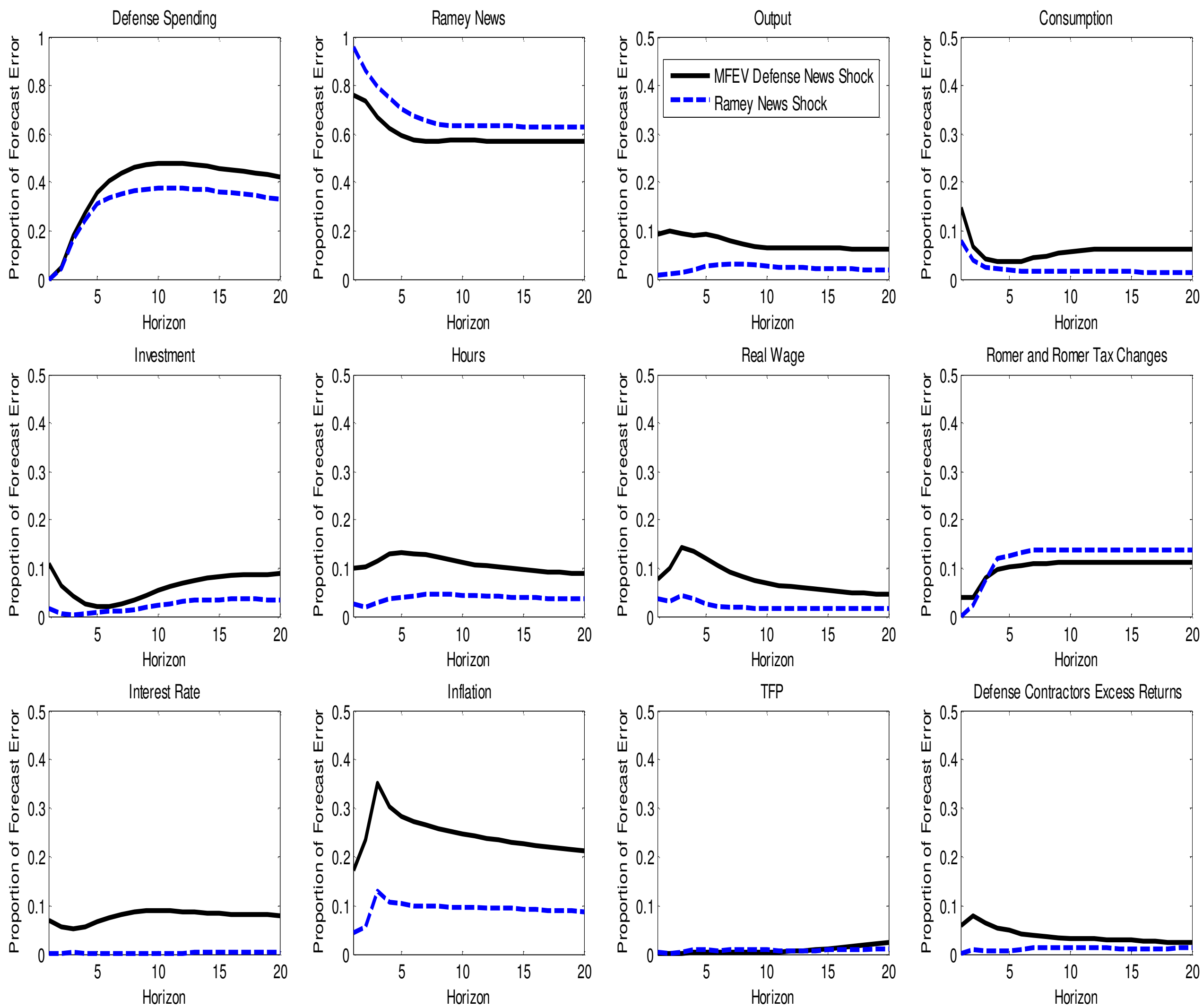
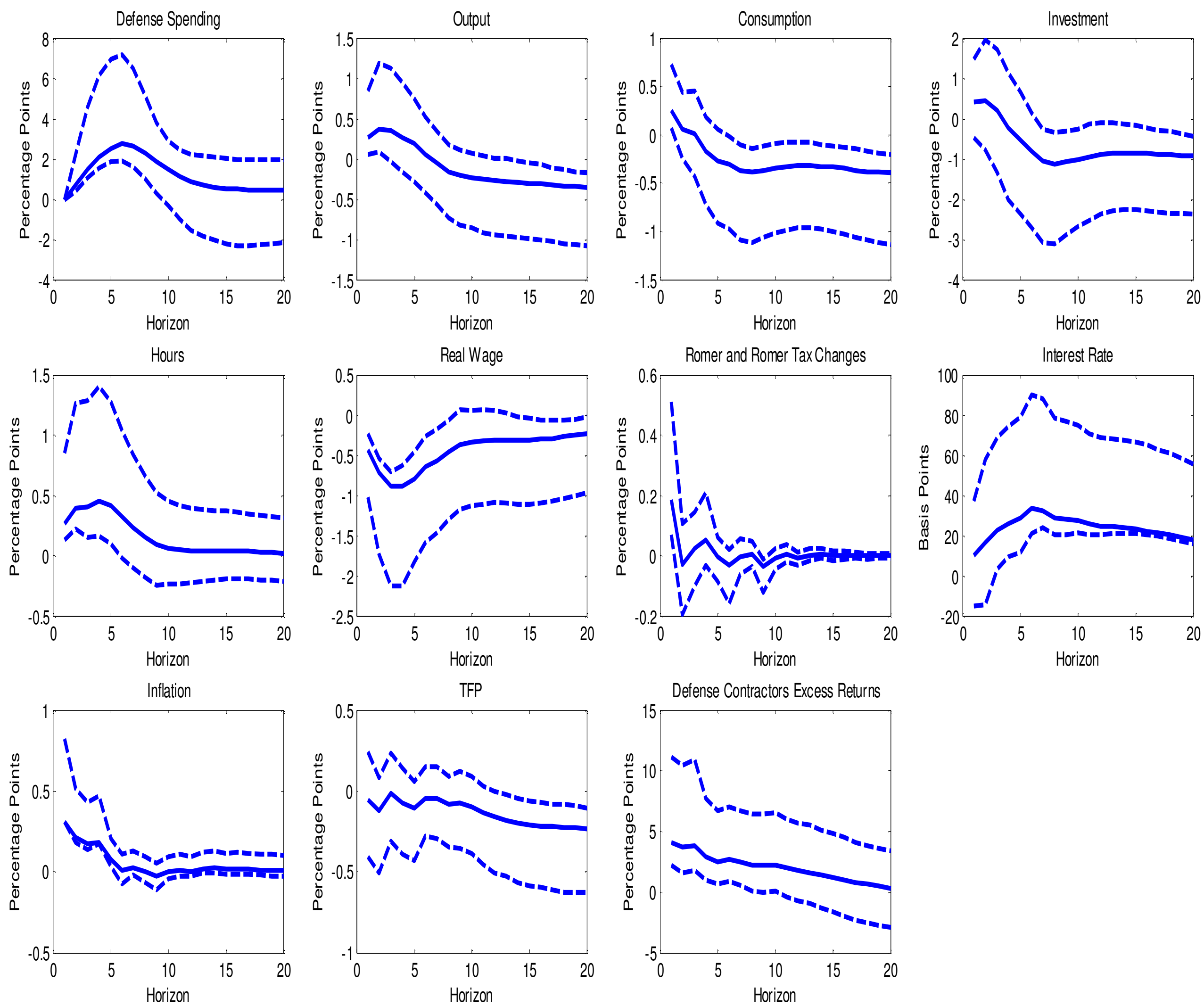
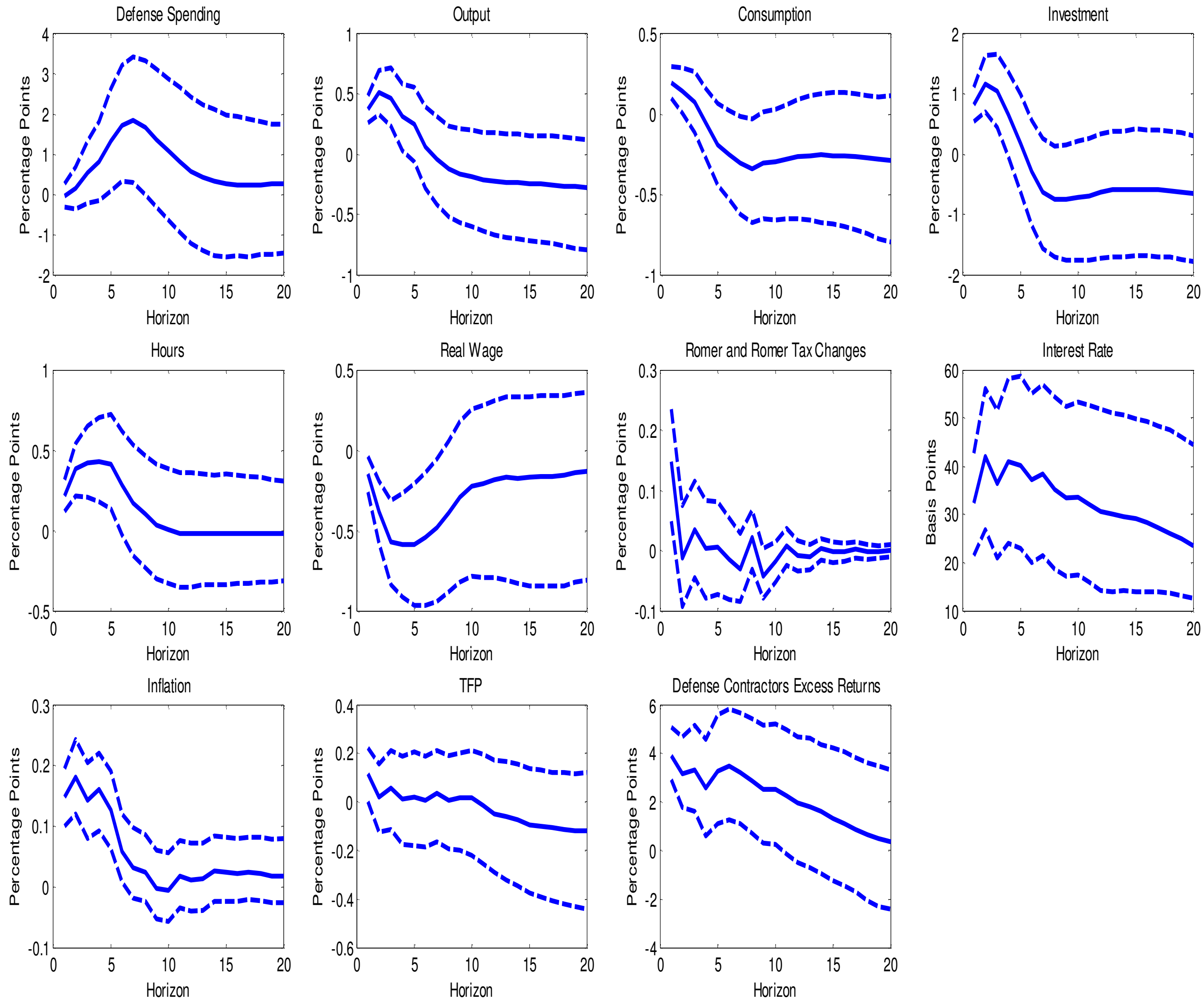


Figure 3: **VAR Without the Ramey (2011) Series: Impulse Responses to a One Standard Deviation Defense News Shock (Solid Lines)**.



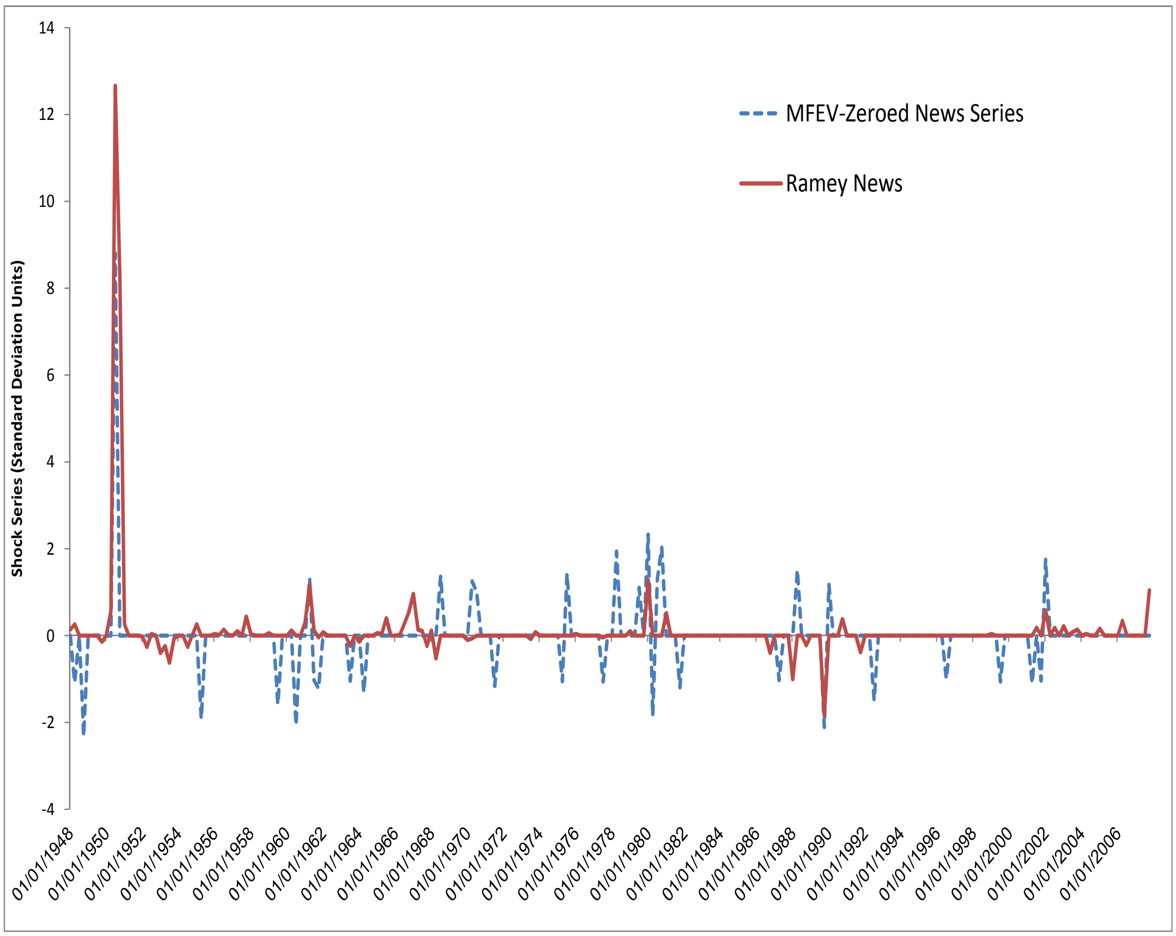
Notes: The impulse responses were obtained from applying the MFEV method explained in section 1 in a VAR that excludes the Ramey (2011) news series. Dashed lines represent 2.5th and 97.5th percentile Hall (1992) confidence bands generated from a residual based bootstrap procedure repeated 2000 times. Horizon is in quarters.

Figure 4: **Impulse responses to MFEVORT (Solid Lines)**.



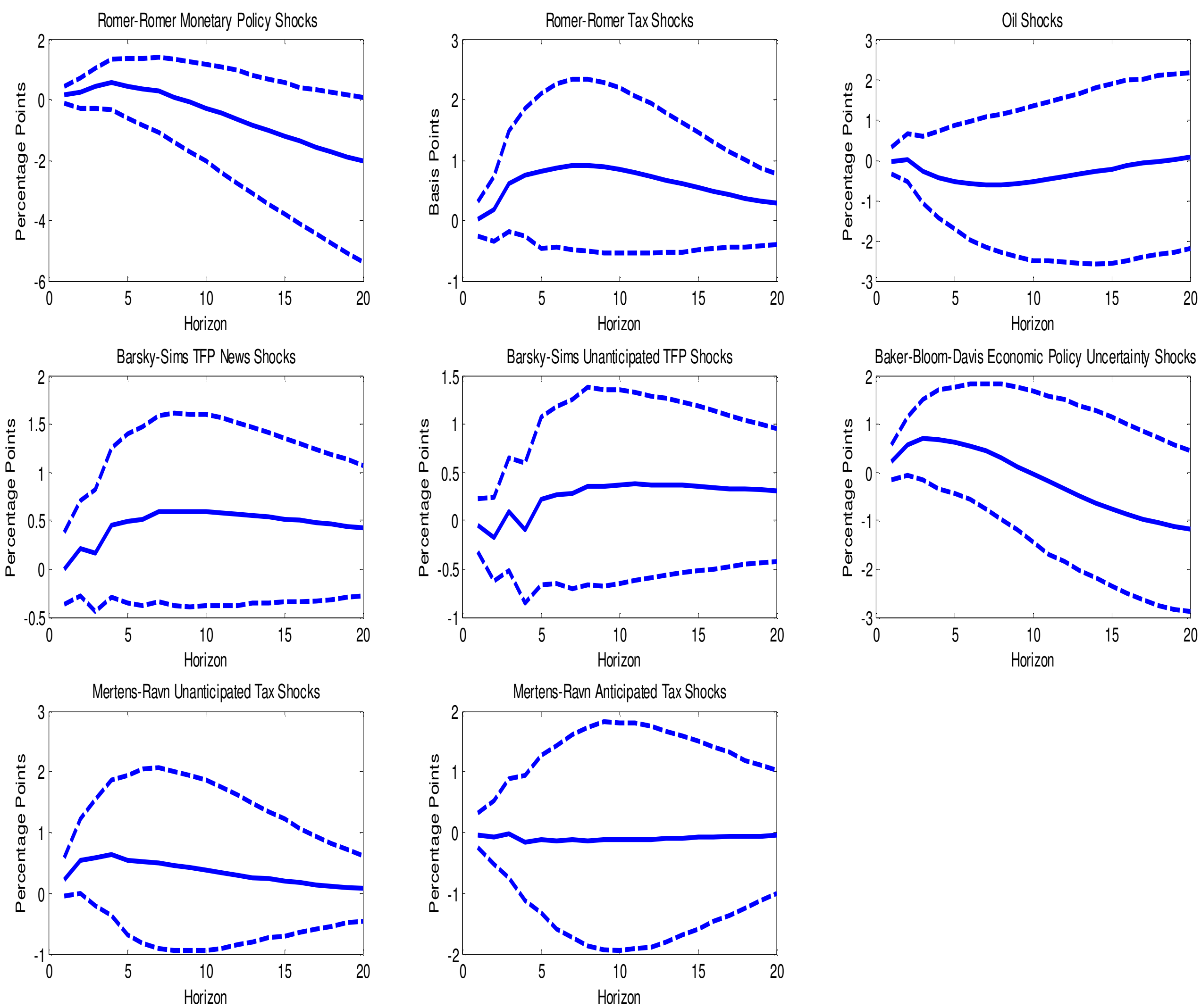
Notes: The impulse responses were obtained from projecting the variables in the benchmark VAR onto their own lags and the current and lagged values of the artificial residual (MFEVORT) obtained from projecting the MFEV news shock series onto Ramey's shock series. Presented impulse responses are with respect to a one standard deviation change in MFEVORT. 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 2.5th and 97.5th percentile Hall (1992) confidence bands generated from a residual based bootstrap procedure repeated 2000 times. Horizon is in quarters.

Figure 5: **Time Series of MFEV-Zeroed Series**.



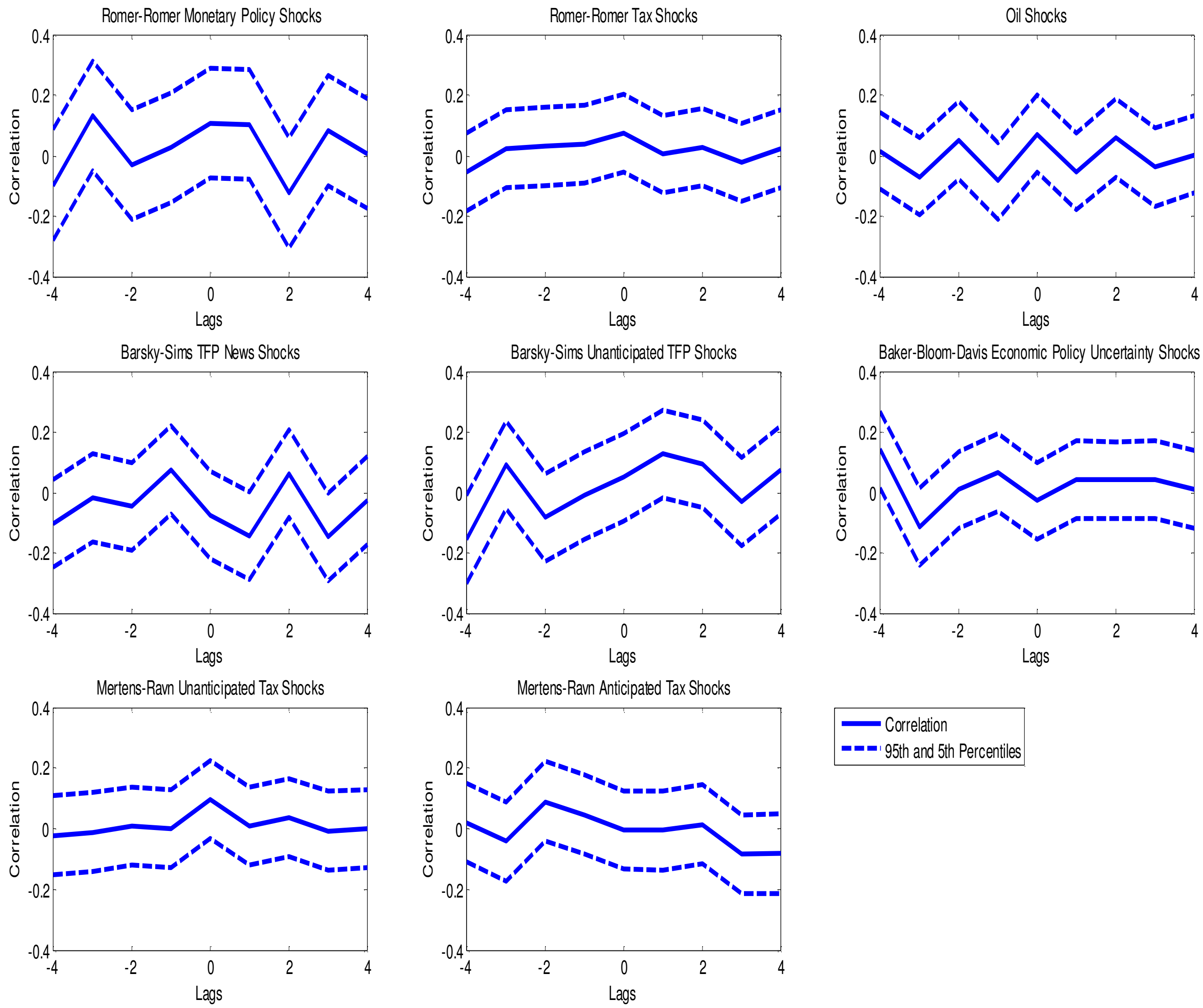
Notes: The plotted series shown by the dashed line is equal to zero if the corresponding MFEV value is less than one standard deviation in absolute value, and is equal to the MFEV value otherwise. The series begins in 1948:Q1 and ends in 2007:Q4. The series shown by the solid line is the raw Ramey (2011) news series.

Figure 6: **Impulse Responses of Defense Spending to Various Macroeconomic Shocks (solid lines)**.



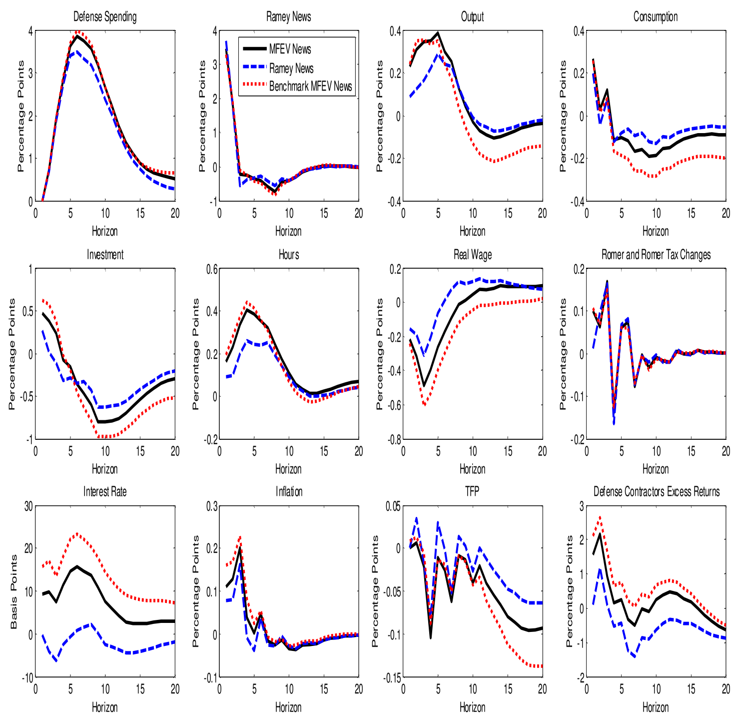
Notes: The impulse responses were obtained from projecting defense spending onto its own four lags and the current and lagged values of each macroeconomic shock. The shocks considered are the Romer and Romer (2004) monetary policy shock measure, Romer and Romer (2010) exogenous tax shock measure, shock to the real price of oil, the TFP news and unanticipated shocks from Barsky and Sims (2011), the innovation to the U.S. economic policy uncertainty index of Baker et al. (2012), and the unanticipated and anticipated tax shocks constructed by Mertens and Ravn (2012). 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 7: **The Cross-Correlation between the MFEV News Shock and Lags/Leads of Other Structural Shocks**.

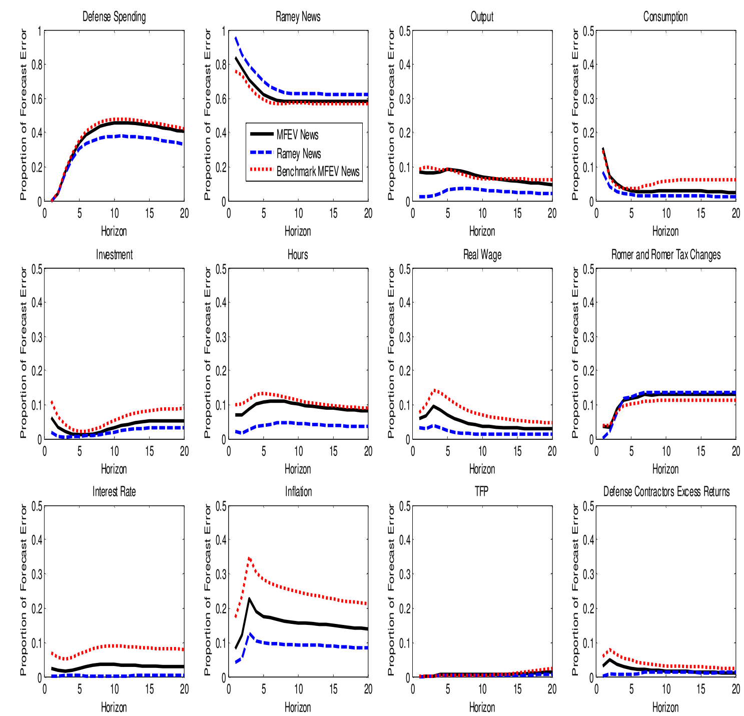


Notes: The solid line is the cross-correlation and the dashed lines represent the 95% asymptotic confidence interval. Apart from the Barsky and Sims (2011) TFP news and unanticipated shock series, which were used in their raw form, all other shocks were constructed as the residuals of univariate regressions of each of the four variables on four of their own lags.

Figure 8: **Results from Extended Estimation Procedure: (a) Impulse Responses; (b) Forecast Error Variance Shares**.



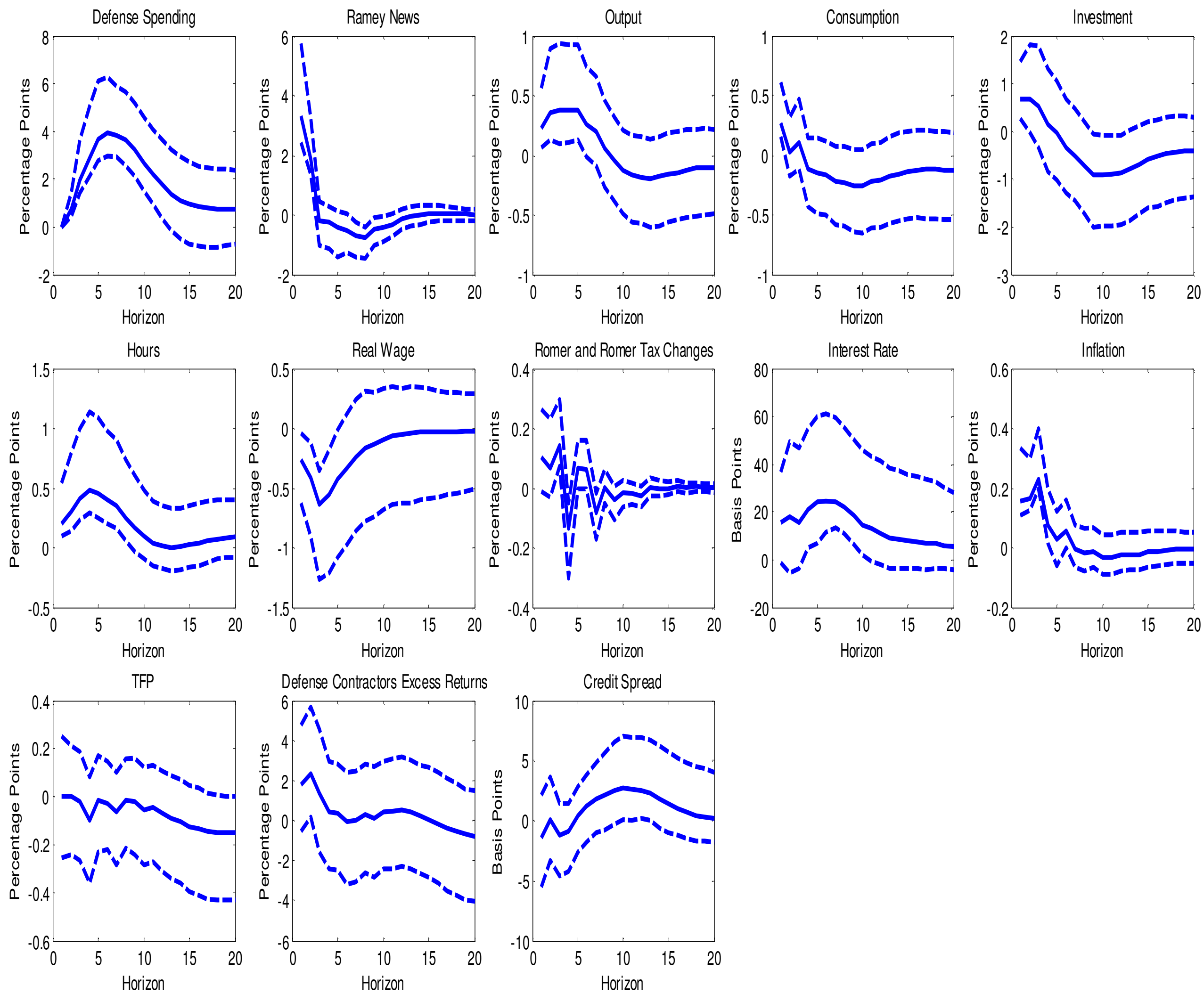
(a) Impulse Responses to a One Standard Deviation MFEV News Shock from Extended Estimation Procedure, Ramey's News Shock, and the Benchmark MFEV News Shock.



(b) The Share of Forecast Error Variance Attributable to the MFEV News Shock from Extended Estimation Procedure, Ramey's News Shock, and the Benchmark MFEV News Shock.

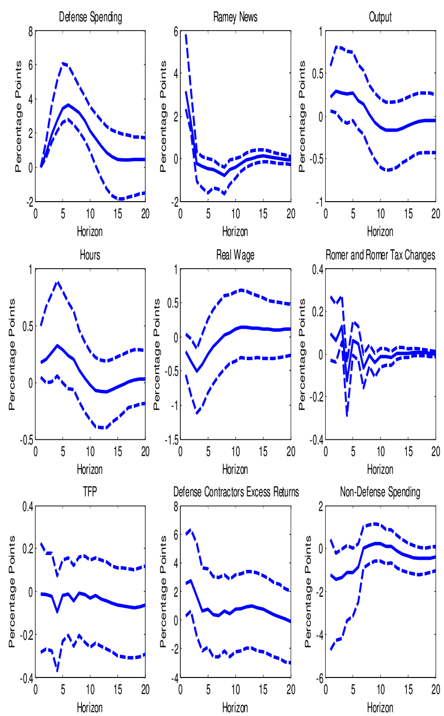
Notes: The MFEV defense news shock is identified as the shock that maximally explains the difference between the sums of contributions to the five-year variation in defense spending and TFP. The Ramey news shock is the shock to the Ramey series that is orthogonal to current TFP and defense spending and the benchmark MFEV news shock is the news shock identified via the baseline identification method (the shock corresponding to Figure 1a). Horizon is in quarters.

Figure 9: **Impulse Responses to a One Standard Deviation Defense News Shock: VAR with Credit Spread (Solid Lines)**.

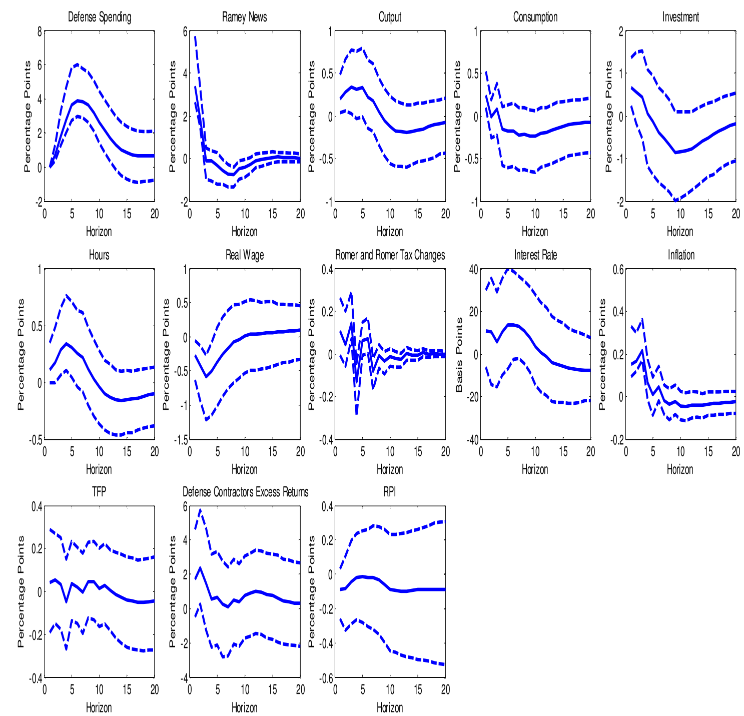


Notes: The impulse responses were obtained from augmenting the benchmark VAR with the spread between Baa bond yields and Aaa bond yields. Dashed lines represent 2.5th and 97.5th percentile Hall (1992) confidence bands generated from a residual based bootstrap procedure repeated 2000 times.

Figure 10: **Larger VARs: (a) VAR with Non-Defense Spending; (b) VAR with Relative Price of Equipment and Durable Goods**.



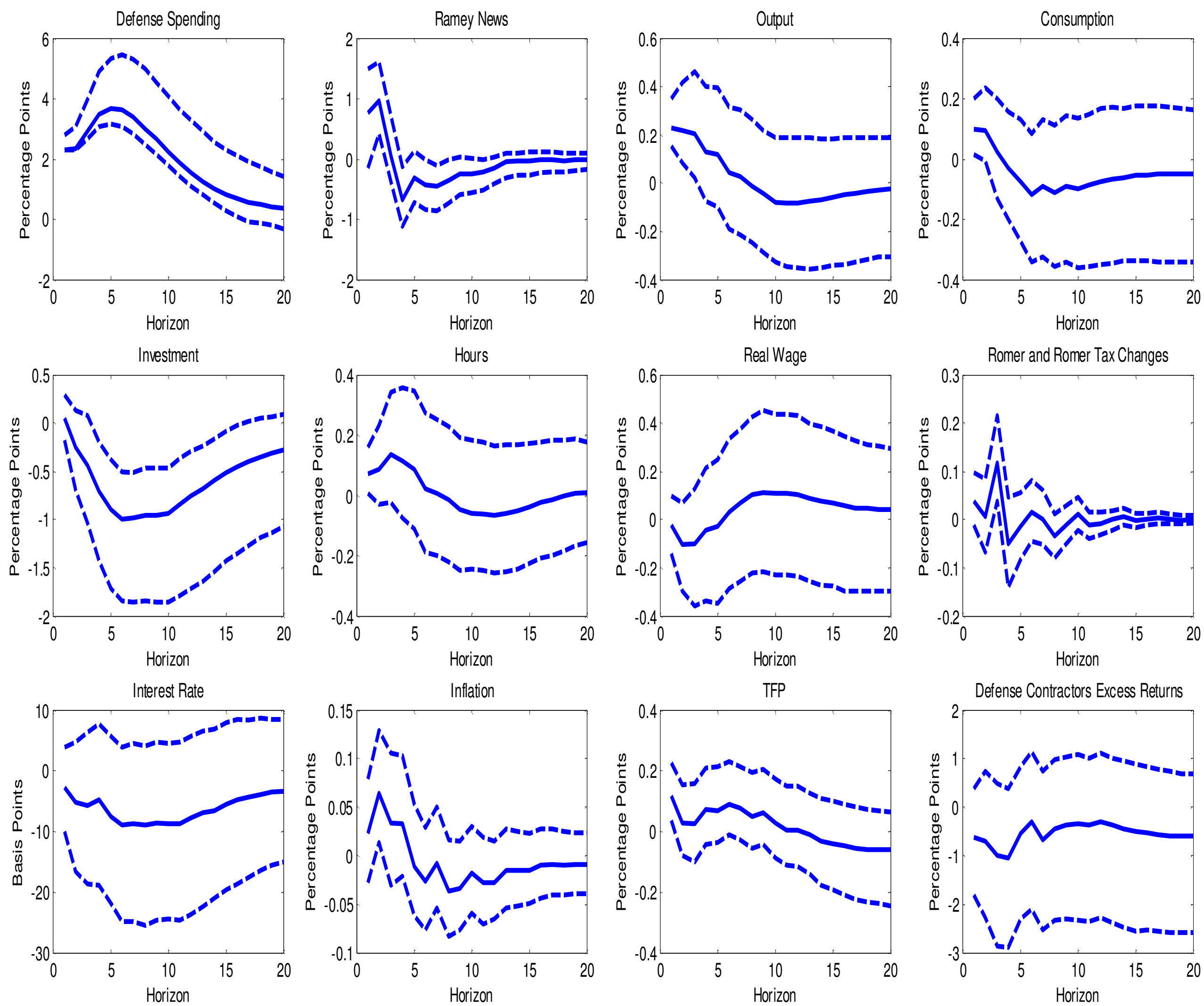
(a) Impulse Responses to a One Standard Deviation Defense News Shock: VAR with Non-Defense Spending.



(b) Impulse Responses to a One Standard Deviation Defense news shock: VAR with Relative Price of Equipment and Durable Goods (RPI).

Notes: Panel (a): The impulse responses were obtained from augmenting the benchmark VAR with real per capital non-defense government spending. Panel (b): The impulse responses were obtained from augmenting the benchmark VAR with the ratio of the deflator of equipment and durable goods to the deflator of non-durable and services goods. Dashed lines represent 2.5th and 97.5th percentile Hall (1992) confidence bands generated from a residual based bootstrap procedure repeated 2000 times.

Figure 11: **Impulse Responses to a One Standard Deviation Unanticipated Defense Shock (Solid Lines)**.



Notes: The unanticipated defense spending shock is identified as the reduced-form VAR innovation in 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. Horizon is in quarters.