Fiscal Foresight, Forecast Revisions and the Effects of Government Spending in the Open Economy

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Abstract

This paper investigates the effects of government spending on the real exchange rate and the trade balance in the US using a new VAR identification procedure based on spending forecast revisions. I find that the real exchange rate appreciates and the trade balance deteriorates after a government spending shock, although the effects are quantitatively small. The findings broadly match the theoretical predictions of the standard Mundell-Fleming model and differ substantially from those existing in literature. Differences are attributable to the fact that, because of fiscal foresight, the government spending is non-fundamental for the variables typically used in open economy VARs. Here, on the contrary, the estimated shock is fundamental.

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1 Introduction

Since the mid 1980s, the U.S. economy has been characterized by a large and growing trade deficit. Around the mid 1980s the deficit was about 3% of GDP while since 2000 has been on average about 5% of GDP. The phenomenon, given its magnitude, has attracted a great deal of attention devoted to assessing the possible causes. Expansionary fiscal policy is in the list. According to the standard textbook Mundell-Fleming model, a fiscal policy expansion worsens the trade balance through the appreciation of the nominal domestic currency following the inflow of foreign capital attracted by a higher interest rate. If prices are sticky the exchange rate will appreciate also in real terms.[1]

Quite surprisingly little evidence about the effects of fiscal policy shocks on the trade deficit and the exchange rates is available.[2] Existing empirical VAR analyses for the US have provided, so far, results which are in sharp contrast with the above theoretical predictions. Kim and Roubini (2008) Corsetti and Muller (2006), Monacelli and Perotti (2007), Ravn, Schmitt-Grohe and Uribe (2007) and Enders, Muller and Scholl (2011) find that the real exchange rate depreciates after an expansionary government spending shock. Results for the trade balance are more mixed. 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.[3]

The findings are so unconventional and puzzling that have sparked an important research effort to better understand the mechanisms that propagate fiscal policy actions. Some authors have extended the standard models in order to account for such a real depreciation of the domestic currency following a fiscal expansion. Ravn, Schmitt-Grohe and Uribe (2007) shows 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 the domestic economy less expensive, that is the real exchange rate depreciates. Corsetti and Muller (2011) shows that if the private sector expects spending cuts in the future the real long term interest rate can fall producing a real depreciation of the exchange rate as well as an improvement of the external balance.

Studying the effects of fiscal shocks using VAR techniques can be problematic though. A few recent works have convincingly argued that, because of the existence of legislative and implementation lags, private agents receive signals about future changes

[1] A partial list of models where a fiscal expansion may generate a worsening of the trade balance includes Dornbusch (1976), Baxter, (1995) and Kollmann, (1998).

[2] On the contrary, a lot of works have been dedicated to study the effects of government spending shocks on domestic variables; a partial list includes Blanchard and Perotti (2002), Gali Lopez-Salido and Valles (2007), Mountford and Uhlig (2002), Ramey and Shapiro (1988).

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

in taxes and government spending before these changes take actually place, the phenomenon called "fiscal foresight" (see e.g. Yang, 2007, Leeper, Walker and Yang, 2008, Mertens and Ravn, 2010).

Leeper, Walker and Yang (2008) (LWY henceforth) shows theoretically, using a closed-economy RBC model that, under fiscal foresight, standard VAR techniques are likely to fail in correctly estimating the fiscal policy shock since a problem of *non-fundamentalness* emerges. Non-fundamentalness typically arises when agents have a larger information set than the econometrician (see Hansen and Sargent, 1980), a situation that can occur when a limited number of variables are considered like in VAR models, see Lippi and Reichilin (1994). But in presence of fiscal foresight non-fundamentalness becomes a very likely scenario. The intuition is that fiscal variables, like taxes or government spending, typically used to identify fiscal policy shocks, are affected only with a delay by fiscal policy actions so that their current and past values do not convey enough information about the current shock.

Forni and Gambetti (2010) provides empirical evidence that government spending shocks are actually *non-fundamental* for the variables typically considered in standard closed-economy specifications. The implication is that VAR models with these variables are unable to consistently estimate the shock. The finding confirms the result obtained in Ramey (2009) that the fiscal policy shock estimated with a VAR as in Perotti (2007) is predicted by the forecast of government spending from the Survey of Professional Forecasters. Although the specifications considered by these authors do not include open economy variables, the results cast some doubt on the reliability of the findings obtained with standard VAR techniques.

But there is also a second problem raised by the presence of fiscal anticipation. Identification of the fiscal policy shock is typically achieved by imposing some restrictions on the impact effect of the fiscal policy variable. The well-known Blanchard and Perotti (2002) identification, for instance, relies on the assumption that contemporaneously only government spending shocks have an effect on government spending. Kim and Roubini (2008) identifies the shock by imposing an impact effect of deficit rather than government spending. However all these identification schemes are in contrast with the idea of delayed effects on fiscal variables. Rather under these identifications, the fiscal shock should paradoxically be one of those labeled as non-policy.

This paper makes two contributions. First of all I investigate whether the government spending shock estimated using the standard identification *à la* Blanchard and Perotti in an open-economy VAR is fundamental. It might be argued that the real exchange rate, due to its forward looking nature, could help in mitigating the problem of non-fundamentalness arising in closed economy VARs. Here I show, using a simple theoretical example, that this is not true: fiscal foresight generates non-fundamentalness of the fiscal shock even in presence of the exchange rate. Moreover I check empirically for non-fundamentalness by testing whether the estimated shock is orthogonal to the government spending forecasts from the Survey of Professional Forecasters and the Ramey's (2011) variable.

The second contribution of the paper is to propose a new VAR identification procedure to identify government spending shock which delivers a fundamental shock. Identification is based on a news variable defined as the revision of the long-term government spending forecast made by the professional forecasters. More specifically, the revision is the difference between the forecast made at time t of government spending growth between time $t+2$ up to $t+4$ and the forecast of the same variable made at time $t-1$. Such a variable represents the new information about future government spending that becomes available at time t to economic agents, proxied by the professional forecasters. The variable is ordered first in a Cholesky identification scheme and the first shock is interpreted as the government spending shock. The identification procedure has two key advantages. First, it incorporates all the information that agents use when forming expectations about future spending so to alleviate the non-fundamentalness problem. Second, government spending can react with delay to the shock, as implied by fiscal foresight, and is not forced to increase on impact as in the standard Blanchard and Perotti (2002) scheme.

The model is estimated using US quarterly data spanning from 1981:III to 2007:IV. The baseline VAR includes the forecast revision variable, federal spending, the primary deficit, GDP, the trade balance and the real exchange rate.

The main findings are the following. First, the government spending shock obtained using the Blanchard and Perotti (2002) identification in the typical open-economy VAR is predictable and hence non-fundamental. Second, using the new identification procedure the real exchange rate appreciates, the trade balance worsens, and the long-term real interest rate increases following a positive government spending shock. Moreover, government spending reacts very slowly to the shock in line with the idea of fiscal anticipation. Differences with the existing evidence are due to the fact that the shock obtained using my identification procedure is fundamental. The results broadly match the theoretical predictions of the standard Mundell-Fleming model. Nonetheless the effects on the trade balance are quantitatively small implying that fiscal policy should not be considered one of the main causes of the large US external deficit.

The remainder of the paper is organized as follows: section 2 discusses the problem of nun-fundamentalness in open economy VARs; section 3 discusses the new identification procedure; section 4 presents the results; section 5 presents some robustness check; section 6 concludes.

2 Non-fundamentalness and open economy variables

2.1 A simple theoretical example

In this subsection I consider a simple theoretical example to show the consequences of fiscal foresight in presence of open economy variables like the exchange rate. One might think that the exchange rate, because of its forward-looking nature can help in mitigating the problems arising because of fiscal foresight in closed economy VARs. Here I show that this is not true in general. On the contrary, even in presence of this forward-looking variable fiscal foresight is likely to give rise to a problem of non-fundamentalness.

The asset market view of exchange rate determination (see Mussa, 1984) assumes that the logarithm of the exchange rate at time t, e_t, is determined by

$$e_t = X_t + aE_t(e_{t+1} - e_t)$$

where $E_t(.)$ denotes the expectation made at time t and X_t is a variable conveying the economy fundamentals that affect the exchange rate at time t. The economy is assumed to be driven by two exogenous processes: technology, θ_t , and government spending g_t characterized by one period of foresight. Specifically

$$\begin{aligned} \theta_t &= u_{\theta t} \\ g_t &= u_{gt-1} \end{aligned}$$

where $u_{\theta t}$ is a white noise technology shock and u_{gt} is a white noise spending shock. The processes are assumed to be white noise for simplicity although the results can be extended to more complicated cases. Therefore $X_t = \beta\theta_t + \gamma g_t = \beta u_{\theta t} + \gamma u_{gt-1}$.

The MA representation of the three variables is

$$z_t = \begin{pmatrix} \theta_t \\ g_t \\ e_t \end{pmatrix} = \begin{pmatrix} 0 & 1 \\ L & 0 \\ \frac{L(1+a)\gamma + a\gamma}{(1+a)^2} & \frac{\beta}{1+a} \end{pmatrix} \begin{pmatrix} u_{gt} \\ u_{\theta t} \end{pmatrix} = B(L)u_t \qquad (1)$$

It easy to see that all the square sub-systems of (1) are non-fundamental. The MA representation of θ_t and g_t has a root equal to zero. The representation of θ_t and e_t has a root equal to $-\frac{a}{1+a}$. Finally the determinant of the representation of e_t and g_t also vanishes in zero. So $u_t = (u_{\theta t}, u_{gt})$ is non-fundamental for any pair of the variables on the left-hand side. So the exchange rate is not enough to make the system fundamental despite its forward-looking nature.

Now let us see more in detail why standard VAR techniques are not successful to correctly recover the shock in this case. Consider the bivariate model $[g_t\ e_t]'$. Its Wold representation is

$$\begin{pmatrix} g_t \\ e_t \end{pmatrix} = \begin{pmatrix} 1 - \frac{\alpha_2\alpha_3}{\alpha_1\alpha_4} & \frac{\alpha_2}{\alpha_4}L \\ -\frac{\alpha_3\alpha_5}{\alpha_1\alpha_4}L & 1 + \frac{\alpha_5}{\alpha_4}L \end{pmatrix} \begin{pmatrix} \eta_{1t} \\ \eta_{2t} \end{pmatrix} \tag{2}$$

where $\alpha_1 = \sigma_g \cos(\lambda)$, $\alpha_2 = \sigma_g \sin(\lambda)$, $\alpha_3 = \sigma_g \frac{\gamma}{1+a}\cos(\lambda)$, $\alpha_4 = \frac{a\gamma}{(1+a)^2}\sin(\lambda) + \sigma_\theta \cos(\lambda)$, $\alpha_5 = \sigma_g \frac{\gamma}{1+a}\sin(\lambda)$, $\lambda = \text{atan}\left(\frac{\sigma_g a\gamma}{\sigma_\theta(1+a)^2}\right)$. The Wold shocks are

$$\begin{pmatrix} \eta_{1t} \\ \eta_{2t} \end{pmatrix} = \begin{pmatrix} \alpha_1 \left[\frac{\delta_1}{\sigma_g}u_{gt-1} + \frac{\delta_2}{\sigma_\theta}u_{\theta t-1}\right] \\ \alpha_3 \left[\frac{\delta_1}{\sigma_g}u_{gt-1} + \frac{\delta_2}{\sigma_\theta}u_{\theta t-1}\right] + \alpha_4 \left[\frac{\delta_3}{\sigma_g}u_{gt} + \frac{\delta_4}{\sigma_\theta}u_{\theta t}\right] \end{pmatrix} \tag{3}$$

where $\delta_1 = \delta_4 = \cos(\lambda)$, $\delta_1 = \delta_3 = \sin(\lambda)$ and σ_g and σ_θ are the standard deviations of u_{gt} and $u_{\theta t}$ respectively. It is easy to see that there is no linear combination of the Wold innovations delivering the government spending shock u_{gt}. This means that standard identification techniques, which entail linear combinations of the Wold shocks, will fail. In particular when applying the Blanchard and Perotti (2002) identification one obtains the following Cholesky representation

$$\begin{pmatrix} g_t \\ e_t \end{pmatrix} = \begin{pmatrix} \alpha_1 & \alpha_2 L \\ \alpha_3 & \alpha_4 + \alpha_5 L \end{pmatrix} \begin{pmatrix} \xi_{1t} \\ \xi_{2t} \end{pmatrix} \tag{4}$$

where the Cholesky shocks are

$$\begin{pmatrix} \xi_{1t} \\ \xi_{2t} \end{pmatrix} = \begin{pmatrix} \frac{\delta_1}{\sigma_g}u_{gt-1} + \frac{\delta_2}{\sigma_\theta}u_{\theta t-1} \\ \frac{\delta_3}{\sigma_g}u_{gt} + \frac{\delta_4}{\sigma_\theta}u_{\theta t} \end{pmatrix} \tag{5}$$

Clearly ξ_{1t} is not the government spending shock. Not only, the result has an important implication which is worth noting. Under fiscal foresight, ξ_{1t} is not orthogonal to $E_{t-1}g_t$. The reason is that ξ_{1t} depends on u_{gt-1}.[4] This means that the shock obtained with a Cholesky identification within a VAR can be predicted by past expectations of the government spending variable. This implication will be exploited later to empirically check the existence of fiscal foresight.

There are two possible solutions to the non-fundamentalness problem. One is that sed in Gambetti (2012) and entails the estimation of a factor model. A second strategy is to use expectations of future spending. Indeed by replacing g_t with $E_t g_{t+1}$ the following subsystem is obtained

$$\begin{pmatrix} E_t g_{t+1} \\ e_t \end{pmatrix} = \begin{pmatrix} 1 & 0 \\ \frac{L(1+a)\gamma + a\gamma}{(1+a)} & \frac{\beta}{1+a} \end{pmatrix} \begin{pmatrix} u_{gt} \\ u_{\theta t} \end{pmatrix} \tag{6}$$

which is obviously fundamental. Note that with q periods of foresight the variable that solves the non-fundamentalness problem is $E_t g_{t+q}$. In this paper we pursue this second approach.

[4]With longer periods of foresight the shock will depend on longer lags of the expectations.

2.2 Evidence

Here I revisit the existing evidence about the effects of government spending shocks on the real exchange rate and the trade balance and check whether the estimated shocks are fundamental.

I begin by running a VAR with the growth rate of federal spending, the growth rate of GDP, the federal primary deficit , the trade balance (the last two expressed as ratio to GDP and taken in differences), and the log of the real exchange rate.[5] The government spending shock is identified as in Blanchard and Perotti (2002) as the first shock in a Cholesky decomposition with federal spending ordered first.

Figure 1 shows the impulse response functions. The solid line is the point estimate while the dotted lines represent the 68% confidence bands computed using the bootstrap-after-bootstrap procedure of Kilian (1998). In line with the existing evidence[6] the real exchange rate significantly depreciates by about 2% after one year. On the other hand the trade balance significantly improves. Interestingly enough, I find reversal in fiscal spending, as also found in Corsetti and Muller (2011), since the response of federal spending changes sign after a few years.

Based on the considerations made in the previous subsection, I check for non-fundamentalness arising from fiscal foresight by testing whether the identified shock is predicted by the forecasts of government spending. If it is, the shock cannot be fundamental.

I use the orthogonality test described in Forni and Gambetti (2010). The test is an F-test of the null hypothesis that the shock is orthogonal to the q-th lag of the q-period ahead forecast of government spending growth. The forecast variable is the forecast of federal spending from the Survey of Professional Forecasters and $q = 1, ..., 4$. The null hypothesis that the shock is orthogonal is rejected at 5% for $q = 1, 3$ and at 10% for all the lags. The shock is non-fundamental.

As an additional check I also test for the orthogonality of the shock to the Ramey (2011)'s military spending variable. The first row of Table 2 shows the p-values of the F-test of the null hypothesis that the shock is orthogonal to the lags of the Ramey's variable up to two years, R_{t-1} $j = 1, ..., 8$. The null is rejected only at 10% for the seventh lag.

Finally, I check the robustness of the results to several VAR specifications listed in Table 1. Figure 2 shows the impulse response functions of government spending, the real exchange rate and the trade balance to the government spending shocks identified as in the baseline VAR. In the left column the responses estimated using 6-variable VARs are

[5] Similar results are obtained using all the variables in levels.

[6] See Kim and Roubini (2008) Corsetti and Muller (2006), Monacelli and Perotti (2007), Ravn, Schmit-Grohe and Uribe (2007) and Enders, Muller and Scholl (2011) .

reported while the boxes in the right column depict those estimated using 7-variable models. In all the specifications the responses are almost identical, both qualitatively and quantitatively, to those obtained in the baseline VAR. The real exchange rate depreciates and the trade balance improves.

For every specification I run the same test of orthogonality. The results are displayed in columns 2 to 9 of Tables 2 and 3. Except for specification 4 and 6, where the null of orthogonality is rejected at 10%, for all the remaining specifications orthogonality to lagged forecasts is rejected at 5%. As far as the Ramey's variable is concerned, orthogonality is rejected at 10% for al the specificaion except the third one.

3 Identification based on forecast revisions

The results of the previous section support the existence of a problem of non-fundamentalness arising from fiscal foresight. In other words, the information set of the typical VAR is too poor. Moreover, the existence of fiscal anticipation suggests that the standard identifying assumptions, a positive impact effect on government spending, are not appropriate. My empirical strategy aims at solving both problems. The main idea is to use the government spending forecasts made by economic agents. As shown in section 2.1 this should solve the non-fundamentalness problem because, in so doing, all the relevant information is included in the information set.[7] However instead of the forecast itself I construct a news variable defined as the difference between the forecast at time t and the forecast of the same variable at time $t-1$. To get the intuition of why this variable can be useful consider the following example. Suppose that the growth rate of spending is an AR(1) with q periods of foresight

$$g_t = \phi g_{t-1} + u_{gt-q}.$$

It is easy to see that the difference between $E_t g_{t+q}$ and $E_{t-1} g_{t+q}$, the expectation or forecast revision, will deliver the shock

$$\begin{aligned} E_t g_{t+q} - E_{t-1} g_{t+q} &= E_t \phi g_{t+q-1} + u_{gt} - E_{t-1} \phi g_{t+q-1} \\ &= u_{gt}. \end{aligned}$$

In practice the identification is achieved as follows. Let g_t be the logarithm of government spending, $g_{t+q|t}$ the logarithm of the q-periods ahead forecast from the Survey of Professional Forecasters given the information available at time t.[8] I define the

[7] As usual in the VAR literature, we implicitly assume that economic agents can observe economic shocks.

[8] I focus on forecasts of the growth rate because in the SPF dataset the forecast have different base year the levels cannot be used.

following two long run forecasts

$$\begin{aligned} f_t^1 &= g_{t+4|t} - g_{t+1|t} \\ f_{t-1}^2 &= g_{t+4|t-1} - g_{t+1|t-1}. \end{aligned}$$

The variable to predict, the sum of the growth rate between time $t+2$ an $t+4$, is the same in the two forecasts. What changes is the information set. Indeed f_t^1 is made using information up to time t while f_t^2 is made using the information only up to time $t-1$. I define the forecast revision as the difference

$$r_t = f_t^1 - f_{t-1}^2. \tag{7}$$

This variable represents the change in the long run forecast due to the new information released at time t which was not available at time $t-1$. A positive value of r_t means that professional forecasters learn, for instance a law is passed, that government spending will increase, not immediately, but in the future. Accordingly they update their predictions. Indeed the variable has the interpretation of a news variable. I use the sum of two to four periods ahead forecast since the exact number of periods of anticipation is unknown but presumably fiscal policy actions take several quarters to materialize. In principle one might want to use also longer horizons forecast but these forecast are not available in the SPF. The forecast revision variable is ordered first in the VAR and the government spending shock is the first in a Cholesky triangularization and the first shock is interpreted as the government spending shock.

Ramey (2010) uses a similar variable, namely the difference between the growth rates of government spending and the expected growth rate from the Survey of Professional Forecasters based on information available up to the previous period. In our notation $\Delta g_t - (g_{t|t-1} - g_{t-1|t-1})$. This variable is ordered first and the first shock in a Cholesky decomposition is interpreted as the government ending shock. A similar approach is used in Corsetti and Muller (2011). Here I prefer not to rely on this variable because, under fiscal anticipation, such an innovation might not include the government spending shock. In fact, going back to the example at the beginning of this section, if $g_t = \phi g_{t-1} + u_{gt-q}$, it is easy to see that $g_t - E_{t-1}g_t = 0$. This can seriously undermine the interpretability of the shock as government spending shock so I prefer not to rely on this variable.

There are two main advantages in using my identifying approach. First, it incorporates valuable information available to economic agents but presumably not conveyed in fiscal variables and consequently omitted in standard specifications. Second, it leaves the impact response of government spending completely unrestricted. In particular, government spending can respond with several periods of delay as implied by fiscal foresight. The identification scheme imposes that at time t, when the government spending shock arrives, forecasters update their forecasts expecting more spending in the future.

The potential drawback of the identification strategy is that the innovation in the forecast revision does not necessarily contain only exogenous government spending shocks. In fact the revision might in principle change contemporaneously because of predicted future increase in government spending reflecting change in systematic fiscal policy. It is true that such policy actions should take even longer lags than discretionary action, but this it is not granted a priori. Therefore in the robustness section I propose an alternative identification scheme where the forecast revision is placed after some variable which fiscal policy is likely to respond to and which are likely to react to the shock with a lag.

4 Results

4.1 Data and baseline specification

I estimate a VAR with three lags for US quarterly data spanning from 1981:III to 2007:IV. The variables included in the baseline VAR are: the growth rate of real federal government spending (Real Federal Consumption Expenditures and Gross Investment); the growth rates of real GDP, the federal primary deficit to GDP ratio, the trade balance to GDP ratio, and the real exchange rate. The forecast revision variable (7) is constructed using the (mean) forecast of the growth rate of federal government spending form the Survey of Professional Forecasters available at the Philadelphia Fed website.

4.2 Informational content of the revision variable

First of all I check empirically that the news variable conveys useful information. To this end I test whether it improves the forecast of government spending. More specifically I regress the growth rate of government spending on two lags of federal spending growth, the growth rate of GDP, the federal primary deficit , the trade balance (the last two expressed as ratio to GDP), the log of the real exchange rate, and the revision variable, and I test whether the coefficients of the latter are zero. This corresponds to a conditional Granger causality test which tells whether, conditional on the past of the other variables, the variable under consideration adds valuable information. I use the out-of-sample test used in Forni and Gambetti (2011) with an estimation period of 75 quarters and two lags. The p-value of the test is 0.01. The revision variable is important to predict federal spending. The result is different from that in Perotti (2011) which finds that the forecast revision is largely driven by noise. In that paper however the revision considered is that of the one period ahead forecast. Obviously, if there are several quarters of anticipation, as it is plausible to expect, the one period ahead forecast revision will miss the spending shock. On the contrary the revision of longer horizons forecast seems to convey valuable information.

4.3 The effects of government spending shocks

I start off by examining the series of the estimated shock, plotted in Figure 3. There are three positive spikes in coincidence of the last three wars: the Gulf War, the War in Afghanistan and the II Gulf War. For the last two episodes the peak exactly coincides with the quarter in which the war officially starts. Moreover it is interesting to note that there are two big negative spikes during the second half of the 80s, a period which coincide with the end of the Reagan military build up and the end of the cold War. The shock seems to capture quite well episodes of exogenous change in government spending.

Figure 4 depicts the responses to the government spending shock identified as the first shock in a Cholesky decomposition with the revision variable ordered first. The solid line represents the point estimates while dotted lines are the 68% confidence bands computed using the bootstrap-after-bootstrap procedure of Kilian (1998). The shock affects government spending with a long delay, the effect becoming significant only after one year. Moreover the response appears to be very sluggish, after about five years spending has increased by about 1% and keeps climbing towards its new steady state level. There is no evidence of spending reversal as found in the VAR without forecast revision, where the response becomes negative after a few years. The response of primary deficit has a similar shape: it starts around zero and increases very slowly.

The trade balance is unaffected on impact and deteriorates significantly after about three quarters. After five years the shock worsens the balance by about 0.1%. The real exchange rate appreciates by about 0.5% on impact and by 1.5% after about one year when it reaches its maximal level. The response is significant at all the horizons and shows a high degree of persistence. The results of section 2.2. are overturned with the new identification.

From a qualitative point of view the results support the twin deficit view. Nonetheless, quantitatively the effects of the government spending turn out to be relatively small, see Table 4. Government spending shocks explain about 7% and 3% of the volatility of the the trade balance and deficit respectively. On the contrary the shock seems to be more important fot the real exchange rate and the 10-year bond rate explaining on average around 10-15% of the variance of the two variables.

From a theoretical point of view, the interest rate stands at the core of the transmission of government spending. In the standard Mundell and Fleming model the real exchange appreciates and the external balance deteriorates because of the inflow of foreign capital attracted by an increase of the domestic interest rate triggered by the expansionary fiscal policy. On the empirical side however, the evidence about the effects of fiscal policy on interest rates is mixed.[9] Here I investigate whether the response of interest rates can explain the above results.

Figure 5 shows the response of real interest rates and inflation.[10] The response of inflation is significantly positive in the second and third quarter while insignificant afterwards. Monetary policy appears to be largely unresponsive. The real federal funds rate increases in the first year after the shock but the response is never significant. On the contrary both the 1-year and the 10-year bond rates significantly increase in the short run, by about 0.2% over the first year. The result is in line with Dai and Philippon (2006) which finds a significant increase of the risk premia on long term government bonds following a fiscal expansion that makes the yield curve steeper. The result is consistent with the standard mechanism of real exchange rate appreciation and external balance deterioration. The main findings of the paper lend broad support to the theoretical predictions of the standard Mundell-Fleming model and other new Keynesian DSGE models under conventional calibrations.

The results stand in sharp contrast with existing works where the effects of government spending socks are obtained using VAR models.[11] In these papers the real exchange rate is always found to depreciate. However they are in line with those obtained in Erceg, Gust and Guerrieri (2005) where, using an estimated Neo-Keynesian open economy DSGE model, the trade balance is found to deteriorate and the real exchange rate to appreciate. Findings similar to mine for an anticipated government spending shock are provided also in Taylor (1993). Finally Beetsma, Giuliodori and Klaassen (2008) and Benetrix and Lane (2010) find an real appreciation for European countries.

4.4 Explaining the differences

Why the results differ so much? I address this question by investigating whether the shock obtained under my identification is fundamental. Specifically I apply the same

[9]Early works, including Plosser (1987) and Evans (1987), fail to find a significant relations between fiscal interest rate and deficits. On the contrary, Elmendorf (1993) shows that when expectations of future deficit, proxied by DRI forecasts, are considered then the above findings are overturned. Laubach and(2005) and Gale and Orszag (2003) find significant effects of fiscal policy on the interest rates.

[10]The responses are obtained by estimating enlarged VAR models. Specifically I use five specifications. The first three specifications include the inflation rate and a real interest rate among the federal funds rate, the 1-year and the 10-year bond rate. The fourth specification is the benchmark VAR plus the spread between the 1-year bond rate and the federal fund rate, while the fifth is the benchmark VAR plus the spread between the 10-year bond rate and the federal fund rate.

[11]See Kim and Roubini (2008) Corsetti and Muller (2006), Monacelli and Perotti (2007), Ravn, Schmidt-Grohe and Uribe (2007).

battery of tests used in section 2.2. Given that the shocks obtained under the two identifications are very similar, I perform the test for the shocks obtained under the baseline identification scheme.

Table 5 shows the p-values of the test of orthogonality to the lags of the forecasts of government spending growth. The null is never rejected, the shock cannot be predicted using past forecasts. Using the forecast revision variable seems to solve for the non-fundamentalness problem arising from fiscal foresight. Table 6 also shows that the shock is not predicted by past values of the Ramey's (2010) variable.

As a last check of fundamentalness I apply the orthogonality test using the first twelve principal components of the dataset used in Gambetti (2010). Specifically I test whether the coefficients of Z_{t-j} $j = 1, ..., 4$ where which is a vector containing the first $r = 1, ..., 2$ components are significantly different from zero. The first column reports the first principal components included in Z_t. 3 for instance means that the first three principal components are included in Z_t. The null that the shock is orthogonal to the lags of the principal components is always rejected at 5%. This last result is particularly important since, by Proposition 4 of Forni and Gambetti (2011), it implies that the shock is truly structural. This means that there is no need, as in principle could be, of adding additional information and estimating for instance a factor model or a FAVAR[12].

Concluding, the shock is non-fundamental for the variables included in the standard VAR specifications but becomes fundamental when the forecast revision variable is used with the identification scheme discussed above. In other words, when the non-fundamentalness problem is solved the results are overturned: the real exchange rate appreciates and and the trade balance worsens.

5 Robustness

I make several checks to assess the robustness of the results.

First of all I change the identification strategy to control for a potential contemporaneous response of the news variable to other non-policy shocks. In this second scheme the revision variable is ordered fifth, after GDP, spending, deficit and the trade balance and before the real exchange rate. In so doing I allow other shocks to have contemporaneous effects on the news. Figure 5 depicts the responses. Again the solid line represents the point estimates while dotted lines are the 68% confidence bands computed using the bootstrap-after-bootstrap procedure of Kilian (1998). Government spending, which now starts at zero by assumption, increases very slowly showing insignificant effect for the first quarters after the shock. The real exchange rate appreciates at all horizons

[12] For this reason I limit my analysis to VAR models

and the effects are always significant. The trade balance significantly worsens after a zero impact effect. Deficit permanently and significantly reduces. Both from a qualitative and quantitative point of view results are very similar to those obtained in the previous subsection. Figure 6 depicts the responses of inflation and interest rates under the second identification.[13] Again, the main results remain unchanged. The short term interest rate increases in the short run but not significantly while the two long term interest rate significantly increase in the short run reaching maximal level, around 0.2% the 1-year bond rate, and 0.3% the 10-year rate. As in the baseline case the two spreads raise. Figure 7 depicts the two shocks obtained under the two identification schemes. The shocks are virtually identical. This explains why the results are so similar to those obtained in the baseline case.

As a second check, I compute the impulse response functions (using the baseline identification scheme) and perform the orthogonality test using other VAR specifications. The specification considered are those listed in Table 1 augmented with the forecast revision. Figure 8 shows the point estimates of the impulse response functions of government spending the real exchange rate an the trade balance. Results are very similar to those obtained in the benchmark VAR. Moreover the null that the identified shock is orthogonal is never rejected (see columns 2-9 of Table 4 and 5).

Third, I use two different revision variables. Specifically I use

$$(g_{t+4|t} - g_{t+2|t}) - (g_{t+4|t-1} - g_{t+2|t-1}) \tag{8}$$

and

$$(g_{t+4|t} - g_{t+3|t}) - (g_{t+4|t-1} - g_{t+3|t-1}) \tag{9}$$

Figure 9 shows the results of the three main aggregates in the baseline case (red solid line) and the other two cases. There are some quantitative differences but the sign and the shape of the response is largely unchanged confirming our earlier conclusions.

Fourth, I estimate the model using all the variables in levels to control for potential cointegration relationships and apply the three identification procedures. Figure 11 show the responses obtained using the standard identification without revisions. The trade balance significantly improves in the medium and long run while the real exchange rate depreciates. Figure 10 shows the responses of obtained using the new identification. The results are very similar to those obtained with the baseline VAR and all the main conclusions are confirmed: the trade balance deteriorates and the domestic currency appreciates in real term.

Finally I use the trade balance and the primary deficit expressed in real terms and not as a ratios to nominal GDP. Results (not shown) are unchanged.

[13] Inflation is ordered before the revision variable while the interest rates are ordered after.

6 Conclusions

This paper studied the effects of government spending policy shocks on the trade balance and the exchange rates. The shock is identified using procedure based on the revisions of the forecast of the professional forecasters. The shock obtained, unlike those obtained using standard VAR identification, is fundamental. The new identification overturns existing results: after an expansionary government spending shocks the trade balance deteriorates and the real exchange rate depreciates. The findings broadly match the theoretical predictions of the standard Mundell-Fleming model. Nonetheless the effects on the trade balance are quantitatively small implying that the fiscal spending shock should be considered quantitatively one of the main causes of the large US external deficit observed over the last decades. We draw two main conclusions. First, the standard open-economy transmission mechanism of government spending seems to be consistent with the data and should not be dismissed. Second, problems arising from fiscal anticipation should be carefully addressed when studying the effects of fiscal policy with empirical models.

References

[1] Anderson, B. D. O., and M. Deistler (2008) Generalized linear dynamic factor modelsa structure theory. In Proc. 47th IEEE Conference on Decision and Control, CDC 2008, pages 19801985, Cancun, Mexico.

[2] Baxter, M. (1995). International trade and business cycles. In: G.M. Grossmann and K. Rogoff, Editors, Handbook of International Economics vol. 3, Amsterdam, North-Holland, pp. 1801-1864

[3] Beetsma R. and M. Giuliodori (2011). The Effects of Government Purchases Shocks: Review and Estimates for the EU. The Economic Journal 121:F4-F32.

[4] Beetsma, R., Giuliodori, M. and Klaassen, F. (2008). The effects of public spending shocks on trade balances and budget deficits in the EU, Journal of the European Economic Association, vol. 6(2), pp. 41423

[5] Benetrix, A.S. and Lane, P.R. (2010). Fiscal shocks and the real exchange rate, mimeo, IIIS, Trinity College Dublin.

[6] Blanchard, O.J. and R. Perotti (2002). An Empirical Characterization of the Dynamic Effects of Changes in Government Spending and Taxes on Output. The Quarterly Journal of Economics: 1329-1368.

[7] Corsetti, G. and G. Muller (2006). Twin deficits: squaring theory, evidence and common sense, Economic Policy 48:597-638.

[8] Corsetti, G., A. Meier and G. Muller (2011a). Fiscal stimulus with spending reversals. Mimeo EUI.

[9] Corsetti, G. K. Kuester, and G. Muller (2011b). Floats, pegs and the transmission of fiscal policy. CEPR Discussion Papers 8180, C.E.P.R. Discussion Papers

[10] Dai, Q., and T. Philippon (2005). Fiscal Policy and the Term Structure of Interest Rates. NBER Working Paper No. 11574.

[11] Dornbusch, R. (1976). Expectations and exchange rates dynamics, Journal of Political Economy 84:1161-1176.

[12] Elmendorf, D.W. (1993) Actual Budget Decit Expectations and Interest Rates. Harvard Institute of Economic Research.

[13] Enders, Z., G. Mller and A. Scholl (2011). How do fiscal and technology shocks affect real exchange rates?: New evidence for the United States. Journal of International Economics, 83(1):53-69.

[14] Erceg, C.J., L. Guerrieri and C. Gust. Expansionary Fiscal Shocks and the US Trade Deficit, International Finance 8(3):363-397.

[15] Evans, P. (1987) Interest Rates and Expected Future Budget Decits in the United States. Journal of Political Economy 95:34-58.

[16] Forni, M., L. Gambetti (2010) Fiscal Foresight and the Effects of Government Spending. CEPR Discussion Paper No. 7840.

[17] Forni, M., L. Gambetti (2011) Sufficient Information in Structural VAR. Mimeo UAB.

[18] Gale, W.G,. and Orszag, P.R. (2003). The Economic Eects of Long-Term Fiscal Discipline. Tax Policy Center, Urban Institute and Brookings Institution.

[19] Gali, J., D. Lopez Salido, and J. Valles (2007). Understanding the Effects of Govern- ment Spending on Consumption. Journal of the European Economic Association 5, 227-270.

[20] Kim, S. and N. Roubini (2008). Twin deficit or twin divergence? Fiscal policy, current account, and real exchange rate in the U.S, Journal of International Economics, 74(2):362-383.

[21] Kollmann, R. (1998). U.S. trade balance dynamics: the role of fiscal policy and productivity shocks and of financial market linkages, Journal of International Money and Finance 17:637-669

[22] Laubach (2009) New Evidence on the Interest Rate Effects of Budget Deficits and Debt. Journal of the European Economic Association, 7(4):858-885.

[23] Leeper, E.M., Walker, T.B. and S.S. Yang (2008). Fiscal Foresight: Analytics and Econometrics, NBER Working Paper No. 14028.

[24] Monacelli, T. and R. Perotti, Fiscal Policy, the Trade Balance and the Real Exchange Rate: Implications for International Risk Sharing. Working Paper, IGIER (2006).

[25] Mertens, K. and M. Ravn (2010). Measuring the Impact of Fiscal Policy in the Face of Anticipation: a Structural VAR Approach. The Economic Journal, 120:544.

[26] Mountford, A. and H. Uhlig (2009). What Are the Effects of Fiscal Policy Shocks. Journal of Applied Econometrics 24(6):960-992. CEPR Discussion Paper No. 3380.

[27] Mussa, M. L. (1984). The Theory of Exchange Rate Determination. in Bilson J. F. O. and and Marston, R.C. *Exchange Rate Theory and Practice* NBER Books, National Bureau of Economic Research.

[28] Obstfeld, M. and K. Rogoff (1995). Exchange rate dynamics redux. Journal of Political Economy 103:624-660.

[29] Perotti, R. (2007). In Search of the Transmission Mechanism of Fiscal Policy. NBER Macroeconomics Annual.

[30] Perotti, R. (2011). Expectations and Fiscal Policy: An Empirical Investigation. Mimeo Bocconi University.

[31] Plosser, C. (1987). Fiscal policy and the term structure. Journal of Monetary Economics, 20(2):343-367

[32] Ramey, V.A. (2009). Identifying Government Spending Shocks: It's All in the Timing, NBER Working Papers no. 15464.

[33] Ramey, V.A. and M. Shapiro (1998). Costly Capital Reallocation and the Effects of Government Spending. Carnegie Rochester Conference on Public Policy 48, 145-194.

[34] Ravn, M., Schmitt-Grohe, S. and M. Uribe (2007). Explaining the Effects of Government Spending Shocks on Consumption and the Real Exchange Rate. NBER Working Papers 13328.

[35] Taylor, J. B., Macroeconomic Policy in a World Economy. New York: W.W. Norton, 1993.

Tables

Specification	Variables
1	Gov. Spend.; GDP; Deficit; Trade Bal.; RER
2	Gov. Spend.; GDP; Deficit; Trade Bal.; RER, Investment
3	Gov. Spend.; GDP; Deficit; Trade Bal.; RER, Consumption
4	Gov. Spend.; GDP; Deficit; Trade Bal.; RER, CPI
5	Gov. Spend.; GDP; Deficit; Trade Bal.; RER, Fed. Funds Rate
6	Gov. Spend.; GDP; Deficit; Trade Bal.; RER, CPI; Fed. Funds Rate
7	Gov. Spend.; GDP; Deficit; Trade Bal.; RER, Investment; Consumption
8	Gov. Spend.; GDP; Deficit; Trade Bal.; RER, Consumption; CPI
9	Gov. Spend.; GDP; Deficit; Trade Bal.; RER, Consumption; Fed. Funds Rate

Tabe 1: VAR speficifications.

VAR	Survey of Professional Forecsters			
specification	$E_{t-1}\Delta g_t$	$E_{t-2}\Delta g_t$	$E_{t-3}\Delta g_t$	$E_{t-4}\Delta g_t$
1 (benchmark)	0.0466	0.0521	0.0315	0.0594
2	0.0488	0.0566	0.0424	0.0749
3	0.0386	0.0540	0.0362	0.0717
4	0.0693	0.0714	0.0568	0.0859
5	0.0540	0.0687	0.0394	0.0660
6	0.1043	0.1205	0.0858	0.1134
7	0.0395	0.0655	0.0674	0.1189
8	0.0460	0.0627	0.0496	0.0733
9	0.0390	0.0621	0.0371	0.0715

Table 2: p-values of the F-test of the null hypotesis that the shock is orthogonal to $E_{t-j}\Delta g_t$, $j = 1, ..., 4$ where Δg_t if the growth rate of the federal spending. In the first colum there apear the VAR specification used to estimate the shock. The first one is the benchmark VAR.

VAR specification	Ramey's variable (R)							
	R_{t-1}	R_{t-2}	R_{t-3}	R_{t-4}	R_{t-5}	R_{t-6}	R_{t-7}	R_{t-8}
1 (benchmark)	0.5932	0.7773	0.6195	0.5552	0.9959	0.6433	0.0858	0.2662
2	0.6800	0.8022	0.7073	0.6093	0.9868	0.6364	0.0535	0.1869
3	0.7097	0.7001	0.7016	0.5319	0.8678	0.9716	0.1130	0.3305
4	0.5080	0.9766	0.8326	0.8062	0.7329	0.7986	0.0544	0.2176
5	0.5847	0.8270	0.7358	0.6351	0.8813	0.5971	0.0742	0.1987
6	0.6387	0.8925	0.8694	0.7832	0.7644	0.6189	0.0547	0.1985
7	0.9037	0.7027	0.6941	0.5377	0.9041	0.9623	0.0623	0.2582
8	0.5399	0.7652	0.8676	0.7455	0.6200	0.9126	0.0941	0.2505
9	0.6571	0.7729	0.8607	0.6036	0.7625	0.9773	0.0730	0.2596

Table 3: p-values of the F-test of the null hypothesis that the shock is orthogonal to the Ramey's variable $R_t - j$, $j = 1, ..., 8$ In the first colum there apear the VAR specification used to estimate the shock. The first one is the benchmark VAR.

Variable:	Horizon (quarters)			
	0	5	9	20
Expectation Revision	100.00	87.45	86.50	86.43
Federal spending	1.94	3.93	9.65	16.64
GDP	1.88	4.28	4.79	5.64
Primary Deficit	0.60	1.34	1.86	3.82
Trade Balance	0.03	3.21	5.06	7.62
Real Exchange Rate	1.28	9.83	11.94	12.95
Inflation	0.90	4.97	5.19	5.56
Real Federal Funds Rate	0.17	1.09	0.58	1.31
Real 1Y Rate	5.20	6.31	5.19	3.65
Real 10Y Rate	13.83	20.11	20.00	17.52
Spread 1Y-FFR	2.50	2.07	2.49	2.47
Spread 10Y-FFR	4.14	2.89	3.97	4.21

Table 4: percentage of forecast error vriance explained by the hock at different horizons.

VAR specification	Survey of Professional Forecsters			
	$E_{t-1}\Delta g_t$	$E_{t-2}\Delta g_t$	$E_{t-3}\Delta g_t$	$E_{t-4}\Delta g_t$
1 (benchmark)	0.6139	0.7950	0.8151	0.7825
2	0.6290	0.8160	0.8761	0.8389
3	0.7600	0.8855	0.9743	0.9259
4	0.5114	0.7115	0.6709	0.7017
5	0.4618	0.7175	0.6668	0.5962
6	0.4826	0.7633	0.6930	0.6984
7	0.8116	0.9445	0.8709	0.7534
8	0.5940	0.7500	0.7649	0.9353
9	0.5661	0.8032	0.8166	0.8607

Table 5: p-values of the F-test of the null hypotesis that the shock is orthogonal to $E_{t-j}\Delta g_t$, $j = 1, ..., 4$ where Δg_t if the growth rate of the federal spending. In the first colum there appear the VAR specification used to estimate the shock. All the specifications include the expectations revision variable.The first one is the benchmark VAR.

VAR specification	Ramey's variable (R)							
	R_{t-1}	R_{t-2}	R_{t-3}	R_{t-4}	R_{t-5}	R_{t-6}	R_{t-7}	R_{t-8}
1 (benchmark)	0.3053	0.4150	0.9003	0.3140	0.7897	0.1471	0.2267	0.5453
2	0.3393	0.3634	0.8809	0.3582	0.7932	0.1216	0.2332	0.4861
3	0.2569	0.2876	0.9089	0.3026	0.9361	0.3319	0.1301	0.7855
4	0.3579	0.3409	0.7419	0.4589	0.9960	0.1098	0.2982	0.6184
5	0.3667	0.3111	0.7110	0.5390	0.9729	0.0732	0.2226	0.6444
6	0.4104	0.4381	0.7835	0.5215	0.9698	0.0912	0.2601	0.7002
7	0.3562	0.2123	0.8369	0.4047	0.9048	0.2778	0.1264	0.7207
8	0.3368	0.1805	0.5884	0.5769	0.6149	0.2475	0.1796	0.8504
9	0.3142	0.2339	0.8179	0.5333	0.7710	0.2265	0.0748	0.8422

Table 6: p-values of the F-test of the null hypotesis that the shock is orthogonal to the Ramey's variable $R_t - j$, $j = 1, ..., 8$ In the first colum there apear the VAR specifications used to estimate the shock. All the specifications include the expectations revision variable. The first one is the benchmark VAR.

Number of principal components in Z_t	Lags of Z_t			
	Z_{t-1}	Z_{t-2}	Z_{t-3}	Z_{t-4}
1	0.5363	0.7777	0.8706	0.3796
2	0.5042	0.6101	0.6723	0.0600
3	0.6942	0.7358	0.7756	0.1321
4	0.7292	0.8037	0.8942	0.2318
5	0.8132	0.8977	0.8791	0.1802
6	0.8961	0.9434	0.9139	0.2409
7	0.9247	0.9484	0.8911	0.2452
8	0.9608	0.9164	0.6668	0.3012
9	0.9807	0.9133	0.1877	0.2064
10	0.9895	0.7752	0.2460	0.2273
11	0.9753	0.7005	0.1470	0.2939
12	0.9298	0.7656	0.2025	0.3147

Table 7: p-values of the F-test of the null hypotesis that the shock is orthogonal to the vector Z_{t-j} including the firs k principalcomponents, $j = 1, ..., 4$ and $k = 1, ..., 12$. In the first column there appear the number of principalcomponents included in Z_t.

Figures

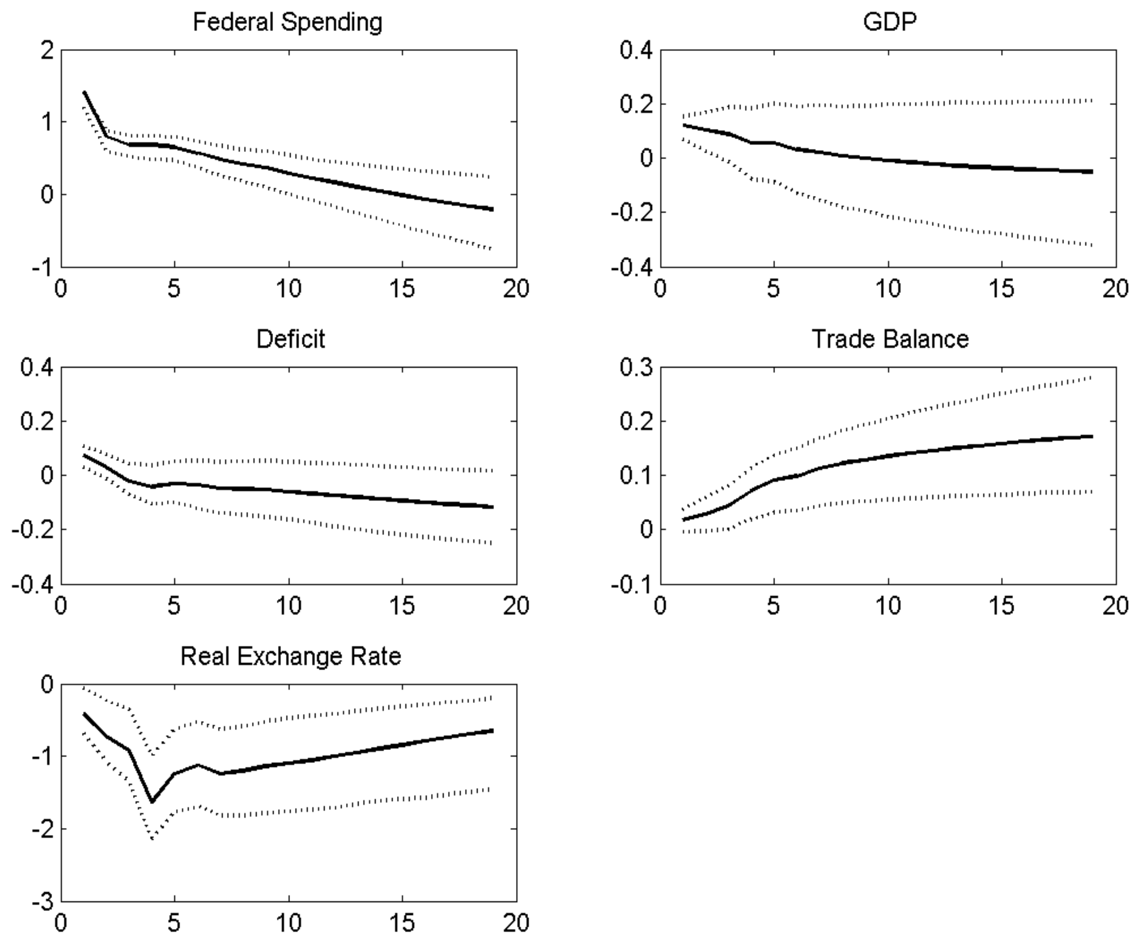

Figure 1: impulse response function of the benchmark VAR. Solid lines are point estimate, dotted lines are the 68% confidence bands.

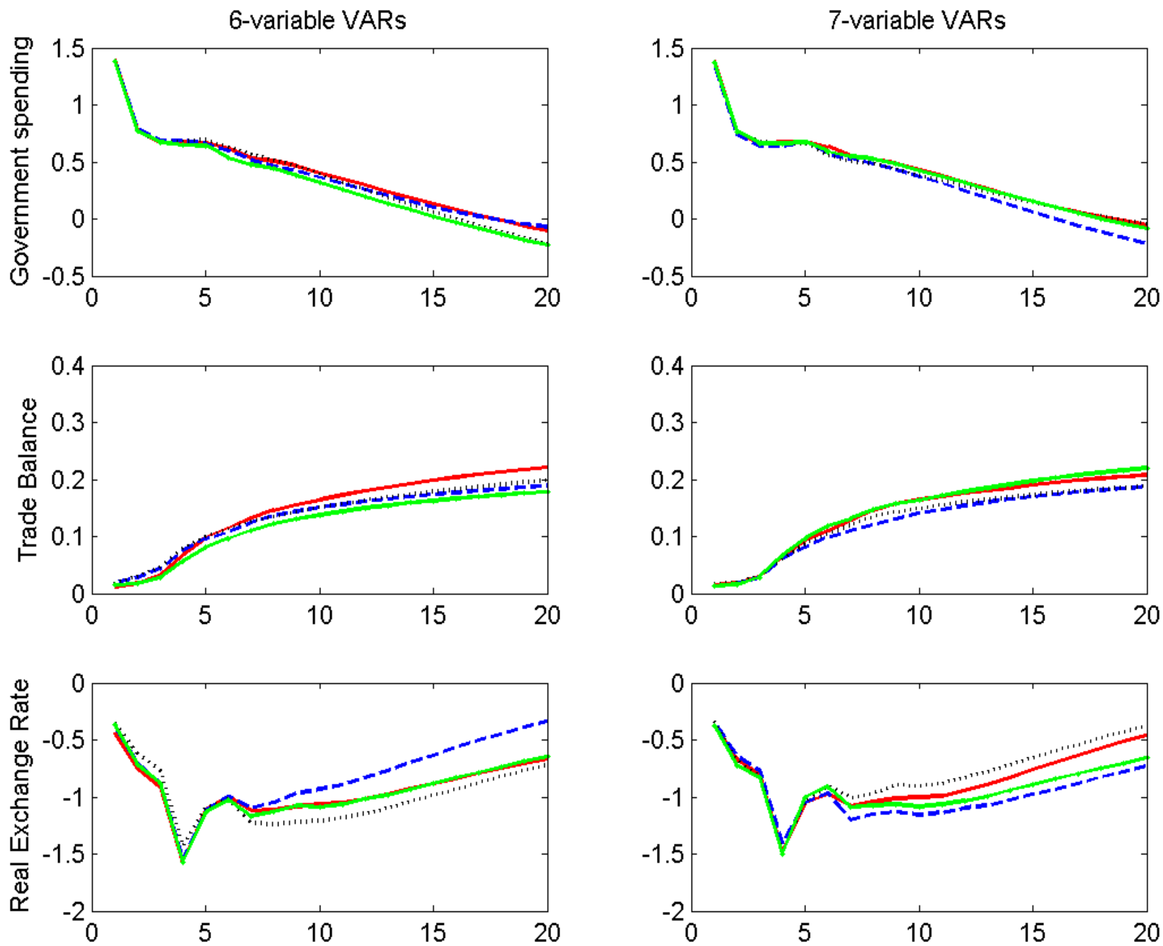

Figure 2: impulse response functions for other VAR specifications listed in Table . 6-Variable specifications: dotted line - specification 2; light solid line - specification 3; solid line - specification 4; dashed line - specification 5; solid line - specification 5. 7-Variable specifications: solid line - specification 6; dashed line - specification 7; light solid line - specification 8; dotted line - specification 8 .

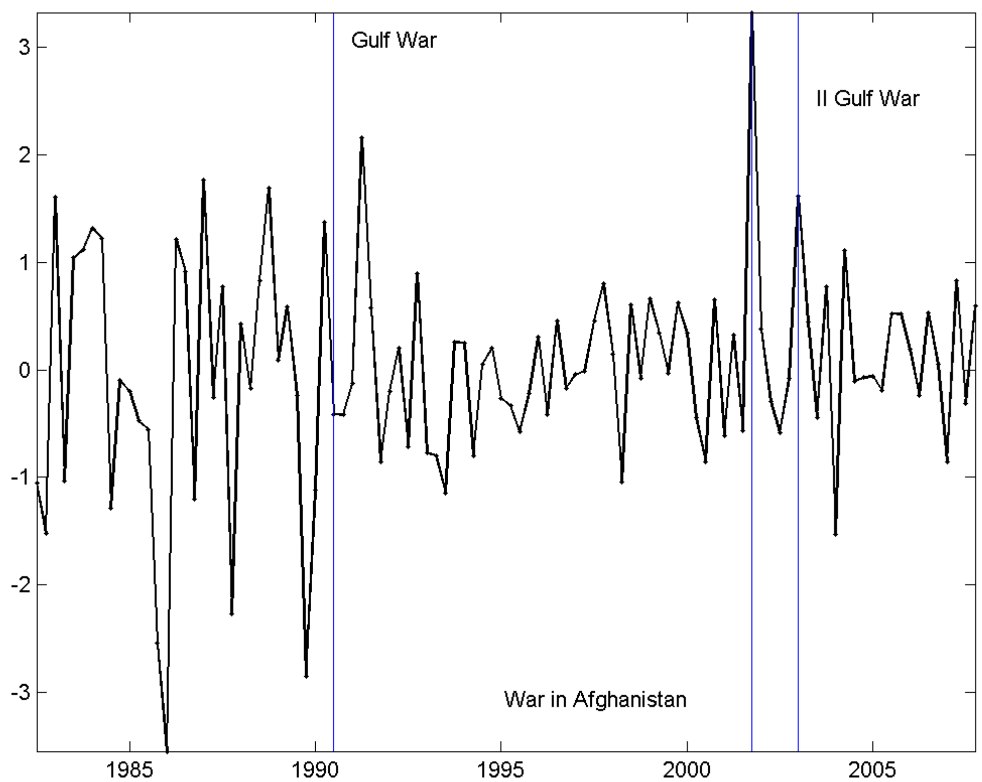

Figure 3: estimated government spending shock.

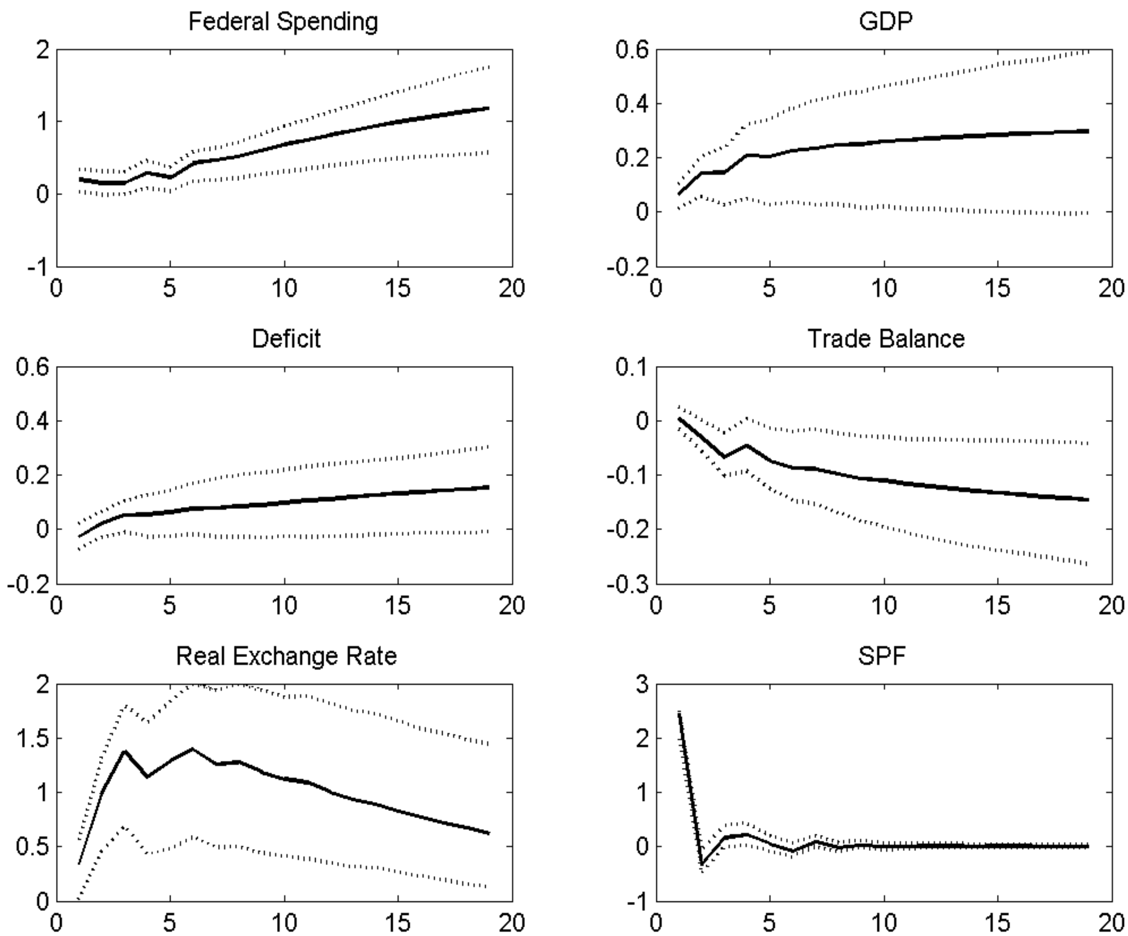

Figure 4: impulse response function of the benchmark VAR augmented with the forecast revisions. Solid lines are point estimate, dotted lines are the 68% confidence bands.

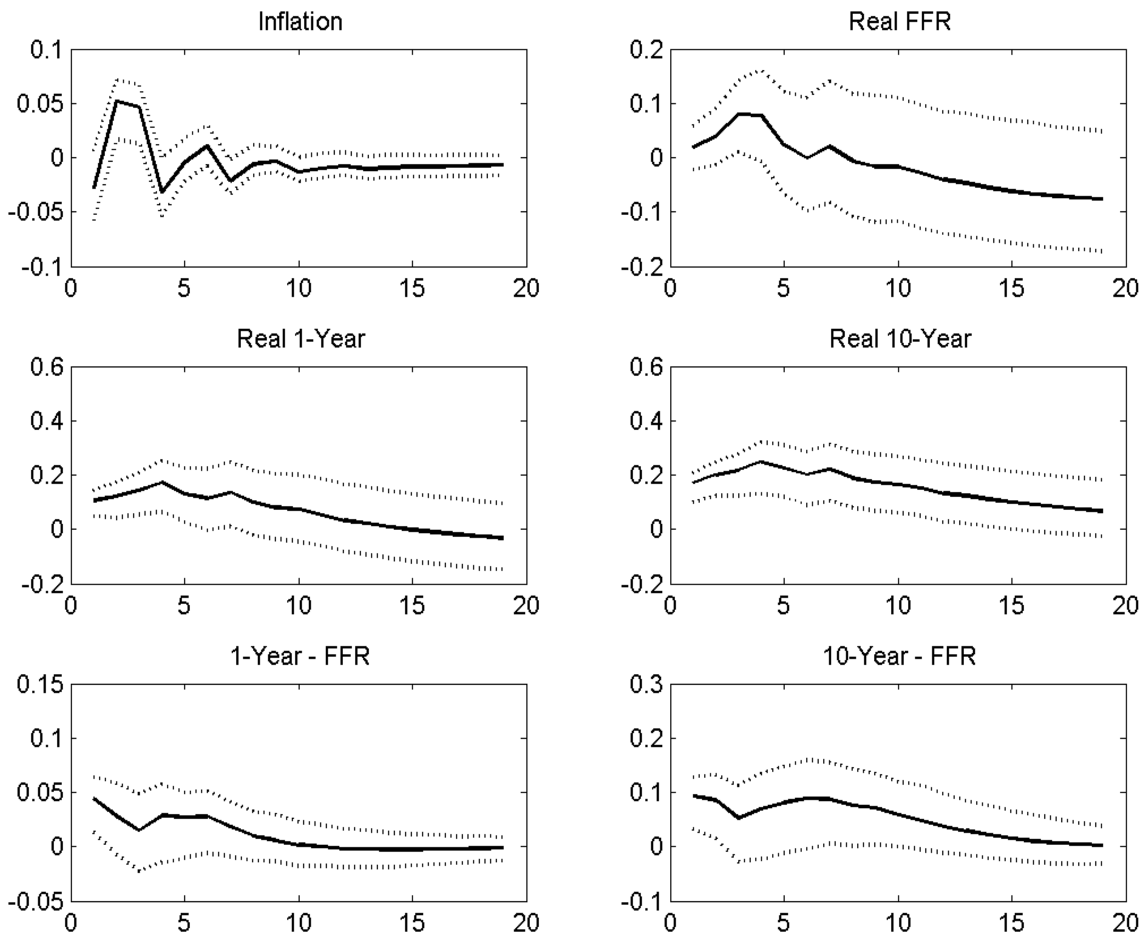

Figure 5: impulse response function of the benchmark VAR augmented with the forecast revisions. Solid lines are point estimate, dotted lines are the 68% confidence bands.

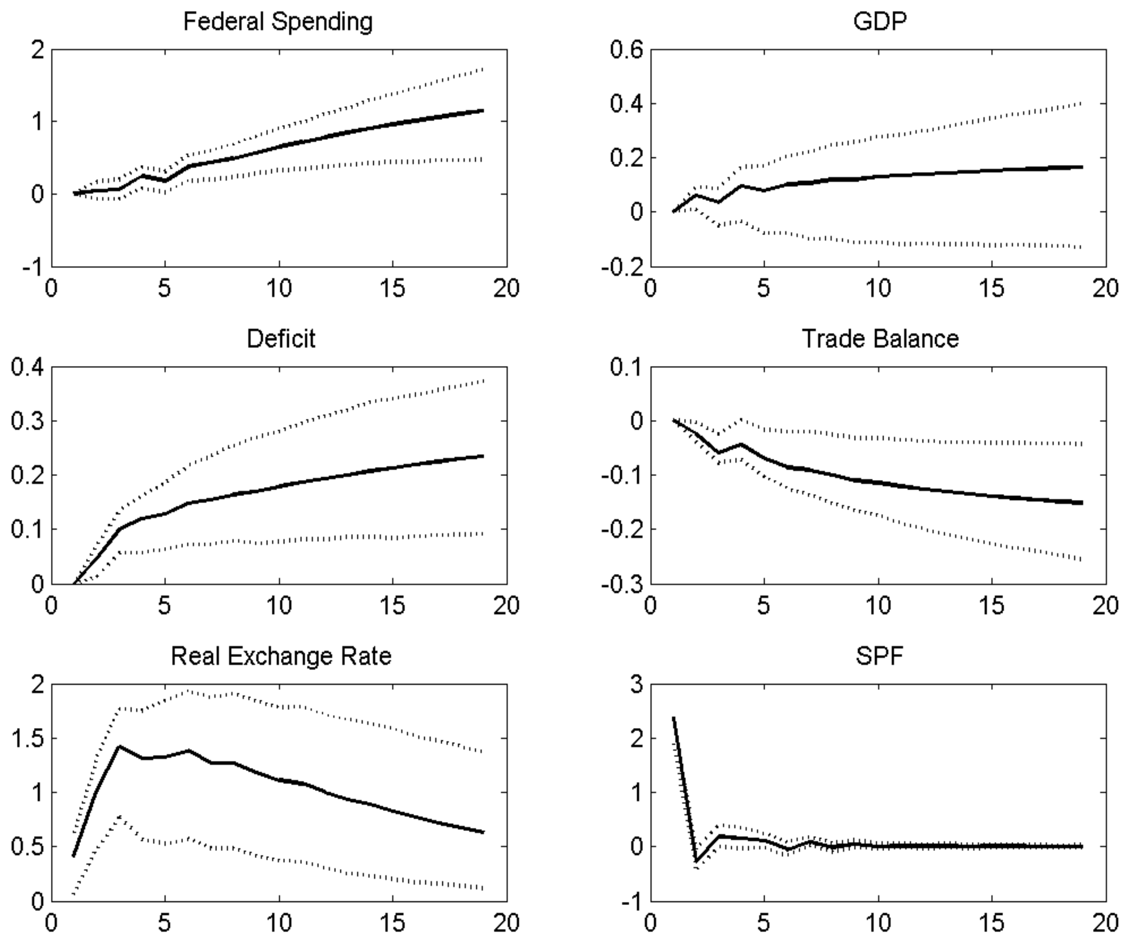

Figure 6: impulse response function of the VAR augmented with the forecast revisions under the alternative identification scheme. Solid lines are point estimate, dotted lines are the 68% confidence bands.

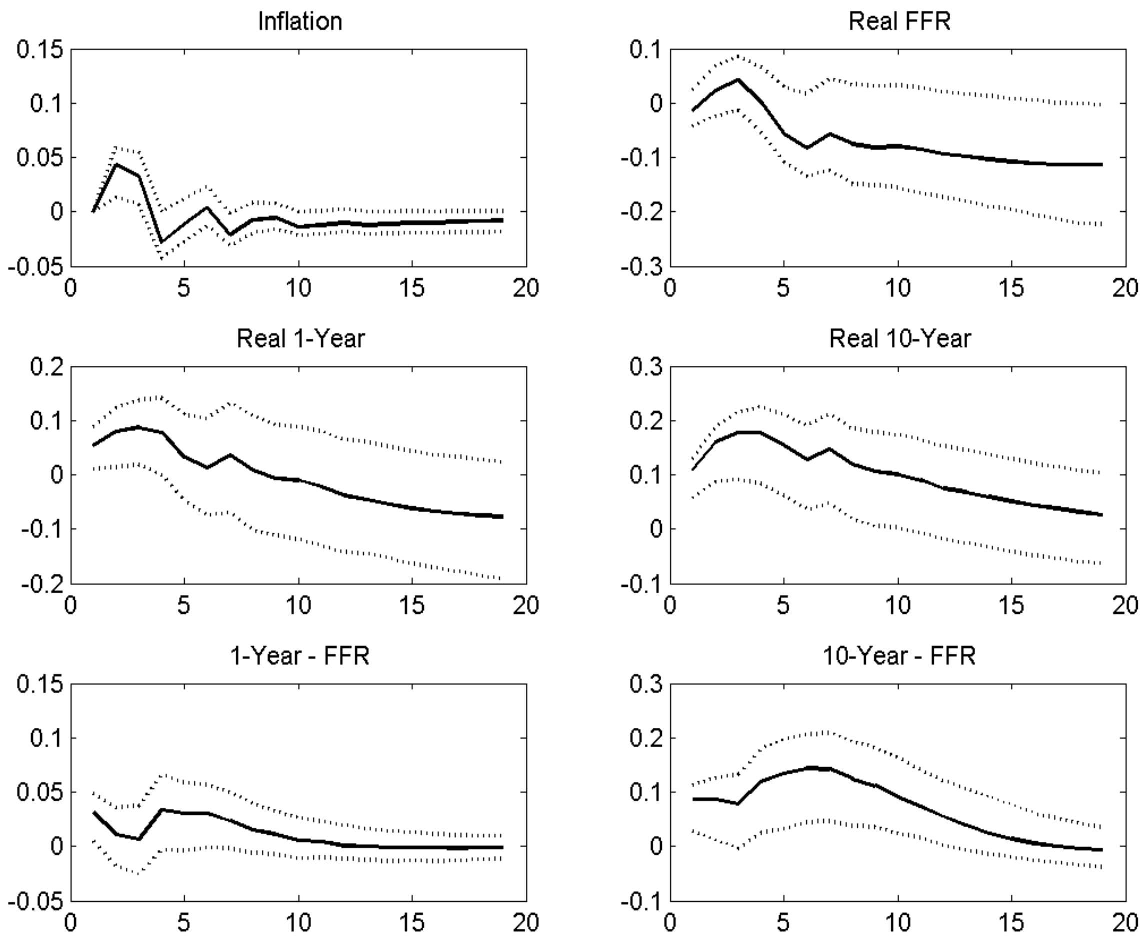

Figure 7: impulse response function of the VAR augmented with the forecast revisions under the alternative identification scheme. Solid lines are point estimate, dotted lines are the 68% confidence bands.

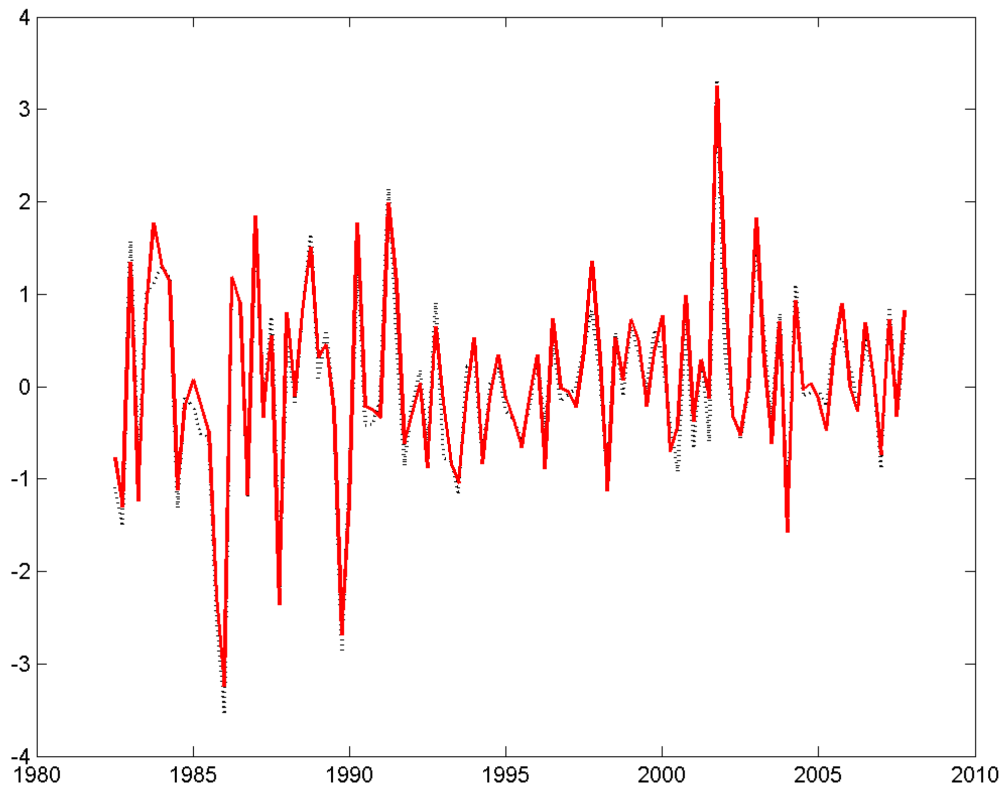

Figure 8: estimated government spending shocks in the two identifications.

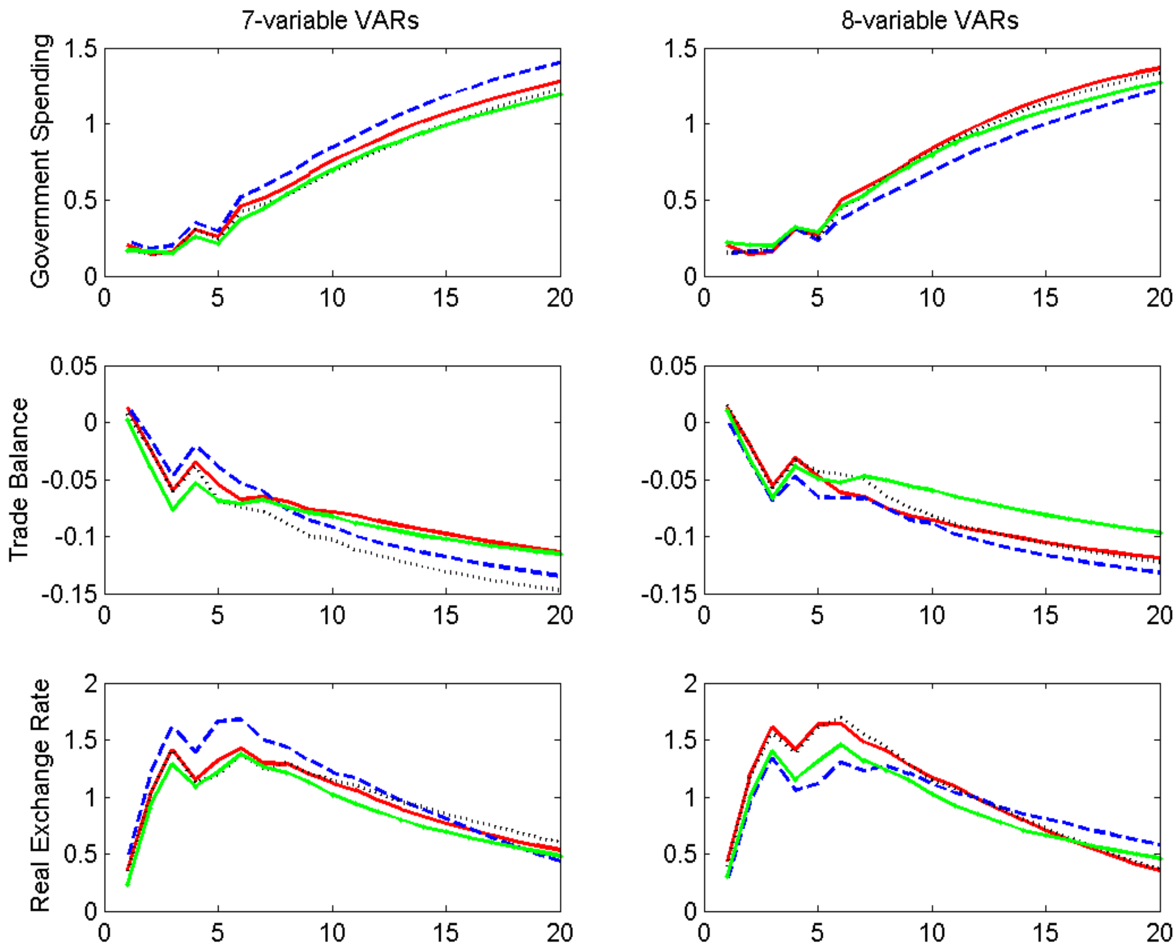

Figure 9: impulse response functions for other VAR specifications listed in Table 1. All the specifications are augmented with the forecast revision. 7-Variable specifications: dotted line - specification 2; light solid line - specification 3; solid line - specification 4; dashed line - specification 5; solid line - specification 5. 8-Variable specifications: solid line - specification 6; dashed line - specification 7; light solid line - specification 8; dotted line - specification 8.

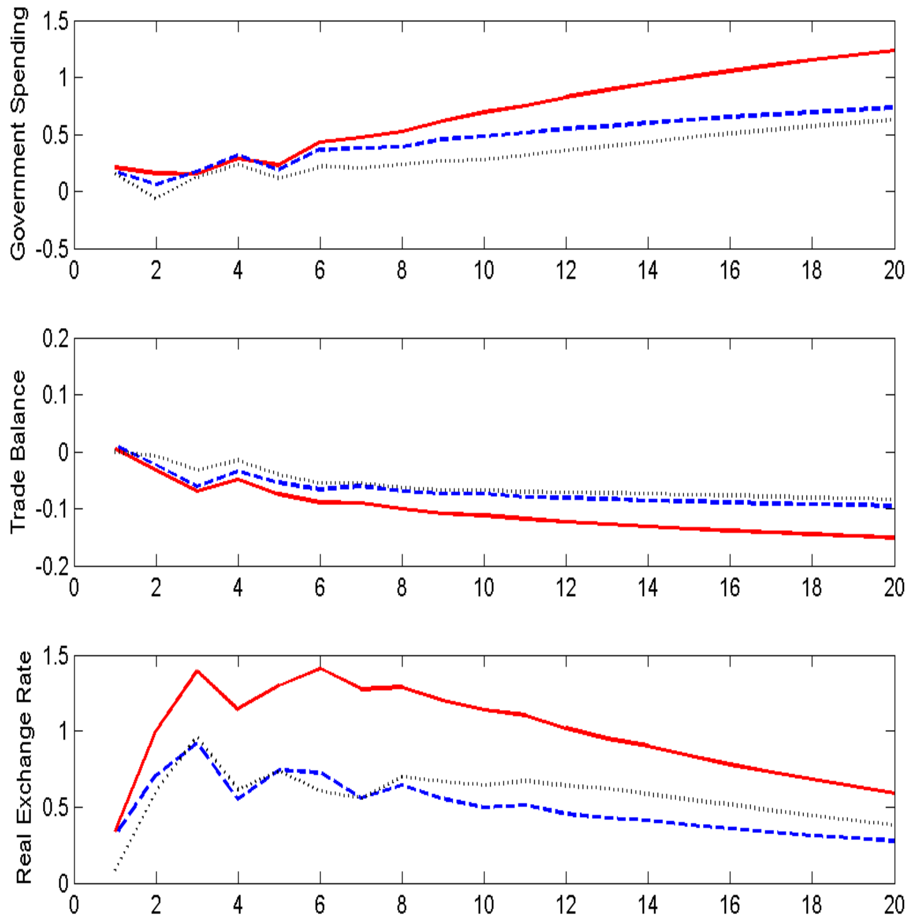

Figure 10: impulse response functions using different forecast revisions. Solid line- with the benchmark variable; doted line - with (8); dashed line - with (9).

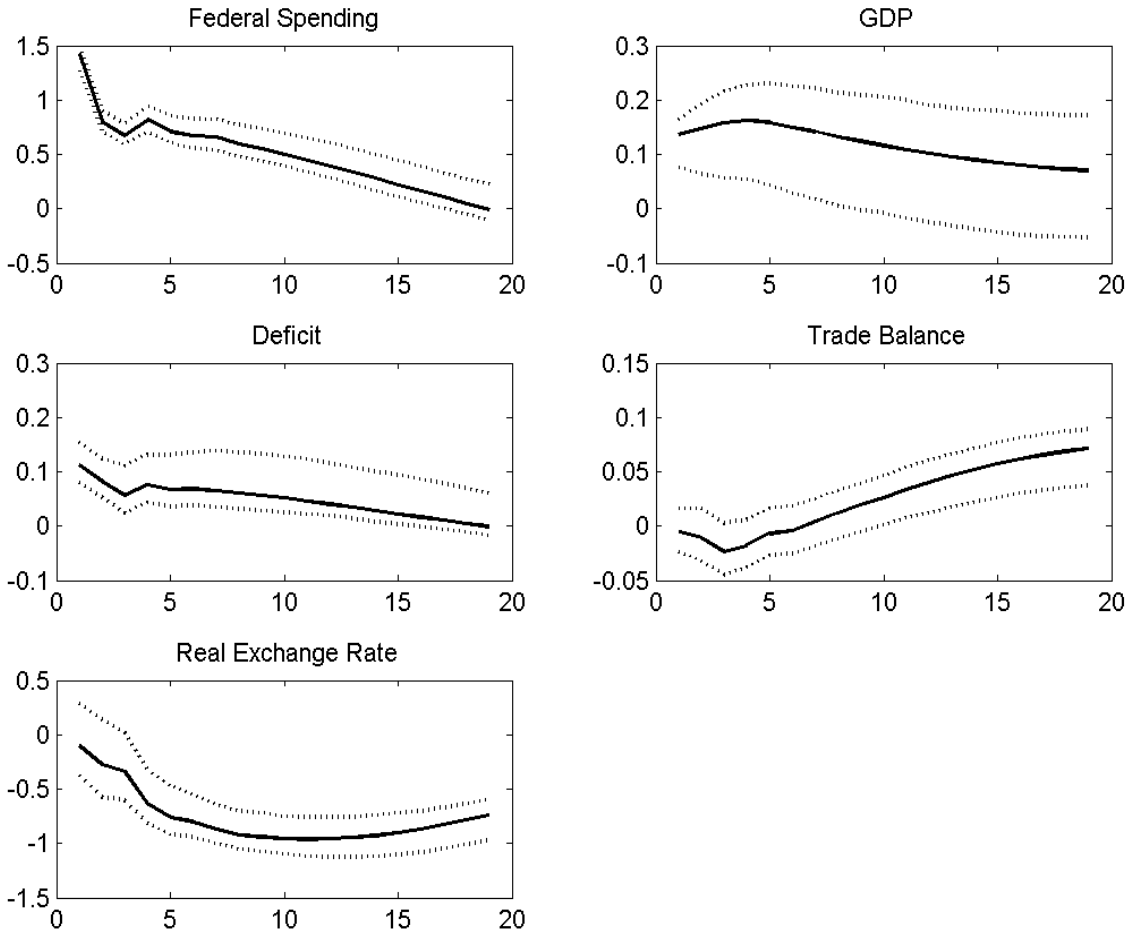

Figure 11: impulse response function in the *levels* specfication. Solid lines are point estimate, dotted lines are the 68% confidence bands.

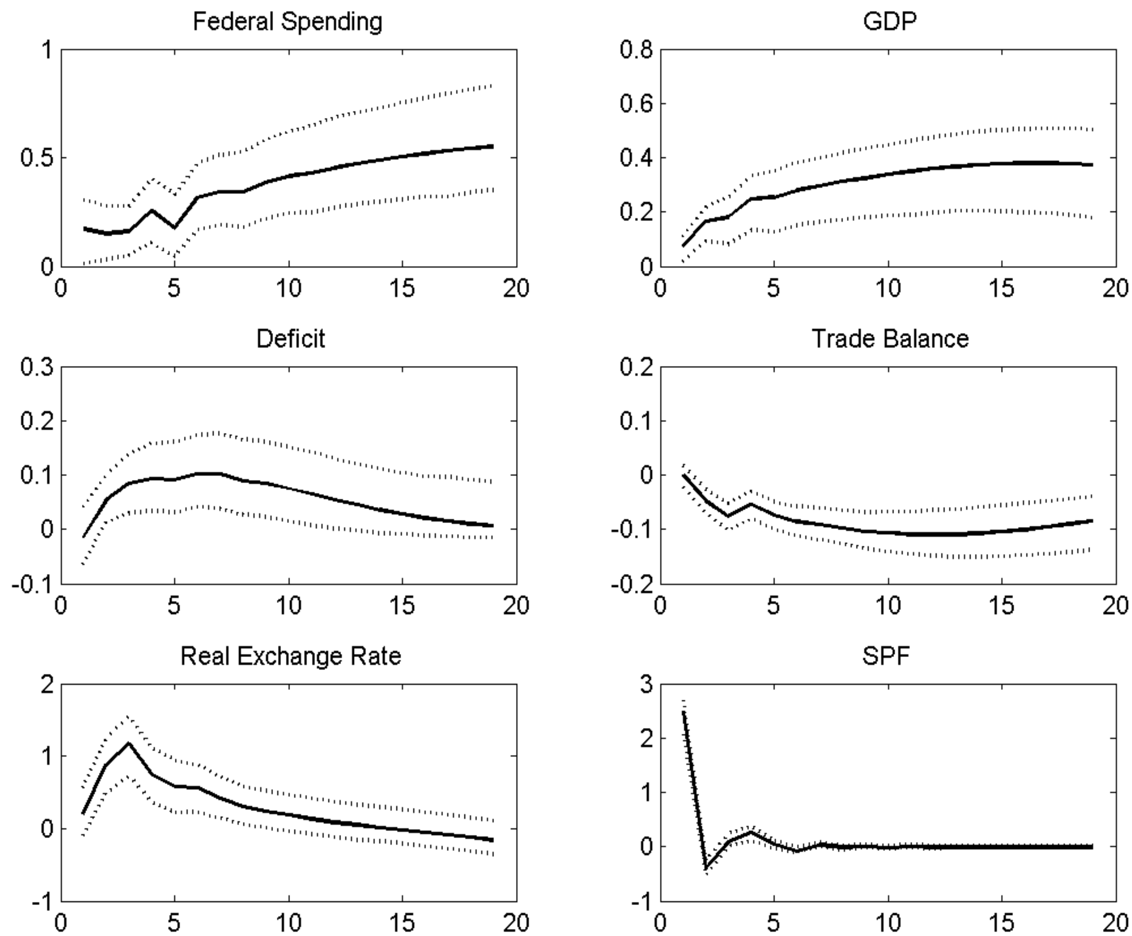

Figure 12: impulse response function in the *levels* specfication with the forecast revision variable. Solid lines are point estimate, dotted lines are the 68% confidence bands.

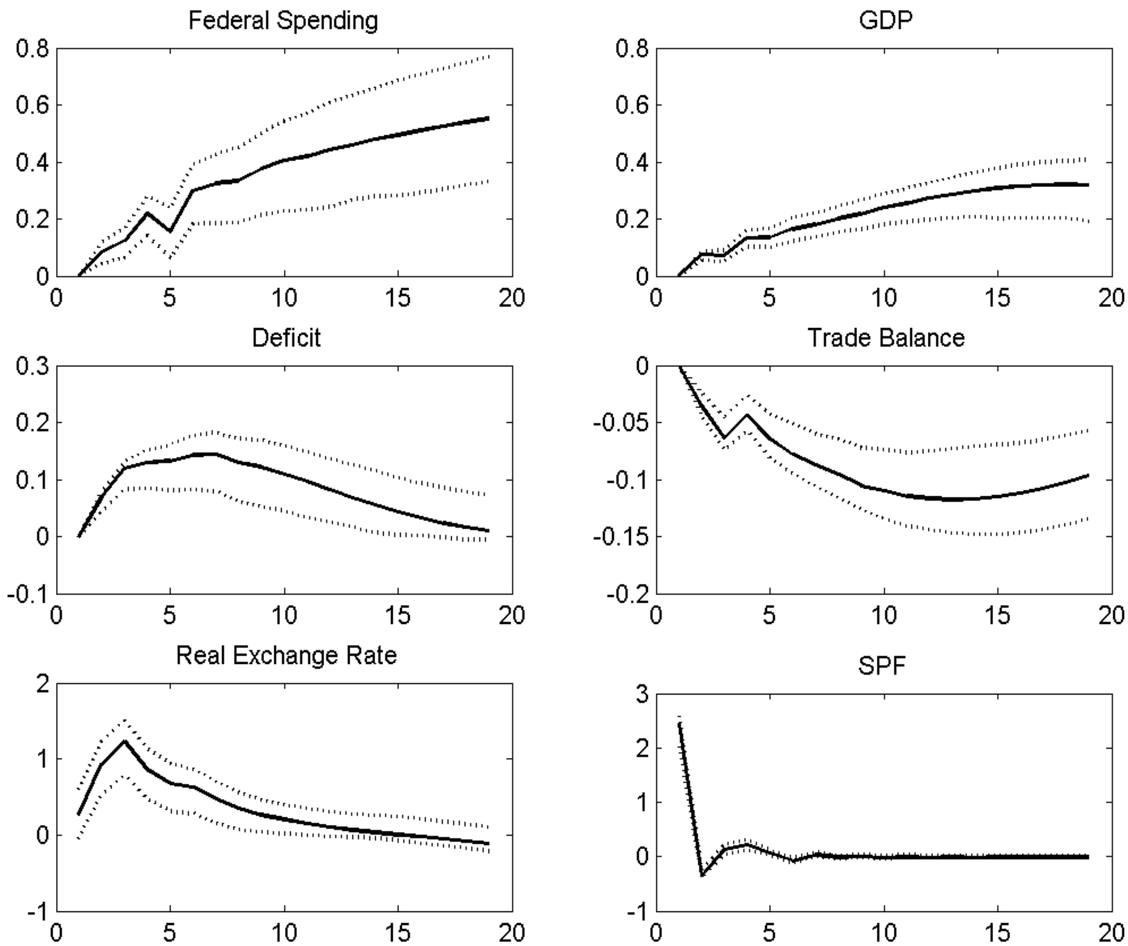

Figure 13: impulse response function in the *levels* specfication with the forecast revision variable and the alternative identification. Solid lines are point estimate, dotted lines are the 68% confidence bands.