Chronicle of Unanticipated and Anticipated Increases in Military Spending

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Abstract

We identify unanticipated and anticipated defense spending shocks and examine their effects in the US economy. Unanticipated shocks have real effects because they induce a sectoral reallocation that increases total factor productivity (TFP) and the output multiplier is zero when the TFP channel is shut down. Anticipated defense spending shocks carry news about fiscal policy that induces a significant and persistent increase in output, consumption, investment, hours and the interest rate. Standard DSGE models fail to produce relatively more pronounced responses of real variables with respect to news shocks. We propose a sticky price model with variable capital utilization, capital adjustment costs, and rule of thumb consumers that replicates the empirical patterns.

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Key words: Anticipated defense spending shocks, Unanticipated defense spending shocks

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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 also agree today that macroeconomic fluctuations may be driven by changes in expectations rather than current economic conditions and that agents react to anticipated changes in exogenous fundamentals before such changes materialize. Schmitt-Grohé and Uribe (2012) show that anticipated shocks account for about half of predicted aggregate fluctuations in output, consumption, investment and employment reconfirming the view that the business cycles are driven by news about future developments. It is usually difficult to observe news about the economy but in some cases researchers can identify news by disentangling information about the timing of events.

One good example of news in the data is the case of fiscal changes. Mertens and Ravn (2012) 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). When the difference between the announcement and the implementation dates is more than 90 days, they assume that the tax liability change is anticipated. They find that the economy reacts differently to preannounced and surprise tax cuts, with the former inducing pre-implementation declines in economic activity. Mertens and Ravn (2011) propose a model that can account for the macroeconomic effects of such shocks.

Anticipation is also important for shocks to government spending. Forni and Gambetti (2010), Leeper, Richter and Walker (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. Along these lines, Ramey (2011) shows that VAR shocks are missing the timing of the news, and therefore that VARs do not properly estimate dynamic fiscal multipliers.

Following the work of Ramey (2011) most researchers would agree that large increases in military spending are anticipated several quarters before they actually occur. Ramey (2011) constructs two measures of government spending shocks. The first uses narrative evidence to construct an estimate of the change in the expected present value of government spending relying on readings of the Business Week, as well as several newspaper sources. 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. Still at times shocks occur and, most importantly, most of the theoretical models in the literature study the effects of unexpected rather than expected increases in fiscal policy. For that reason, in this paper we study the transmission mechanism of both anticipated and unexpected changes in military spending. We identify unexpected changes as positive shocks to military spending that are orthogonal to Ramey's news series about fiscal shocks. Using the methodology of 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. This identification approach requires finding the linear combination of VAR innovations contemporaneously uncorrelated with current defense spending which maximally contributes to defense spending's future forecast error variance. Our identified defense news shocks are strongly correlated with the Ramey (2011) news shocks, but they explain a much bigger share of the variation in all real variables at business cycle frequencies and they are estimated to have more significant and positive effects in the economy, implying that the component in the MFEV series that is independent of the Ramey shock series encloses important information on future defense spending that generates the observed differences in the transmission mechanism of the two identified news shocks.

Anticipation effects represent a serious challenge to the study of the effects of fiscal policy shocks. Few other studies have tried to deal with the issue of anticipation of government spending shocks. First, Mertens and Ravn (2010) use a DSGE model to derive a fiscal SVAR estimator that is applicable when shocks are anticipated and apply it to US data. Contrary to our findings on military spending, they conclude that anticipation does not overturn the earlier findings of the SVAR literature. Nevertheless, their methodology to derive estimates for unanticipated and anticipated fiscal spending shocks comes at the cost of additional identification restrictions which are needed to disentangle anticipated fiscal shocks from other structural shocks, due to which they focus on permanent spending shocks and adopt a VECM framework. As it is reasonable to argue that most government spending shocks are temporary in the U.S., their focus on permanent shocks does not seem to apply to most fiscal shocks, thus rendering their analysis a bit restrictive. The permanent fiscal shocks would probably be mostly state and local spending on schools, which are driven in large part by demographics and have their own independent effects. In contrast, we can look at temporary fiscal shocks within our empirical framework and use only medium-run restrictions to identify such shocks, that is, ours is a much less restricted framework.

Second, Leeper, Richter and Walker (2012) also identify two types of fiscal news - government spending and changes in tax policy. They identify news concerning taxes through the municipal bond market, and news concerning government spending through the Survey of Professional Forecasters. They then map the reduced-form estimates of news into a DSGE framework and conclude that news concerning fiscal variables is a time-varying process that can have important qualitative and quantitative effects. Third, 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. He introduces the fiscal news in the VAR and 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. Finally, Bruckner and Pappa (2013) exploit specific announcements - the bidding for the organization of the Olympic Games - to measure news shocks in the data and examine the macroeconomic effects of such news using panel data for 188 countries during the period 1950-2009. In the bidding countries output growth, investment, and private consumption significantly increase about nine to seven years before the Olympic Games are hosted providing strong evidence that economies react to news shocks.

Our empirical results can be summarized as follows: First, unexpected increases in military defense spending increase TFP and output and decrease investment on impact. The fact that TFP is not completely exogenous is not new. In early studies, Hall (1988), Mankiw (1989) and Evans (1992) show that TFP can be forecast using military spending, or monetary policy indicators. Furthermore, Evans (1992) finds that the influence of money, interest rates, and government spending is economically significant: their innovations account for between one-quarter and one-half of TFP forecast error variance. We show that the positive relationship between military spending and TFP continues to hold when we condition the analysis to unexpected military spending increases. Second, since unexpected increases in military spending increase TFP, the output effect of the shock might be due to the positive responses of the TFP. Indeed, when we force the fiscal shocks to be orthogonal contemporaneously to TFP movements, we find that the output multiplier is zero. These results hold only when we look at unexpected increases in total government spending. Thus, in agreement with Ramey and Shapiro (2011), unexpected increases in military spending do not generate any significant demand effects and the positive responses of output to such shocks are induced mostly by supply factors. Third, we show that the observed response of TFP can be explained by changes in the sectoral reallocation. Earlier work by Phelan and Trejos (2000) show in a theoretical model that sectoral reallocations due to military buildups can generate responses that are qualitatively similar to productivity shocks. In a similar spirit, Ramey and Shapiro (2011) argue that many of the significant changes in overall government spending are directed to a few subcategories of spending and, as a result, variations in spending on those programs can represent important shifts in demand for the output of key industries. We show that unanticipated defense shocks raise capacity utilization in the aerospace related industries, which is consistent with the observed concentration of defense spending in these industries. Exploiting the relation derived in Basu and Fernald (1997) between the aggregate TFP growth rate, technological growth, and reallocation to obtain a proxy for reallocation, we also show that our identified defense shock significantly raises this reallocation proxy and has a 30% correlation with it, while our shock which is orthogonalized with respect to TFP does not and only has an 0.08 correlation with it, implying that reallocation is a significant factor explaining the observed movements in TFP after the fiscal shock[1].

On the other hand, anticipated fiscal shocks carry news about fiscal policy that induce a significant and persistent increase in output, consumption, investment, hours and the interest rate and induce a much more pronounced increase in macroeconomic activity in the pre-implementation period. Moreover, TFP does not react significantly to the fiscal news shocks implying that such shocks involve a different propagation channel relative to unexpected increases in military spending.

We use standard RBC and New Keynesian models to show that they are incapable to generate responses compatible with the data. RBC models can reproduce qualitatively the empirical impulse responses: they generate almost zero multipliers with respect to unanticipated fiscal shocks but induce small increases in economic activity with respect to anticipated shocks and cannot induce increases in consumption in the pre-implementation period. New Keynesian models induce sizeable effects with respect to unexpected increases in government spending. Earlier theoretical models have been proposed to overturn the fall in consumption with respect to fiscal shocks (for a revision of this literature see Canova and Pappa (2011)) and in the 'News Driven Business Cycles' literature many mechanisms have been put forward for genrating significant demand effects for TFP news shocks (for a revision see Beaudry and Portier (2013)). In order to look for a mechanism that would propagate the effects of news shocks and at the same time induce zero multipliers with respect to unexpected shocks we have experimented with the various alternatives provided in the two strand of literature. To define better our search we have looked for mechanism that could fit the standard quantitative DSGE models. The elements we have identified as crucial for replicating the empirical findings are (a) the existence of rule of thumb consumers to induce an increase in consumption in response to unexpected increases in government spending (b) variable capacity utilization and capital adjustment costs to boost the reaction of the economy in

[1] To examine if other explanations can account for the evidence, we have investigated whether unexpected increases in military spending could be related with (a) increases in patriotism, mirrored in increases in work effort during such episodes; (b) with changes in consumers' confidence and (c) with changes in R&D. None of these other explanations seems to account for the responses we obtain.

response to shocks (c) sticky prices to generate increases in demand with respect to shocks and (d) distortionary income taxation to mute the responses of the economy with respect to unexpected increases in government spending and to induce increases in demand in the face of increases in future taxation with the implementation of the fiscal policy expansion.

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 try to investigate the relationship between unexpected changes in military spending and TFP. In Section 6 we present the standard model and introduce the necessary modifications to mimic model and data responses and Section 7 concludes.

2 Econometric Strategy

2.1 Data

The data covers the period from 1947:Q1 to 2008:Q4. We measure defense spending, output, hours, consumption, and investment in real per capita terms. Leeper, Walker and Yang (2012) and Ramey (2011) have discussed how luck of information about fiscal events can undermine identification in SVAR's. One efficient way to address this problem is to add more information to the VAR, as shown by Sims (2012) and Gambetti and Forni (2011). To comply with this, we also include in the estimation the Ramey (2011) news series. Apart from enabling us to alleviate the missing information problem, the inclusion of this series allows us to check the correlation of our news shock with the latter series as well as compare the effects of our shock with the effects of Ramey's news shock. We also include in the VAR the real manufacturing wage, the Barro and Redlick (2011) average marginal tax rate, the interest rate on 3 month T-bills, CPI inflation, and TFP.

For the TFP series, we employ the real-time, quarterly series on total factor productivity (TFP) for the U.S. business sector, adjusted for variations in factor utilization (labor effort and capital's workweek), constructed by Fernald (2012) and is available on his website.[2]

[2] http://www.frbsf.org/economics/economists/staff.php?jfernald

Apart from the TFP series, all data comes from Ramey's website.[3]

2.2 Identifying Unanticipated Military Spending Shocks

We assume that defense spending is driven by two shocks: an unanticipated component, impacting on the level of spending in the same period and an anticipated shock, which agents observe in advance, affecting the level of defense spending in the future. We refer to the latter as the defense news shock. For example, a process, ϵ_t, that incorporates both unanticipated and defense news shocks could be:

$$\epsilon_t = \kappa\epsilon_{t-1} + e_{t-1} + \eta_t \tag{1}$$

where parameter $0 \leq \kappa < 1$ describes the persistence of the process. η is an *iid* shock unanticipated shock, while e_t is an *iid* news shock. We now turn to explaining how we intend to identify the unanticipated defense shock η_t.

In Equation (1), η_t is the only shock that has a contemporaneous effect on defense spending. Our benchmark VAR includes government defense spending, real aggregates, the real wages the Barro and Redlick (2011) average marginal tax rate, interest rates, inflation, and total factor productivity (TFP). To obtain the unexpected shock we consider a VAR that includes the Ramey (2011) news series (which proxies for e_t). The unanticipated defense shock is identified as the VAR innovation in defense spending orthogonalized with respect to the Ramey (2011) news series.

Leeper, Walker and Yang (2012) have demonstrated how the presence of fiscal foresight can create a wedge between economic shocks and VAR innovation and, thus, limit the ability of VAR's to attain shock identification. This wedge is a direct result of the econometrician's inability to observe the news component of fiscal policy. To address this potential non-invertibility issue, we insert the Ramey (2011) measure of defense news shocks into our VAR. The orthogonalization restriction is imposed to ensure that our identified unanticipated defense shock is unrelated to the Ramey (2011) news shocks.

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

Let y_t be a kx1 vector of observables and let the VAR in the observables be given as

$$y_t = B_1 y_{t-1} + B_2 y_{t-2} + ... + B_p y_{t-p} + B_c + u_t \tag{2}$$

where B_i are kxk matrices, p denotes the number of lags, B_c is a kx1 vector of constants, and u_t is the kx1 vector of reduced-form innovations with variance-covariance matrix Σ.

It is assumed that there exists a linear mapping between the reduced-form innovations and economic shocks, e_t, given as

$$u_t = Ae_t \tag{3}$$

with $e_t \sim (0, I)$. The impact matrix A must satisfy $AA' = \Sigma$. There are, however, an infinite number of impact matrices that solve the system. In particular, for some arbitrary orthogonalization, C, the entire space of permissible impact matrices can be written as CD, where D is a k x k orthonormal matrix (D'^{-1} and $DD' = I$, where I is the identity matrix). We place the Ramey (2011) news series and government defense spending variable in the first and second positions in the VAR, respectively, and the unanticipated defense shock is identified via the second column of the Cholesky factor of Σ. This implies that our identified unanticipated shock is orthogonal to the Ramey (2011) news series. We view this orthogonality as important because it ensures that the identified unanticipated shock is unrelated to defense news events, consistent with its definition of being a surprise innovation in defense spending.

2.3 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. This identification approach requires finding the linear combination of VAR innovations contemporaneously uncorrelated with current defense spending which maximally contributes to defense spending's future forecast error variance. The restriction with respect to defense spending is important for identification as it imposes on the identified shock to have no contemporaneous effect on defense spending.

Formally, our identification strategy is an application of the Barsky and Sims (2011) maximum forecast error variance (MFEV) approach for the identification of defense news shocks, which they employ to identify TFP news shocks. 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 given as

$$y_t = B(L)u_t \tag{4}$$

where $B(L)$ is a kxk matrix polynomial in the lag operator, L, of moving average coefficients and u_t is the kx1 vector of reduced-form innovations. We assume that there exists a linear mapping between the reduced-form innovations and structural shocks, ε_t, given as

$$u_t = A\varepsilon_t \tag{5}$$

Equations (4) and (5) imply a structural moving average representation

$$y_t = C(L)\varepsilon_t \tag{6}$$

where $C(L) = B(L)A$ and $\varepsilon_t = A^{-1}u_t$. The impact matrix A must satisfy $AA' = \Sigma$, where Σ is the variance-covariance matrix of reduced-form innovations. There are, however, an infinite number of impact matrices that solve the system. In particular, for some arbitrary orthogonalization, $\widetilde{A}$ (we choose the convenient Choleski decomposition), the entire space of permissible impact matrices can be written as $\widetilde{A}D$, where D is a k x k orthonormal matrix (D'^{-1} and $DD' = I$, where I is the identity matrix).

The h step ahead forecast error is

$$y_{t+h} - E_t y_{t+h} = \sum_{\tau=0}^{h} B_\tau \widetilde{A} D \varepsilon_{t+h-\tau} \tag{7}$$

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 then given as

$$\Omega_{i,j} = \sum_{\tau=0}^{h} B_{i,\tau} \widetilde{A} \gamma \gamma' \widetilde{A}' B'_{i,\tau} \tag{8}$$

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 unanticipated defense shock and defense news shock as 1 and 2, respectively. The defense news shocks identification requires finding the γ which maximizes the sum of contribution to the forecast error variance of defense spending over a range of horizons, from 0 to H (the truncation horizon), subject to the restriction that these shocks have no contemporaneous effect on defense spending. Formally, this identification strategy requires solving the following optimization problem

$$\gamma^* = \underset{\gamma}{\text{argmax}} \sum_{h=0}^{H} \Omega_{1,2}(h) = \sum_{h=0}^{H} \sum_{\tau=0}^{h} B_{2,\tau} \widetilde{A} \gamma \gamma' \widetilde{A}' B'_{2,\tau} \quad (9)$$

$$\text{subject to} \quad \widetilde{A}(1,j) = 0 \ \ \forall j > 1 \quad (10)$$

$$\gamma(1,1) = 0 \quad (11)$$

$$\gamma' \gamma = 1 \quad (12)$$

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

3 Empirical Evidence

3.1 Time Series of Identified Shocks

Figure 1 jointly shows the unanticipated defense shock, our identified MFEV news shocks, and the Ramey (2011) news shocks. To make the figure more readable, we present a one year trailing moving average of the shock series. Shaded areas represent the major war periods.

The identified unanticipated defense shock series clearly captures war periods: sizeable positive realizations generally take place during war periods followed by negative realizations after the ending of the wars. Most apparent is the Vietnam war, in which positive realizations (with a magnitude of 1.5 standard deviation) occurred during the war followed by negative realizations (of nearly -1 standard deviation magnitude). Moreover, the shock captures well the significant (and unexpected) military budget reductions that took place during the 1990s.

The Figure also depicts the time series of identified MFEV news and the Ramey news shocks from the benchmark VAR. These two shock series are strongly correlated with a contemporaneous correlation of 81%. It is apparent that the MFEV news shock series captures important defense news events such as the Korea 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 were of course accounted for in the narrative approach taken by Ramey (2011). As we shall see in the next section, despite being strongly correlated, these two shock series have significantly different implications for the macroeconomy.

The unexpected shock series and the news shock series, which are orthogonal by construction, have different time patterns, apart from the second gulf war. Moreover, the largest defense news event took place in the beginning of the Korean War, while the largest unexpected increase in military spending is associated with the Vietnam War. Some unexpected increases in military spending took place in the mid-1980s, one was related to the defense news series and one was not.

3.2 Impulse responses: Unexpected increases in military spending

Figure 2 depicts the estimated impulse responses of all the endogenous variables to a positive one standard deviation unanticipated defense shock. Dashed lines representing 2.5th and 97.5th percentile confidence bands, respectively, constructed with a bootstrap procedure, repeated 2000 times. We use the Hall confidence intervals (see Hall (1992)) which attain the nominal confidence content, at least asymptotically, under general conditions and has relatively good small sample properties, as shown by Kilian (1999).

The unanticipated defense shock generates an impact output multiplier of 0.87. An one standard deviation unexpected shock in military spending raises output by 0.15% on impact after which this effect declines and falls to zero after one year. Defense spending exhibits a persistent response with an initial impact of 2.25% , peaking at 2.6% after one year. Moreover, investment significantly declines following the shock with a peak response of 0.84% after one year. The shock does not seem to affect the labor market and both hours and real wage responses are insignificant. Consumption demand is not affected by the shock either. The same holds true for the responses of the interest rate and inflation and the shock appears to be uncorrelated with changes in the average marginal income tax rate.

Interestingly, TFP significantly rises following the shock with a 0.24% rise on impact. This increase in TFP is quite persistent and only dies out after two years. The immediate significant jump in TFP following the shock is an indication that the mechanism which governs the relation between defense spending and TFP operates contemporaneously. Overall, apart from defense spending, output, investment, and TFP, the responses of the other variables are small and insignificant. Hence, the shock seems to generate a positive multiplier that it is smaller than one due to the crowding out of private investment. But how do responses of the economy look like when TFP is constrained to be unaffected by the shock?

3.2.1 Shutting Down the TFP Response

Figure 3 presents the estimated impulse responses of all the variables to a positive one standard deviation unanticipated defense shock orthogonalized with respect to current TFP. This amounts to placing TFP in the first position in the VAR, the Ramey (2011) news series in the second position, and defense spending in the third position. The unanticipated defense shock is identified from the third column of the Cholesky factor of the VAR variance covariance matrix.

It is apparent that output now essentially doesn't change resulting in a zero multiplier and investment declines more compared to the benchmark case with a peak response of 0.92%. Hence, the unanticipated government expansion generates a crowding out of the private sector and zero output multipliers. In a following subsection we try to explore the relationship behing TFP and military spending more extensively.

3.3 Impulse responses: Anticipated Increases in Defense Spending

Figure 4 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 2.5st and 97.5th percentile confidence bands. Following a positive defense news shock, defense spending does not change on impact, by construction, after which it grows quite gradually peaking after 7 quarters at 3.8% higher than its pre-shock value. Output, investment, consumption, and hours all jump up on impact, with the responses being both statistically and economically significant at 0.25%, 0.73%, 0.21%, 0.29%, respectively. The peak response of output is obtained after 5 quarters reaching 0.4% whereas the peak multiplier, excluding the trivial case of an infinite multiplier at the impact horizon, is obtained after 3 quarters, reaching 1.93. Output and hours follow more of a hump-shaped response and return to their pre-shock value only after three years, as opposed to consumption and investment the response of which returns to zero much more quickly after a year and a half. Note also that the investment response becomes negative after reaching zero.

It is also apparent that the real wage declines following the news shock with the peak decline occurring after one year at nearly 0.5%. 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 (2011) 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. Moreover, the news shock also raises the average marginal income tax rate as well as inflation and interest rates. Note that the tax rate increases in a gradual manner reflecting the notion that defense news shocks foretell future increase in both defense spending and tax rates. Finally, note that the news shock has an insignificant effect on TFP at essentially all horizons, providing further indication that this shock generates mechanisms that are different from those induced by the unanticipated shock. Moreover, the insignificant response of TFP at future horizon may suggest that the former mechanisms potentially offset the latter ones, thus resulting in no TFP response following the news shock.

For comparison purposes, Figure 5 shows the estimated impulse responses of all the variables to a positive one standard deviation shock to the Ramey news variable orthogonalized with respect to current defense spending.[4] Two important differences stand out. First, our news shock has a bigger effect on defense spending as the peak response of spending following the Ramey news shock is 3.13% compared to 3.8% according to our estimation. Second, in addition to the responses of all the variables (excluding the Ramey news series) being significantly weaker compared to those in Figure 4,[5] it is apparent that for some of the variables the signs also reverse. In particular, investment falls after one quarter and remains negative thereafter, consumption falls slightly after one quarter, and interest rates also decline. Nevertheless, it should be noted that these responses are not statistically significant, which is also the case for hours (with essentially zero responses). As for TFP, Apart from the 5-quarter horizon at which it has a mildly significant response, the Ramey news shock does not have a significant effect on TFP, smilar to the MFEV news shock.

3.4 Forecast error variance decompositions

Figure 6 shows the share of the forecast error variance of the variables in the VAR attributable to defense news shocks, as identified with the MFEV method, the Ramey news shock, and the unanticipated defense shock. It is apparent that the MFEV news shock accounts for a bigger share of the FEVD of all the variables compared to Ramey's news shocks. The MFEV news shocks explains 53% of the variation in defense spending at the three year horizon compared to 34% by the Ramey news shock. Moreover, the MFEV news shock explains 64% of the variation in the Ramey news variable at the impact horizon. This result indicates that our identified news shock is strongly related to Ramey's news shock though it appears to contain more information on future defense spending in addition to having a much bigger effect on the other variables.

In addition to the defense spending variable, our news shock accounts for a bigger share

[4]It's important to add this orthogonalization restriction as omitting it results in the Ramey news shock having a significant impact effect on defense spending of 0.39%.

[5] The peak response of output is obtained after 5 quarters reaching 0.14% and reflecting a multiplier of 0.63.

of the variation in all other variables: it explains approximately 14% of output variation at business cycle frequencies compared to less than 1% explained by Ramey's news shock, and more than 20% of the business cycle variation in hours compared to essentially a zero share accounted for by Ramey's news shock. Schmitt-Grohé and Uribe (2012) provide a number in between. They find that government spending shocks account for close to 10 percent of the variance of output growth.

The MFEV news shock also account for a much bigger share of the business cycle variation in the nominal variables and the Barro and Redlick (2011) average marginal tax rate. In particular, our news shocks explains 16% of the variation in inflation at the three quarter horizon and 13% of the variation in the tax rate at the two year horizon, compared to contributions of 2% and 8% by the Ramey news shock, respectively. Furthermore, our news shock explains more than 6% of the business cycle variation in interest rates compared to essentially zero in the case of Ramey's news shock.

4 Robustness

The results of the previous section are challenging since they seem to suggest that the stimulative effects of government spending are due to the positive contemporaneous relationship between military spending and TFP. In this section we provide results from a number of sensitivity checks we run to establish the robustness of our findings 3.

4.1 Results for the 1939-2008 Sample

Figures 7, 8a, and 8b correspond to Figures 2, 4, and 5 with the only difference being that now the VAR is estimated using the larger sample period of 1939:Q2-2008:Q4 and thus also excludes TFP. Even though excluding TFP from the system does not allow us to examine the relevance of the TFP channel for unanticipated shocks in this larger sample, we consider it still worthwhile to investigate whether the qualitative nature of our results as well as the relative importance of the MFEV news shock hold in this larger sample. Including the world war II period introduces additional large fiscal events, both unanticipated and anticipated, that are much larger in magnitude relative to post world war II fiscal events. This was confirmed for the news shock case by the narrative analysis undertaken in Ramey (2011).

There are two noticeable differences with respect to the benchmark impulse responses to the unanticipated shock. First, consumption declines on impact following the shock, this compared to an insignificant and negligible positive response in the benchmark case. Second, the tax rate increases significantly following the shock while it exhibited an insignificant response in the benchmark case. Furthermore, the peak multiplier is obtained after three quarters, reaching 0.76.

It is apparent from both Figure 8a and Figure 8b that, by and large, the results are qualitatively unchanged for the MFEV news shock and the Ramey news shock. The MFEV news shock continues to raise output, hours, and consumption, though the significant rise in investment observed in the benchmark case is not robust to the extension of the sample period. While the point estimate impact effect on investment is still positive, it is apparent that investment starts to decline much sooner compared to the benchmark case though this decline becomes significant only after 6 quarters.

Moreover, it is evident that the responses are quantitatively stronger than the benchmark responses and that the MFEV news shock still generates much stronger responses than the Ramey news shock. In particular, the peak repones of defense spending is 5.7% following the MFEV news shock compared to 2.9% following the Ramey news shock. The peak effects of the MFEV news shock on output and hours are twice as large as those of the benchmark case reaching 1.2% after 6 quarters. 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 impulse responses of output and hours.

4.2 Results for a post-Korea Sample

Next we examine the sensitivity of our results to excluding the Korean war episode. Figures 9a and 9b correspond to Figures 2 and 3, respectively, with the only difference being that now the VAR is estimated using the smaller sample period of 1955:Q1-2008:Q4 which excludes the Korean war. Results are qualitatively unchanged: The significant relation between the unanticipated defense shock and TFP continues to hold and orthogonalizing the unanticipated shock with respect to TFP continues to generate a multiplier of zero with complete crowding out of the private sector.

Furthermore, Figures 10a and 10b show the impulse responses of the variables to the MFEV and Ramey news shocks, respectively. The results are unchanged: the MFEV news shock continues to significantly raise the real aggregates, inflation, and interest rates, while still maintaining stronger effects than the Ramey news shock.

4.3 Different Truncation Horizon

Figure 11 displays the responses to the MFEV news shock for four separate truncation horizons, $H = 10$, 20 (benchmark), 30, and 40. The results remain similar across the four truncation horizons and demonstrate that our inference regarding the implications of the MFEV news shock is robust to assuming different truncation horizons.

5 Why Does TFP Rise Following Unanticipated Defense Shocks?

Using industry-level data, Nekarda and Ramey (2011) find that government spending shocks slightly reduce labor productivity. As discussed in that paper, a plausible explanation for the difference between the aggregate relation between government spending and productivity and the industry-level relation is the sectoral reallocation effects that take place following a government spending shock. Basu and Fernald (1997) have shown that aggregate TFP growth can be written as the sum of technological growth and a reallocation term:

$$\Delta TFP_t = \Delta a_t + \sum_i \omega_i(\gamma_i - \bar{\gamma})\Delta x_{it} \tag{13}$$

where Δa_t is the growth rate of aggregate technology, $\bar{\gamma}$ is the weighted average returns to scale across industries, γ_i is returns to scale in industry i, and ω_i is the share of industry i in total output. The last term represents reallocation of inputs across industries and will be non zero as long as different industries have different returns to scale.

It is generally known that government spending is mainly concentrated in certain aerospace related industries. As Table 1 in Nekarda and Ramey (2011) demonstrates[6], over 60% of shipments in aerospace related industries go to the federal government. To confirm that our identified unanticipated defense shocks induce a reallocation of production towards these industries, we added to our benchmark VAR the log of the capacity utilization rate in the aerospace and miscellaneous transportation equipment sector and recover shocks as in the benchmark case. The series of capacity utilization was taken from the Board of Governors database and is available from 1948 in monthly frequency which we convert to quarterly frequency via averaging.

Figure 12 presents the results from this augmented VAR. As shown in the figure, the unanticipated defense shocks significantly raises the capacity utilization rate on impact and its response peaks at 1.21% after 11 quarters. The responses of the other variables are unchanged with respect to the benchmark VAR. Given the findings obtained in Basu and Fernald (1997) and Nekarda and Ramey (2011) that returns to scale are generally higher in durable manufacturing than non-durable manufacturing, one can guess that the reallocation of production towards the aerospace related industries is likely to generate higher aggregate TFP growth via the reallocation term.

To shed further light on the importance of the reallocation mechanism one needs to have a proxy for the reallocation term in Equation (13). We measure the reallocation term as the difference between the annual aggregate TFP growth measure of Fernald (2012) and the annual technological growth measure of Basu et al. (2006). The former does not account for reallocation of factor inputs and simply calculates a utilization-adjusted aggregate Solow residual whereas the latter accounts for reallocation by constructing aggregate technological growth from industry-specific utilization-adjusted Solow residuals. Note that that both measures use the same utilization adjustment. Our proxy for reallocation runs annually from 1948 to 1996, to investigate our hypothesis we extract the defense shocks from an annual VAR with the same variables as in our benchmark model.

Figures 13 and 14 present the response of our reallocation term to our annualized bench-

[6] See also Table 4 of Perotti (2007).

mark unanticipated defense shocks as well as the annualized unanticipated defense shocks orthogonalized with respect to current TFP. We can see clearly that reallocation jumps significantly following the unanticipated shock. This is consistent with the significant correlation of 30% that these two variables have. In contrast, the unanticipated shock that is orthogonal to TFP has an insignificant effect on reallocation. This too is consistent with the observed low correlation of 8% between the two series. Overall, the results from this exercise indicate that a reallocation mechanism appears to be the driving force behind the relation between unanticipated defense shocks and TFP[7].

Our conclusions are consistent with the results of Phelan and Trejos (2000) and Ramey and Shapiro (2011). However, alternative explanations for the observed responses of TFP to unanticipated military spending shocks exist, since TFP measures unobservables that can affect production. We tried various other explanations for why military spending increase TFP since most of them are not confirmed in the data. For example, unexpected shocks in military spending might signal that the economy is in danger raising the sense of patriotism and making workers exert more effort at work to contribute to the strengthening of the country. We took annual data from the PSID from 1967 to 2008 on absences from work due to vacation taken (in weeks) and examined their correlation with our identified unanticipated shock their correlation is positive and insignificant. Also, if unexpected increases in military spending increase firms and consumers confidence this could be reflected in the determination of TFP. We included consumer confidence data from the Michigan Survey of Consumers in our VAR. This confidence series summarizes responses to a forward-looking question concerning aggregate expectations over a five year horizon and is available from 1960:Q1. The response of consumers confidence to our identified shock is not significant, while that of TFP is significantly positive, indicating that confidence changes is the wrong channel to look at as a potential explanation for our findings. Finally, military spending affects innovative, high-tech military projects that can potentially increase the economy-wide R&D.

[7]To reinforce our findings we have tried to investigate whether reallocations of hours between durables and nondurable goods can account for the TFP responses to military spending shock. However, the responses of durables and nondurables hours to the unanticipated military spending shock were not significant. We believe that further disaggregation is needed to recover significant effects, but due to unavailability of data we have concentrated on the effects of the shock on capacity utilization instead.

Hence, unexpected increases in military spending could affect the R&D of the economy, and eventually TFP measures. Nevertheless, such effect cannot be contemporaneous as it takes time for R&D to build up and change TFP.

6 A Theoretical model

We begin by exploring what a standard DSGE model predicts concerning the effects of anticipated and unanticipated shocks in order to assess its empirical relevance. the model is pretty standard and we briefly discuss its main ingredients below.

6.1 The benchmark DSGE model

This section presents a general equilibrium dynamic model that encompasses a flexible price RBC and a New-Keynesian sticky price setup as special cases.

6.1.1 Households

Households derive utility from private consumption, $C_t$and leisure, $1 - N_t$. At time 0 households choose sequences for private consumption, labor supply, capital to be used next period K_{t+1}, nominal state-contigent bonds, $D_{t+1}$and government bonds, B_{t+1} to maximize the expected discounted utility:

$$E_0 \sum_{t=0}^{\infty} \beta^t u(C_t, N_t) = \beta^t \frac{\left[C_t(1-N_t)^{1-\phi}\right]^{1-\sigma} - 1}{1-\sigma} \tag{14}$$

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. We assume that $C_t = \left[\int_0^1 C_{it}(i)^{\frac{\varepsilon-1}{\varepsilon}} di\right]^{\frac{\varepsilon}{\varepsilon-1}}$, where C_{it} stands for consumption of product i and ε is the elasticity of substitution between different varieties of goods. The household maximizes utility subject to the sequence of budget constraints:

$$\begin{aligned} P_t(C_t + I_t) + E_t\{Q_{t,t+1}D_{t+1}\} + R_t^{-1}B_{t+1} \quad &\leq \\ (1-\tau^l)P_t w_t N_t + [r_t - \tau^k(r_t - \delta)]P_t K_t + D_t + B_t - T_t P_t + \Xi_t & \end{aligned} \tag{15}$$

where $(1-\tau^l)P_t w_t N_t$, is the after tax nominal labor income, $[r_t - \tau^k(r_t - \delta^p)]P_t K_t$is the after tax nominal capital income (allowing for depreciation), Ξ_t, are nominal profits from the firms (which are owned by consumers), and $T_t P_t$ 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 . With the disposable income the household purchases consumption goods, $P_t C_t$, capital goods,$P_t I_t$, and assets. Private capital accumulates according to:

$$K_{t+1} = I_t + (1-\delta)K_t - \nu\left(\frac{K_{t+1}}{K_t}\right)K_t \tag{16}$$

where δ is a constant depreciation rate and the function $\nu(.)$ is parameterized as

$$\nu\left(\frac{K_{t+1}}{K_t}\right) = \frac{b}{2}\left[\frac{K_{t+1}-(1-\delta)K_t}{K_t} - \delta\right]^2 \tag{17}$$

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

6.1.2 Firms

A firm j produces output according to:

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

where $K_t(j)$ and $N_t(j)$ are private capital and labor inputs hired by firm j, and Z_t is an aggregate technology shock. The production function displays constant returns to scale with respect to private inputs. 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

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

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

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

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[8]. Given the Calvo pricing assumption, the evolution of the aggregate price index is:

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

For the flexible-RBC version of the model, the fraction of firms that can reset the price at each t is equal to one. Hence, prices are determined by:

$$P_t = \frac{\varepsilon}{\varepsilon-1}\frac{1}{1-\tau^{\varepsilon}}MC_t, \qquad \forall t \tag{24}$$

6.1.3 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:

$$P_tG_t - \tau^{\varepsilon}P_tY_t - \tau^l w_t P_t N_t - \tau^k(r_t-\delta)P_tK_t - P_tT_t + B_t = R_t^{-1}B_{t+1} \tag{25}$$

[8] This assumption is not necessary for comparing the two models. As shown by Hornstein (1993), the qualitative implications of a monopolistic competitive RBC model are identical to those of a competitive one.

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. In order to ensure determinacy of equilibria and a non-explosive solution for debt (see e.g., Leeper (1991)), we assume that a debt targeting rule of the form:

$$T_t = \overline{T} \exp(\zeta_b (b_t - \overline{b})) \tag{26}$$

where $b_t = \frac{B_t}{GDP_t}$.

The debt rule in (x) implies that deficit in equilibrium is small in size and has low volatility for both models. Note that setting ζ_b very high delivers similar results with a model that abstracts from debt and considers that 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:

$$R_t = \overline{R} \exp(\zeta_\pi \pi_t + \epsilon_t^R) \tag{27}$$

where ϵ_t^R is a monetary policy shock.

6.1.4 Closing the model

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

$$Y_t = C_t + I_t + G_t \tag{28}$$

6.1.5 Introducing anticipated and unanticipated government spending shocks

The government spending shock, G_t , is subject to anticipated as well as unanticipated innovations. Following our empirical results, we will study a formulation with 6-quarter anticipated shocks. Government spending evolves according to:

$$\ln(\frac{G_t}{G}) = \rho_g \ln(\frac{G_{t-1}}{G}) + \varepsilon_{g,t} \tag{29}$$

$$\varepsilon_{g,t} = \varepsilon_{g,t}^0 + \varepsilon_{g,t-6}^6 \tag{30}$$

where $\varepsilon_{g,t}^{j}$, for $j = 0, 6$ is assumed to be an i.i.d normal disturbance with mean zero and standard deviation σ_{g}^{j} and is uncorrelated across time and across possible anticipation horizons. The innovation $\varepsilon_{g,t}^{j}$ denotes the j-period anticipated changes in the logarithm of G_t. In other words, $\varepsilon_{g,t-6}^{6}$ is a six-period anticipated innovation in G_t. Agents are assumed to observe in in period t current and past values of the innovations $\varepsilon_{g,t}^{0}$ and $\varepsilon_{g,t-6}^{6}$ and they can forecast future values of $\varepsilon_{g,t}$ as follows:

$$E_t \varepsilon_{g,t+k} = \left\{ \begin{array}{c} \varepsilon_{g,t+k-6}^{6}, \text{ if} 1 \leq k \leq 6 \\ 0, \text{ if} k > 6 \end{array} \right\}$$

Since agents are forward looking they use the information contained in the realizations of $\varepsilon_{g,t}^{j}$ in their current choices of consumption, leisure, investment and asset and bond holdings.

We solve the model by approximating the equilibrium conditions around the flexible price non-stochastic steady state. The parameterization we use is standard and is summarized in Table 1. We consider both the flexible and the sticky price version of the model by varying parameter, γ, the degree of price stickiness. Figure 15 presents the impulse responses of the flexible and the sticky price model to an unanticipated increase in government spending. In the absence of externalities from government spending shocks, the RBC model (left panel) predicts a crowding out of investment and a minimal increase in output followed by the increase in the labor supply as a consequence of the negative wealth the shock induces to private agents. On the other hand, the output effects of the shock for the sticky price model are stronger as they result from a combination of an increase in the labor supply due to the negative wealth effect and the increase in labor demand stemming from the assumption of price stickiness.

In Figure 16 we present impulse responses to the anticipated government spending shock in the two models. Both models predict an increase in output and investment in the impact period, in which the news becomes known to the private agents, and a fall in private consumption. However, the size of the impact response is very small relative to the multipliers reported in the previous section and relative to the impact response induced by unexpected shocks. Hence, although one could argue that the RBC model can match qualitatively the empirical impulse responses it is far from replicating quantitatively the empirical findings both in terms of the consumption responses to the shocks and in terms of the size of the fiscal multipliers related to fiscal news shocks.

Luckily we are neither the first in the literature to face difficulties in inducing positive responses of consumption after government spending shocks nor the first to have difficulties in propagating news shocks in the economy. various theoretical models have been suggested for generating increases in consumption after a fiscal expansion. The various alternative mechanisms can be summarized as follows: (a) the consumption and hours' complementarities 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 that existing RBC models cannot generate intuitive news driven business cycles. Several modifications of the standard model have been suggested for propagating TFP news shocks in this strand of literature[9]: (a) making consumption or leisure an inferior good (see, Eusepi and Preston (2009)); (b) 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) 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)).

In order to look for a mechanism that would propagate the effects of news shocks and at the same time induce zero multipliers with respect to unexpected shocks we have experimented with the various alternatives provided in the two strands of literature. To define better our search we have looked for mechanisms that could fit the standard quantitative DSGE models. In the next section we present the necessary modifications to the benchmark model that make it match the empirical findings.

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

6.2 A modified DSGE model

Distortionary taxation is a crucial element for generating significant positive effects from the news shocks. This is because agents that receive a signal about future increases in government spending, with passive fiscal rule in place or with a balanced budget rule, realize that taxes will increase in the future and, as a result increase their labor supply when the news are delivered propagating the effects of the news shocks. Yet, as Baxter and King (1993) have shown, when taxes are distortionary the output effects of an unexpected balanced budget increases in spending are negative and this is in contrast with the evidence presented in the previous section. Hence, distortionary taxation by itself cannot explain jointly the zero multiplier in responses to unexpected shocks and the positive and significant responses with respect to anticipated shocks.

In order to achieve zero multipliers with respect to unexpected spending shocks that are partially financed with distortionary taxation we need to introduce features in the model that would propagate the effects of the initial increase in spending in the economy. We have considered several alternative mechanisms to achieve this goal. The most successful was the introduction of a share of non Ricardian consumers in the model economy (widely known as rule-of-thumb consumers). The behavior of those households is, by definition, insulated from the otherwise stabilizing force associated with changes in real interest rates. Moreover, since these consumers consume their disposable income and in the presence of sticky prices the latter is augmented through the increases in the real wage induced by the increased labor demand, those agents will increase consumption after the unexpected shock whenever fiscal policy is characterized by a rule such as the one described in (equation: debt rule). Note that with a balanced budget rule non-Ricardian agents would not experience an increase in their disposable income and they would not increase their consumption on impact. On the other hand, those agents should not react to news about fiscal policy since they do not intertemporaly substitute consumption. Hence the presence of rule-of-thumb consumers alone would not be enough to propagate fiscal news shocks in the model economy. In order to propagate such shocks an additional element is needed that will exacerbate responses to news. Borrowing from the intuition of Jaimovich and Rebelo (2009), we introduce variable capital utilization. Variable capital utilization given the complementarities between effective capital and labor in the economy propagates the news shocks and at the same time the initial impact of unexpected shocks in the underlying economy and counteract the negative effect of distortionary taxation in output in the face of unexpected government increases. Hence, we modify the sticky price model by adding to the benchmark economy the following features (a) rule of thumb consumers (b) variable capacity utilization and (c) distortionary income taxation[10].

Figure 17 presents the impulse responses of the modified economy with respect to unanticipated and anticipated changes in government spending. The responses in the figure match relatively well their empirical counterparts.

7 Conclusions

Our results are very important for directing future research in fiscal policy issues since they render the efforts of many economists to build models that produce high output multipliers in response to unexpected government spending increases unsuitable. Unexpected increases in government spending shocks do not involve significant demand effects and our findings bring us back to square one: the RBC model.

Yet, Ramey (2011) and others find significant responses of the macroeconomy to fiscal news. We show that news about military spending do affect aggregate demand, but the mechanism at work with respect to those shocks is very different relative to the mechanism characterizing the unexpected shocks we identify in the current paper and what economists (ourselves included) have modeled so far as fiscal shocks in dynamic stochastic general equilibrium models.

[10] The loglinear equations for the modified model are presented in the online appendix.

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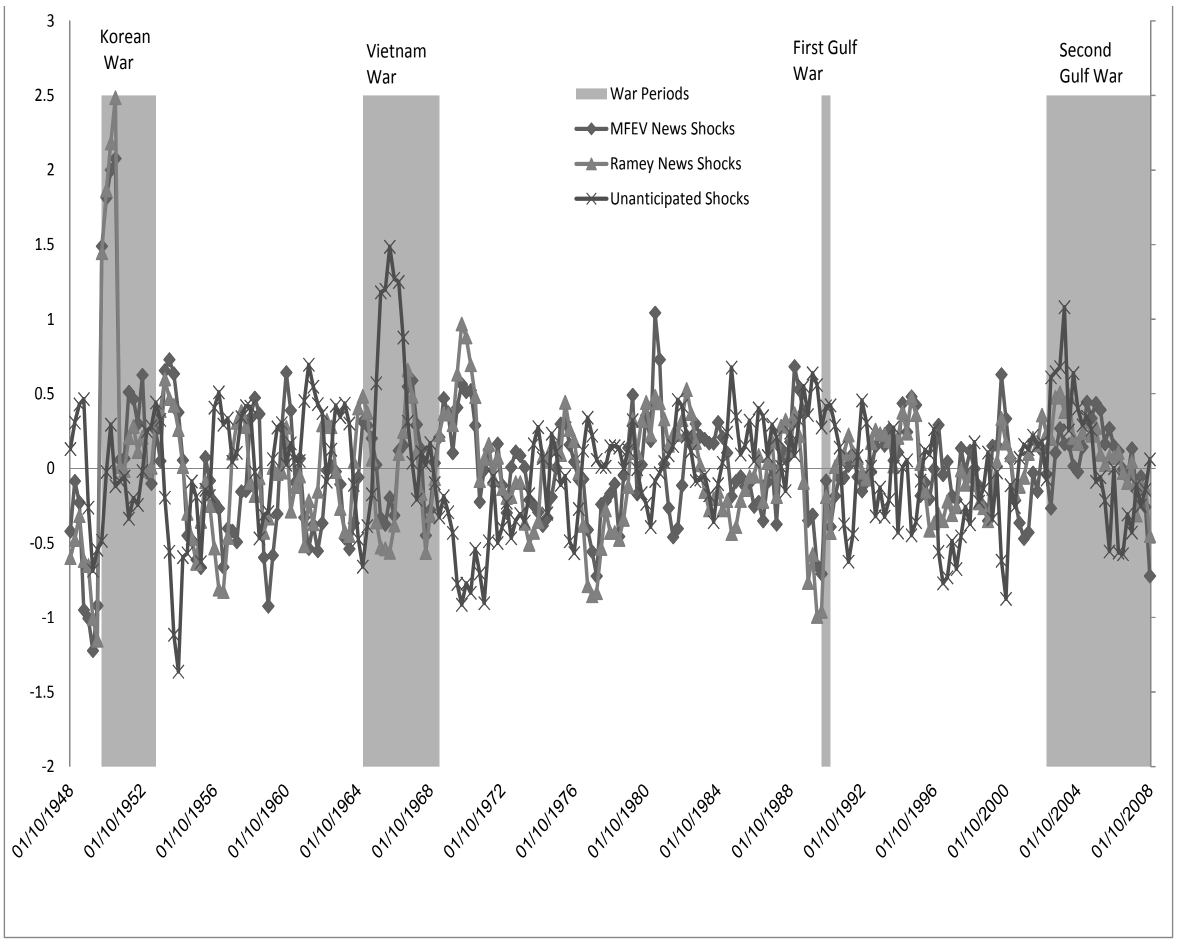
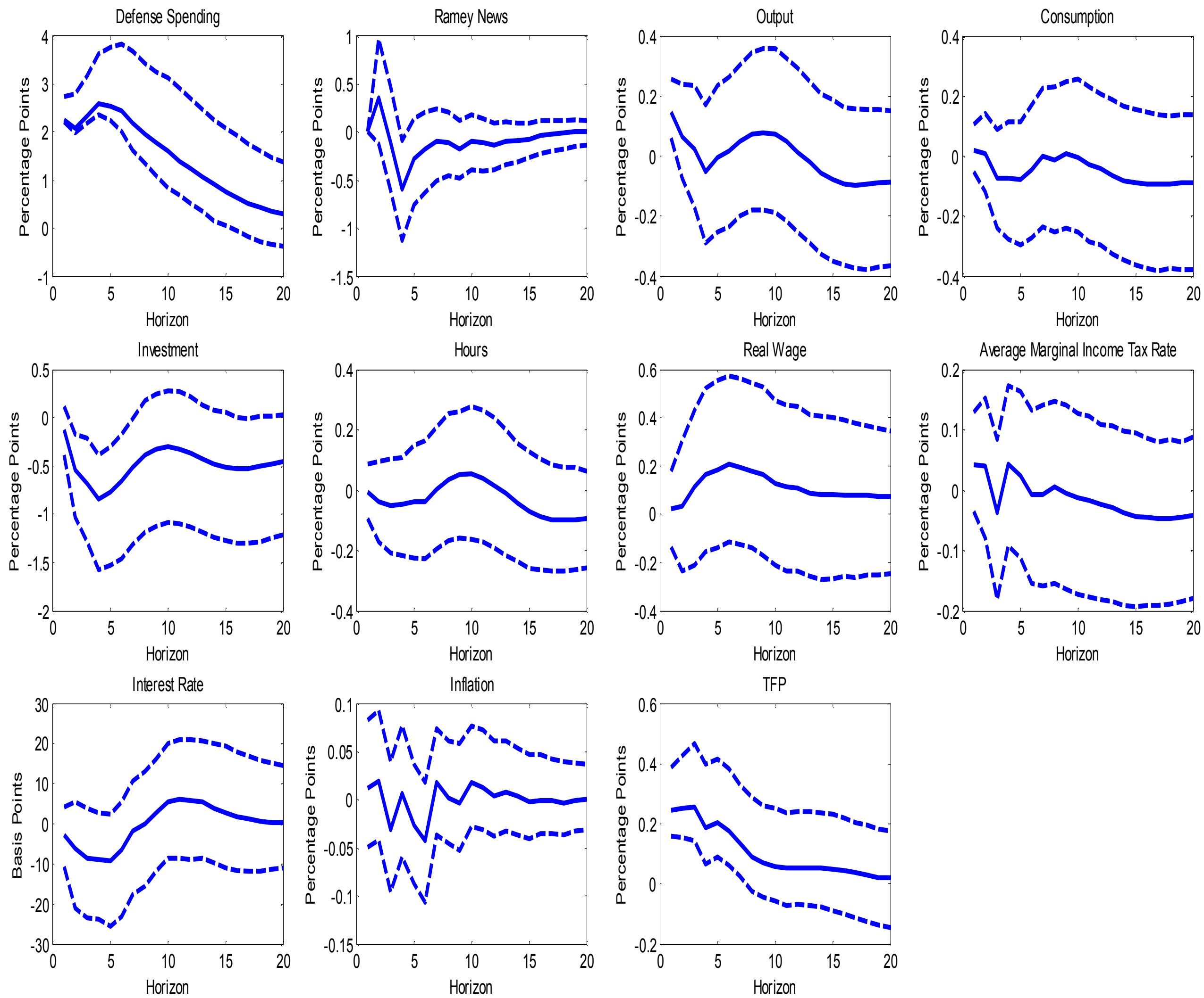
	Table 1: Parameter values or ranges	
β	discount factor	0.99
B/Y	steady state debt to output ratio	0.6
σ	risk aversion coefficient	2
ϕ	preference parameter	0.7
b	adjustment cost parameter	5
δ	capital depreciation rate	0.025
α	capital share	0.36
τ^l	average labor tax rate	0.3
τ^k	average capital tax rate	0.4
G/Y	steady state G/Y ratio	0.18
ζ_π	Taylor's coefficient	1.5
ζ_b	coefficient on debt rule	3.5
γ	degree of price stickiness	0,0.75
$\frac{\varepsilon}{\varepsilon-1}$	steady state markup	7.88
ρ_G	persistence of G shock	0.94
λ	rule of thumb consumers	0.3
ϕ_u	elasticity of depreciation to changes in utilization	1.40

Figure 1: **Identified Unanticipated Defense Shock and Ramey (2011) News Shock Time Series (smoothed).**



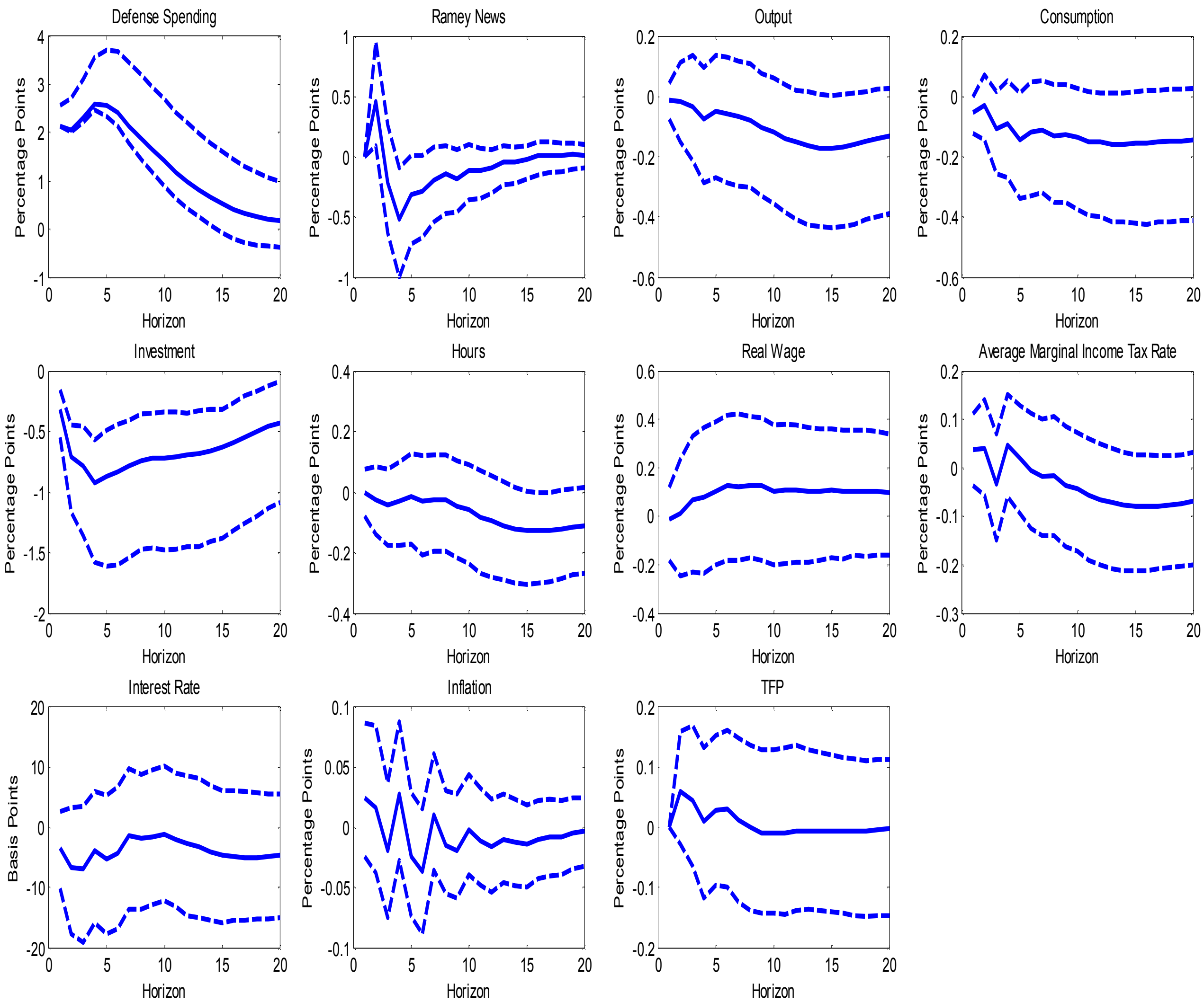
Notes: The war periods are represented by the shaded areas. So as to render the figure more readable, the plotted identified shock series is smoothed using a one year moving average. Specifically, it is calculated as $\varepsilon_t^s = (\varepsilon_{t-3} + \varepsilon_{t-2} + \varepsilon_{t-1} + \varepsilon_t)/4$, where ε_t is the identified shock series. The plotted series begins in 1948:Q4 and ends in 2008:Q1.

Figure 2: **Impulse responses to a one standard deviation Unanticipated Defense Shock from the Benchmark VAR (solid lines)**.



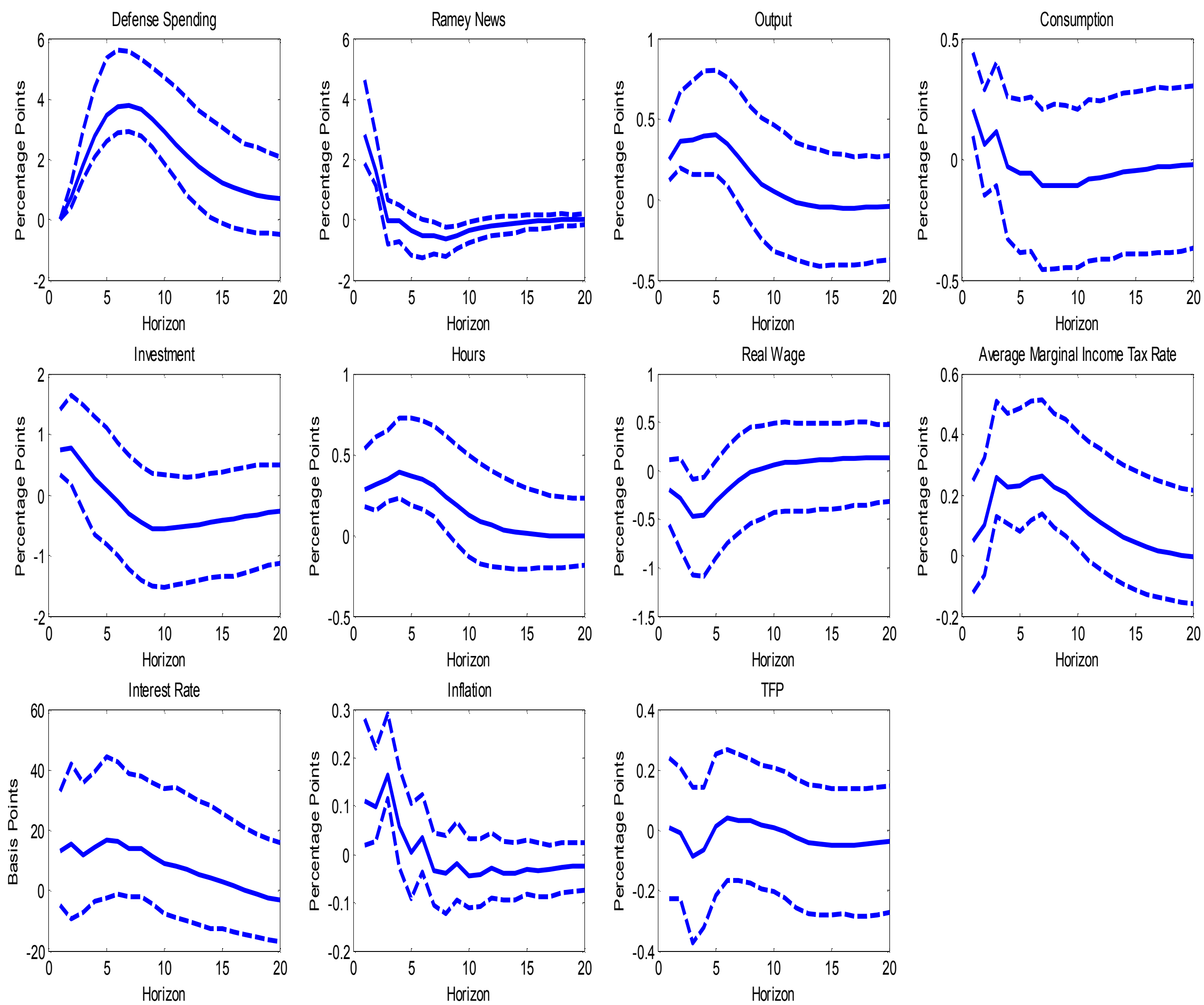
Notes: The unanticipated defense spending shocks is identified as the VAR innovation in defense spending orthogonalized with respect to the Ramey (2011) news series. Dashed lines represent 2.5th and 97.5th percentile Hall (1992) confidence bands generated from a residual based bootstrap procedure repeated 2000 times. Horizon is in quarters.

Figure 3: **TFP Shut Down: Impulse responses to a one standard deviation Unanticipated Defense Shock from the Benchmark VAR (solid lines)**.



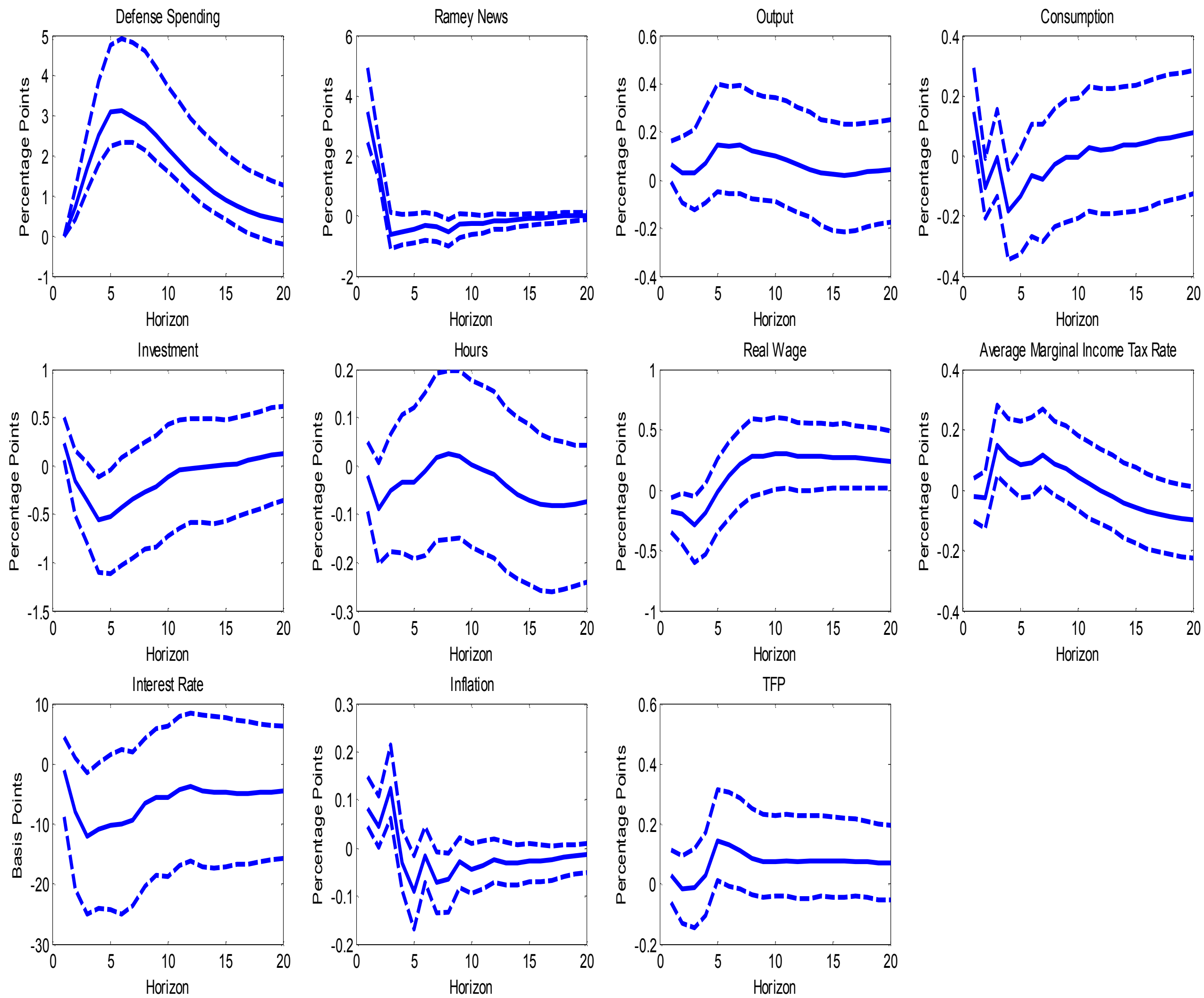
Notes: The unanticipated defense spending shocks is identified as the VAR innovation in defense spending orthogonalized with respect to the Ramey (2011) news series and TFP. Dashed lines represent 2.5th and 97.5th percentile Hall (1992) confidence bands generated from a residual based bootstrap procedure repeated 2000 times. Horizon is in quarters.

Figure 4: **Impulse responses to a one standard deviation MFEV Defense News Shock from the Benchmark VAR (solid lines).**



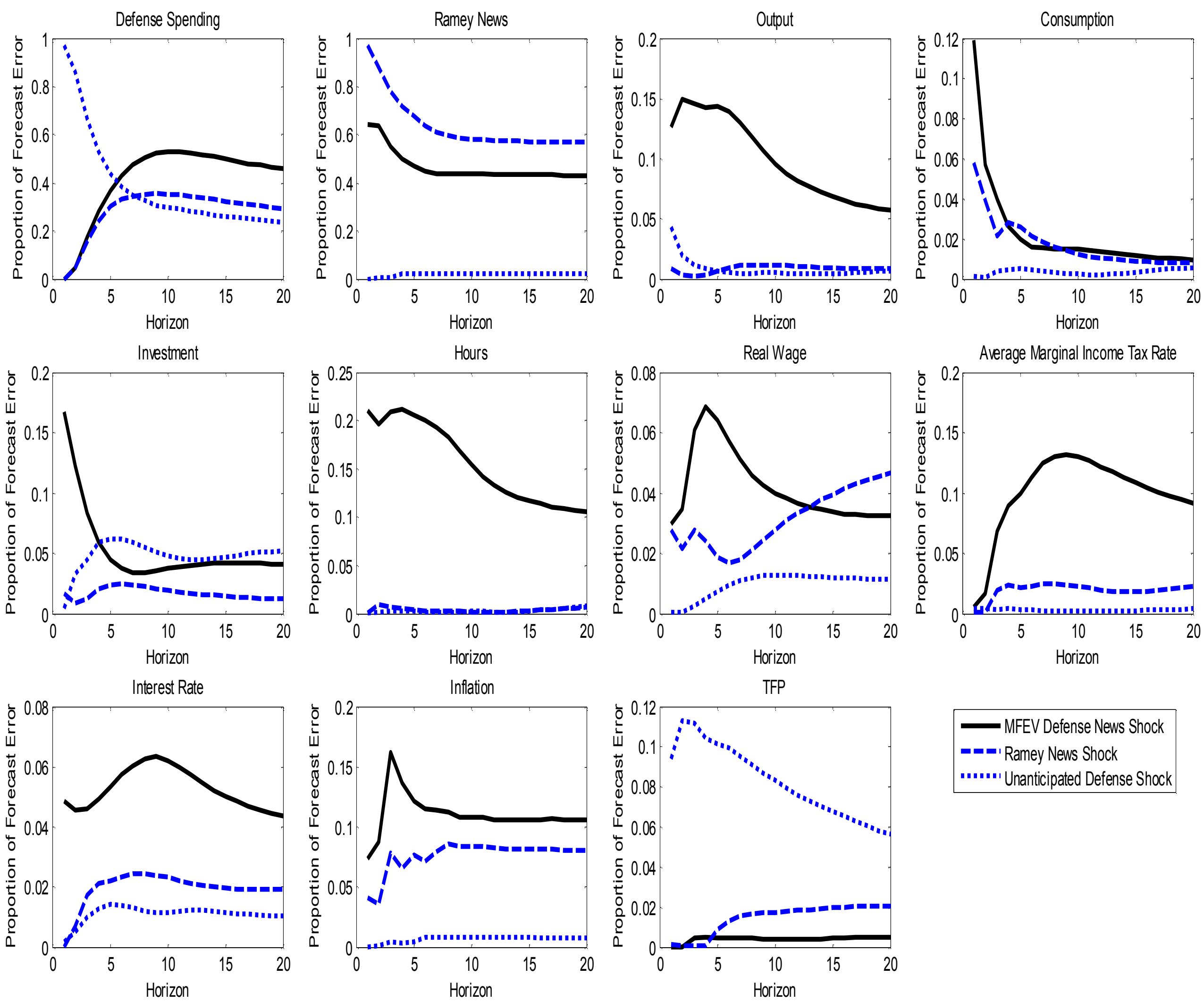
Notes: The impulse responses were obtained from applying the MFEV method explained in section 2.2. Dashed lines represent 2.5th and 97.5th percentile Hall (1992) confidence bands generated from a residual based bootstrap procedure repeated 2000 times. Horizon is in quarters.

Figure 5: **Impulse responses to a one standard deviation Ramey's Defense News Shock from the Benchmark VAR (solid lines).**



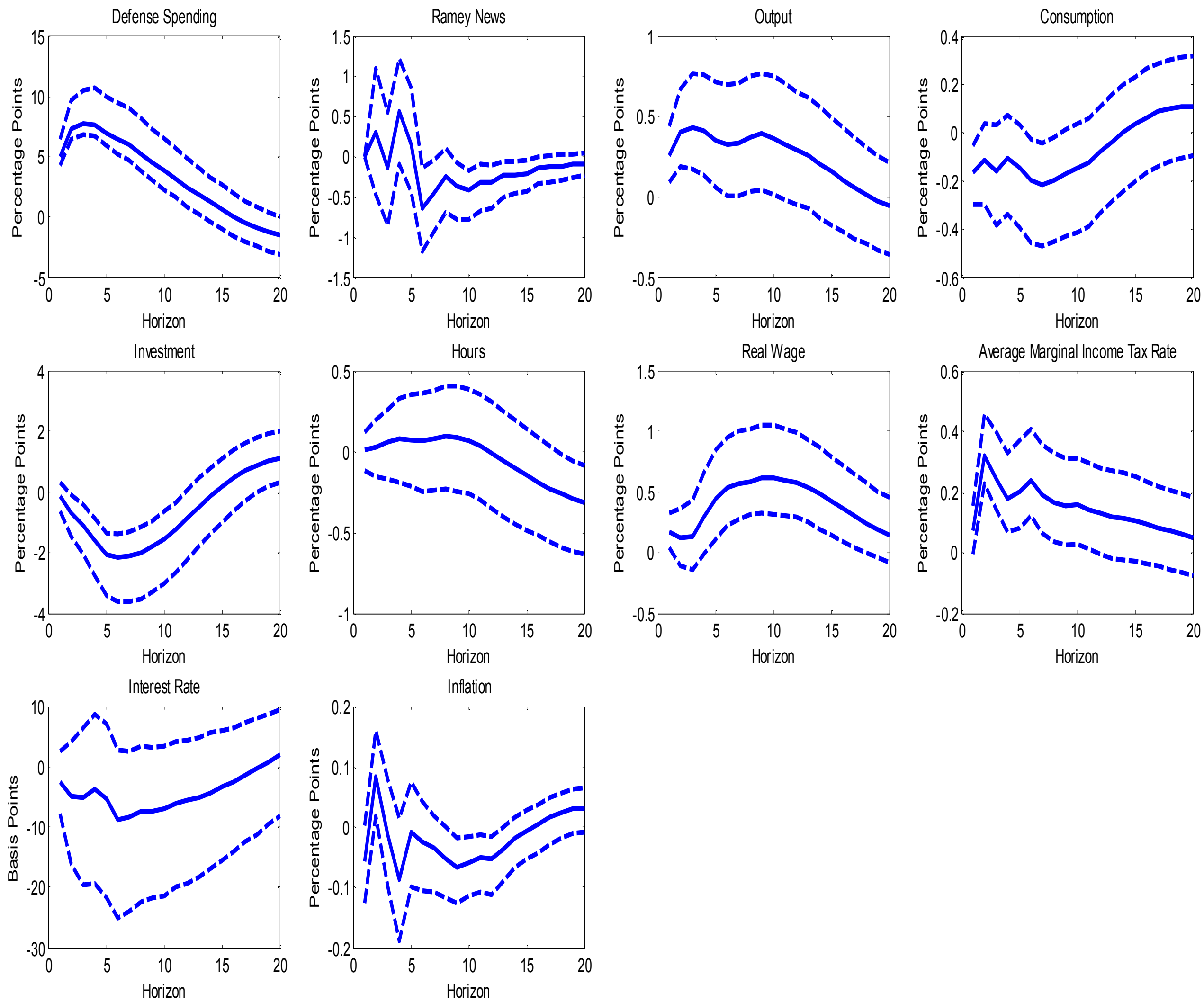
Notes: The impulse response are with respect to the shock to the Ramey's news variable orthogonalized with respect to current defense spending. Dashed lines represent 2.5th and 97.5th percentile Hall (1992) confidence bands generated from a residual based bootstrap procedure repeated 2000 times. Horizon is in quarters.

Figure 6: **The Share of Forecast Error Variance Attributable to Unanticipated Defense Shocks, MFEV News Shocks, and Ramey's News Shocks**.



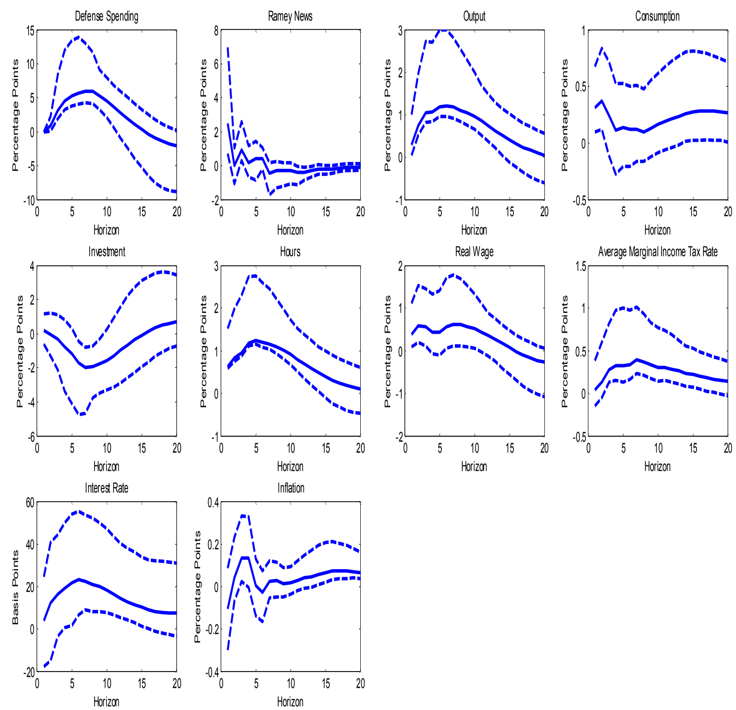
Notes: The unanticipated shock, MFEV news shock, and Ramey's news shock correspond to those from figures 2, 4, and 5, respectively.

Figure 7: **Larger Sample (1939-2008): Unanticipated Defense Shocks Impulse Responses**.

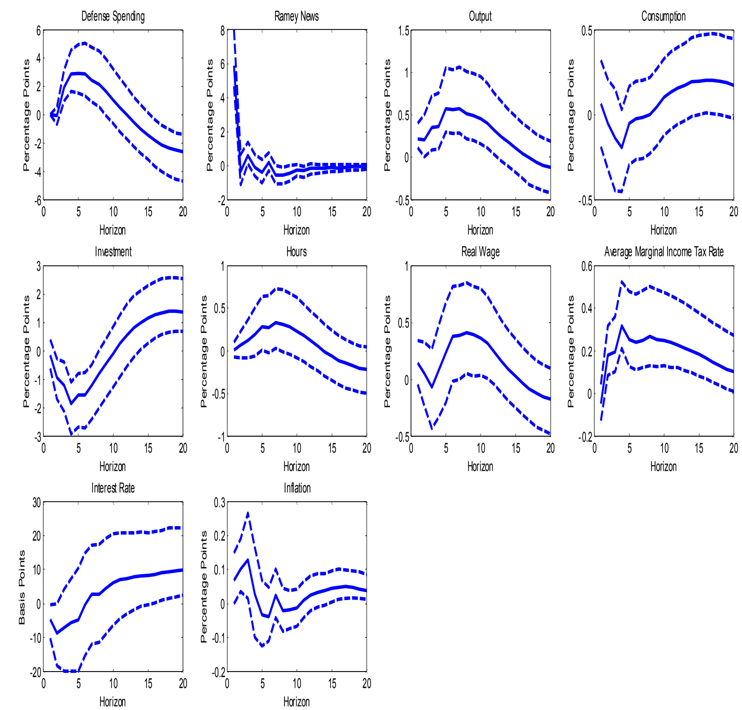


Notes: These unanticipated defense shock impulse responses are obtained from using the larger sample period of 1939:Q2-2008:Q1.

Figure 8: **Larger Sample (1939-2008): (a) Impulse Responses to MFEV News Shock; (b) Impulse Responses to Ramey News Shock**



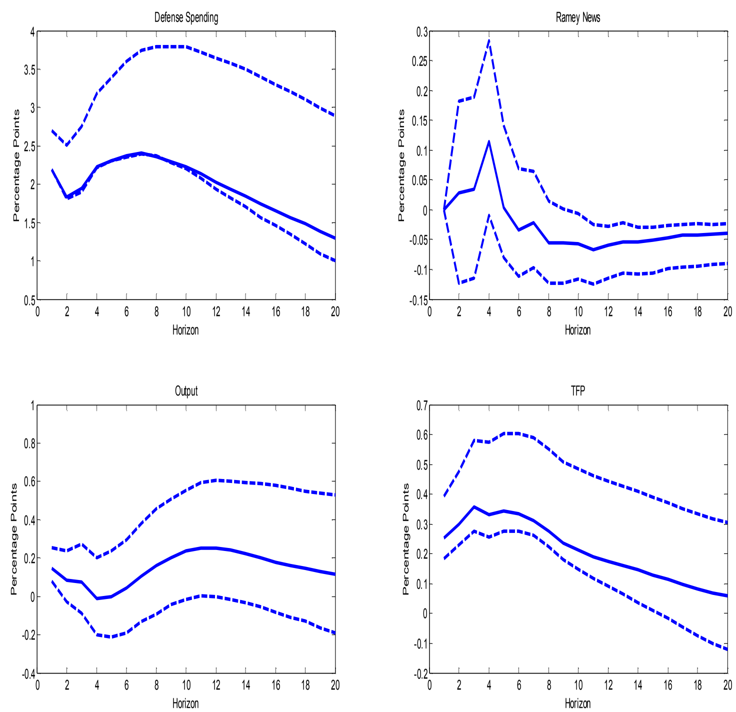
(a) Impulse responses to a one standard deviation MFEV News Shock.



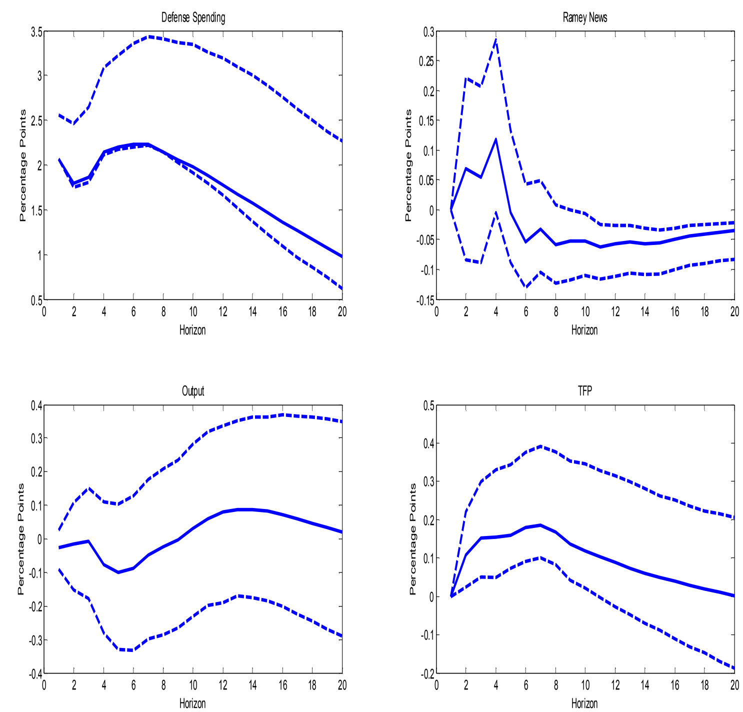
(b) Impulse responses to a one standard deviation Ramey News Shock.

Notes: Panel (a): The impulse responses were obtained from applying the MFEV method explained in section 2.2 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 9: **Post-Korea Sample (1955-2008): (a) Unrestricted TFP; (b) Restricted TFP**



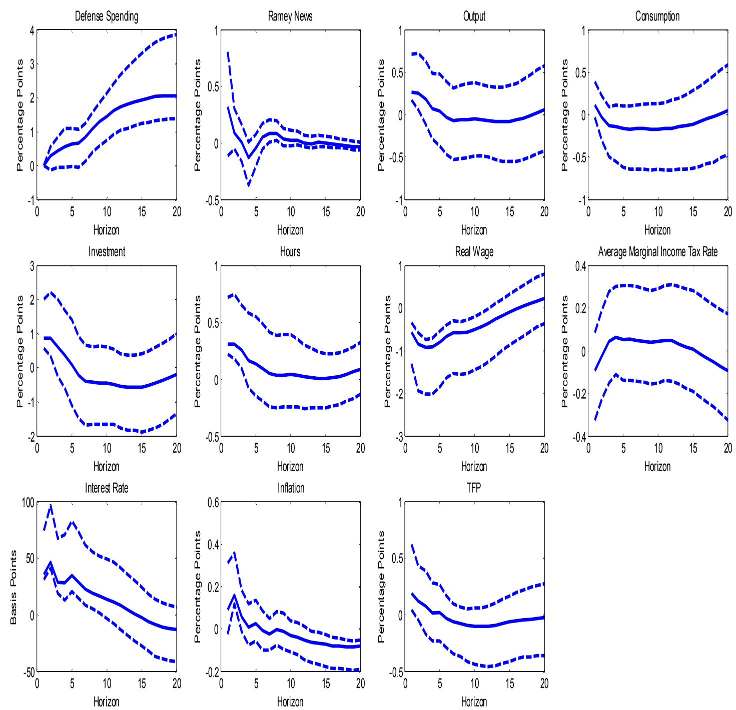
(a) Impulse responses to a one standard deviation Unanticipated defense spending Shock (Unrestricted TFP).



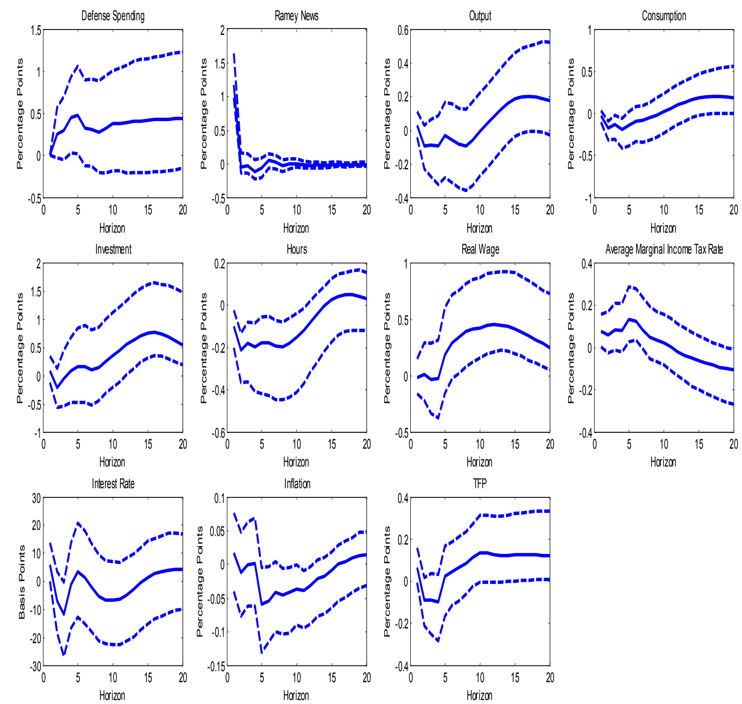
(b) Impulse responses to a one standard deviation Unanticipated defense spending Shock (TFP Shutdown).

Notes: Panel (a): The unanticipated defense spending shocks is identified as the VAR innovation in defense spending orthogonalized with respect to the Ramey (2011) news series using the sample period 1955-2008. 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. Panel (b): The unanticipated defense spending shocks is identified as the VAR innovation in defense spending orthogonalized with respect to the Ramey (2011) news series and TFP using the sample period 1955-2008. 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 10: **Post-Korea Sample (1955-2008): (a) Impulse Responses to MFEV News Shock; (b) Impulse Responses to Ramey News Shock**



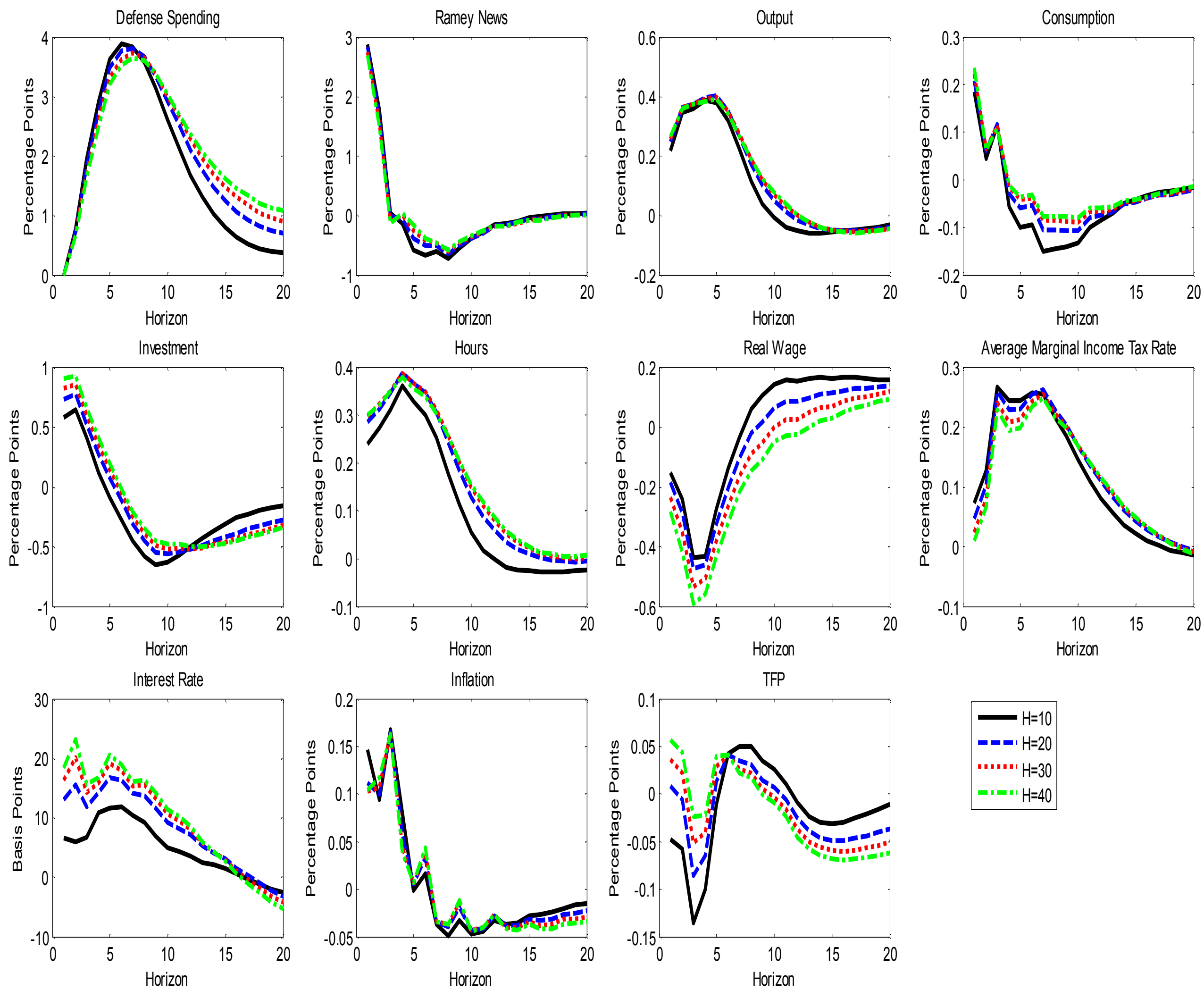
(a) Impulse responses to a one standard deviation MFEV News Shock.



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

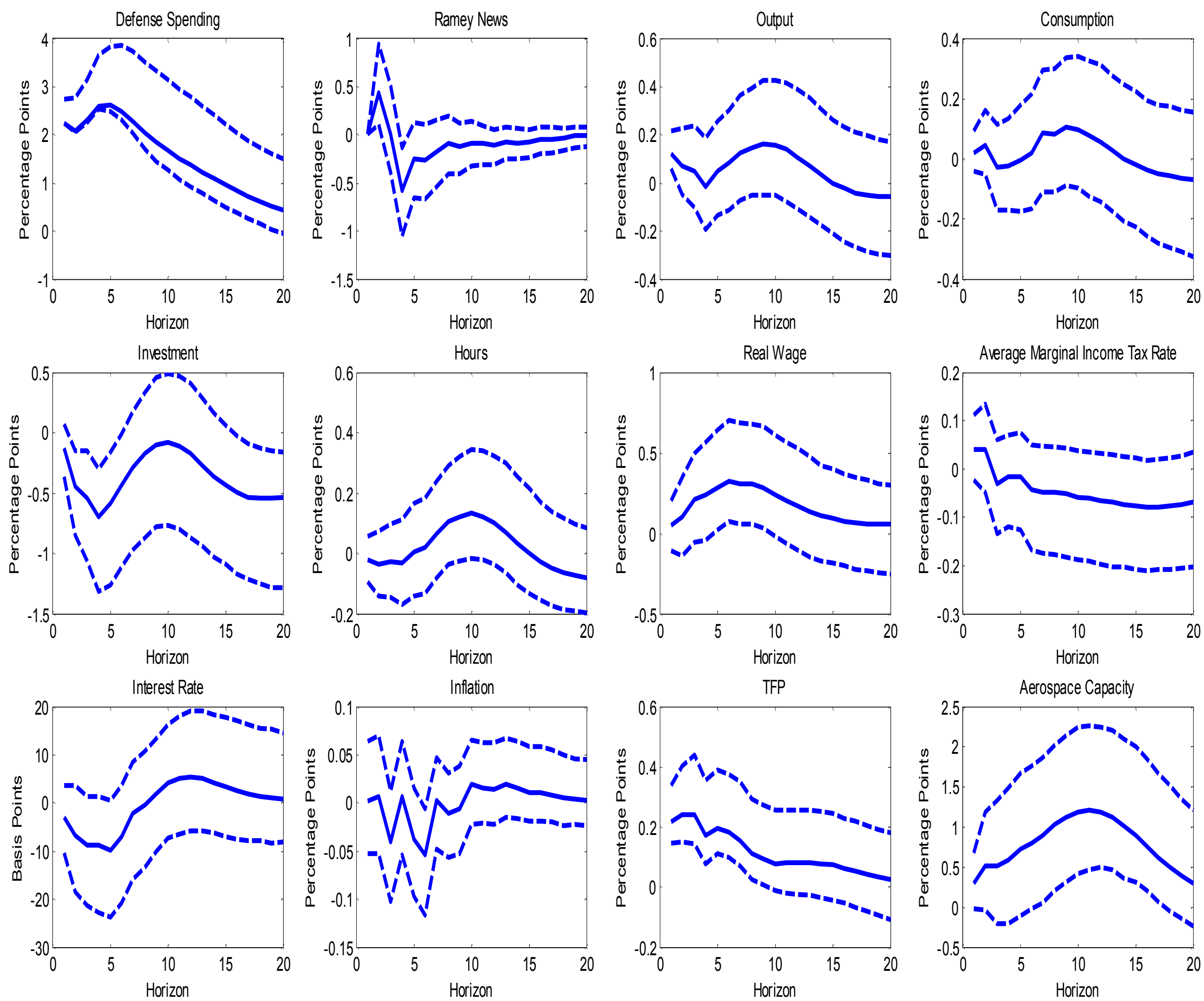
Notes: Panel (a): The impulse responses were obtained from applying the MFEV method explained in section 2.2 on the benchmark VAR using the sample period 1955:Q1-2008:Q4. Dashed lines represent 2.5th and 97.5th percentile Hall (1992) confidence bands generated from a residual based bootstrap procedure 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 11: **Robustness to Different Truncation Horizons: MFEV News Shocks Impulse Responses**.



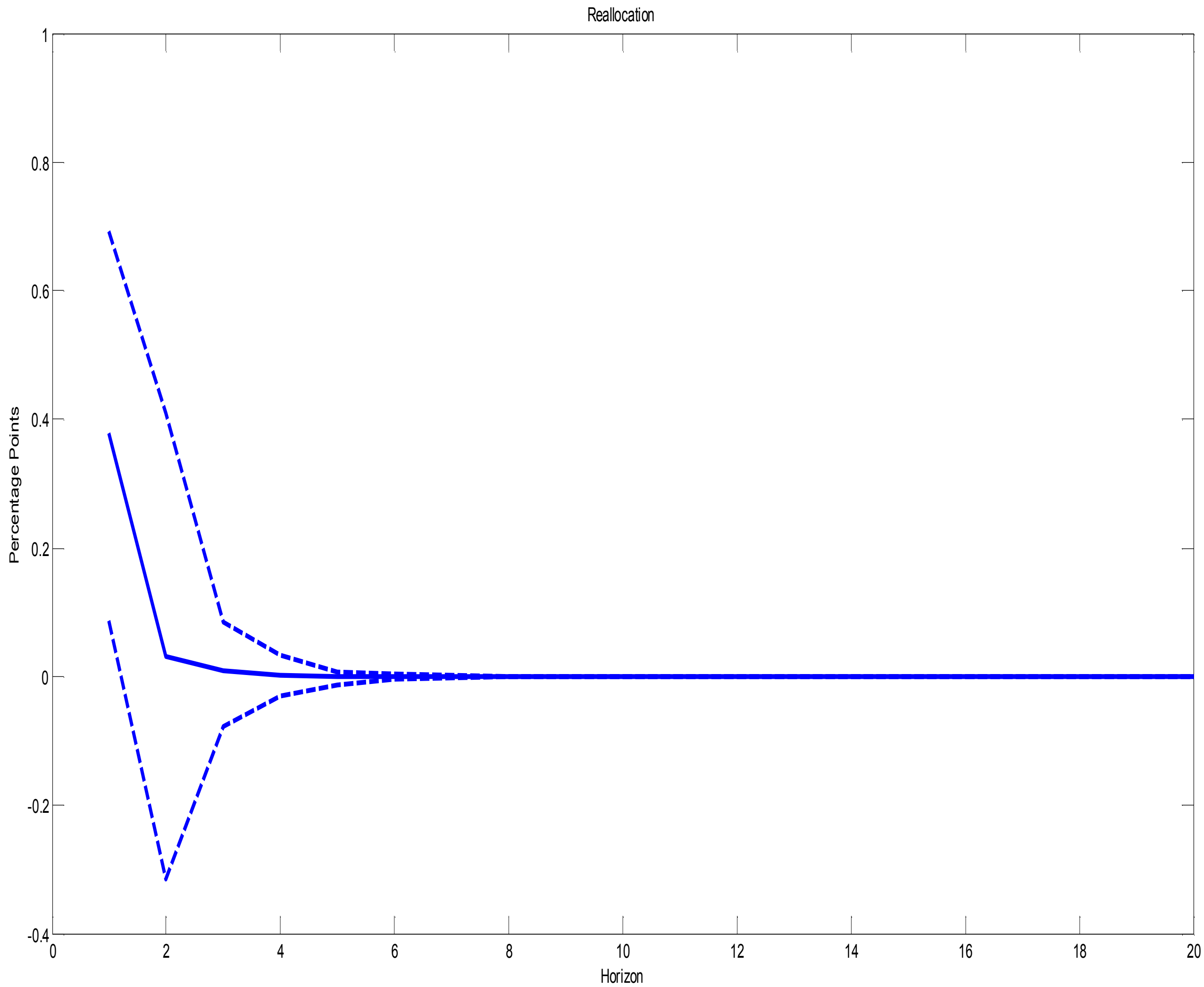
Notes: The solid, dashed, dotted and dash-dotted lines are the estimated impulse responses to the defense news shock from a VAR with a truncation horizon, H, equal to 10, 20, 30, and 40 periods, respectively. .

Figure 12: **Impulse responses to a one standard deviation Unanticipated Defense Shock (VAR with Aerospace Capacity Utilization)**.



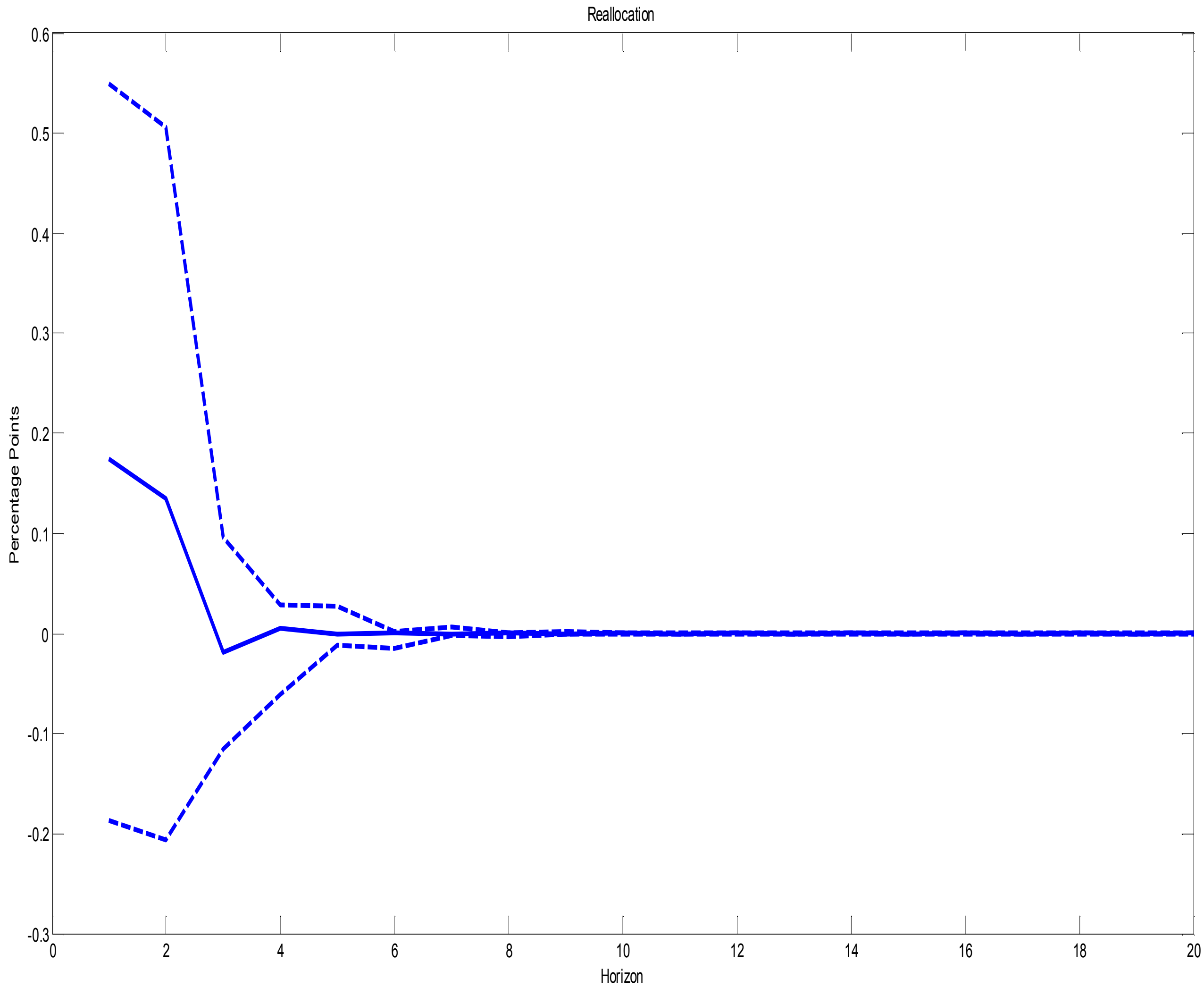
Notes: The unanticipated defense spending shocks is identified as the VAR innovation in defense spending orthogonalized with respect to the Ramey (2011) news series from a VAR that includes capacity utilization in the Aerospace and Miscellaneous Transportation Equipment Sector. Dashed lines represent 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 13: **Impulse responses of Reallocation measure to a one standard deviation annualized Unanticipated Defense Shock**.



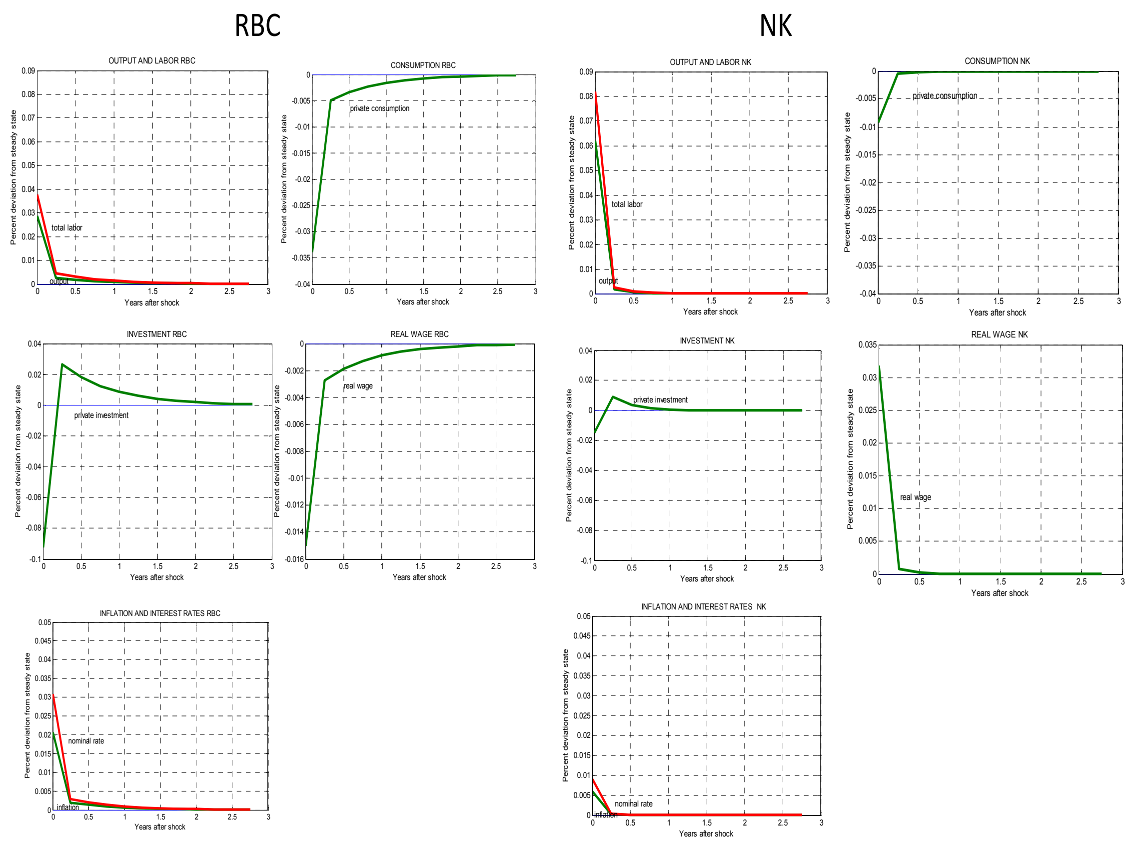
Notes: The Response was obtained from a two variable annual VAR with reallocation and annualized unanticipated defense Shocks. Reallocation is measured as the difference between the annual Fernald (2012) aggregate TFP measure and the purified technology measure of Basu et al. (2006). Dashed lines represent 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 14: **Impulse responses of Reallocation measure to a one standard deviation annualized TFP-Orthogonaized Unanticipated Defense Shock**.



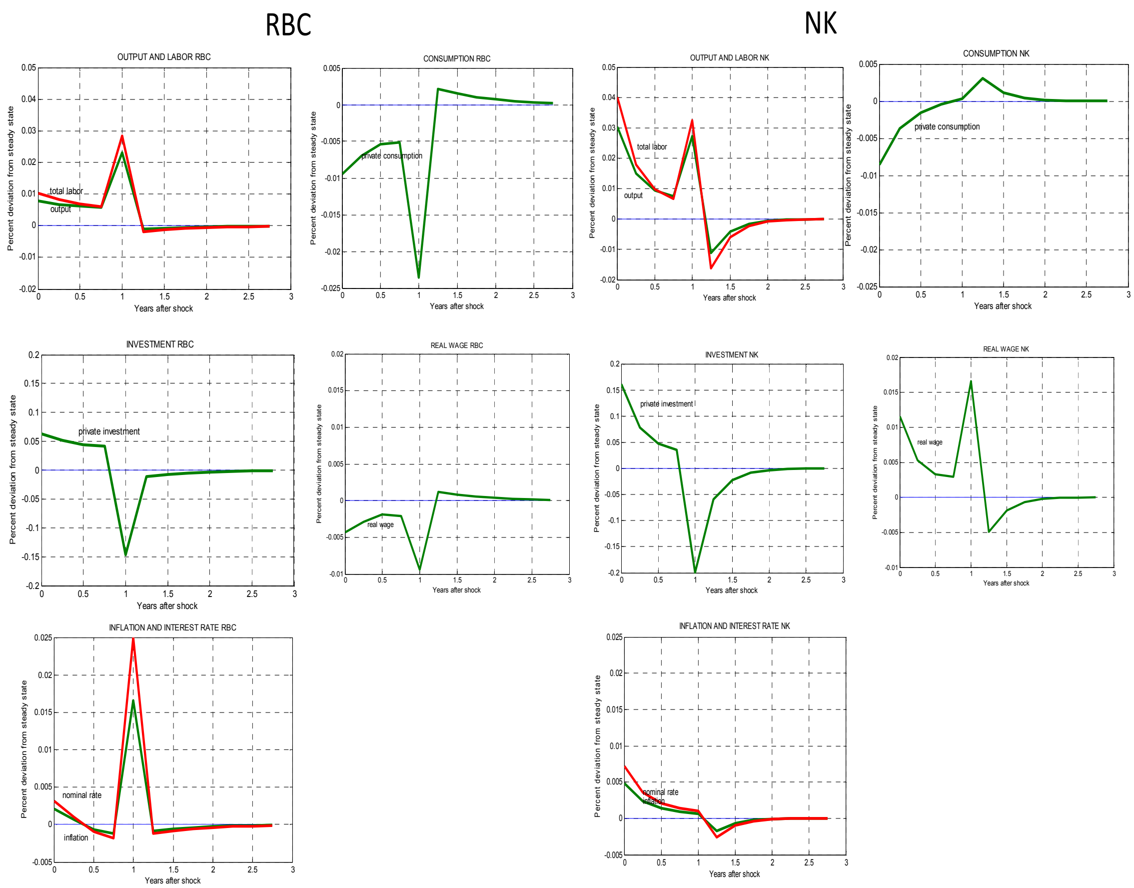
Notes: The Response was obtained from a two variable annual VAR with reallocation and annualized unanticipated defense Shock series that is orthogonalized with respect to TFP (the shock series from Figure 3. Reallocation is measured as the difference between the annual Fernald (2012) aggregate TFP measure and the purified technology measure of Basu et al. (2006). 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 15: **Benchmark DSGE Model: Responses to an unanticipated shock.**



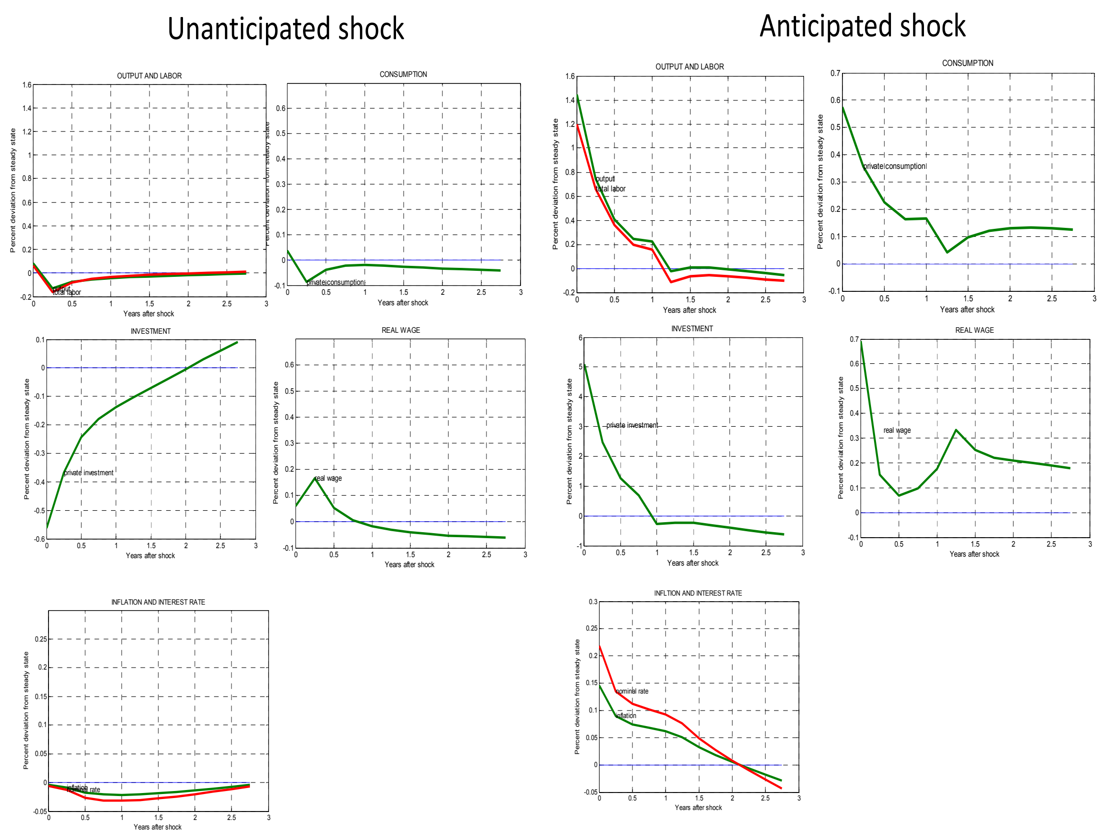
Notes: The Responses were obtained from the model of Section 6.1, where the lest panel corresponds to the flexible price version of the model (RBC) and the right panel corresponds to the sticky price version of the model (NK).

Figure 16: **Benchmark DSGE Model: Responses to an anticipated shock**.



Notes: The Responses were obtained from the model of Section 6.1, where the lest panel corresponds to the flexible price version of the model (RBC) and the right panel corresponds to the sticky price version of the model (NK).

Figure 17: **Modified DSGE Model: Responses to an unanticipated and anticipated shocks**.



Notes: The Responses were obtained from the model of Section 6.2, where the left panel shows the responses to an unanticipated shock and the right panel shows the responses to an anticipated shock.