Government Spending News and Surprise Shocks in Open Economy VARs

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Abstract

By using the Survey of Professional Forecasters, we provide new evidence on the open-economy effects of government spending, and address a key puzzle in the literature, that the real exchange rate depreciates in response to an expansion. First, we document that spending is well anticipated at the one-year horizon, in line with the "fiscal foresight" hypothesis, but the "depreciation" puzzle is not due to non-fundamentalness. Second, we identify both "news" (or "foresight") shocks and "surprise" shocks by using a novel structural VAR procedure and show that the US dollar appreciates after a news shock and depreciates after a surprise shock. Such effects are related to the different timing of the "spending reversals" associated with the two shocks and are broadly consistent with the prediction of a DSGE model with spending reversals.

JEL classification: C32, E32, E62.

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1 Introduction

While there is still a widespread disagreement among economists about the effects of government spending shocks on consumption, empirical VAR evidence strongly supports, at least with US data, the view that increases in government spending lead, in advanced economies with flexible exchange rates, to a depreciation of the real domestic currency (see Kim and Roubini, 2008, Corsetti and Muller, 2006, Monacelli and Perotti, 2007, Ravn, Schmitt-Grohe and Uribe, 2007, and Enders, Muller and Scholl, 2011).[1,2] The result stands in sharp contrast with standard theory, which predicts that fiscal policy expansions appreciate the real exchange rate. Indeed, the finding has sparked an important research effort to reconcile the theory with the empirical evidence. Ravn, Schmitt-Grohe and Uribe, 2007, show that, with deep habits, the increase in aggregate demand triggered by government spending leads to a reduction of the domestic markup, which in turn makes domestic output less expensive, i.e. the real exchange rate depreciates. Corsetti, Meier and Muller, 2012, argue that spending expansions are systematically followed by spending reductions. If, when a positive government spending shock occurs, agents anticipate such "spending reversals", the real long term interest rate may fall, leading to a real depreciation of the exchange rate, as well as an improvement of the external balance.

A few recent works have maintained that fiscal policy actions are anticipated to a large extent, because of the existence of legislative and implementation lags. That is, agents receive signals about future changes in taxes and government spending well before these changes take actually place (see e.g. Yang, 2007, Leeper, Walker and Yang, 2013, Mertens and Ravn, 2010).

Fiscal anticipation entails an important difficulty for VAR analysis. As shown by Leeper, Walker and Yang, 2013, if the VAR does not contain enough information, the underlying structural MA representation of the variables considered in the VAR is not invertible, or "non-fundamental", so that the VAR is misspecified and can provide misleading results. Evidence of non-fundamentalness for a standard closed economy VAR specification is provided by Ramey, 2011, which shows that the spending shock estimated with this specification is predicted by the forecasts reported in the Survey of Professional Forecasters

[1]Blanchard and Perotti, 2002, Fatas and Mihov, 2001, Gali, Lopez Salido and Valles, 2007, Mountford and Uhlig, 2002, and Perotti, 2002, 2007, find that consumption increases. Ramey, 2011, Ramey and and Shapiro, 1998, Burnside, Eichenbaum, and Fisher, 2004, Cavallo, 2005, Edelberg, Eichenbaum, and Fisher, 1999, Eichenbaum and Fisher, 2005, find that consumption declines. Kim and Roubini, 2008, find that the trade balance improves while Monacelli and Perotti, 2007, and Ravn, Schmidt-Grohe and Uribe, 2007, find that it worsens.

[2]Beetsma, Giuliodori and Klaassen, 2008, Beetsma, Giuliodori and Klaassen, 2008 and Benetrix and Lane, 2009 find that for European countries the real exchange rate appreciates.

and therefore cannot be a genuine structural shock.[3] Hence, at least in principle, the puzzling open-economy effects of government spending shocks could be an artifact due to non-fundamentalness.

Apart from the fundamentalness problem, the traditional identification scheme of Blanchard and Perotti, 2002, being based on actual current spending changes, is unsuited to capture "news" or "foresight" shocks, which, by their very definition, have only delayed effects on spending. Ramey, 2011, proposes different specifications and methods, based on newspaper sources like the *Business Week*, as well as the Survey of Professional Forecasters. Such sources of information seem potentially useful to capture foresight shocks.

Summing up, the fiscal foresight literature raises several questions which are still open. First, is government spending really anticipated? and to what extent? After all, it can be argued that, even when a specific expenditure has already been earmarked, there is still a substantial uncertainty about the exact timing of the disbursement. Is it possible to document fiscal anticipation with time series data? Second, assuming that fiscal foresight is effectively there, non-fundamentalness, while being a possibility, is not a necessary implication of fiscal anticipation, and depends on the particular VAR specification chosen by the econometrician. Are standard open economy VAR specifications really affected by non-fundamentalness? Finally, assuming that we have enough information in the VAR and the fundamentalness problem is not there, how can we identify the foresight shocks? Are they quantitatively important? And what are their effects?

We address these questions by using the Survey of Professional Forecasters. We find that government spending is predicted much better than GDP and consumption over the 1-year horizon. This result provides a definite empirical support for the fiscal foresight hypothesis. On the other hand, 1-quarter ahead government spending is predicted worse than GDP and consumption, so that fiscal foresight is essentially a medium-run phenomenon. We rationalize this finding by assuming, as is usual in the "news shock" literature, that there are both "anticipated" and "non-anticipated" shocks. The former are "news" or "foresight" shocks, which have only delayed effects on spending but, on impact, affect agents' expectations. The latter are "surprise" shocks, which affect spending on impact and are only observed when agents see realized spending. Such shocks are conceptually identical to the spending shocks of the traditional VAR approach *à la* Blanchard and Perotti, 2002.

Using the fundamentalness test proposed in Forni and Gambetti, 2014, we find (somewhat surprisingly and contrary to the result obtained in Ramey, 2011) that, despite fiscal foresight, our open-economy VAR specification is not affected by non-fundamentalness.

[3]The solution to the problem of non-fundamentalness is to extend the econometrician information set. Several approaches have been proposed in the literature. Mertens and Ravn, 2010, use Blaschke factors, i.e. dynamic rotations of the reduced form VAR innovations. Forni and Gambetti, 2010, employ a structural factor model. Ellahie and Ricco, 2012, uses a large Bayesian VAR.

Hence, the explanation for the puzzling behavior of exchange rates must be sought elsewhere.

From the methodological point of view, the main contribution of this paper is represented by a new VAR procedure to identify news shocks based on the SPF. First, we use the professional forecasts of government spending to construct a variable which is affected contemporaneously by the news shock. Then we include this variable in the VAR, ordered second after government spending, and identify by imposing a standard Cholesky scheme. The second residual is the news shock, whereas the first one is the surprise shock.

Our estimated news shock displays spikes coinciding with episodes like the fall of the Berlin Wall (1989:IV), the War in Afghanistan (2001:IV), the I and II Gulf Wars (1990:III and 2003:I) and the approval of the fiscal stimulus package (2009:I). All these episodes are followed by substantial changes in government expenditures.

We find that the effects of news shocks, in terms of explained variance, are quantitatively comparable to those of surprise shocks. Hence, they should not be neglected when evaluating fiscal policy. News shocks raise both consumption and output, the government spending multiplier being above one in the short run and essentially zero in the long-run. The fiscal expansion generates a significant increase of the long-term interest rate, a significant appreciation of the dollar and a significant deterioration of the current account balance. Hence there is no "depreciation puzzle" for the news shock. On the contrary, in line with the result of the fundamentalness test, the surprise shock estimated with the VAR specification including the survey variable is almost identical to the one obtained with the standard specification and its effects are the same, i.e. the long-term interest rate declines and the dollar depreciates.

At first sight, the effects of news and surprise shocks may seem in sharp contrast to each other; but a closer look reveals that all differences boil down to a phase shift of four-five years and are related to expectations with opposite sign. After a positive surprise shock, government spending increases on impact but then decreases immediately and declines below the pre-shock level after about four-five years. As a consequence, agents immediately revise their expectations of future spending downward, long-term interest rates decline and the domestic currency depreciates, as predicted in Corsetti, Meier and Muller, 2012. By contrast, after a news shock, government spending increases gradually and reaches a maximum after about four-five years. The news shock also exhibits spending reversals, but they occur much later. Hence agents anticipate an increase of government spending, the long-term interest rate increases and the domestic currency appreciates.

To better evaluate whether the effects of the news shock are in line with the theory, we introduce a news shock into the two-country model of Faccini, Mumtaz and Surico, 2012, which is a simplified version of Corsetti, Meier and Muller, 2012. The effects of both the news and the surprise shocks on the long-run interest rate, the exchange rate and net exports are consistent with the model, when a term inducing spending reversals is included in the policy rule. On the other hand, the effects of both news and surprise shock on consumption are puzzling.

Our identifying procedure was first proposed in an old version of this paper, i.e. Gambetti, 2012, which of course is absorbed in the present work. Our procedure has been used in two interesting papers, i.e. Ricco, 2013, which does not focus on open-economy issues, and Caggiano *et al.*, 2014, where a nonlinear VAR is estimated to assess whether news shocks have different effects in booms and recessions.

The remainder of the paper is organized as follows. Section 2 documents and qualify fiscal foresight by using professional forecasts. Section 3 addresses the fundamentalness question. Section 4 presents our identification strategy and discusses the relation of our work with previous literature, with special emphasis on Ramey, 2011, and Perotti, 2011. Section 5 presents evidence about the news and the surprise shocks, as well as their impulse-response functions. Section 6 discusses the relation of our empirical results with the theory. A robustness analysis is provided in the Appendix.

2 Is government spending anticipated?

Policy measures like Obama's Fiscal Stimulus or the Budget Control Act of 2011 provide a clear indication about the sign of future government spending changes, but the size and the timing of such changes are often uncertain to a large extent. Does fiscal foresight imply that government spending is more predictable than other economic variables, like for instance GDP or consumption? The answer is far from obvious. To our knowledge, there are no empirical works documenting fiscal foresight with time series data. The aim of this section is to provide evidence about fiscal policy anticipation and to quantify fiscal foresight by using the Survey of Professional Forecasters (SPF henceforth) reported by the Federal Reserve Bank of Philadelphia.

As a first step we evaluate the forecasting accuracy of SPF as compared to simple standard time series models. This is an important exercise to gauge the informational content of the SPF forecasts.

In the SPF, the forecasts of the levels are subject to several changes of the base year during the sample period. Hence, following Ramey, 2011, and Perotti, 2011, we focus on the forecasts of the growth rates. Precisely, we use the annualized percent change of mean responses for the real federal government consumption expenditure and gross investment. The Survey reports, for each quarter t, the forecasts $f_t(h)$ made at time t for periods $t+h$, $h = 0, \ldots, 4$. At time t, when the forecasts are made, the forecasters know (the first release) of government spending growth for time $t-1$. From the original data we derive the implied cumulated forecasts, i.e. the forecasts of government spending growth between t and $t+h$, call it $F_t(0,h) = \sum_{j=0}^{h} f_t(j)$. We evaluate the accuracy of $f(h)$ and $F(0,h)$, $h = 0, \ldots, 4$. The target is the government spending growth (mnemonic FEDGOV, see below for a complete description of the data) for the whole period 1981:III-2013:III (multiplied by 400 to get annualized percentage rates). We shall keep this sample period throughout the paper. The starting date is the starting date of the Survey.

The times series models we use are: (a) the best univariate autoregressive model (order 4); (b) the 4-lag autoregression augmented with the first lag of real GDP growth and the first lag of the spread between 10-year government bonds yield and the federal funds rate. The initial date of the sample is 1960:I and the parameters are estimated with a rolling window of 82 quarters.[4] To make a fair comparison, we compute $f^a(h)$ and $f^b(h)$, $h = 0, \ldots, 4$, by using data up to time $t-1$.[5] Hence $f^a(h)$ and $f^b(h)$ are what are usually called the $h+1$-step-ahead forecasts. For $h > 0$, the forecasts are obtained by direct projections (rather than the iterative method). The accuracy of the forecasts is measured by the mean square forecast error (MSFE), normalized by dividing by the variance of the target. This number is the fraction of unpredictable variance, which can be interpreted as measuring the degree of "foresight".

Results are reported in Table 1. The professional forecasts perform better than time series models at all horizons. For $h = 3, 4$ the difference is significant according to the Diebold and Mariano test, for both cumulative and non-cumulative forecasts. The finding suggests that SPF data provide useful information for predicting government spending.

Next we compare the accuracy of the professional forecasts for FEDGOV growth with the accuracy of professional forecasts for GDP growth and consumption growth. Table 1 shows the results. An interesting finding emerges. Predictability of consumption and GDP decreases with the horizon whereas the predictability of government spending increases with the horizon. At horizon 4, for instance, the cumulative-forecast mean-square errors for real GDP and consumption are 0.71 and 0.77 respectively, as against 0.50 for FEDGOV. At short horizons, particularly the first quarter, the rankings are reversed: both GDP and consumption growth are predicted better than FEDGOV growth (0.52 and 0.64 respectively, as against 0.80 for FEDGOV).

Higher predictability of government spending relative to GDP at longer horizons supports the presence of fiscal anticipation. Nonetheless it must be noticed that fiscal foresight does not hold in the very short run and even at the 4-quarter horizon there is still a substantial fraction of variance which is not anticipated. A plausible interpretation is that future government spending over a one-year or two-year horizon is well anticipated, but the exact timing of expenditure across different quarters is highly unpredictable. In sum, our results

[4] Keeping fixed the starting date of the sample used for estimation provides qualitatively similar results.

[5] Notice, however, that we do not use vintage data, so that the econometrician knows the last release of FEDGOV, whereas the professional forecasters know only the first release.

are compatible with the existence of a sizable "foresight" shock as well as a non-anticipated or "surprise" shock having large short-run effects.

3 Does the depreciation puzzle depend on non-fundamentalness?

Several papers have noticed that fiscal foresight can lead to non-fundamentalness of the structural MA representation of the variables included in the VAR (see Leeper, Walker and Yang, 2013, for a thorough discussion). The problem arises from the fact that fiscal variables do not convey information about the current news shock because they react only with a delay. If the VAR information is deficient VAR results can be misleading. Well known monetary policy puzzles like the price puzzle and the exchange rate puzzle are due to informational deficiency and disappear when VAR information is properly amended (Bernanke, Boivin and Eliasz, 2005; Forni and Gambetti, 2010). This could in principle be the case also for the puzzling open-economy effects of government spending.

On the other hand, news is likely to affect immediately forward-looking variables like interest rates and exchange rates, given that these variables closely reflect agents' expectations. Including such variables in the VAR might provide enough information to reconstruct the relevant shocks. Hence fundamentalness, or sufficient information, is ultimately an empirical question. In previous literature fundamentalness has been tacitly assumed without testing because fundamentalness tests were not available. Ramey, 2011, is a noticeable exception, since the Granger-causality test used therein is essentially equivalent to a fundamentalness test.

We test for sufficient information by using the orthogonality test recently proposed by Forni and Gambetti, 2014. The test is based on a simple theoretical result: if any linear combination of the VAR residuals is correlated with the past of available information, the structural MA representation of the variables included in the VAR is non-fundamental and the VAR is misspecified, in the sense that it does not include enough information to reconstruct the structural shocks. The testing procedure is the following: first, estimate a VAR and identify the shocks of interest; second, regress such shocks on the past values of a set of variables reflecting agents' information and perform an F-test for the significance of the regression. We use as regressors both the principal components of a large macroeconomic data set and the professional forecasts.

The government spending shock is identified, following Blanchard and Perotti, 2002, as the first Cholesky shock in a VAR including, in that order, real federal government consumption expenditures and gross investment (FEDGOV), real GDP, real personal consumption expenditures (CONS), the federal surplus divided by GDP (SUR), net exports of goods and services divided by GDP (NX), the 10-Year Treasury Constant Maturity Rate

(10YBOND) and the real exchange rate (RER). This is specification A.[6] Following previous literature, FEDGOV, GDP and CONS are taken in log-levels (multiplied by 100 to express the impulse-response functions in percentage rates of variation). The time span is 1981:III-2013:III (as already noticed, the starting date is the starting date of the Survey). We estimated a Bayesian VAR with diffuse prior and 4 lags.

Figure 1 shows the impulse response functions of the unit variance government spending shock, together with the 68% (dark gray) and the 90% (light gray) probability intervals.[7] The impulse response functions report the puzzle. There is a depreciation of the US dollar driven by a fall in interest rate which improves net export.

Using the estimated government spending shock we run the orthogonality test. For comparison, we also report the results for a simple three-variable specification including FEDGOV, GDP and CONS (specification B). We regress the estimated government spending shock on seven sets of regressors: the first five include the series reported by the Survey, from $f(0)$ to $f(4)$, taken one at a time. The sixth set (All) includes all of the series $f(h)$, $h = 0, \ldots, 4$. The seventh set includes the lags of a single series that we shall use in the sequel, i.e. the cumulated forecast $F(1, 4) = f(1) + \cdots + f(4)$.

Results are shown in Table 2. The table reports the p-values of the test for the seven sets of regressors (rows) and different numbers of lags (columns). The upper panel shows results for specification B; the lower panel for specification A. Orthogonality is clearly rejected for the shock estimated with the small VAR by many regressor-lag configurations. By contrast, fundamentalness is never rejected in the lower panel.[8] Similar results (not shown here) are obtained when regressing the other six shocks of the Cholesky identification.[9]

The result is confirmed when the surprise shock is regressed onto the principal components of a large data set (this is the implementation suggested in Forni and Gambetti, 2014). The data set is the one of Forni *et al.*, 2014, to which we refer for more detailed information about the series and the data treatment. Table 3 shows that specification B is deficient, whereas the seven-variable specification A is not.

We conclude that there is no evidence of non-fundamentalness for the open-economy

[6]FEDGOV: BEA code B823RA3; GDP: BEA code A191RX1; CONS: BEA code DPCERX1; SUR: federal receipts, BEA code W018RC1, minus federal expenditures, BEA code W019RC1, over nominal GDP, BEA code A191RC1; NX: net exports of goods and services, BEA code A019RC1, divided by GDP; 10YBOND: Board of Governors of the Federal Reserve System; RER: trade weighted U.S. dollar index, major currencies, Board of Governors of the Federal Reserve System. 10YBOND and the exchange rate index are quarterly averages of the original monthly series.

[7]The reported impulse response functions are the averages of the posterior distribution over 500 draws.

[8]In a previous version of the paper (Gambetti, 2012) we found that fundamentalness was rejected. This is because we used a different VAR specification in two respects. First we did not include the long-term interest rate. Second, we used growth rates instead of levels for FEDGOV, GDP, CONS, SUR and NX.

[9]We also performed the Granger causality test proposed in Forni and Gambetti, 2014, obtaining the same result.

VAR specification. Hence the depreciation puzzle cannot be due to non-fundamentalness.

4 Identifying government spending shocks

The evidence of Section 2 supports the existence of a sizable "news" shock as well as a non-anticipated or "surprise" shock. The former represents news in the sense that it is observed by agents at time t but has delayed effects on government spending. The latter is a surprise since it immediately affects government spending but is only known once agents observe spending itself.

The news-surprise representation has become common in the literature focusing on technology news shocks. In line with this literature, to ensure that the news shock has zero impact effect on spending, we impose a Cholesky identification scheme with government spending ordered first and a suitable variable, capturing agents' current information about future change in government spending, ordered second. The first shock is the surprise shock and the second shock is the news shock.

The basic novelty of our approach is the variable revealing the news shock, which is ordered second in the VAR. We use two different variables, so that we have two VAR specifications. The former is the SPF expectation of future spending growth for the following four quarters, i.e. the cumulated forecast $F(1,4)$ introduced in Section 3. The latter is a "news variable" defined as the difference between the forecast of government spending growth, made at time t, for the following quarters reported by the Survey, and the forecast, for the same quarters, made at time $t-1$.

4.1 Assumptions

To better illustrate our foresight variables and motivate our identification scheme, it is useful to introduce a few assumptions about spending growth and the SPF forecasts.

First, we assume that the growth rate of government spending, g_t, follows the model

$$g_t = \phi(L)\varepsilon_t + \theta(L)\eta_t + \delta(L)\xi_t, \tag{1}$$

where $\phi(L) = \sum_{k=0}^{\infty} \phi_k L^k$, $\theta(L) = \sum_{k=0}^{\infty} \theta_k L^k$ and $\delta(L) = \sum_{k=0}^{\infty} \delta_k L^k$ are impulse response functions in the lag operator L, ε_t is the foresight shock, η_t is the surprise shock and ξ_t is a non-policy shock reflecting "endogeneity" of public spending, i.e. a possible automatic, non-discretionary reaction of spending to shocks affecting some target variable like GDP. All shocks are normalized to have unit variance. The shock ξ_t may be a vector, in which case δ_k is a row vector. By definition of news shock, government spending will react with some delay $s > 0$ to ε_t, i.e. $\phi_k = 0$ for $k < s$. By contrast, $\theta_0 \neq 0$ is the distinguishing feature of the "surprise" shock.

Moreover, following Blanchard and Perotti, 2002, we assume that the non-policy shocks have no contemporaneous effects on g_t, owing to some perception and/or implementation delay, i.e. $\delta_0 = 0$. The condition $\delta_0 = 0$ is the condition that we impose when ordering after government spending and the SPF variable all other variables included in the VAR specification.

Finally, we make an important assumption about the informational flows of the Survey. Let $\mathcal{P}_t$ be the information set of economic agents, as well as professional forecasters, at time t, and $E_t^{\mathcal{P}}$ be the expectation conditional on $\mathcal{P}_t$. As observed above, the Survey reports, for each t, the forecast made at time t for $g_t, g_{t+1}, \ldots, g_{t+4}$. At time t, the forecasters know the (first release of) g_{t-1}. Contrary to the simplifying assumption commonly made in the literature, the nowcast of g_t is very different from g_t, i.e. $E_t^{\mathcal{P}} g_t \neq g_t$. This is only possible if agents observe with delay some of the shocks appearing in equation (1).

Clearly the news shock cannot be observed with delay by its very definition, since it reflects precisely the new information about future spending growth which is available at time t. By contrast, the surprise shock reflects unexpected changes of spending growth, and is likely fully observed when official data become available, which happens with some delay. To make things simple, we assume that agents observe η_t with a one-period delay, i.e. at time $t + 1$. For convenience, we make the same assumption about ξ_t (this makes little difference, as we shall show that ξ_t has small effects on spending).

Formally, we assume $E_t^{\mathcal{P}} \eta_t = E_t^{\mathcal{P}} \xi_t = 0$, $E_t^{\mathcal{P}} \eta_{t-k} = \eta_{t-k}$, $E_t^{\mathcal{P}} \xi_{t-k} = \xi_{t-k}$ for $k > 0$, and $E_t^{\mathcal{P}} \varepsilon_{t-k} = \varepsilon_{t-k}$ for $k \geq 0$. We show in the sequel that this assumption, besides being a simple and convenient way to rationalize the large difference between the nowcast of g_t and g_t itself, is consistent with the empirical evidence.

4.2 Specification #1

Given these assumptions, our aim is to construct a variable which is affected by ε_t *at time* t (unlike g_t, which is only affected at time $t + s$) and therefore conveys information about its current value (rather than its past values). The simple case $g_t = \varepsilon_{t-s}$ can be useful to illustrate our point. In this case, we have:

$$\begin{aligned}
E_t^{\mathcal{P}} g_{t+1} &= \varepsilon_{t-s+1} \\
&\cdots \\
E_t^{\mathcal{P}} g_{t+s-1} &= \varepsilon_{t-1} \\
E_t^{\mathcal{P}} g_{t+s} &= \varepsilon_t \\
E_t^{\mathcal{P}} g_{t+s+1} &= 0 \\
&\cdots \\
E_t^{\mathcal{P}} g_{t+H} &= 0
\end{aligned}$$

If the number of periods of anticipation were known, we could simply take $E_t^{\mathcal{P}} g_{t+s}$. Unfortunately in practice s is unknown and this case is more problematic. For, if we consider the "wrong" horizon $h \neq s$, the expectation does not contain ε_t and therefore is useless to our purpose. However, the *sum* of the expectations up to H-period ahead

$$F_t(1,H) = \sum_{h=1}^{H} E_t^{\mathcal{P}} g_{t+h} = \varepsilon_t + ... + \varepsilon_{t-s+1}$$

always contains ε_t, provided that $H \geq s$.

Going back to the general case of equation (1), by summing the first h-period ahead expectation, $h = 1, ..., H$, we obtain

$$F_t(1,H) = \sum_{h=1}^{H} E_t^{\mathcal{P}} g_{t+h} = \tilde{\phi}_0 \varepsilon_t + \sum_{j=1}^{\infty} \tilde{\phi}_j \varepsilon_{t-j} + \sum_{j=1}^{\infty} \tilde{\theta}_j \eta_{t-j} + \sum_{j=1}^{\infty} \tilde{\delta}_j \xi_{t-j} \quad (2)$$

where $\tilde{\phi}_0 = \sum_{k=s}^{H} \phi_k$, $\tilde{\phi}_j = \sum_{k=j+1}^{H+j} \phi_k$, $\tilde{\theta}_j = \sum_{k=j+1}^{H+j} \theta_k$, $\tilde{\delta}_j = \sum_{k=j+1}^{H+j} \delta_k$. Note that $F_t(1,H)$ also contains the lags of all the shocks. However, by running a VAR including $F_t(1,H)$, we condition on the past of the variables and get rid of the lagged values of the shocks. We call "Specification #1" the VAR specification including $F_t(1,H)$ and "Identification #1" the corresponding identification.

4.3 Specification #2

Our second specification hinges on a news variable defined as the difference between the forecast of government spending growth, made at time t, for the following quarters reported by the Survey, and the forecast, for the same quarters, made at time $t-1$. Under our assumptions, the revision of the h-step ahead forecast is

$$E_t^{\mathcal{P}} g_{t+h} - E_{t-1}^{\mathcal{P}} g_{t+h} = \phi_h \varepsilon_t + \theta_{h+1} \eta_{t-1} + \delta_{h+1} \xi_{t-1}. \quad (3)$$

Again, the revision misses the target if $h \neq s$. By contrast, summing the first H revisions we get

$$\begin{aligned} n_t(1,H) &= F_t(1,H) - F_{t-1}(2,H+1) \\ &= \sum_{h=1}^{H} (E_t^{\mathcal{P}} g_{t+h} - E_{t-1}^{\mathcal{P}} g_{t+h}) \\ &= \tilde{\phi}_0 \varepsilon_t + \tilde{\theta}_1 \eta_{t-1} + \tilde{\delta}_1 \xi_{t-1} \end{aligned} \quad (4)$$

which always contains ε_t as long as $H \geq s$. The news variable conveys the new information that becomes available at time t: the current news shock, as before, and the first lag of the other shocks. As before, identification can be achieved by conditioning onto the past of the variables. We call "Specification #2" the VAR specification including $n_t(1,H)$ and "Identification #2" the corresponding identification.

4.4 Alternative orderings and surprise shocks

Our Cholesky ordering correspond to a standard practice in the news shock literature. It amounts to define the news shock as the residual of the projection of the SPF variable onto the space spanned by the past of all variables, plus the present of g_t. This residual, under the fundamentalness assumption, is, for both specifications, $\tilde{\phi}_0\varepsilon_t$ (see equations 2 and 4), which delivers ε_t after normalization to get unit variance. Note however that, under our informational assumptions, the SPF variable could alternatively be ordered first, since, as shown in equations (2) and (4), both $F_t(1,H)$ and $n_t(1,H)$ contain only past values of η_t, so that only conditioning on the past of the variables (without the present of g_t) should produce similar result. In the Appendix we show that this is in fact the case. This evidence provides a confirmation for our assumption about the delayed observation of η_t, since, would η_t be observed at time t, the two projections would deliver different results.

Coming to the surprise shock, let observe that we identify it in just the same way as the spending shock of the traditional VAR approach of Blanchard and Perotti, 2002, i.e. as the first Cholesky shock of our VAR specification, where government spending is ordered first. Put another way, we take the residual of the projection of g_t onto the past of all variables. Letting $E_{t-1}g_t$ denote such projection, under our assumptions (and given fundamentalness), the residual is

$$g_t - E_{t-1}g_t = \phi_0\varepsilon_t + \theta_0\eta_t + \delta_0\xi_t = \theta_0\eta_t \tag{5}$$

Unit variance normalization gives an estimate of η_t.[10]

4.5 Relations with the literature

Ramey, 2011, uses $g_t - E^{\mathcal{P}}_{t-1}$ in place of g_t, in order to identify a government spending shock which is not anticipated by professional forecasters. The variable is ordered first in a VAR; the first Cholesky shock is the estimated government spending shock.

According to our assumptions

$$g_t - E^{\mathcal{P}}_{t-1}g_t = \theta_0\eta_t + \theta_1\eta_{t-1} + \delta_1\xi_{t-1}. \tag{6}$$

If the VAR contains enough information, Ramey's procedure delivers the correct result, since by conditioning on the past of the variables we cancel the past values of the shocks from the right-hand side of the above equation. In the Appendix we show that Ramey's method gives the same results as ours.

[10] Even in the case of the surprise shock, under our assumptions, government spending could be ordered second after the SPF variable and the surprise shock could be defined as the second one in the Cholesky decomposition. This is because also conditioning on the present of the SPF variable, which does not contain η_t, should be ineffective.

Ramey's procedure is essentially equivalent to retaining g_t as the first variable and augmenting the VAR with the 1-step-ahead forecast from SPF. The latter strategy is the one followed by Auerbach and Gorodnichenko, 2012, and Born *et al.*, 2013. Both methods are termed "EVARs" (Expectation augmented VARs) by Perotti, 2011. EVARs are aimed at cleaning the surprise shock from anticipated government spending changes and can be useful if the VAR specification, with no SPF information, is non-fundamental. Note however that EVARs, as defined above, are useless to find the news shock ε_t, which does not appear in equation (6).

If non-fundamentalness is not there, the procedures in Blanchard and Perotti, 2002, and Ramey, 2011, should produce the same result. In the Appendix we show that this is the case for our open economy specification, consistently with the results of Section 3. Perotti, 2011, documents that the EVAR-SVAR equivalence holds true for a standard closed economy information set. We interpret Perotti' findings as indicating that his specification, like ours, is essentially unaffected by the non-fundamentalness problem.

Perotti, 2011, observes that

$$g_t - E_{t-1}^{\mathcal{P}} g_t = \left(g_t - E_t^{\mathcal{P}} g_t\right) + \left(E_t^{\mathcal{P}} g_t - E_{t-1}^{\mathcal{P}} g_t\right) \quad (7)$$

and argues that the former term on the right hand side is the one which really matters, whereas the latter term, "which is the one that can be related to the wealth effect of the neoclassical model, is essentially noise". From this he concludes that SPF data cannot help in identifying government spending shocks.

Under our assumptions,

$$\begin{aligned} g_t - E_t^{\mathcal{P}} g_t &= \theta_0 \eta_t \\ E_t^{\mathcal{P}} g_t - E_{t-1}^{\mathcal{P}} g_t &= \theta_1 \eta_{t-1} + \delta_1 \xi_{t-1}. \end{aligned}$$

These two equations explain Perotti's findings: the former term is the one which really matters to identify the surprise shock, while the latter does not contain the present of η_t and therefore is uninformative.[11] This however depends on the information set of professional forecasters and should not be interpreted as meaning that SPF data are useless, since they are useful to identify the news shock ε_t. More generally, the fact that $E_{t-1}^{\mathcal{P}} g_t$ is a poor predictor of g_t is consistent with the results reported in Section 2. It does not depend on poor quality of SPF data, but on the fact that g_t is subject to a large short-run uncertainty, owing to the large impact effect of η_t. On the other hand, we know that g_t is very well

[11] Ricco, 2013, identifies the surprise shock (which he name "misexpected shock") by using the nowcast error in place of g_t. We do this as a robustness exercise in Subsection 5.5. In addition, Ricco takes a different point of view about the term $E_t^{\mathcal{P}} g_t - E_{t-1}^{\mathcal{P}} g_t$, which he uses to identify a third kind of government spending shock.

predicted at the 1-year horizon and this is consistent with the large, delayed effects of ε_t that are shown in the following section.

We conclude this subsection by briefly discussing the Ramey's military spending variable. As documented in Corsetti, Meier and Muller, 2012, when the variable is included in a recursive VAR with government spending ordered first, such variable does not modify the puzzling effects of surprise shocks on exchange rates. This finding is in line with our result that standard open economy VAR specification are not affected by the problem of deficient information. On the other hand, when identifying the spending shock as the first one in a recursive VAR with Ramey's variable ordered first, the shock has negative contemporaneous and lagged effects on spending. This means that the shock should be interpreted as a negative surprise shock rather than a positive foresight shock. The positive effects on the exchange rate are then correctly interpreted in Corsetti, Meier and Muller, 2012, as confirming the puzzle rather than denying it. The result suggests that the Ramey's variable seems unsuited to correctly capture the foresight shock.

5 Evidence

In this section we report the empirical results obtained by estimating our VAR specifications #1 and #2. The longest available horizon in the SPF is 4. We therefore take $H = 4$ for Specification #1, which therefore includes $F_t(1,4)$. As for Specification #2, we are forced to take $n_t(1,3)$, since $n_t(1,4) = F_t(1,4) - F_{t-1}(2,5)$ would involve horizon 5, which is not available. The other variables included in the VAR are the seven variables used in Section 3 for Specification A. The sample period is again 1981:III-2013:III. As for Specification A, we estimated a Bayesian VAR with diffuse prior and four lags.

5.1 The news variable and the estimated news shocks

To begin, let us analyze the informational content of the news variable $n_t(1,3)$ used in Identification #2. The top panel of Figure 2 plots the series. Positive (negative) values mean that professional forecasters revise their expectations about future spending upward (downward). The variable displays positive spikes in coincidence of three war episodes: the Gulf War (1990:III), the War in Afghanistan (2001:IV), and the Iraq War (2003:I). As documented in the literature, these episodes are associated with sizable increases in military spending.[12] A negative spike is observed in correspondence to the fall of the Berlin Wall (1989:IV). This is in line with Ramey, 2011, which estimates a spending cut of about 507.6 billions of dollars in 1989 associated with the end of the Cold War. Moreover the series displays large variations in coincidence with legislative acts like the Obama's

[12] According to Ramey, 2011, in these three episodes government spending increased in the following quarters by about 112.1, 296.3 and 123.8 billions of dollars respectively.

fiscal stimulus package (2009:I) or the Strategic Defense Initiative (1983:I). The evidence reinforces the result of Section 2, pointing out that the news variable actually contains valuable information related to changes in government spending.

The mid and bottom panels of Figure 2 plot the two news shocks obtained under Identification #1 and Identification #2 respectively. Despite a few differences, the two shocks are very similar, the correlation being 0.8. There is still a striking correspondence between peaks and troughs of the shocks and the political episodes associated with the vertical lines. Moreover, for the shock obtained with Identification #1, the matching is perhaps even stronger: in particular, the fiscal stimulus of the Bush administration in 2008 is now visible.[13] All the shocks are orthogonal to the lags of the SPF forecasts as well as the lags of the principal components used in Table 3.[14]

5.2 The effects of news shocks

Figure 3 plots the impulse response functions of the news shock obtained with Identification #1. The estimated effect on spending is small in the first three quarters, in accordance with the idea of anticipation, and becomes large and significant at lag 4. The maximal effect is reached after about four years. After four years, spending declines gradually toward zero. Federal surplus (fifth panel) moves symmetrically. Consistently with the effect on spending, the expectation of future spending growth, reported in the upper-left panel, is positive; it decreases gradually after the positive impact and becomes negative after about four years.

GDP is almost unaffected on impact. The positive effect after one year is barely significant. We computed the government spending multiplier as the effect on log GDP at various lags, divided by the maximal effect on log spending, divided by the average share of government spending over GDP. After an impact of 0.4, it reaches a maximum of about 1.3 after one year, is nearly 1 after 6 quarters, and reaches 0 after about two years. Hence federal spending crowds out private spending in the medium-run. The effect on consumption is positive and significant on impact and declines thereafter, losing significance after 6 quarters. The real exchange rate appreciates significantly and, consistently, the trade balance significantly worsens. The results can be explained by the response of the long-term interest rate which rises immediately and significantly, anticipating future spending growth and the reduction of Federal surplus.

Table 4, upper panel, shows the variance decomposition at different horizons. The fraction of the forecast error variance of government spending explained by the news shock is relatively large. At the 6-year horizon the foresight shock explains almost 30% of total variance. The estimated effects on GDP and consumption are modest in terms of variance decomposition, apart from the 10% of consumption volatility explained by the shock on

[13]The news-based shock is very similar to $n_t(1,3)$ itself, the correlation being 0.81.

[14]Results are available upon request.

impact. At the 2-year horizon, the shock accounts for 10 and 12% of the volatility of the 10-year bond and the exchange-rate variation, respectively.

Figure 4 shows the impulse response functions obtained with Identification #2. The response of government spending is again zero on impact, increases slowly, reaching the maximal level after about 3 years. Both consumption and output increase significantly in the short-run but in the long-run the effect is zero or even negative. The deficit to GDP ratio does not change significantly, although the point estimate is positive in the short run, when output increases and spending is unchanged and then falls in the long run, when output is back to its pre-shock level and spending is significantly higher.

The effects on the real exchange rate, the trade balance and the interest rate net exports are similar to those obtained before, confirming that, for the news shock, the depreciation puzzle is not there.

Table 4, central panel, shows the variance decomposition at different horizons. The fraction of the forecast error variance of government spending explained by the anticipated shock is much smaller than that obtained with Identification #1 even in the long run: only about 11% at the 6-year horizon. Reducing the maximal forecasting horizon seems to be detrimental in terms of variance decomposition, in accordance with the finding of Figure 3, that government spending has a large reaction at lag 4. The estimated effect on GDP reaches a maximum of 13% at the 1-year horizon. At the 2-year horizon, the shock explains about 17% of the volatility of the 10-year bond interest rate and about 14% of the exchange-rate variation. Albeit not very large, these effects are quantitatively comparable to those of the surprise shock (indeed, they are often larger). Hence, they should not be neglected when evaluating the effects of fiscal policy.

5.3 The estimated surprise shocks

Figure 5 displays the three surprise shocks obtained with Specification A (top panel), Specification #1 (mid panel), and Specification #2 (bottom panel).

A few remarks are in order. First, the three shocks are almost identical, the correlations being around 0.95. This confirms the fact that the shock is already well identified with Specification A, in line with the fundamentalness test performed in Section 3. Second, the surprise shock seems to be poorly connected with historical events, since there are no large peaks or troughs in correspondence of the vertical lines. This behavior is consistent with our definition of news and surprise shock. In fact, while the former reflects changes in expectations often related to identifiable political events, the latter mainly reflects the deviations of realized spending from such expectations and therefore there is no reason to expect a correspondence either in the timing or in the sign.

5.4 The effects of surprise shocks

Figure 6 plots the impulse response functions of the surprise shock estimated with Identification #1. We do not report the results for Identification #2 since they are almost identical. The impulse response functions are very similar to those of Figure 1. Again these results are mutually consistent and in line with the findings of Section 3.

The effect on government spending is large on impact, then declines gradually, and takes on negative values after about five years. At long-run horizons the effect is negative. Hence, there is spending reversal. Symmetrically, federal surplus declines on impact and in the short-run, but increases in the long-run. In terms of variance decomposition (Table 4) the effect of the unanticipated shock is very large in the short run but is smaller than that of the foresight shock at the 6-year horizon (about 20%).

GDP reacts positively and significantly on impact; after 2 periods, the effect becomes negative, albeit not significant. The effect on consumption is zero on impact and negative in the short-medium run; however, it is quantitatively modest and not significant. The variance decomposition of Table 4 confirms that the effects on GDP and consumption are small, but for the contemporaneous effect on GDP, which explains about 10% of GDP volatility.

5.5 Spending reversals

For the surprise shock, unexpected spending increases are reabsorbed by spending reversals. The finding provides support to the thesis put forward in Corsetti, Meier and Muller, 2012. Consistently agents revise their expectation of future spending downward, see the upper-left panel of Figure 6. This has the effect of reducing the long-run interest rates, which in turn produces a real depreciation of the exchange rate and a consequent improvement of the trade balance. By contrast, when political events induce agents to revise upwards their expectation of future spending, interest rates go up and the domestic currency appreciates.

But does spending reversal hold true also for the foresight shock? To answer this question we show in Figure 7 the impulse response functions of both the foresight shock (upper panel) and the surprise shock (lower panel) on FEDGOV over the unusually long horizon of 20 years. The result is striking. For both shocks, the impulse response functions have the shape of a long-run sine wave with a period of about 20 years. Positive effects are followed by significantly negative effects, with a distance of about ten years between the turning points. The two functions, which look inconsistent in the range 0-20 quarters, now appear very similar, albeit out of phase by about five years. Indeed, a closer look to Figures 5 and 6 reveals that all differences reduce to a phase shift. Figure 8 reports, on the left column, the response functions of $F(1,4)$, FEDGOV, SUR and RER to the foresight shock, taken from lag 20 onward, and, on the right column, the corresponding response functions for the surprise shock. The response functions in the left column are much smoother because of an obvious estimation effect, but, apart for this, the general shape and the quantitative effects are similar. The same result holds for the variables not shown in Figure 8.[15] The effects of the unanticipated shock mirror those of the anticipated shock with a 5-year delay.

So the answer is yes, reversal are observed also for news shocks but they occur much later, after a period of persistent increase of government spending. The key factor to understand the response of the real exchange rate to spending shocks is the timing of spending reversals. When the shock generates persistent effects on government spending and reversals occur only far in the future, then the real exchange rate appreciates and the trade balance worsens through an increase in the long term interest rate. On the contrary, when the reversal occurs quickly and the increase in spending is relatively short-lived the long term interest rate falls and the currency depreciates.

6 What does the theory tell us?

Are the results in line with the theory? As already observed, Corsetti, Meier and Muller, 2012, proposes an open-economy model with spending reversal which delivers theoretical predictions in line with our empirical results. However, for the news shocks answering the above question is harder since the standard open economy models do not make any prediction about the effects of fiscal news. In order to have a theoretical benchmark we augment with government spending news shocks the two-country model of Faccini, Mumtaz and Surico, 2012, which is a simplified version of Corsetti, Meier and Muller, 2012.[16] Spending reversals are introduced along the lines of Corsetti, Meier and Muller, 2012, by extending the standard government spending rule with a debt component. More specifically, government spending follows the relation

$$g_t = \phi g_{t-1} + \delta d_t + \gamma(L) u_t, \quad u_t \sim N(0, 1) \tag{8}$$

where d_t is public debt, u_t is the government spending shock and $\gamma(L)$ is a polynomial in the lag operator. We consider various specifications of equation (8). All the parametrization share the same value of the autoregressive parameter $\phi = 0.9$. We consider both the case with no spending reversal ($\delta = 0$) and with spending reversal (in line with the literature, we set $\delta = -0.02$). For each of the two calibrations of δ we derive the theoretical impulse response functions of both the surprise and the news shock. We do this by using different parameterizations of $\gamma(L)$. For the surprise shock we assume $\gamma(L) = 1$. For the news

[15] The only exception is the initial jump of GDP following the unanticipated shock, which is missing for the foresight shock, since there is no jump in federal spending at lag 20.

[16] We refer the reader to the Appendix of Faccini, Mumtaz and Surico, 2012, for the model equations and their log linear form.

shock we use two different specifications. In the former one (specification 1) we assume a simple delay of 4 quarters, i.e. $\gamma(L) = L^4$. In the latter one (specification 2) we assume the triangular MA(21) distributed lag

$$\gamma(L) = \sum_{k=3}^{21} \gamma_k L^k \qquad \gamma_k = \frac{1 - |k - 12|/10}{3.8} \tag{9}$$

The coefficients of the MA are chosen to get an hump-shaped impulse response function for government spending, peaking at lag 15 with a value equal to 1, in the model with spending reversals.

Figure 9a and 9b report the impulse response functions for the model with no reversal and the model with spending reversals, respectively. The dotted line corresponds to the surprise shock, i.e. $\gamma(L) = 1$. The other lines correspond to the news shocks: the dashed line corresponds to the specification $\gamma(L) = L^4$; the solid line corresponds to the MA(21) specification.

In absence of spending reversal (Figure 9a), the effects of surprise and news shocks have the same sign, except for GDP. The long term interest rate increases, the real exchange rate appreciates, net exports decline, and consumption falls after an expansionary government spending shock in all specifications. Here the depreciation puzzle clearly emerges for the surprise shock.

Figure 9b plots the impulse response functions for the specification with spending reversals. As already shown in the literature, spending reversals make theoretical and empirical responses to the surprise shock much closer. In particular the reversal generates a depreciation of the exchange rate triggered by the reduction of the long-term rate. For the MA specification, the responses of government spending, exchange rate, interest rate and net exports are qualitatively similar to those obtained with the VAR model. In particular, the long-run waves obtained with the VAR model are now evident. By contrast, the response of consumption (and therefore GDP) is at odds with empirical evidence, for both the news and the surprise shock. The model predicts that consumption should decline after a news shock and increase after a surprise shock, whereas our empirical impulse response functions have opposite signs. Additional work is needed to reconcile theoretical predictions about consumption with empirical evidence. This is beyond the scope of the present work but we believe it would be an interesting line of future research.

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Tables

	Horizon: quarters ahead				
Method	0	1	2	3	4
	non-cumulated forecasts				
AR(4)	0.92	0.96	0.94	0.99	1.05
ARX(4,1)	0.94	0.96	0.92	0.98	1.03
SPF FEDGOV growth	0.80*	0.83**	0.84	0.84***	0.85***
SPF GDP growth	0.52	0.77	0.88	0.89	0.91
SPF CONS growth	0.64	0.82	0.90	1.00	0.99
	cumulated forecasts				
AR(4)	0.92	0.80	0.75	0.77	0.83
ARX(4,1)	0.94	0.80	0.72	0.73	0.78
SPF FEDGOV growth	0.80*	0.68	0.62	0.54**	0.50***
SPF GDP growth	0.52	0.54	0.62	0.67	0.72
SPF CONS growth	0.64	0.65	0.68	0.73	0.77

Table 1. Accuracy of professional forecasts (SPF) and alternative forecasts obtained with standard time series methods. Accuracy is measured by the Mean Square Forecast Error, divided by the variance of the target variable. In the first three lines of each panel the target variable is federal government spending growth. In the last two lines of each panel the target is GDP growth and consumption growth, respectively. The alternative models are a simple autoregressive mode of order 4 (AR(4)) and an autoregressive model of order 4 augmented with the first lag of GDP growth and the spread between the 10-year bond interest rate and the federal funds rate (ARX(4,1)). The stars denote significance of the Diebold and Mariano test against the ARX(4,1): one star 10%; two stars 5%; three stars 1%.

	Number of lags			
Regressors	1 lag	2 lags	3 lags	4 lags
	3-variable VAR (specification B)			
$f(0)$	0.17	0.36	0.44	0.07
$f(1)$	0.00	0.00	0.00	0.01
$f(2)$	0.02	0.01	0.01	0.02
$f(3)$	0.37	0.39	0.01	0.02
$f(4)$	0.22	0.19	0.28	0.03
All	0.02	0.01	0.03	0.05
$F(1,4)$	0.02	0.08	0.12	0.08
	7-variable VAR (specification A)			
$f(0)$	0.53	0.77	0.93	0.46
$f(1)$	0.34	0.40	0.51	0.60
$f(2)$	0.43	0.62	0.76	0.84
$f(3)$	0.59	0.42	0.52	0.61
$f(4)$	0.71	0.60	0.56	0.61
All	0.71	0.60	0.56	0.61
$F(1,4)$	0.38	0.43	0.51	0.81

Table 2. Test of orthogonality: p-values of the F-test of the regression of the federal government spending shock estimated with the 7-variable VAR on seven sets of regressors. The first five include the series reported by the Survey, from $f(0)$ to $f(4)$, taken one at a time. The sixth set (All) includes all of the series $f(h)$, $h = 0, \ldots, 4$. The seventh set includes the sum $F(1,4) = f(1) + \cdots + f(4)$.

	Number of lags			
Regressors	1 lag	2 lags	3 lags	4 lags
	3-variable VAR (specification B)			
pc_1	0.68	0.84	0.92	0.97
pc_2	0.03	0.09	0.22	0.26
pc_3	0.57	0.37	0.58	0.63
pc_4	0.02	0.08	0.07	0.10
pc_5	0.13	0.18	0.34	0.36
$pc_1 - pc_5$	0.30	0.40	0.64	0.49
	7-variable VAR (specification A)			
pc_1	0.99	0.39	0.43	0.68
pc_2	0.24	0.15	0.20	0.25
pc_3	0.61	0.53	0.71	0.89
pc_4	0.12	0.25	0.15	0.07
pc_5	0.72	0.73	0.87	0.47
$pc_1 - pc_5$	0.72	0.72	0.89	0.81

Table 3. Test of orthogonality: p-values of the F-test of the regression of the federal government spending shock estimated with the 7-variable VAR on six sets of regressors. The first five include the largest five principal components of a macroeconomic data set (see Forni *et al.* 2014 for details), taken one at a time. The sixth set includes all of the largest five principal components.

	Horizon: quarters after the shock				
Variables	0	4	8	12	24
	News shock - Identification #1				
FEDGOV	0.0	3.0	10.8	21.6	29.6
$F(1,4)$	99.2	58.7	45.2	36.8	27.4
GDP	1.3	3.4	3.6	4.2	4.9
CONS	9.2	6.4	6.2	6.1	6.2
SUR	0.8	2.4	6.3	10.9	13.4
NX	0.8	8.5	10.9	13.4	13.7
10YBOND	3.8	13.9	12.6	11.3	10.6
RER	1.8	3.9	10.0	9.8	12.7
	News shock - Identification #2				
FEDGOV	0.0	2.0	4.2	6.7	10.8
GDP	2.9	10.6	9.8	9.2	7.6
CONS	6.4	8.5	10.6	10.7	8.1
SUR	1.6	2.8	3.5	3.9	5.9
NX	0.8	7.8	10.1	12.9	11.4
10YBOND	4.8	16.0	13.5	13.7	13.5
RER	2.1	9.5	15.7	14.1	13.6
	Surprise shock - Identification #1				
FEDGOV	100.0	69.9	59.4	44.3	21.3
$F(1,4)$	0.8	3.4	4.9	7.9	14.2
GDP	8.7	4.1	5.3	5.2	5.5
CONS	0.9	4.0	5.9	6.4	8.3
SUR	6.9	8.2	9.8	8.5	7.3
NX	0.8	2.8	4.5	5.3	11.3
10YBOND	0.8	3.9	4.0	3.9	4.7
RER	5.7	8.6	11.2	13.6	16.0

Table 4: Variance decomposition. Percentage of the forecast error variance explained by the news and surprise shocks at different horizons.

Figures

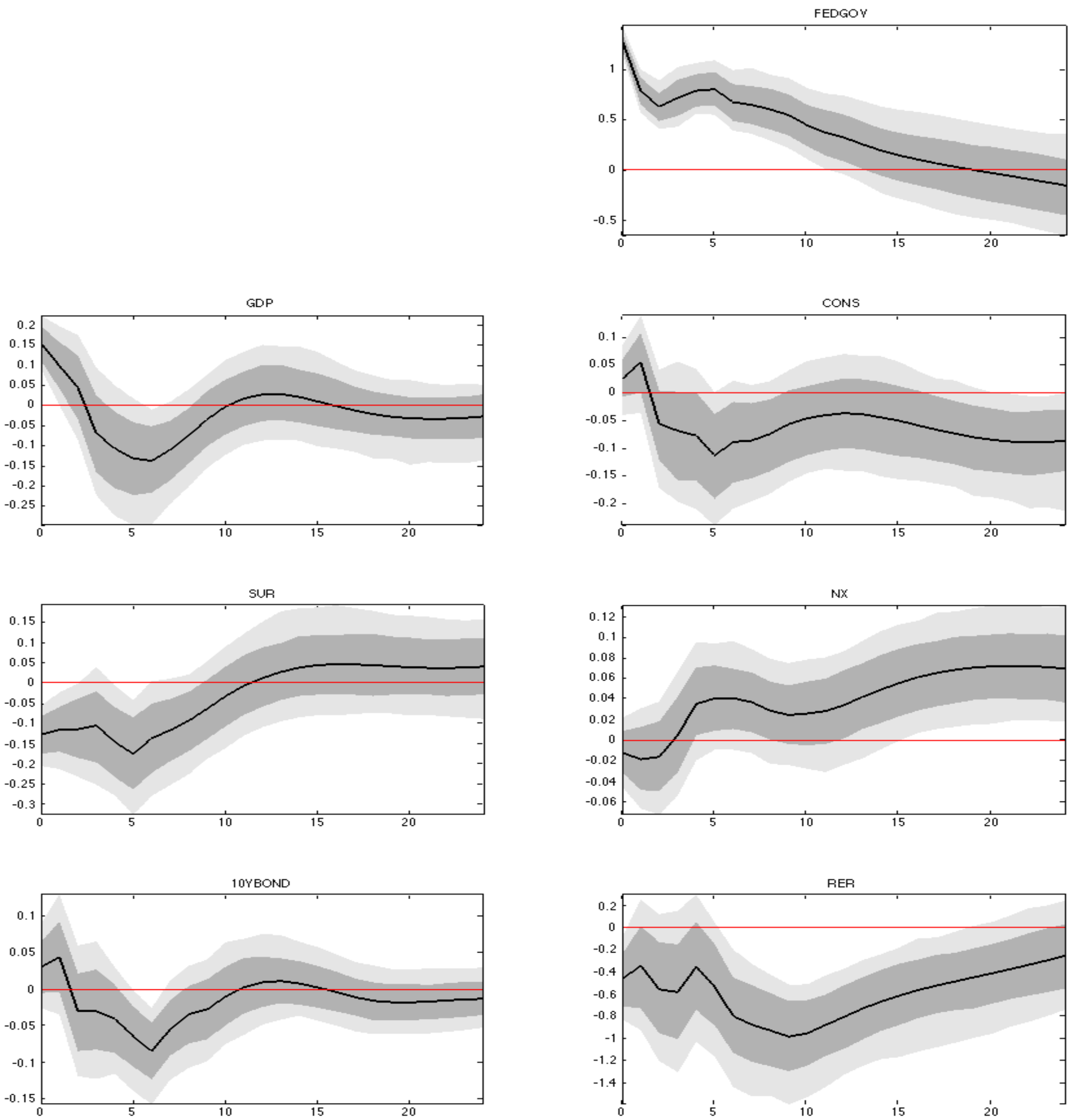

Figure 1: Impulse response functions to the government spending shock in a seven-variable bayesian VAR with diffuse prior including, in this order, real federal spending, real GDP, real consumption, federal surplus divided by GDP, net exports divided by GDP, the 10-year bond interest rate and the exchange rate. The shock is the first one of the Cholesky decomposition. Solid lines are point estimates (average across 500 draws), dark-gray area is the 68% confidence region; light-gray area is the 90% confidence region.

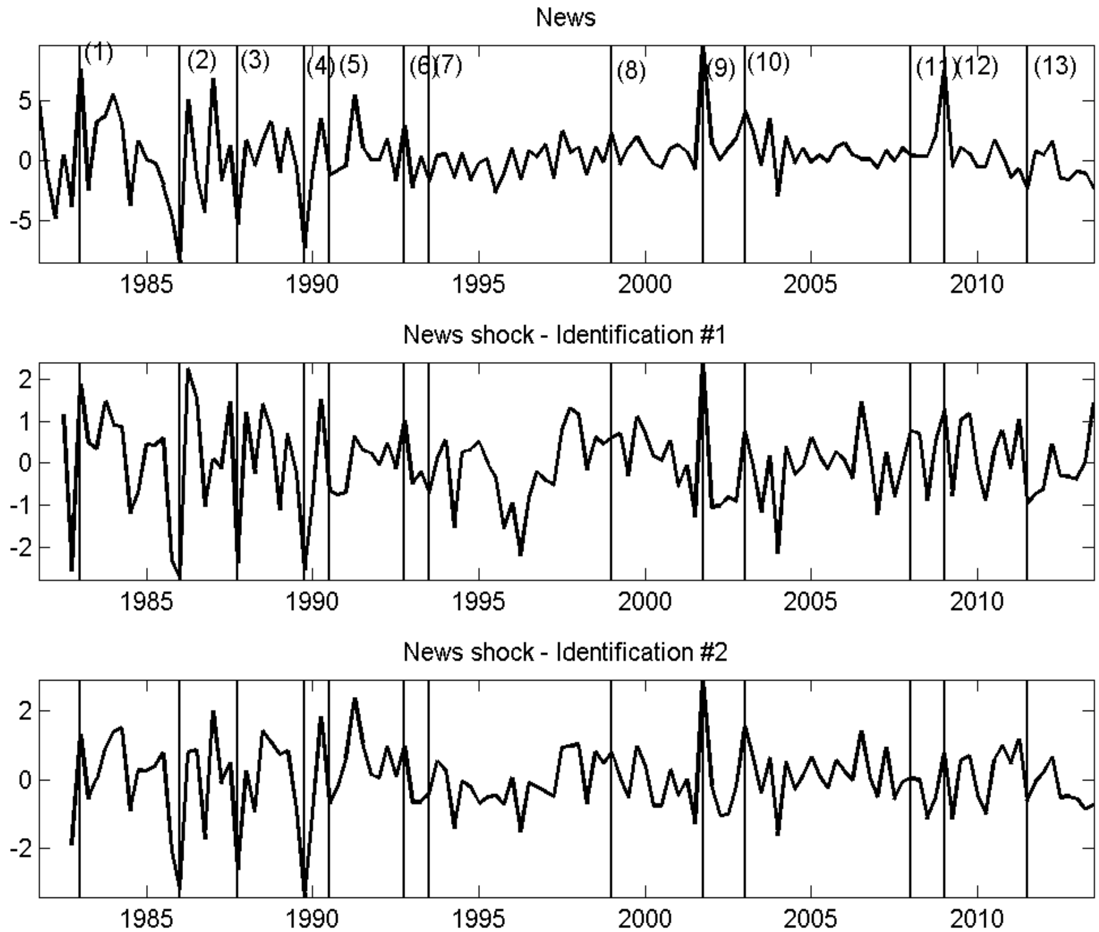

Figure 2: Top panel - spending news variable NEWS; mid panel - news shock under identification #1; bottom panel - news shock under identification #2. The vertical lines are associated with the following episodes:
(1) 1983:I - Strategic Defense Initiative;
(2) 1986:I - Emergency Deficit Control Act;
(3) 1987:IV - Emergency Deficit Control Reaffirmation Act
(4) 1989:IV - Berlin Wall fall;
(5) 1990:III - Gulf War;
(6) 1992:IV - Clinton's election;
(7) 1993:III - Omnibus Budget Reconciliation Act;
(8) 1999:I - Kosovo War;
(9) 2001:IV - War in Afghanistan;
(10) 2003:I - II Gulf War;
(11) 2008:I - 2008 Fiscal Stimulus;
(12) 2009:I - Obama Fiscal Stimulus;
(13) 2011:III - Budget Control Act of 2011.

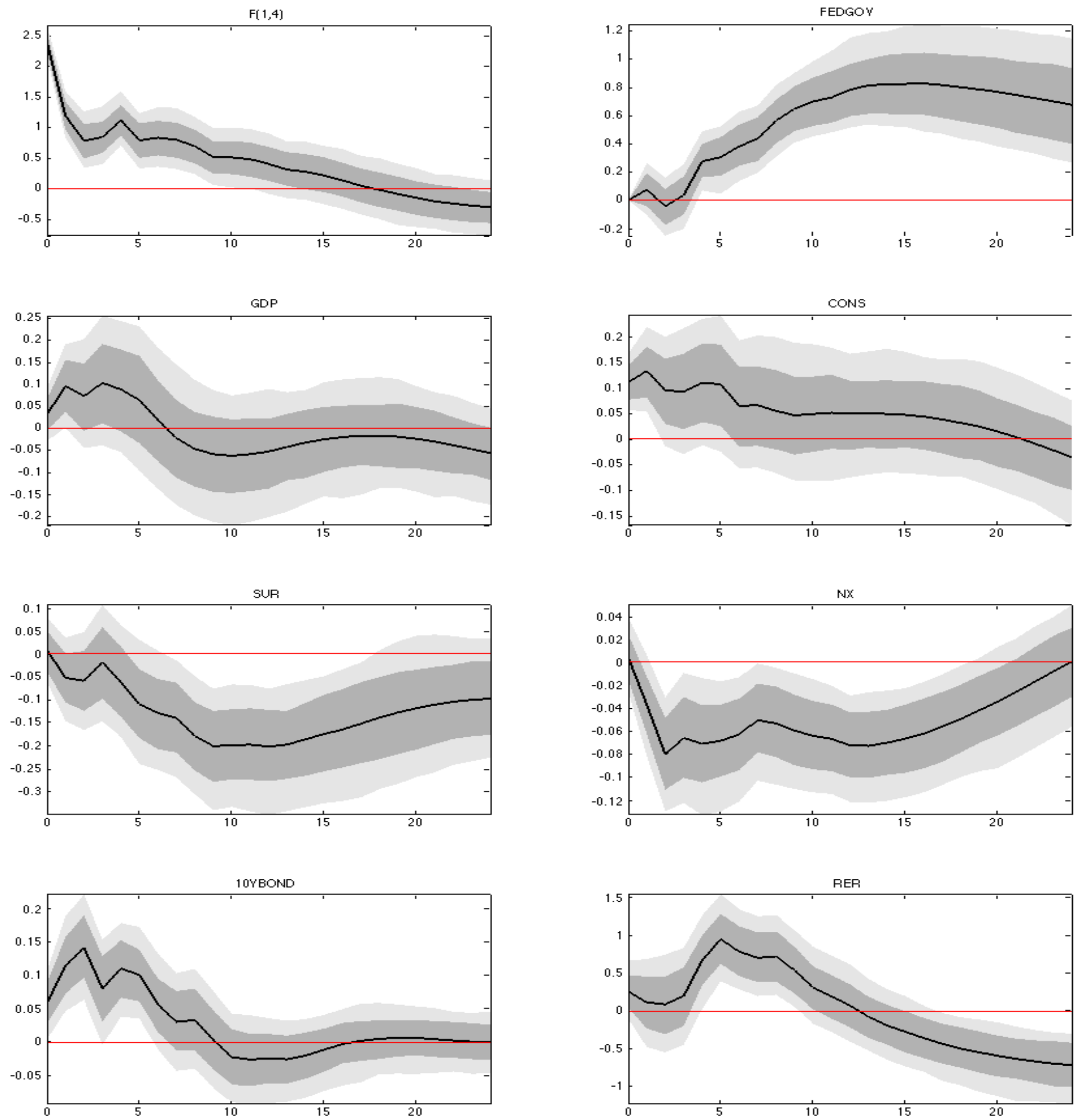

Figure 3: Impulse response functions to a foresight (anticipated) spending shock (Identification #1) with in a eight-variable Bayesian VAR with diffuse prior including, in this order, real federal spending, the cumulated professional forecast $F(1,4)$, real GDP, real consumption, federal surplus divided by GDP, net exports divided by GDP, the 10-year bond interest rate and the exchange rate; the shock is the second one of the Cholesky decomposition. Solid lines are point estimates (average across 500 draws), dark-gray area is the 68% confidence region; light-gray area is the 90% confidence region.

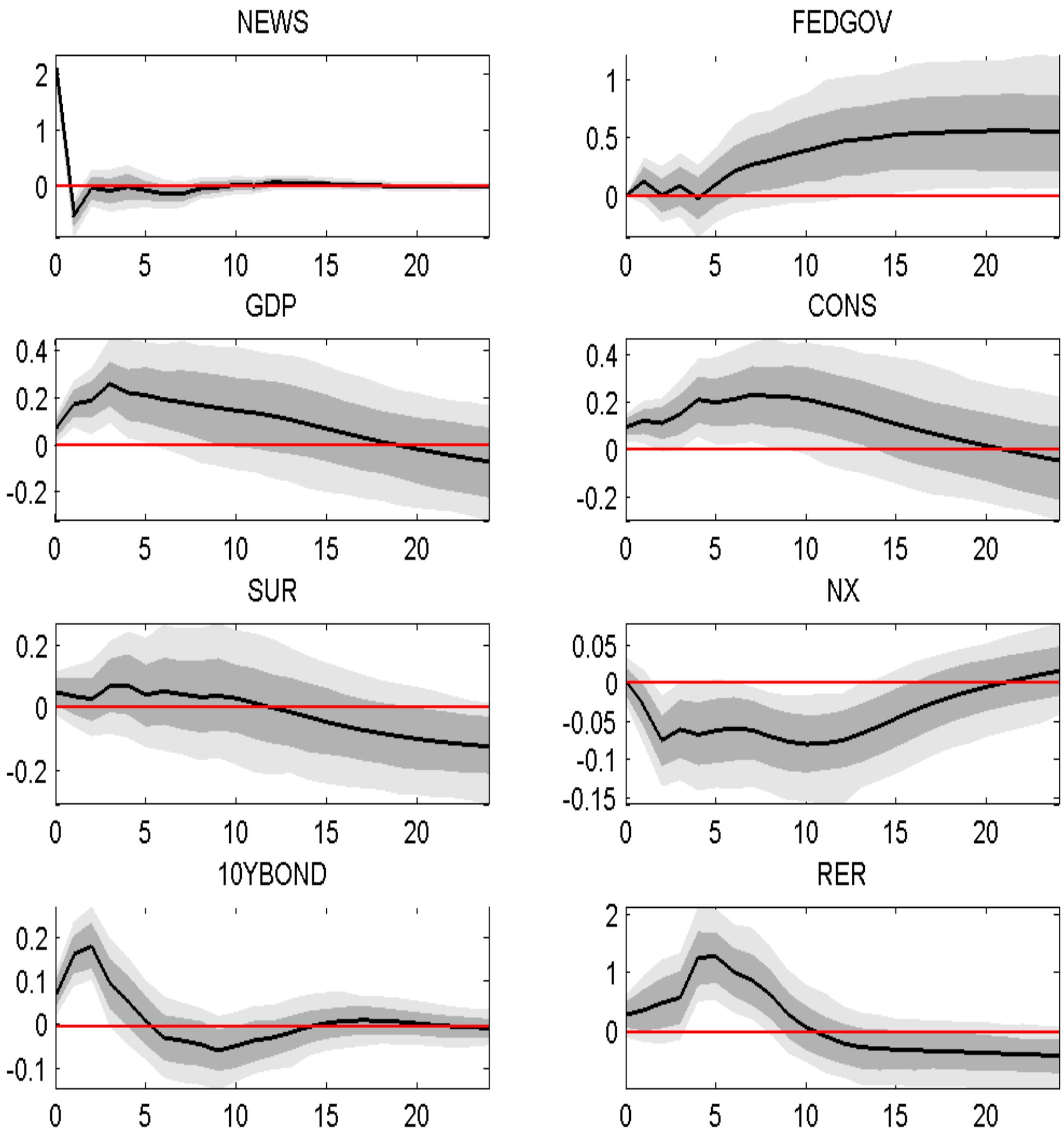

Figure 4: Impulse response functions to a foresight (anticipated) spending shock (Identification #2) in a eight-variable bayesian VAR with diffuse prior including, in this order, the news spending variable, real federal spending, real GDP, real consumption, federal surplus divided by GDP, net exports divided by GDP, the 10-year bond interest rate and the exchange rate. The shock is the first one of the Cholesky decomposition. Solid lines are point estimates (average across 500 draws), dark-gray area is the 68% confidence region; light-gray area is the 90% confidence region.

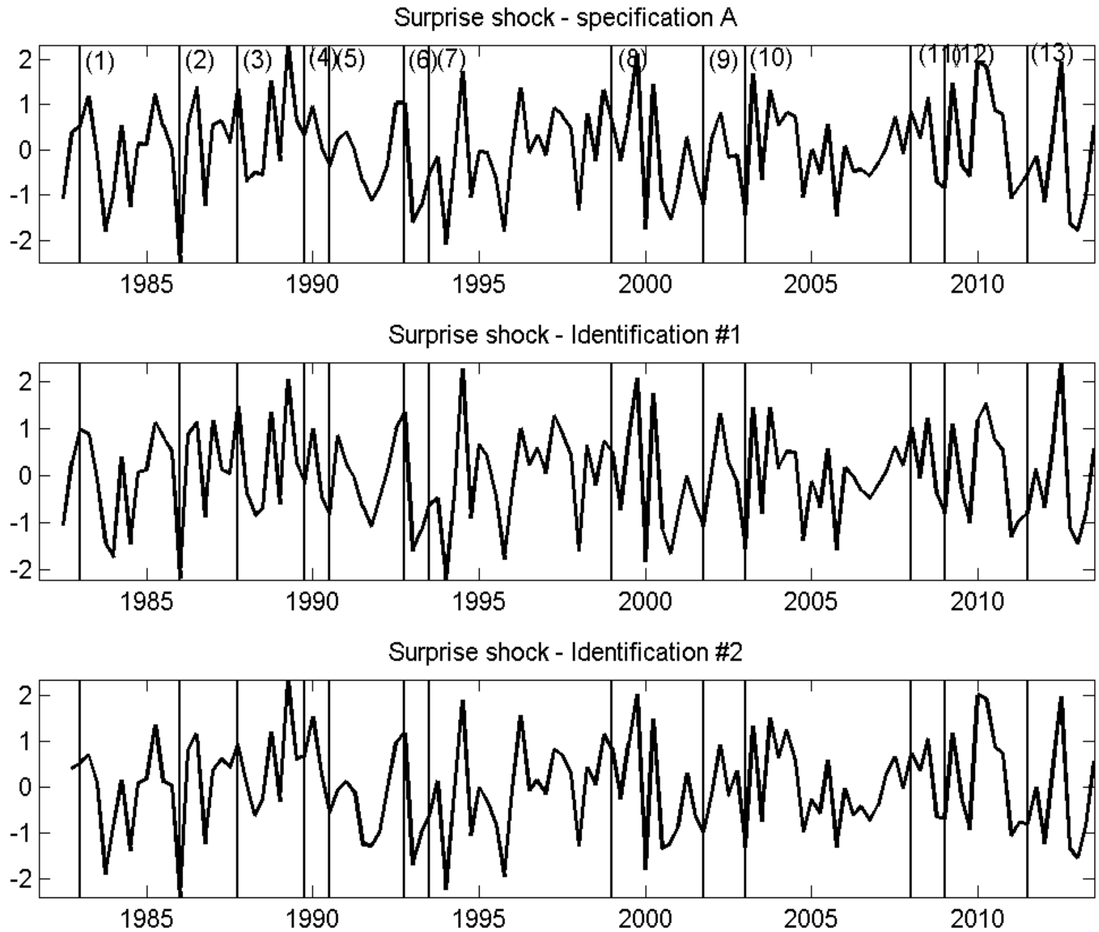

Figure 5: Top panel - surprise shock in specification A; mid panel - surprise shock under identification #1; bottom panel - surprise shock under identification #2. The vertical lines are associated with the following episodes:

(1) 1983:I - Strategic Defense Initiative;
(2) 1986:I - Emergency Deficit Control Act;
(3) 1987:IV - Emergency Deficit Control Reaffirmation Act
(4) 1989:IV - Berlin Wall fall;
(5) 1990:III - Gulf War;
(6) 1992:IV - Clinton's election;
(7) 1993:III - Omnibus Budget Reconciliation Act;
(8) 1999:I - Kosovo War;
(9) 2001:IV - War in Afghanistan;
(10) 2003:I - II Gulf War;
(11) 2008:I - 2008 Fiscal Stimulus;
(12) 2009:I - Obama Fiscal Stimulus;
(13) 2011:III - Budget Control Act of 2011.

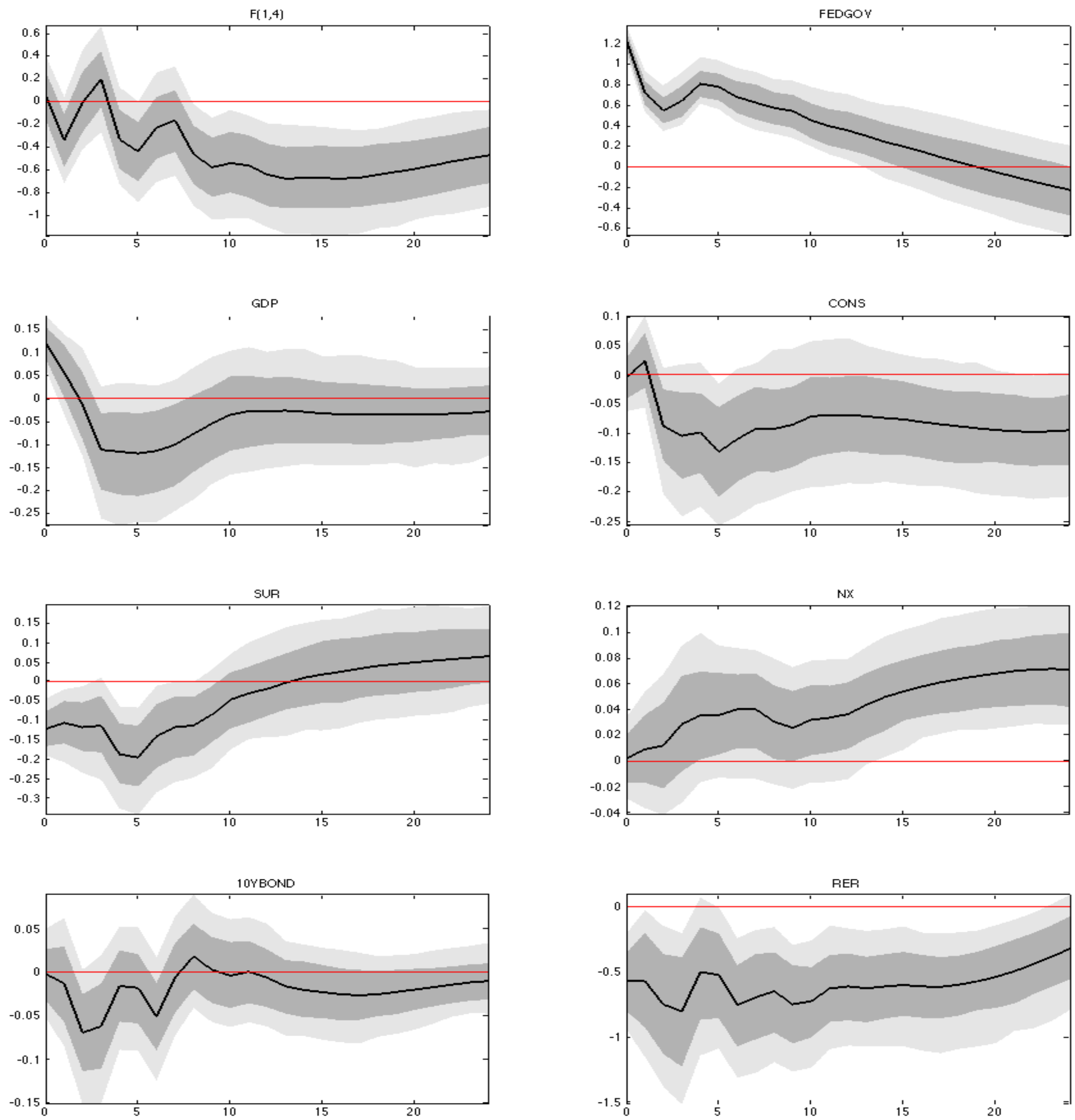

Figure 6: Impulse response functions to a surprise (unanticipated) spending shock (Identification #1) in a eight-variable Bayesian VAR with diffuse prior including, in this order, real federal spending, the cumulated professional forecast $F(1,4)$, real GDP, real consumption, federal surplus divided by GDP, net exports divided by GDP, the 10-year bond interest rate and the exchange rate; the shock is the first one of the Cholesky decomposition. Solid lines are point estimates (average across 500 draws), dark-gray area is the 68% confidence region; light-gray area is the 90% confidence region.

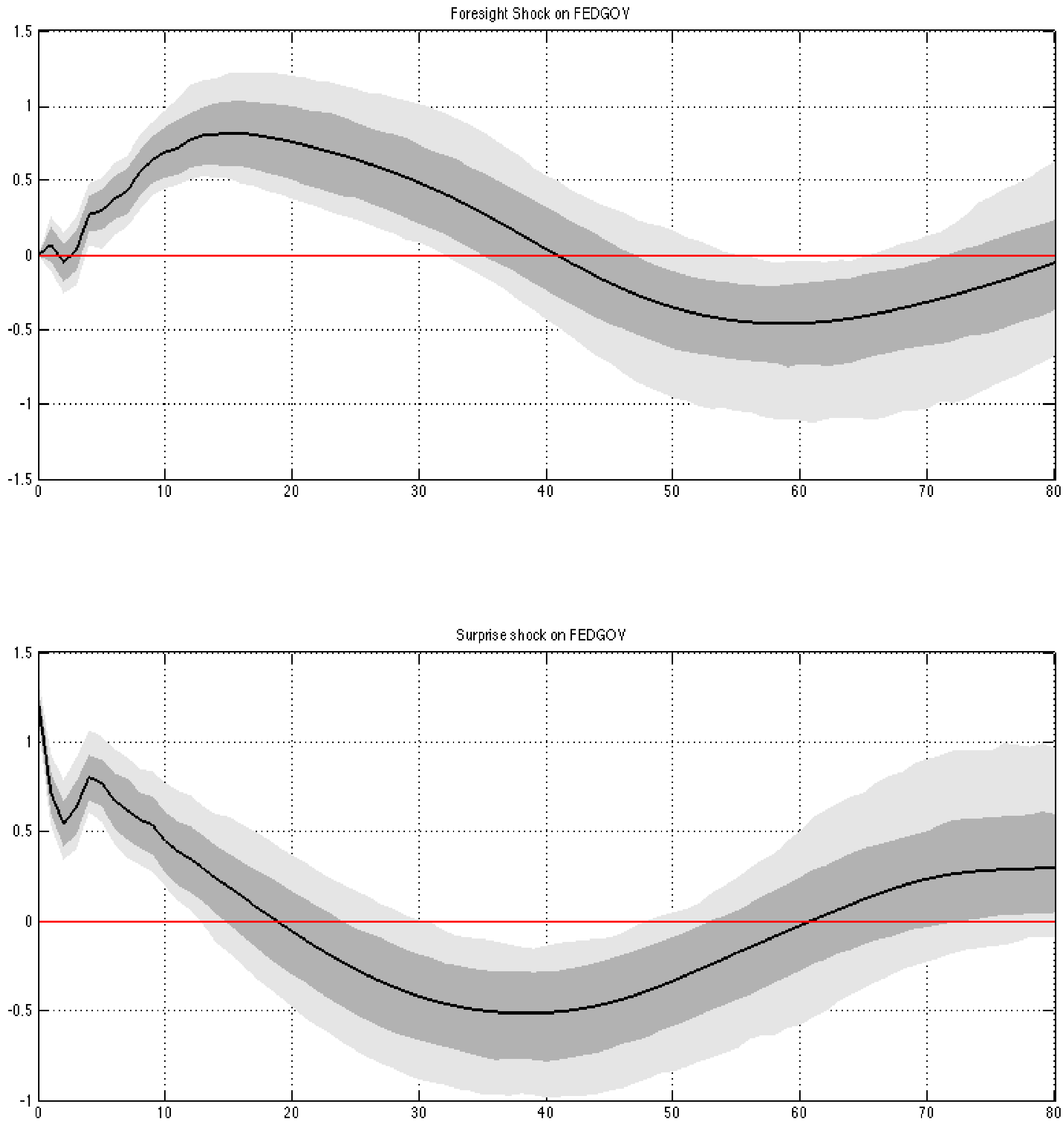

Figure 7: Impulse response functions to a foresight (upper panel) and a surprise (lower panel) spending shock (Identification #1) to real federal spending. The horizon of the horizontal axis is enlarged to 20 years. Solid lines are point estimates (average across 500 draws), dark-gray area is the 68% confidence region; light-gray area is the 90% confidence region.

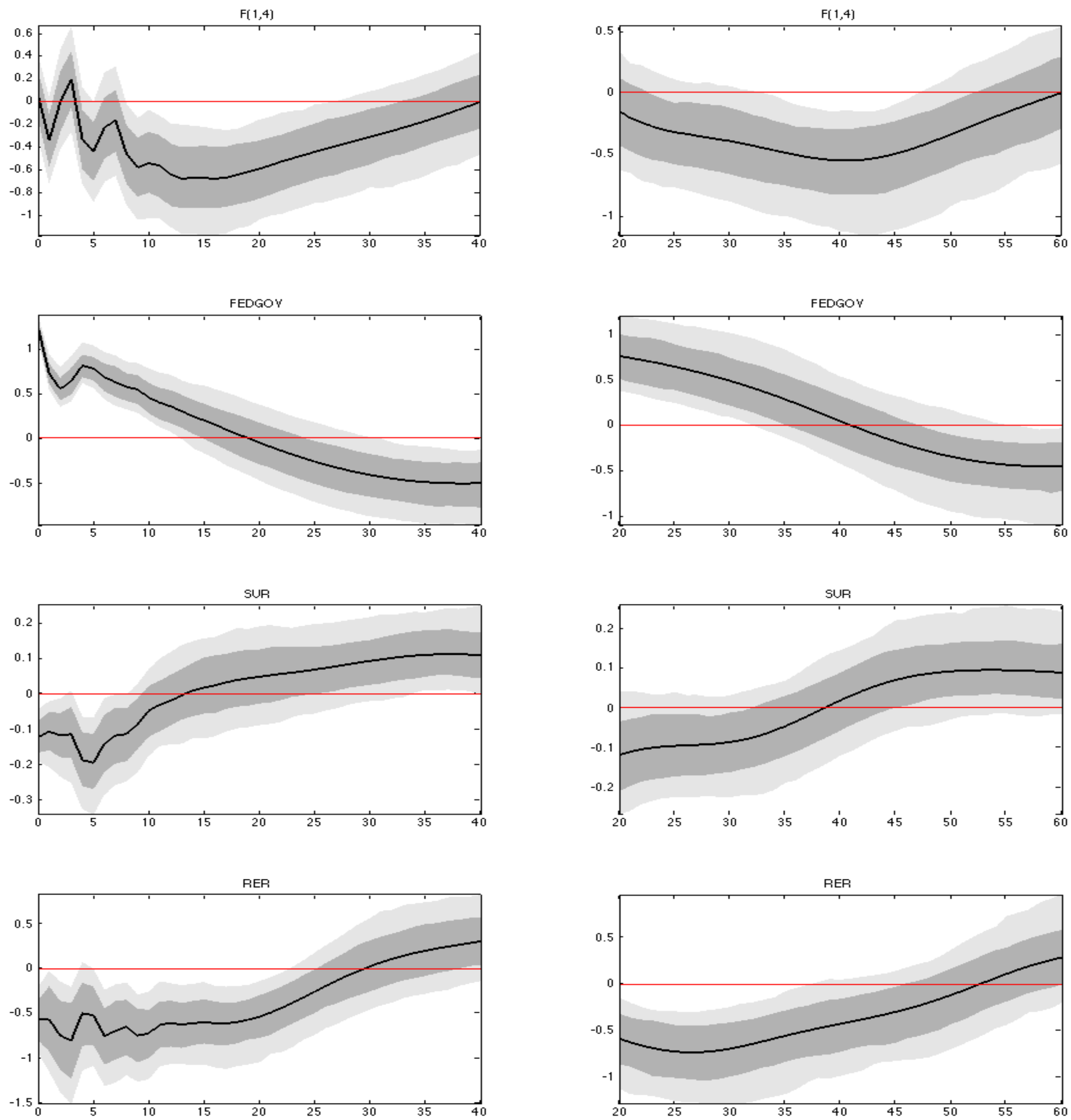

Figure 8: Impulse response functions to a foresight (right column) and a surprise (left column) spending shock (Identification #1) to selected variables. In the right column the impulse response functions are shifted ahead by 20 periods. Solid lines are point estimates (average across 500 draws), dark-gray area is the 68% confidence region; light-gray area is the 90% confidence region.

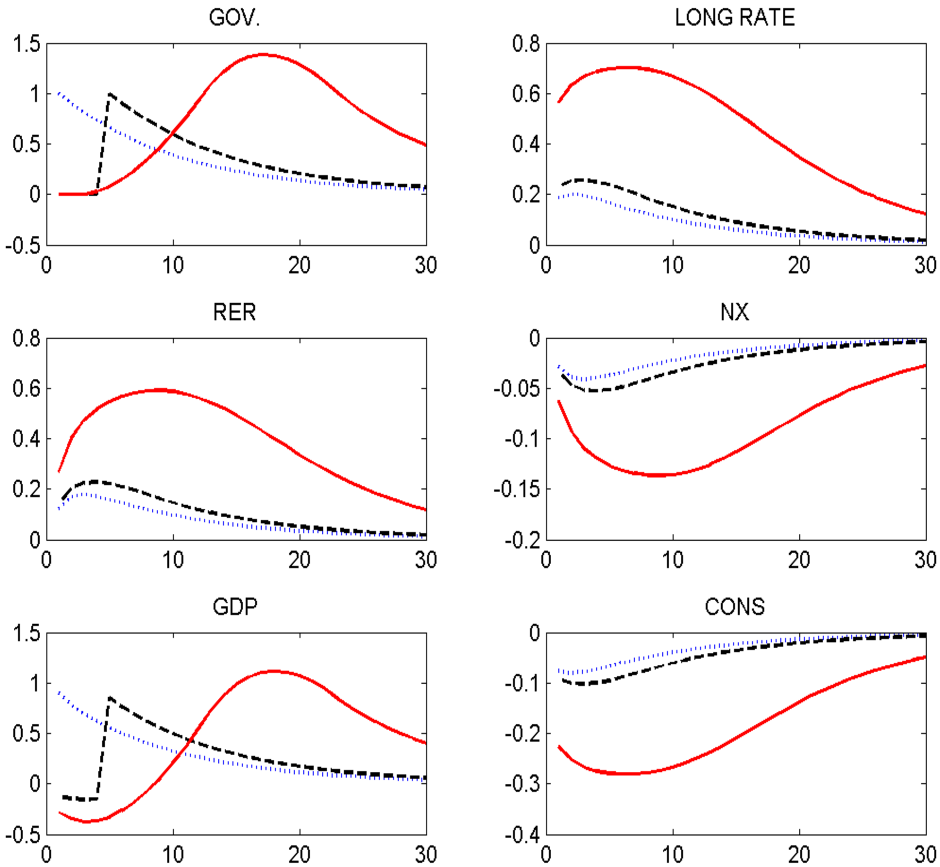

Figure 9a: Theoretical impulse response functions of surprise and news shocks in the model of Faccini, Mumtaz and Surico, 2012, with no spending reversals. Dotted line: $\gamma(L) = 1$ (surprise shock). Dashed line: $\gamma(L) = L^4$ (news shock, specification 1). Solid line: $\gamma(L) = \sum_{k=3}^{21} \gamma_k L^k, \ \ \gamma_k = \frac{1-|k-12|/10}{3.8}$ (news shock, specification 2).

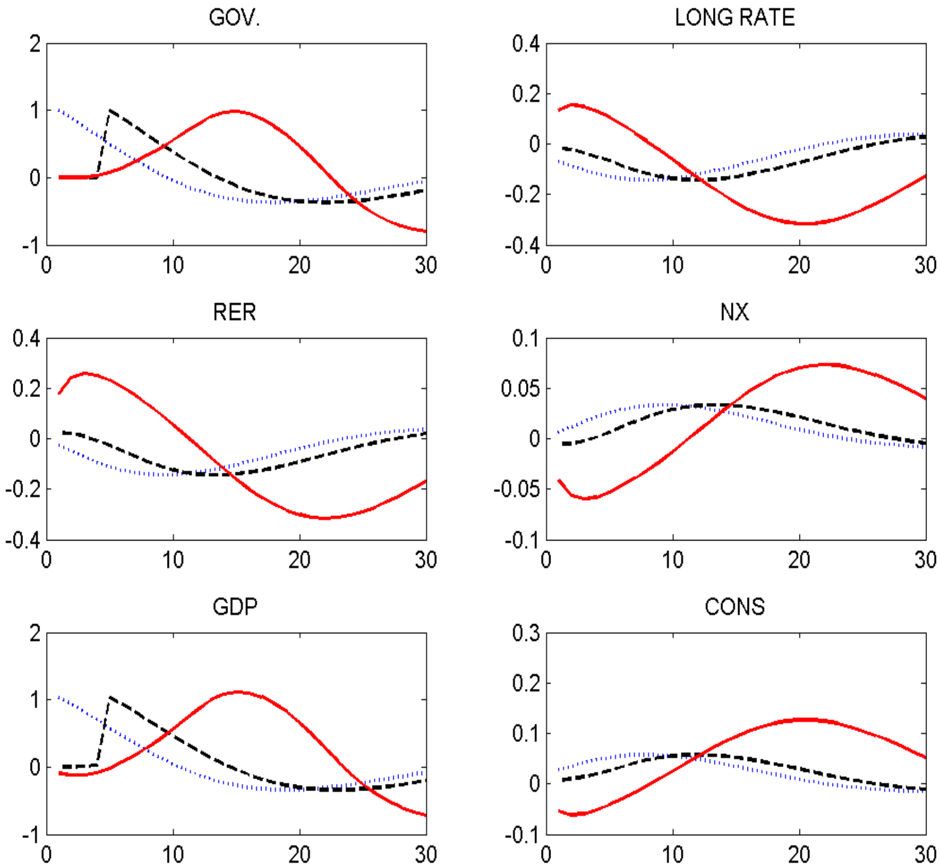

Figure 9b: Theoretical impulse response functions of surprise and news shocks in the model of Faccini, Mumtaz and Surico, 2012, with spending reversals. Dotted line: $\gamma(L) = 1$ (surprise shock). Dashed line: $\gamma(L) = L^4$ (news shock, specification 1). Solid line: $\gamma(L) = \sum_{k=3}^{21} \gamma_k L^k$, $\gamma_k = \frac{1-|k-12|/10}{3.8}$ (news shock, specification 2).

Appendix: Robustness

We make a few robustness checks. As observed in Subsection 4.1, the news shock could also be identified by ordering the news variable first. The impulse response functions obtained under this alternative ordering for Specification #2 are shown in Figure A1. The figure is very similar to Figure 4. The only minor difference is that the impact effect of the news shock on government spending, being not forced to be 0, is now positive, albeit small and not significant. This result confirm the validity of our assumption about the information set of the professional forecasters.

As a second robustness check, following the discussion of Subsection 4.3, we identified the surprise shock by using two alternative methods: first, we used the expectation revision $g_t - E^{\mathcal{P}}_{t-1} g_t$, as in Ramey, 2011; second, we used the nowcast error $g_t - E^{\mathcal{P}}_t g_t$, as in Ricco, 2013. Such variables are ordered first in the respective VARs and the surprise shock is obtained in both cases as the first Cholesky shock. The estimated impulse response functions are displayed in Figures A2 and A3. The results are almost identical to those obtained with the baseline identification (Figure 6): the shock triggers a real depreciation of the exchange rate as well as an improvement in the trade balance.

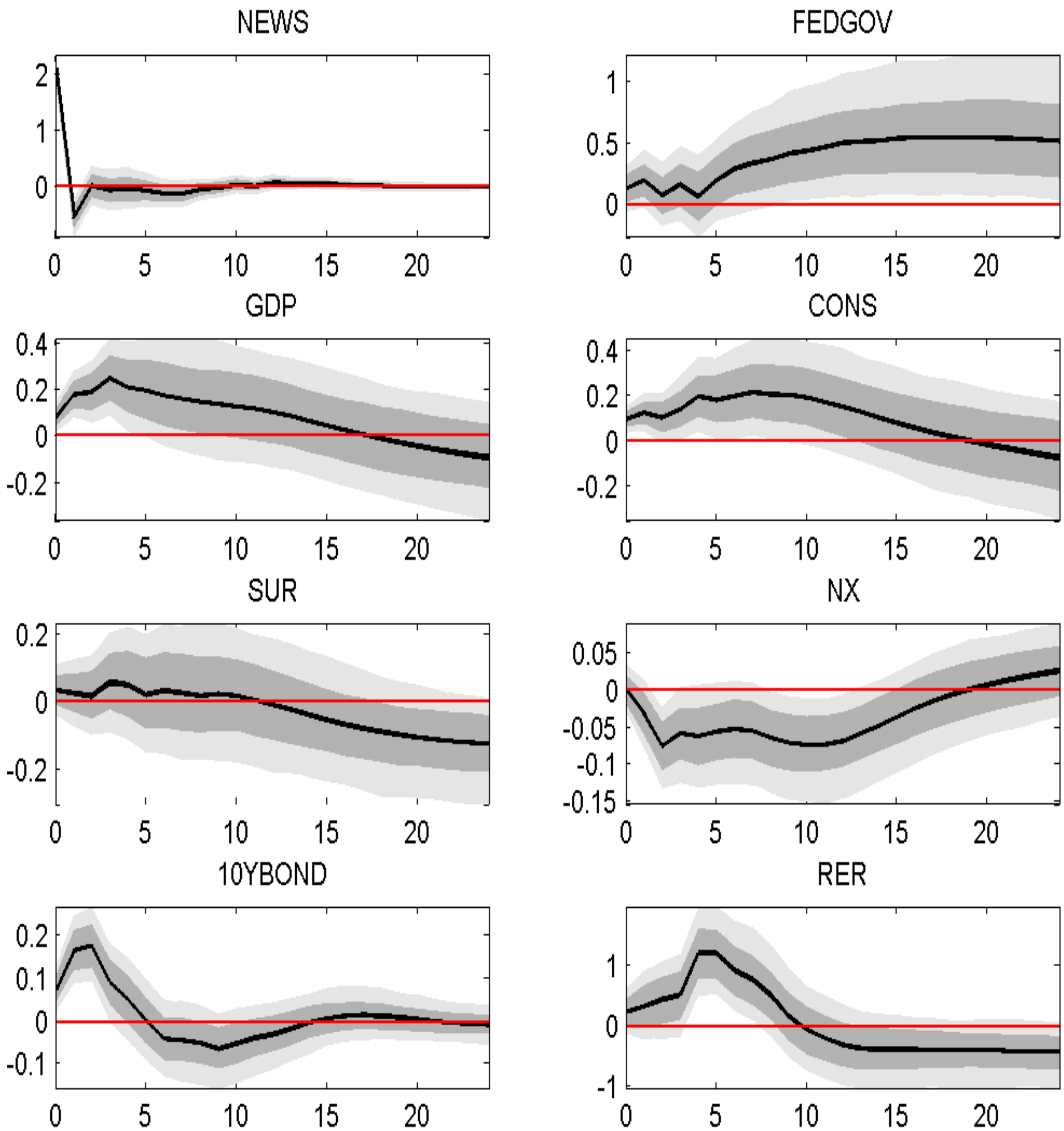

Figure A1: Impulse response functions to a news shock. The VAR includes, in this order, the news spending variable, real federal spending, real GDP, real consumption, federal surplus divided by GDP, net exports divided by GDP, the 10-year bond interest rate and the exchange rate; the shock is the first one of the Cholesky decomposition. Solid lines are point estimates (average across 500 draws), dark-gray area is the 68% confidence region; light-gray area is the 90% confidence region.

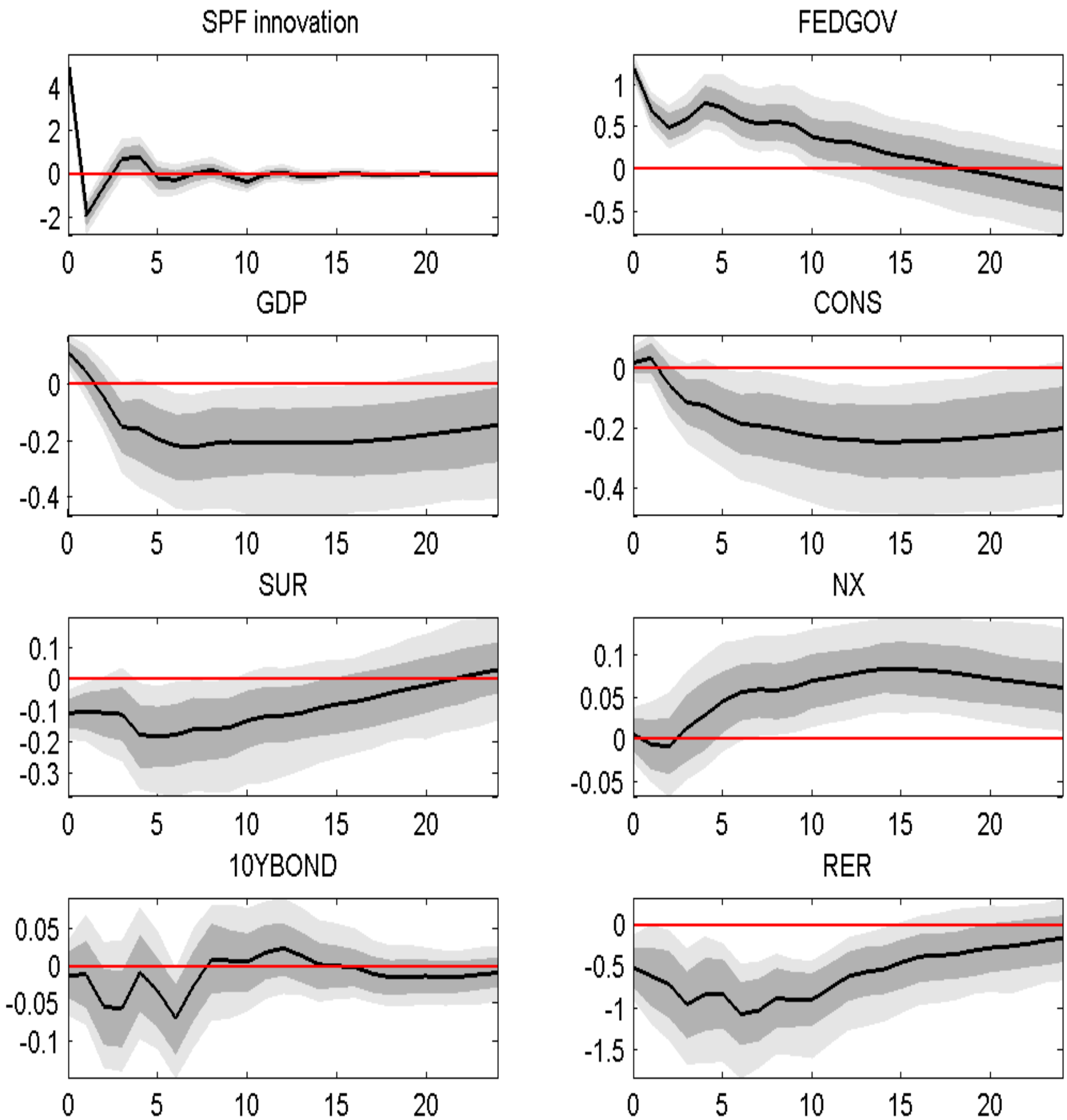

Figure A2: Impulse response functions to a surprise (unanticipated) shock. The VAR includes, in this order, the expectation revision $g_t - E^{\mathcal{P}}_{t-1} g_t$, real federal spending, real GDP, real consumption, federal surplus divided by GDP, net exports divided by GDP, the 10-year bond interest rate and the exchange rate; the shock is the first one of the Cholesky decomposition. Solid lines are point estimates (average across 500 draws), dark-gray area is the 68% confidence region; light-gray area is the 90% confidence region.

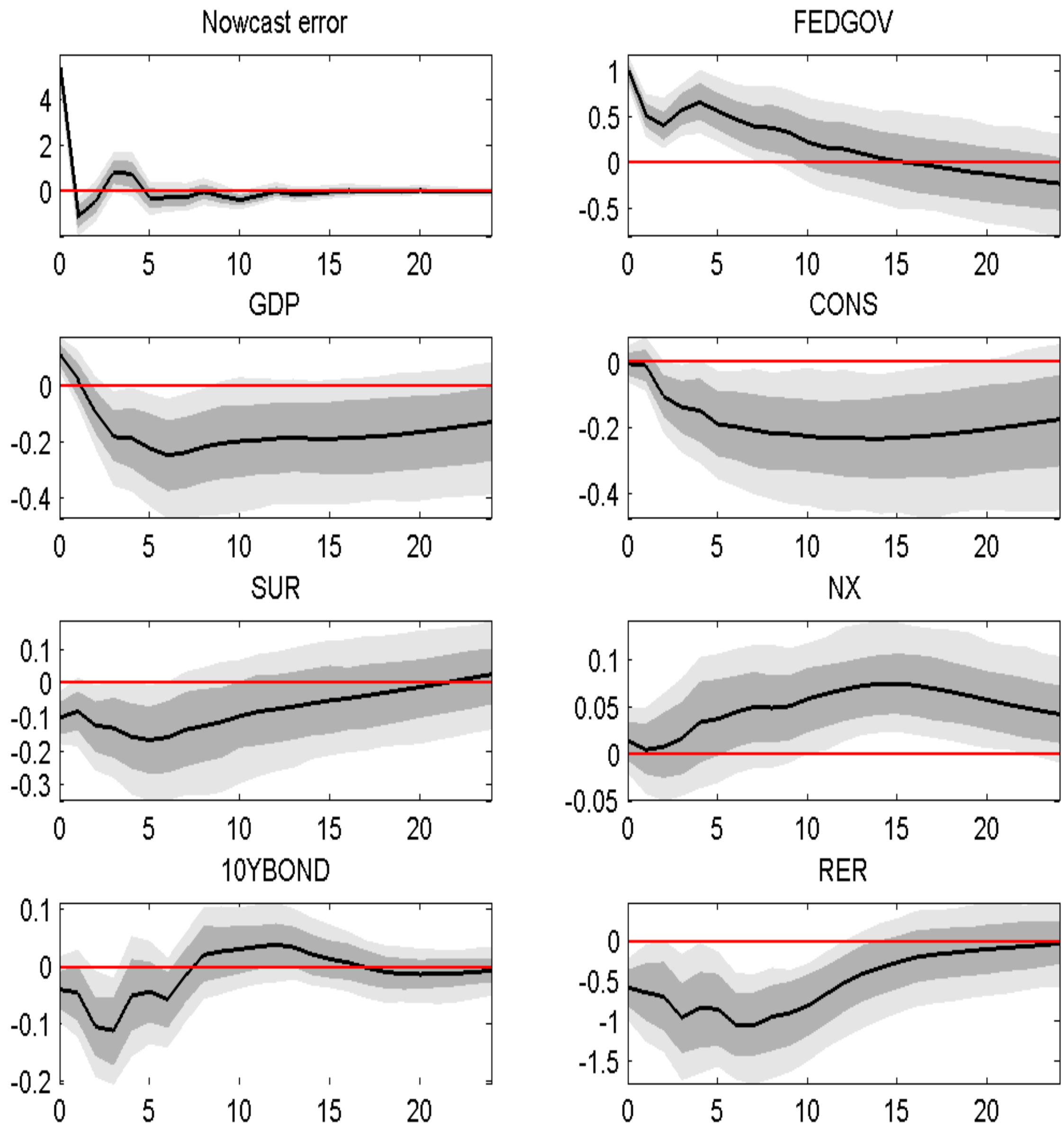

Figure A3: Impulse response functions to a surprise (unanticipated) shock. The VAR includes, in this order, the nowcast error $g_t - E_t^{\mathcal{P}} g_t$, real federal spending, real GDP, real consumption, federal surplus divided by GDP, net exports divided by GDP, the 10-year bond interest rate and the exchange rate; the shock is the first one of the Cholesky decomposition. Solid lines are point estimates (average across 500 draws), dark-gray area is the 68% confidence region; light-gray area is the 90% confidence region.