What Do We Know about Fiscal Policy Shocks Effects?

A Comparative Analysis

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February 2006

Abstract

The empirical literature studying the effects of fiscal policy shocks uses VAR models to characterize the economy. The existing papers differ among each other in two important elements: the methodology used for the identification of fiscal policy shocks and the VAR specification. Not suprisingly the results obtained are often diverse. The aim of this paper is to test whether differences in the results can be explained by different VAR specifications or they are an outcome of the different methodologies implemented. In order to evaluate it we build a common VAR and then we compare the impulse responses obtained using different methodologies. We find that if the order of variables in the recursive approach is well selected, there are only minor differences between the impulse responses obtained using the recursive approach and the Blanchard-Perotti approach, both for government expenditure and government revenue shocks. However the fiscal dummy variable approach yields significantly different impulse responses than the ones generated by the other two methodologies.

JEL Classification: C32, E20, E60, E62

1   Introduction

For the last ten years the number of empirical studies investigating the effects of fiscal policy shocks on the economy has increased considerably. Following the empirical literature on the effects of monetary policy shocks, all these studies use VAR models to describe the structure of the economy. But they differ for the methodology used to identify fiscal policy shocks. We can group these methodologies in four main categories:

- Recursive approach which is based on the so-called Cholesky decomposition.

- Blanchard-Perotti approach which imposes short-term restrictions based on institutional information on tax and transfer system.

- Mountford-Uhlig approach which imposes sign restrictions directly on the impulse response functions.

- Fiscal dummy variable approach, or narrative approach, which identifies exogenous shocks in military spending through dummy variables, and studies the effects of a shock to the dummies[1].

Although all the empirical literature we refer is based on VAR models, VAR specifications differ, sometimes considerably, among papers: there are used different variables, dataset, sample periods, dummies and trends.

Results produced by these approaches often differ from each other: For instance there is no agreement on the effects of an increase in government expenditure or a decrease in government revenue on consumption and investment, as well as for the effects on interest rate and inflation.

Effects of fiscal policy shocks on the economy are extremely important to discern between competing macroeconomic models. For Instance while Keynesian models predict that an increase in government expenditure should foster private consumption, neoclassical models predict the opposite.

The aim of this paper is to test whether results obtained applying different methodologies differ because of the different approach used or because of different VAR specifications. In order to evaluate it we build a common VAR, with a selected number of variables and a common dataset. Then we compare impulse responses obtained using different methodologies. In this version of the paper we implement the recursive approach, the Blanchard-Perotti approach and the narrative approach. We

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[1] A detailed explanation of these methods is provided in Sections 2 and 3.

test both for government expenditure and government revenue shocks, except for the fiscal dummy variable approach, where it is possible to test only for the first type of shock

Since the recursive approach does not rely on specific events or assumptions on the structure of the economy and it is relatively easy to implement, we take it as our benchmark approach. Then we compare results obtained using the Blanchard-Perotti approach and the fiscal dummy variable approach with the results obtained using our benchmark approach.

We find that if the order of the variables in the recursive approach is well selected, there are only minor differences between the impulse responses generated using the recursive approach and the Blanchard-Perotti approach, both for government expenditure and government revenue shocks. The comparison between the recursive approach and the fiscal dummy variable approach leads to different results. Indeed apart from the response of GDP and government spending to a shock to the latter variable, the impulse responses calculated for the other variables show different patterns. It is important to underline that it is difficult to compare these two approaches because they are based on two different econometric techniques[2].

Aside from this introduction the paper proceeds as follow. Section 2 reviews the literature on the topic. Section 3 presents the econometric methodology, describing the VAR model and the identification approaches used in the paper. Section 4 presents the results. Section 5 presents conclusions and the future research agenda.

2 Literature Review

Vector Autoregressive (VAR) models have become increasingly popular in modern macroeconomics. Since Sims introduced VAR analysis in his 1980 seminal paper, this methodology has been largely applied in order to study effects of monetary policy shocks on the economy. In contrast, the literature on applying vector autoregressive models to analyze the effects of fiscal policy shocks is rather thin. The majority of the research has been focused on U.S. economy[3]. According to the aim of our paper and following the literature, studies based on VAR analysis in fiscal policy issues can be grouped into four main categories:

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[2] This issue is explained in section 4.2

[3] Almost all the papers reported in our analysis are focused on U.S. We will explicitly mention when this is not the case.

A first approach is the so-called "Recursive VAR Approach". It is based on Cholesky decomposition in order to identify fiscal policy shocks. Recent papers applying this methodology are written by Fatás and Mihov (2001 a, b) and Favero (2002). This approach is based on specific assumptions concerning the slugginesh of certain variables: For instance in Fatás and Mihov (2001 b) they assume that government spending is predetermined with respect to output and government revenue. This methodology is relatively easy to implement, but it has the disadvantage that results are sensitive to different ordering of variables.

A second approach due to Blanchard and Perotti (2002), relies on institutional information about tax and transfer systems and about the timing of tax collections in order to identify the automatic response of taxes and government spending to economic activity. This identification scheme relies on a two-step procedure: In a first step, the institutional information is used to estimate cyclically adjusted government revenue and government expenditures. In a second step, estimates of fiscal policy shocks are obtained. Blanchard and Perotti (2002) applied this approach to estimate the effects of government expenditure and government revenue shocks for the United States. Other studies using this approach are Höppner (2003: Chapter 3.3) for Germany, Kuttner and Posen (2002) for Japan, and Perotti (2004) for five OECD countries (Australia, Canada, the United Kingdom, the United States, and West Germany). On one side this approach is difficult to implement because it is necessary to calculate country specific elasticities of government expenditure and government revenue to GDP. On the other side it should provide a more precise and consistent estimation of the effects of fiscal policy shocks with respect to the recursive approach.

The third approach identifies fiscal policy shocks via sign restrictions on the impulse responses. This approach was introduced by Faust (1998) and Uhlig (1999) to study the effects of monetary policy shocks and was applied to fiscal policy analysis by Mountford and Uhlig (2002) and by Canova and Pappa (2002). Unlike the recursive VAR approach, the sign-restrictions approach does not impose linear restrictions on the contemporaneous relations between reduced-form and structural disturbances. Rather, Mountford and Uhlig (2002) impose restrictions directly on the impulse responses. For instance, a deficit spending shock is identified as increasing in government spending, leaving government revenues unchanged for four quarters. An advantage of this approach is that it can handle anticipated fiscal policy shocks. The main disadvantages are that: 1) it is not possible to know when the shock occurs; 2) it rules out by assumption such phenomena as "expansionary fiscal contractions" that have

received a lot of attention in the recent literature on the effects of fiscal policy[4].

A fourth approach is the fiscal dummy variable approach (or narrative approach) introduced by Ramey and Shapiro (1998) and further developed by Edelberg, Eichenbaum and Fisher (1999), Burnside et. al (2004) and Eichenbaum and Fisher (2004). These studies analyze the effects of large increases in military spending in the United States. The underlying idea is that spending increases associated with the Korean war, the Vietnam war, and the Reagan military build-up can be viewed as essentially unrelated to the state of the economy. Eichenbaum and Fisher (2004) apply this methodology in order to assess the state of U.S. economy in the aftermath of 9/11. They conclude that the large exogenous increase in government spending experienced after 9/11 did not produce the same effects on the economy as the Ramey and Shapiro episodes. The major advantage of this approach is that there is no need for the identification of a structural form. On the other and, other substantial fiscal shocks can be occurred around the same time, thus polluting the identification of the military build-up shocks. Moreover this methodology does not allow the analysis of a tax shock.

The studies mentioned above agree for some aspects while disagree for others. All of them find that an increase in government expenditure or a cut in government revenue produce positive effects on output. The most controversial findings are related to the effects of fiscal shocks to consumption and investment. Blanchard and Perotti (2002) documented a positive response of consumption to positive spending shock, while investment decreases as consequence of both a tax and a spending shock. Fatás and Mihov (2001 a,b) find a positive response of consumption and investment to a spending shock. According to Mountford and Uhlig (2002) consumption does not react to an increase in government spending while it decreases after an increase in tax; investment declines in both cases. Edelberg, Eichenbaum and Fisher (1999) show an increase of private consumption. Burnside et al. (2004) show that consumption does not respond significantly to a spending shock, while investment rises on impact and then it converges quickly to its preshock level.

3   Methodology

Our VAR benchmark specification can be written in a reduced form as follow:

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[4]See Gavazzi et al. (2000).

$$X_t = \mu_0 + \mu_1 t + \mu_2 t^2 + A(L)X_{t-1} + \Phi D_1 + \Psi D_2 + u_t \tag{1}$$

where:

- μ_0 is a constant; t represents a linear trend and t^2 represents a quadratic trend.

- $A(L)$ is a (nxn) matrix representing a lag polynomial. We decided to include four lags.

- $X_t = [g_t, y_t, t_t, \pi_t, i_t]$ represents the vector of macroeconomic variables necessary to describe the economy: g_t is the log of real government expenditure on good and services per-capita; t_t is the log of real net primary revenues per-capita (defined as government revenues less government transfers, both net of property income)[5]; y_t is the log of real output per-capita; π_t is the GDP deflator; i_t is the 3-month Treasury Bill Interest Rate.

- D_1 is a dummy variable which assumes value 1 during the so-called "Ramey - Shapiro" episodes: the Korean War (1950:3), the Vietnam War (1965:1) and the Carter-Reagan build-up (1980:1); 0 otherwise. We call it "War Dummy".

- D_2 is a dummy variable capturing the large 1975 tax cut[6]: it takes value 1 in $t = 1975 : 2$; 0 otherwise.

- $u_t = [u_t^g, u_t^y, u_t^t, u_t^\pi, u_t^i]$ is the vector of reduced form residuals, which in general have nonzero cross correlation.

We use quarterly data for U.S. for the 1947:1 2004:4 period. More information about data can be found in the appendix. The VAR is estimated using equation-by-equation least squares.

In a second step we augment the vector of variables to $X_t = [g_t, z_t, y_t, t_t, \pi_t, i_t]$ where z_t indicates either consumption, investment (both in log and real per-capita terms), employment in the private sector and hourly wage in the manufacturing sector[7]. We run a 6-variable VAR with the variable of interest z_t changing . This approach is implemented in order to avoid the estimation of a large number of parameters simultaneously.

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[5] This measure follows Blanchard and Perotti (2002) and Mountford and Uhlig (2002).

[6] See Blanchard Perotti(2002)

[7] We decided to take the hourly wage in the manufacturing sector because the same series for the private sector starts only in 1964:1.

We are interested in investigating the effects of shocks in government expenditure and government revenue on our set of macroeconomic variables. But we cannot do it using this reduced form specification. The variance covariance matrix $\Sigma = E[u_t u'_t]$ is not a diagonal matrix. This imply that we cannot identify the consequences of a shock in, say , government expenditure, on our set of macroeconomic variables. Indeed, if we would give a standard deviation shock to this variable, the system would be affected to shocks to the other variables as well, through the covariance relation. In order to overcome this problem, we have to transform Σ into a diagonal matrix, i.e. we have to solve the so called identification problem.

In this paper we consider two solutions to the identification problem. The first one, known as the recursive approach, was introduced by Sims(1980) and relies on the Cholesky decomposition. We take the specification used in Fatás and Mihov (2001 b). The second solution has been developed by Blanchard and Perotti (2002), who relies on institutional information about the tax and transfer system to identify the short-run relationship between government spending, tax and GDP. For the second solution we will use the specification presented in Perotti (2004). In the following subsections we analyze more in detail these identification schemes. The last subsection provides the intuition behind the so-called fiscal dummy variable approach.

3.1   Recursive approach

If we premultiply eq (1) by the (nxn) matrix A_0 we obtain the structural form

$$A_0 X_t = A0 + A_0 \mu_1 t + A_0 \mu_2 t^2 A^*(L) X_{t-1} + A_0 \Phi D_1 + A_0 \Psi D_2 + B e_t \tag{2}$$

where $A^* = A_0 A$ and $B e_t = A_0 u_t$ describe the relations between the structural disturbances e_t and the reduced-form disturbances u_t. In the literature this representation of the structural form is often called the AB model[8] The aim of our identification procedure is to select B and A_0 in such a way that the variance covariance matrix of the structural disturbances, denoted by $D = E[ee']$ is diagonal. In the Cholesky decomposition introduced by Sims (1980), B is restricted to be an identity matrix and A_0 to be a lower triangular matrix:

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[8] Amisano and Giannini (1997)

$$e_t = A_0 u_t \tag{3}$$

$$u_t = A_0^{-1} e_t \tag{4}$$

$$E[u_t u_t'] = E[A_0^{-1} e_t e_t' A_0^{-1}] = A_0^{-1} E[e_t e_t'] A_0^{-1} = \Sigma \tag{5}$$

with

$$A_0 = \begin{bmatrix} a_{11,0} & 0 & 0 & 0 & 0 \\ a_{21,0} & a_{22,0} & 0 & 0 & 0 \\ a_{31,0} & a_{32,0} & a_{33,0} & 0 & 0 \\ a_{41,0} & a_{42,0} & a_{43,0} & a_{44,0} & 0 \\ a_{51,0} & a_{52,0} & a_{53,0} & a_{54,0} & a_{55,0} \end{bmatrix} \tag{6}$$

This methodology has been used in Fatás and Mihov (2001 a, b) to study the effects of a shock to government spending. The order of variables plays a central role in the application of this identification scheme. It defines the short-run relations between variables. The order selected in this paper is the following:

$$[g_t, z_t, y_t, t_t, \pi_t, i_t] \tag{7}$$

with $z_t = [c_t, inv_t, emp_t, w_t]$

We decided to order government expenditure, consumption and investment before GDP because of all them are components of GDP in the National Account Identity. Government revenue is ordered after GDP in order to capture the automatic response of government revenue to business cycle fluctuations. Order of inflation and interest rate are selected following the Taylor Rule. As shown is Section 4.1, inverting the order of these two variables would change substantially the impulse response functions.

3.2 Blanchard-Perotti Approach

We refer to the identification scheme used by Perotti (2004), an extension of the original Blanchard and Perotti (2002) in order to take into account inflation and interest rate. Their key assumption is to consider absent the effect of a shock to economic activity in determining fiscal policy within a quarter. Thus they can estimate the automatic response of fiscal variables to economic activity and by implication to obtain estimates of fiscal policy shocks.

The relations between the reduced form residuals and the structural shocks can be written as follow:

$$u_t^g = \alpha_{gy} u_t^y + \alpha_{g\pi} u_t^\pi + \alpha_{gi} u_t^i + \beta_{gt} e_t^t + e_t^g \tag{8}$$

$$u_t^t = \alpha_{ty} u_t^y + \alpha_{t\pi} u_t^\pi + \alpha_{ti} u_t^i + \beta_{tg} e_t^g + e_t^t \tag{9}$$

$$u_t^y = \alpha_{yg} u_t^g + \alpha_{yt} u_t^t + e_t^y \tag{10}$$

$$u_t^\pi = \alpha_{\pi g} u_t^g + \alpha_{\pi t} u_t^t + \alpha_{\pi y} u_t^y + e_t^\pi \tag{11}$$

$$u_t^i = \alpha_{ig} u_t^g + \alpha_{it} u_t^t + \alpha_{iy} u_t^y + \alpha_{i\pi} u_t^\pi + e_t^i \tag{12}$$

Using institutional information about the tax and transfer systems they estimate the elasticities of government revenue and expenditure to GDP, inflation and interest rate (the elasticities involving the last two variables are estimated only in Perotti (2004)). Then they construct the cyclically adjusted fiscal shocks and they use these measures as instruments for estimating the remaining equations.

In our estimation procedure,instead, we take the estimates of elasticities of government expenditure and revenue to GDP, inflation and interest rate ($\alpha_{gi} = \alpha_{ti} = 0$,$\alpha_{t\pi} = 0$, $\alpha_{g\pi} = -0.5$, $\alpha_{ty} = 1.85$,

$\alpha_{t\pi} = 1.25$[9] and $\alpha_{gy} = 0$)[10] and we assume $\beta_{gt} = 0$ (that is, we assume expenditure decisions are taken before than tax decision[11]). We can write the previous set of equations in matrix form:

$$
\begin{bmatrix}
1 & 0 & 0 & -0.5 & 0 \\
0 & 1 & -1.85 & -1.25 & 0 \\
\alpha_{yg} & \alpha_{yt} & 1 & 0 & 0 \\
\alpha_{\pi g} & \alpha_{\pi t} & \alpha_{\pi y} & 1 & 0 \\
\alpha_{ig} & \alpha_{it} & \alpha_{iy} & \alpha_{i\pi} & 1
\end{bmatrix}
\begin{bmatrix}
u_t^g \\
u_t^t \\
u_t^y \\
u_t^\pi \\
u_t^i
\end{bmatrix}
=
\begin{bmatrix}
1 & 0 & 0 & 0 & 0 \\
\beta_{tg} & 1 & 0 & 0 & 0 \\
0 & 0 & 1 & 0 & 0 \\
0 & 0 & 0 & 1 & 0 \\
0 & 0 & 0 & 0 & 1
\end{bmatrix}
\begin{bmatrix}
e_t^g \\
e_t^t \\
e_t^y \\
e_t^\pi \\
e_t^i
\end{bmatrix}
\tag{13}
$$

That is, we rewrite the relations between reduced form errors and structural shocks in an AB form:

$$
Au_t = Be_t \tag{14}
$$

In Perotti (2004) the baseline VAR contains the same set of variables used in this paper (although he uses a 10-year nominal interest rate). But the sample period is different: indeed in his paper it goes from 1960:1 to 2001:4 for U.S., and throughout the paper he divides the sample into two parts, with the break set in 1979:4.

3.3   The Fiscal Dummy Variable Approach

The fiscal dummy variable approach, also known as narrative approach, has been introduced by Ramey and Shapiro (1998). In our paper we take the specification used in Edelberg Eichenbaum and Fisher (1999) and Burnside, Eichenbaum and Fisher (2004). The idea behind this approach is to consider defense spending as proxy of government spending. Then, following Ramey and Shapiro (1998) they isolate three exogenous events that led to large military buildups: the Korean War, the Vietnam War and the Carter-Reagan Buildup. They define the set of war dummy variables D_t, where $D_t = 1$ if $t = \{1950 : 3, 1965 : 1, 1980 : 1\}$, 0 otherwise. The VAR can be written as:

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[9] We check the robustness of our results testing for different values of α_{ty}, $\alpha_{t\pi}$ and $\alpha_{g\pi}$.

[10] see Appendix 2 - Perotti (2004)

[11] As documented in Blanchard and Perotti (2002) and Perotti (2004), taking $\beta_{tg} = 0$ would not change the results because the correlation between net tax and spending is low.

$$X_t = \mu_0 + \mu_1 t + A(L)X_{t-1} + \Phi D_1 + u_t \tag{15}$$

A and Φ are estimated using equation-by-equation least squares. The dynamic response of X_t to a shock in defense expenditure can be studied assuming that D_1 takes value of one.

Their VAR specifications presents several differences from our benchmark VAR:

- they use different sets of variables with respect to our specification: For instance in Edelberg, Eichenbaum and Fisher (1999) the log of the producer price index of crude fuel is included in the baseline VAR; the log level of Ramey and Shapiro's measure of real defense purchases is used as proxy of government expenditure; a measure of government revenue is not included in the set of variables.

- In the VAR is included a break in the linear trend in 1973:2 (Burnside et al.), there is no quadratic trend, as well as there is not our second dummy variable for the net tax cut episode of 1975:2.

- The sample goes from 1948:1 to 1996:1 in Edelberg et al. (1999) and from 1947:1 to 1995:4 in Burnside et al. (2004)

An important point to underline is that we are implicitly assuming that this methodology can be applied using government expenditure instead of military spending, hypothesis implicitly assumed in most studies belonging to the literature. For instance in Burnside et. al. (2004) they use real government purchases instead of military spending.

4 Results

In order to compare the results obtained using these three different approaches, we take the recursive approach as benchmark. First we show the response of the economy to shocks in government expenditures and government revenue using this method. Then we compare these results with the ones obtained using the Blanchard-Perotti approach and the fiscal dummy variable approach.

In order to determine a common specification for our VAR, we implemented our analysis using a VAR with the war dummy and one without it, to test whether the responses obtained with the recursive approach and Blanchard-Perotti were robust to different specifications. Indeed in Fatás and Mihov (2001a,b) and Perotti (2004) VARs do not include the war dummy. Results showed that impulse responses are almost the same using both specifications. There are slight differences for investment and government expenditure, while there are larger differences for the interest rate, but still negligible for affecting our results[12]. So we decided to include in our VAR the war dummy.

For the recursive approach and for Blanchard-Perotti we analyze both a government expenditure shock and a government revenue shock. For GDP, government revenue, government expenditure, consumption and investment we calculate fiscal multipliers, that is we express responses as dollar change in each variable to a dollar shock in one of the fiscal variables. For the remaining variables instead we show the percent change in each variable to a standard deviation shock in the one of the fiscal variables. Numerical results are presented in Tables 1,2,3,4. For the fiscal dummy variable approach we calculate only the fiscal multiplier for GDP, as in Eichenbaum and Fisher (2004). Results are reported in Table 5.

4.1   Recursive Approach

Response to Government Expenditure Shock

Figure 2 and Figure 2a show responses to a shock to government expenditure. On impact GDP increases by 50 cents and then it increases to reach a peak of 91 cents after 9 quarters. From then on, it converges to the trend.Government expenditure and government revenue also show a positive response to the shock, the former with a peak of 1.36 dollar after 4 quarters, the latter with a peak of 71 cents after 10 quarters. As GDP, after the peak they converge to trend.

The response of GDP deflator is small. and persistently negative. The response of the interest rate is negative, with a trough of -12.23 percent after 5 quarters and then a tendency to converge to its equilibrium.

The response of consumption is zero on impact. It reaches a peak of 37 cents after 9 quarters and then it converges to its equilibrium. Investment instead, reacts negatively on impact, reaching a trough of - 1 dollar after 4 quarters. It reaches the equilibrium after ten quarters.

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[12]Results are available upon request

Employment does not almost react to the shock, while the nominal wage decrease steadily.

We can compare our results with the one presented in Fatás and Mihov (2001b). The major differences regard the response of investment (positive) and the response of interest rate (smaller and positive on impact). Responses of other variables show the same sign, although patterns can change.

Response to Government Revenue Shock

Figure 3 and 3a show responses to a shock to government revenue. GDP does not react on impact, becoming positive for the first year. Later on it starts declining with a trough after 9 quarters of - 81 cents. Them it converges to its trend. Government expenditure shows a positive small reaction from the 2nd to the 13th quarter. Government revenue tends to converge quickly to its steady state, but from the 13th quarter it starts increasing again. The response of GDP deflator is not significantly different from 0, while the interest rate shows a positive reaction until the 8th quarter; then it becomes negative without converging to its steady state.

Consumption again does not react on impact, but then it shows a negative pattern, with the peak of 54 cents after 8 quarters. Investment remains slightly positive for the first 4 quarters. Then it becomes negative until the 16th quarter, when it reaches its preshock equilibrium. Employment does not show any significant reaction, while the nominal wage shows a small negative reaction only two years after the shock.

The results would have completely changed if we had used another ordering for the variables. In particular, ordering government revenue before GDP would have produced a different outcome. But, as shown in Figure 3b and in Figure 3c, this alternative order is inconsistent because it predicts an increase in GDP, consumption and investment after a positive government revenue shock. This underline the importance of selecting a reasoned order of variables in implementing the recursive approach.

Summing up, GDP and consumption show a positive reaction to a government expenditure shock and a negative reaction to government revenue shock. Investment reacts negatively to both types of shock. Interest rate declines after a government spending shock, while it reacts positively to an expenditure shock, to become negative after two years. The response of employment is never significant while nominal wage decreases slightly with both type of shocks. Our results differ from Fatás and Mihov (2001b) concerning the sign of the impulse responses for investment and for interest rate.

4.2 Comparing the Recursive Approach with the Blanchard-Perotti Approach

Government Expenditure Shock

Figure 4 and Figure 4a show impulse responses to an expenditure shock calculated using the recursive approach and the Blanchard-Perotti approach. The two methods provide similar responses. The only slight differences are connected to the magnitude of peaks for GDP and government revenue, respectively of 16 cents and 14 cents. Consumption seems to be shifted toward the x-axis using the Blanchard-Perotti method, with a difference in the peak of 11 cents. Interest rate shows a 2-percent difference in the response for the 3rd and 4th quarters, to become the same later on. Differences for the other variables can be considered negligible.

Government Revenue Shock

Figure 5 and Figure 5a provides the comparison of the two methods in presence of a government revenue shock. In this case differences between methods are even smaller. None of the variables considered in our analysis show a statistically significant difference in the impulse responses estimated with these two methods.

Summarizing, impulse responses obtained implementing the recursive and the Blanchard-Perotti approaches seem to be similar, showing only minor differences in presence of an expenditure shock.

In general our results seem to be consistent with the one obtained in Perotti (2004)[13].Substantial differences appear in the response of the interest rate, but as mentioned before, he uses a 10-year interest rate while we use a 3-month interest rate. Other differences can be present in the pattern of impulse responses to other variables but not in the signs. In our framework is puzzling the response of GDP to a shock to government revenue. Indeed both Blanchard and Perotti (2002) and Perotti(2004) show in their papers that the response of GDP should be negative on impact, while we obtain a response of 0. But form the 10th quarter the two functions do not show substantial differences. We will further investigate the source of this difference.

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[13]He tests for a positive government expenditure shock and a negative government revenue shock (tax cut).

4.3 Comparing the Recursive Approach with the Fiscal Dummy Variable Approach

The magnitude of the impulse responses calculated using the recursive approach and the ones calculated using the fiscal dummy variable approach differs in a significant way. In the recursive approach the impulse response function gives the percentage response of the variable to a one-standard-deviation shock to the fiscal variable. In the narrative approach instead, the impulse response function gives the percentage response of the variable to a unit shock in the war dummy. Moreover it is not possible to scale the impulse responses in order to bring them to a comparable magnitude. Indeed while the impulse response of GDP obtained via the recursive approach is:

$$\frac{du_t^y}{de_t^g}\sigma_{e^g} = \frac{d\log GDP}{de_t^g}\sigma_{e^g} \tag{16}$$

the impulse response of GDP obtained via the narrative approach is simply:

$$\log GDP_d - \log GDP \tag{17}$$

where eq (17) represents the difference in the GDP forecast produced by the VAR with a shock in the war dummy ($\log GDP_d$) and by a VAR without a shock in the war dummy ($\log GDP$)

So in order to implement our analysis we compare only the patterns of the impulse responses generated with the two approaches; then we calculate a fiscal multiplier for GDP following Eichenbaum and Fisher (2004) in order to have also a numerical comparison.

Graphic comparison

Figure 6 and Figure 6a show impulse responses calculated using the fiscal dummy variable approach. GDP shows a similar pattern with respect to the impulse response calculated with the recursive approach, but the peak is reached after 5 quarters instead of 9. Interestingly it becomes negative from the 16th quarter. On impact the response of government spending is slightly negative[14], converging to the trend after a peak at the 6th quarter. The overall pattern seems to be similar to the impulse response calculated using the recursive approach. The different responses on impact are due

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[14]Burnside, Eichenbaum and Fisher(2004) show exactly the same response.

to an econometric artefact[15]. Government revenue shows on impact a stronger initial response with respect to the recursive approach, with the peak after 6 quarters; after the 15th quarter it becomes negative. GDP deflator and interest rate show complete different patterns. Indeed while using the fiscal dummy approach they are both positive and for the recursive approach they are both constantly negative.

Consumption reacts positively on impact, becoming negative after 10 quarters; using the recursive approach it is always positive. Investment reacts positively in the first half of the sample, to turn negative in the second half. Response of investment using the recursive approach is first negative, then close to 0. Nominal wage shows opposite reaction functions, while employment shows opposite reaction functions in the first half of the sample, but then in both cases it converges to its steady state. In the narrative approach the convergence takes place 5 quarters later.

Comparing impulse responses obtained in our set-up with the previous empirical literature we find that for Burnside et al. (2004) investment shows a milder reaction. Edelberg et al. (1999) reports that both GDP deflator and interest rate become negative respectively after 10 quarters and 13 quarters. Responses of GDP, government expenditure, consumption and employment look very similar to our responses. We cannot compare government revenue and nominal wage, in the papers mentioned above they use real wage and they divide government revenue into labor tax and capital tax.

Fiscal multiplier

In the studies using the narrative approach, fiscal multipliers are almost never calculated. The only exception can be found in Eichenbaum and Fisher (2004), where the authors calculated the fiscal multiplier of GDP. In particular they calculate the yearly cumulative change in output divided by the yearly cumulative change in government expenditure. Table 5 shows the results obtained reproducing this exercise in our framework. It offers also a comparison with the yearly average of quarterly multipliers calculated using the recursive approach. For the first year the two multipliers are almost equal. But while in the recursive approach the effect of the expenditure shock reaches its peak after 3 years, in the narrative approach the multiplier steadily declines becoming negative for the last two years.

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[15] In the recursive approach we scale the impulse responses using the standard deviation of the shock. So the response of government expenditure to a shock to the same variable is by construction equal to one.

Our estimate of the fiscal multiplier for GDP does not differ substantially from the one of Eichenbaum and Fisher (2004). It appears to be slightly smaller on average. They calculate it only for 4 years, so we do not know whether also their estimate becomes negative in the 5th and 6th year.

The two approaches analyzed in this section seem to produce quite different outcomes. Indeed apart from the responses of GDP and Government expenditure, all the other variables show different patterns of their impulse response functions. Also fiscal multipliers calculated for GDP show a different pattern. We have to stress that it is not possible to compare the magnitude of the impulse response functions to the government shock because of the different econometric methodologies used.

5 Conclusion

In this paper we compare the impulse response functions generated applying three different methods to identify fiscal policy shocks. In particular we want to understand whether different results reported in the empirical literature on fiscal policy shocks are due to different VAR specifications or to different econometric approaches. Our main finding is that the recursive approach and the Blanchard-Perotti approach lead to similar impulse response functions when they are applied on a common VAR and using a common dataset. This result is obtained testing both for government expenditure and government revenue shocks. The application of the fiscal dummy variable approach leads to different impulse response functions with respect to the recursive approach, except for responses of GDP and government expenditure. The latter comparison was implemented only for a government expenditure shock.

In particular, the three approaches implemented agree on showing a positive reaction of GDP, government expenditure and government revenue to a positive government expenditure shock. Concerning the other variables, the recursive approach and the Blanchard-Perotti approach on one side, and the fiscal dummy variable approach on the other side, produce almost opposite reaction functions. Using the first two approaches we find that consumption increases (decreases) and investment decreases (decreases) after a positive expenditure (revenue) shock.

Our future research will aim to identify the determinants behind the common impulse response functions obtained for the recursive approach and for the Blanchard-Perotti approach. Then we will

include in our analysis the sign restriction approach used in Mountford and Uhlig (2002).

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6 Data Appendix

All the components of national income are in real per capita terms and are transformed from their nominal values by dividing them by the GDP deflator (NIPA table 1.1.4 Row 1) and the population measure (NIPA table 2.1 Row 38). Data taken from NIPA are revised in March 2005. All the series are seasonally adjusted by the source.

- GDP: This is NIPA table 1.1.5 Row 1.

- Private Consumption: This is NIPA table 1.1.5 Row 2.

- Total Government Expenditure: This is 'Federal Defense Consumption Expenditures', NIPA table 3.9.5 Row 12, plus 'Federal Non Defense Consumption Expenditures', NIPA table 3.9.5 Row 17, plus 'State and Local Consumption Expenditures', NIPA table 3.9.5 Row 22, plus 'Federal Defense Gross Investment', NIPA table 3.9.5 Row 13, plus 'Federal Non Defense Gross Investment', NIPA table 3.9.5 Row 18, plus 'State and Local Gross Investment', NIPA table 3.9.5 Row 23.

- Total Government Revenue : This is 'Government Current Receipts', NIPA table 3.1 Row 1, minus 'Current Transfers Payments', NIPA table 3.1 Row 17, and 'Interest payments', NIPA table 3.1 Row 22.

- Private Domestic Investment: This is 'Gross Private Domestic Investment, NIPA table 1.1.5 Row 6.

- Interest Rate: Net 3 month Treasury Bill secondary market interest rate (TB3MS); Federal Reserve Bank of St. Louis. We take the arithmetic average of the monthly figures to get a quarterly figure.

- The GDP Deflator: This is NIPA table 1.1.4 Row 1.

- Wages: Manufacturing sector- Average hourly earnings of production workers - dollars per hour (Series Id: CES3000000006), Bureau of Labor Statistics (BLS).

- Total Private Employment: Total Private, Quarterly Averages (Series Id: CES0500000081) - Bureau of Labor Statistics (BLS). We take the arithmetic average of the monthly figures to get a quarterly figure.

Table 1. Recursive Approach - Responses to a Government Expenditure Shock

	Fiscal Multipliers						
Quarter	4	8	12	16	20	24	peak
GDP	0.39	0.87	0.76	0.40	0.24	0.19	0.91(9)
Gov. Expend.	1.36	1.02	0.78	0.52	0.29	0.16	1.36(4)
Gov. Rev.	0.18	0.64	0.62	0.31	0.15	0.03	0.71(10)
Consumption	0.14	0.34	0.27	0.14	0.09	0.05	0.37(9)
Investment	-1.01	-0.24	0.02	-0.05	-0.05	-0.02	-1.01(4)
	Percent Change						
Quarter	4	8	12	16	20	24	peak
GDP Deflator	-0.19	-0.28	-0.27	-0.27	-0.026	-0.023	-0.029(9)
Interest Rate	-10.68	-9.37	-6.12	-4.69	-3.51	-2.39	-12.23(5)
Employment	-0.1	-0.01	0.03	-0.01	-0.03	-0.03	-0.10(3)
Wage	-0.18	-0.29	-0.30	-0.33	-0.33	-0.31	-0.33(19)

Fiscal multipliers are defined as dollar change in the variable of interest to a dollar shock in one of the fiscal variables. Percent change means percent response in the variable of interest to a standard deviation shock in the one of the fiscal variables. Both measures are scaled using the standard deviation of the structural shock. The number in brackets indicates the quarter when the peak has been registered.

Table 2. Recursive Approach - Responses to a Government Revenue Shock

	Fiscal Multipliers						
Quarter	4	8	12	16	20	24	peak
GDP	0.03	-0.75	-0.64	-0.32	-0.20	-0.13	-0.81(9)
Gov. Expend.	0.24	0.27	0.03	-0.04	-0.03	-0.02	0.33(6)
Gov. Rev.	0.8	0.03	0.0	0.18	0.23	0.24	0.92(1)
Consumption	-0.28	-0.54	-0.30	-0.20	-0.16	-0.09	-0.54(8)
Investment	0.0	-0.64	-0.32	0.0	0.03	0.0	-0.65(9)
	Percent Change						
Quarter	4	8	12	16	20	24	peak
GDP Deflator	0.08	0.03	-0.06	-0.12	-0.16	-0.21	-0.21(24)
Interest Rate	3.6	-0.30	-2.48	-2.50	-2.07	-1.71	4.43(3)
Employment	0.05	-0.04	-0.07	-0.03	-0.02	-0.02	-0.08(11)
Wage	0.05	-0.01	-0.13	-0.18	-0.22	-0.27	-0.27(24)

Fiscal multipliers are defined as dollar change in the variable of interest to a dollar shock in one of the fiscal variables. Percent change means percent response in the variable of interest to a standard deviation shock in the one of the fiscal variables. Both measures are scaled using the standard deviation of the structural shock. The number in brackets indicates the quarter when the peak has been registered.

Table 3. Blanchard-Perotti Approach - Responses to a Government Expenditure Shock

	Fiscal Multipliers							
Quarter	4	8	12	16	20	24	peak	Peak Recursive approach
GDP	0.36	0.69	0.66	0.37	0.23	0.19	0.75(1)	0.91(9)
Gov. Expend.	1.41	1.06	0.77	0.52	0.29	0.16	1.41(4)	1.36(4)
Gov. Rev.	0.20	0.50	0.52	0.28	0.13	0.07	0.58(10)	0.71(10)
Consumption	0.05	0.22	0.20	0.08	0.04	0.02	0.26(9)	0.37(9)
Investment	-1.0	-0.34	0.0	-0.03	-0.04	-0.02	-1.0(4)	-1.01(4)
	Percent Change							
Quarter	4	8	12	16	20	24	peak	Peak Recursive approach
GDP Deflator	-0.13	-0.22	-0.22	-0.21	-0.20	-0.17	-0.23(9)	-0.29(9)
Interest Rate	-9.46	-9.34	-6.36	-4.77	-3.44	-2.12	-11.54(5)	-12.23(5)
Employment	-0.1	-0.05	0.0	-0.03	-0.03	-0.03	-0.10(5)	-0.10(3)
Wage	-0.14	-0.25	-0.27	-0.28	-0.28	-0.26	-0.28(18)	-0.33(19)

Fiscal multipliers are defined as dollar change in the variable of interest to a dollar shock in one of the fiscal variables. Percent change means percent response in the variable of interest to a standard deviation shock in the one of the fiscal variables. Both measures are scaled using the standard deviation of the structural shock. The number in brackets indicates the quarter when the peak has been registered.

Table 4. Blanchard-Perotti Approach - Responses to a Government Revenue Shock

	Fiscal Multipliers - BP - Tax Shock							
quarter	4	8	12	16	20	24	peak	Peak Recursive approach
GDP	-0.04	-0.83	-0.71	-0.37	-0.23	-0.16	-0.89(9)	-0.81(9)
Gov. Expend.	0.23	0.27	0.01	-0.05	-0.03	-0.03	0.33(6)	0.33(6)
Gov. Rev.	0.87	0.07	0.04	0.23	0.28	0.29	1.01(1)	0.92(1)
Consumption	-0.28	-0.57	-0.32	-0.20	-0.16	-0.09	-0.57(8)	-0.54(8)
Investment	-0.03	-0.70	-0.36	-0.04	0.03	0.0	-0.71(9)	-0.65(9)
	Percent Change							
	4	8	12	16	20	24	peak	Peak Recursive approach
GDP Deflator	0.07	0.0	-0.09	-0.16	-0.22	-0.27	-0.27(24)	-0.21(24)
Interest Rate	3.44	-0.48	-2.82	-2.85	-2.41	-2.04	4.34(3)	4.43(3)
Employment	0.07	-0.05	-0.10	-0.06	-0.04	-0.04	-0.11(11)	-0.08(11)
Wage	0.07	-0.01	-0.13	-0.19	-0.24	-0.29	-0.29(24)	-0.27(24)

Fiscal multipliers are defined as dollar change in the variable of interest to a dollar shock in one of the fiscal variables. Percent change means percent response in the variable of interest to a standard deviation shock in the one of the fiscal variables. Both measures are scaled using the standard deviation of the structural shock. The number in brackets indicates the quarter when the peak has been registered.

Table 5. Fiscal Multipliers for GDP- Fiscal Dummy Variable Approach Vs. Recursive Approach

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Dummy Approach	0.48	0.32	0.19	0.05	-0.07	-0.12
Recursive Approach	0.43	0.69	0.85	0.53	0.28	0.21

For the fiscal dummy variable approach the fiscal multiplier is calculated as the yearly cumulative change in output divided by the yearly cumulative change in government expenditure. For the recursive approach the fiscal multiplier is an yearly arithmetic average of quarterly fiscal multipliers.

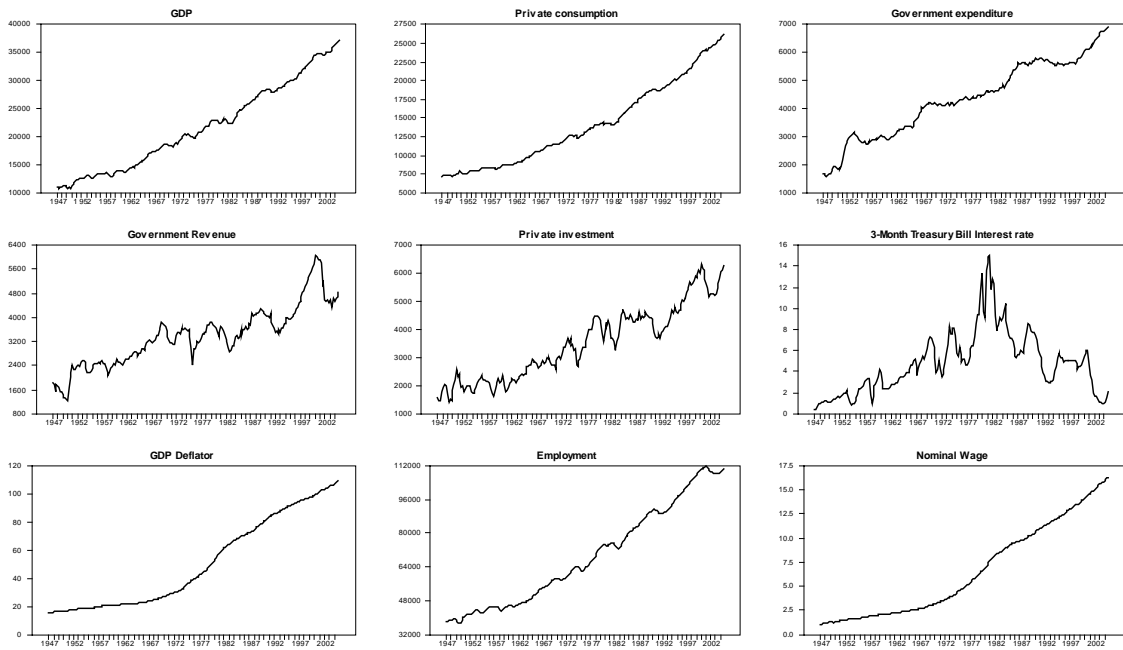# Fig.1 - Selected Variables in the United States 1947:1-2004:4

GDP

Private consumption

Government expenditure

Government Revenue

Private investment

3-Month Treasury Bill Interest rate

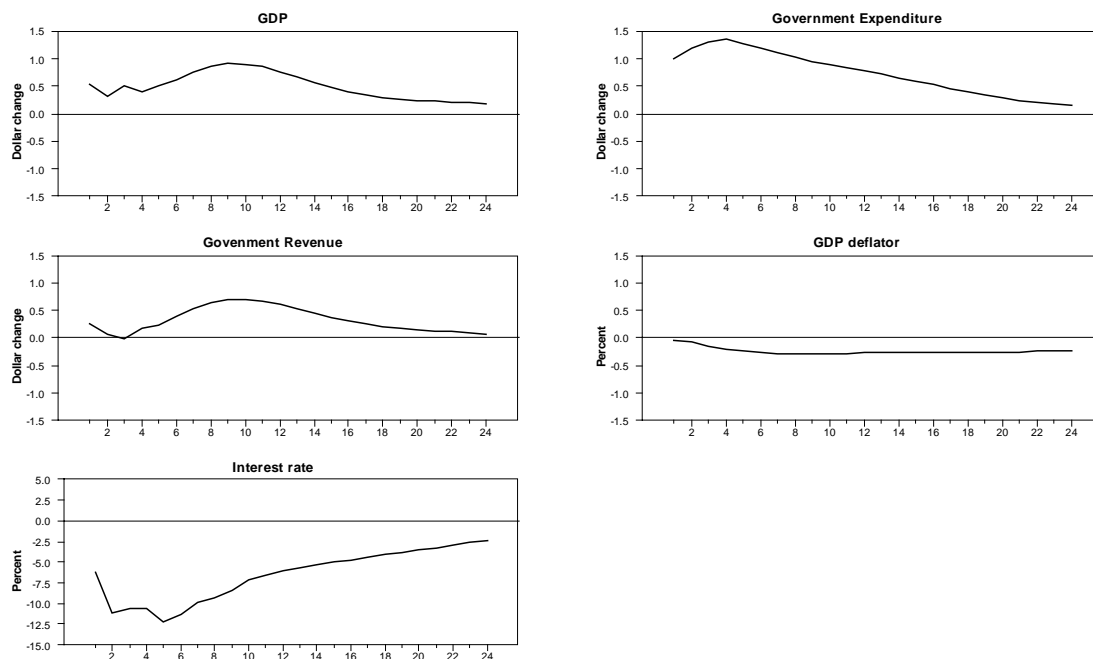GDP Deflator

Employment

Nominal Wage

Fig.2 - Responses to a Spending Shock - Recursive Approach

Fig.2a - Responses to a Spending Shock - Recursive Approach

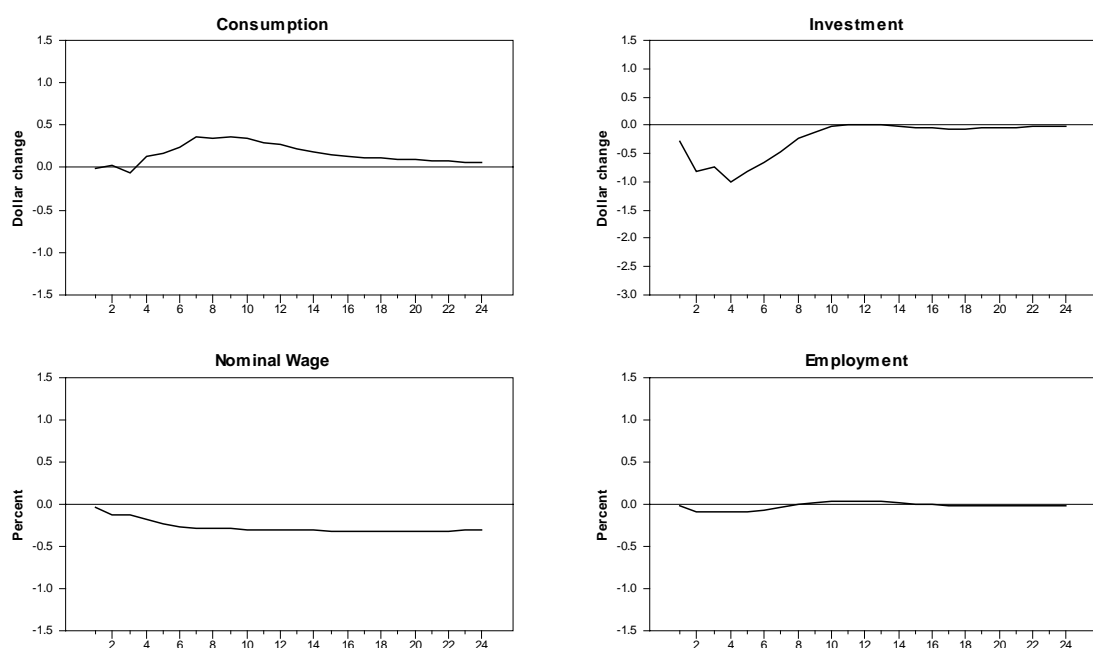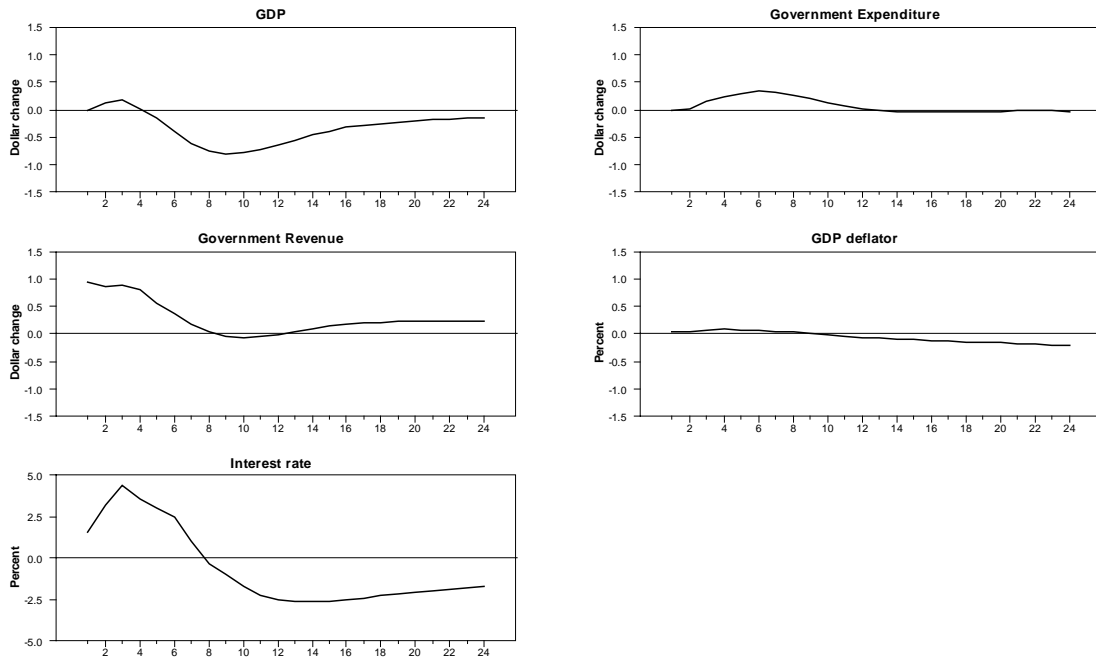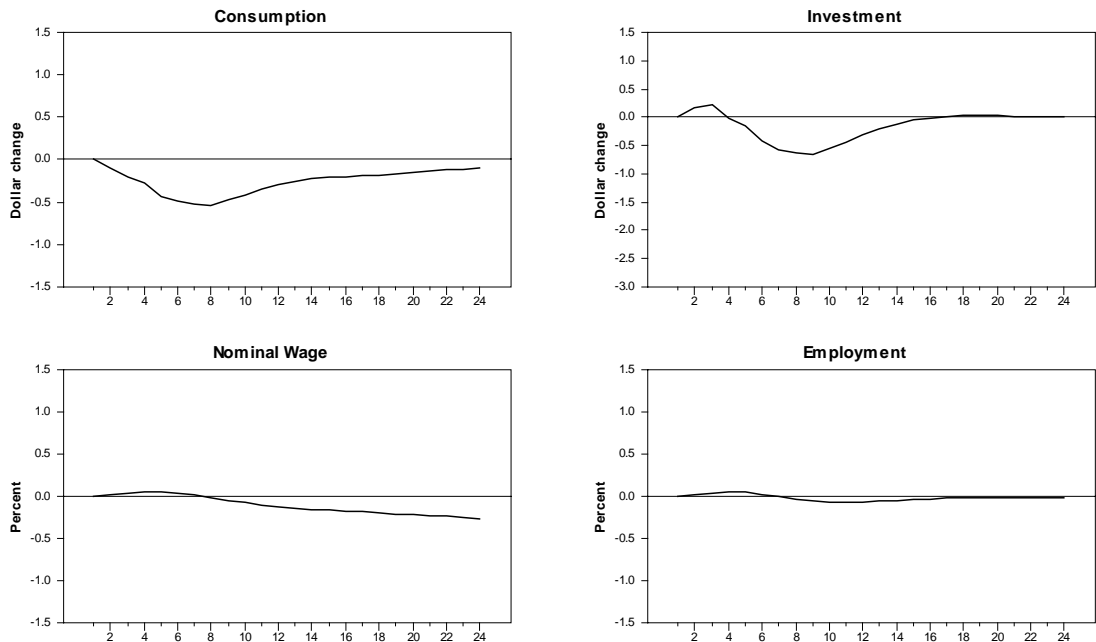# Fig.3 - Responses to a Tax Shock - Recursive Approach

GDP

Government Expenditure

Government Revenue

GDP deflator

Interest rate

Fig.3a - Responses to a Tax Shock - Recursive Approach

Consumption

Investment

Nominal Wage

Employment

Fig.3b - Tax Shock - Recursive Approach with Alternative Order

GDP

Government Expenditure

Government Revenue

GDP deflator

Interest rate

Fig.3c - Tax Shock - Recursive Approach with Alternative Order

Consumption

Investment

Nominal Wage

Employment

Fig.4 - Recursive Approach Vs. Blanchard-Perotti - Spending Shock

GDP

Government Expenditure

Government Revenue

GDP deflator

Interest rate

Fig.4a - Recursive Approach Vs. Blanchard-Perotti - Spending Shock

Consumption

Investment

Nominal Wage

Employment
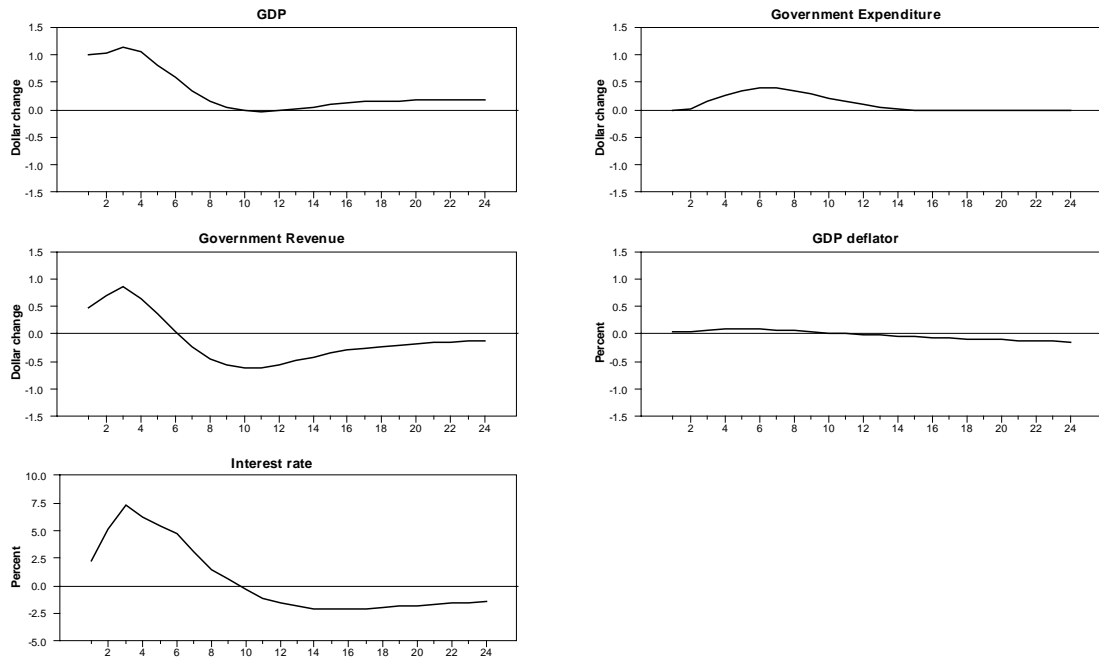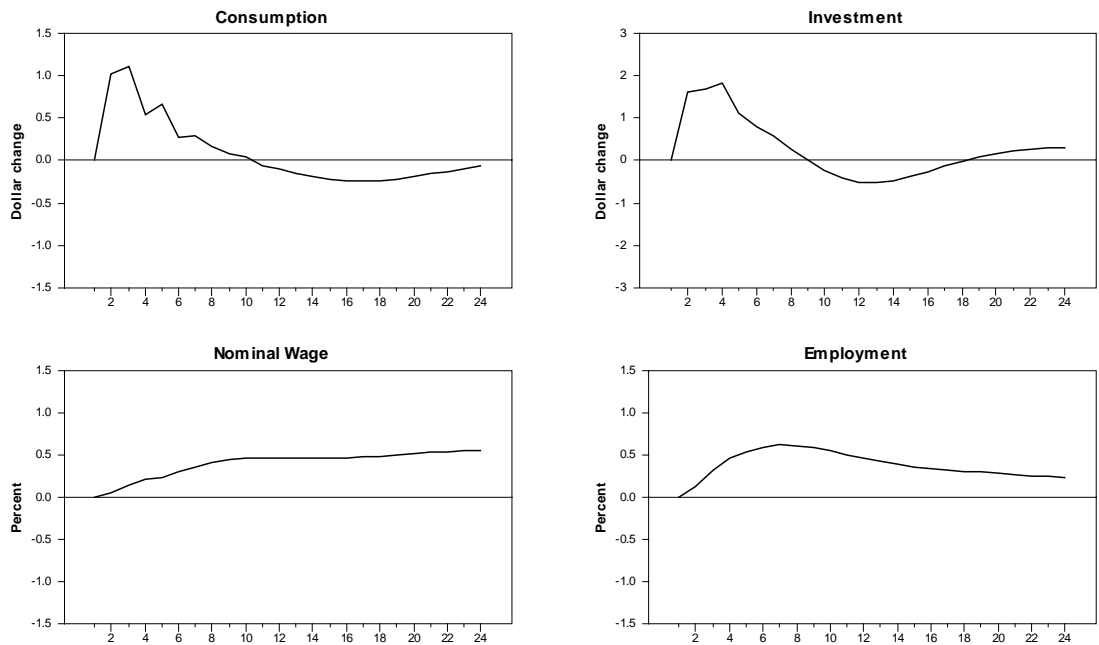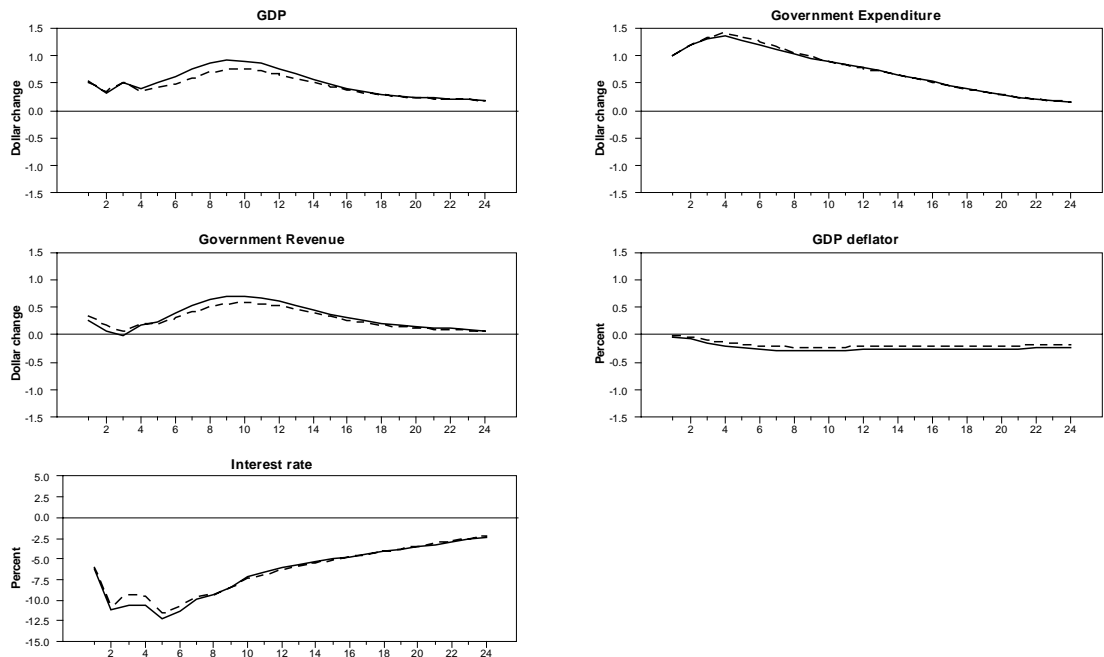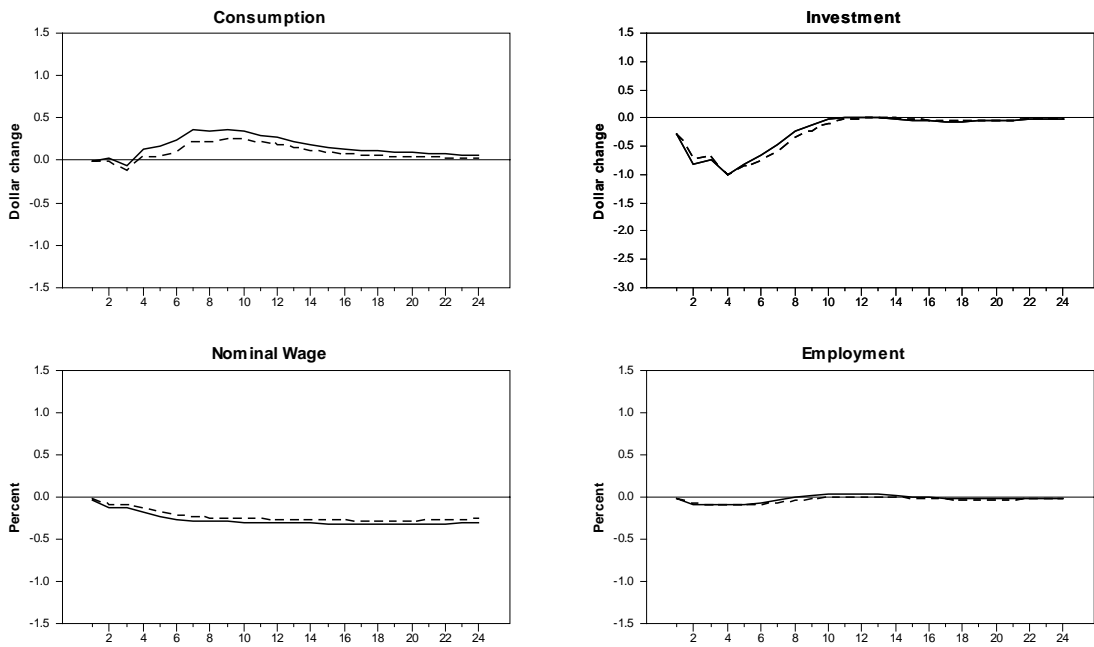
_____ : Recursive Approach   - - - : Blanchard Perotti Approach

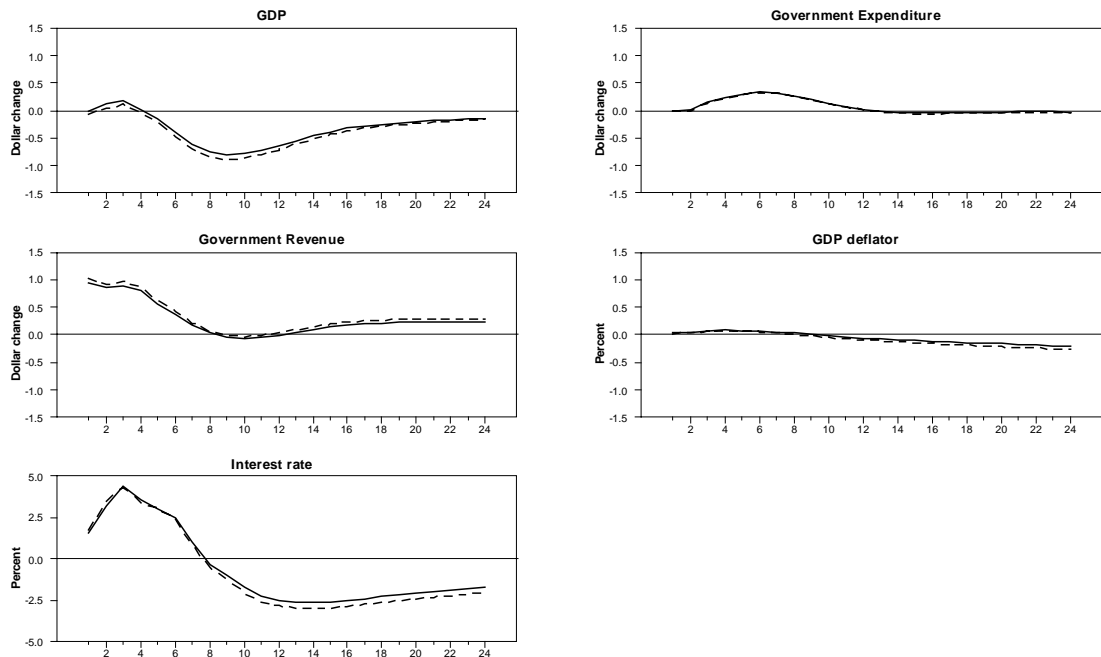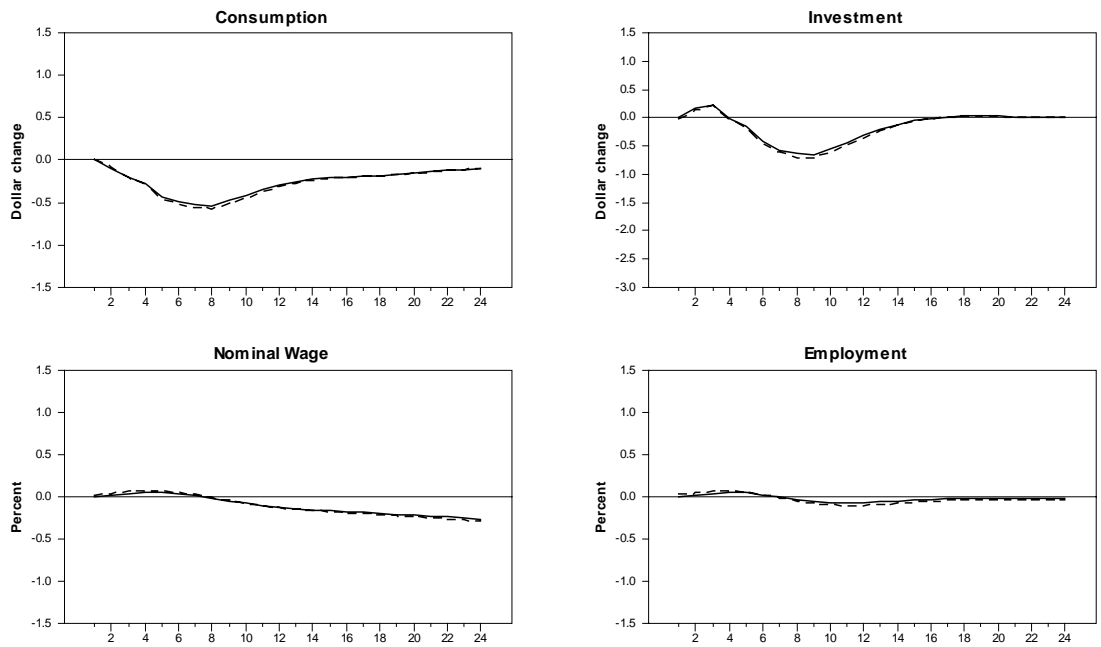# Fig.5 - Recursive Approach Vs. Blanchard-Perotti - Tax Shock

GDP

Government Expenditure

Government Revenue

GDP deflator

Interest rate

Fig.5a - Recursive Approach Vs. Blanchard_Perotti - Tax Shock

Consumption

Investment

Nominal Wage

Employment

_____ : Recursive Approach   - - - : Blanchard Perotti Approach

Fig.6 - Fiscal Dummy Variable Approach - Spending Shock

GDP

Government Expenditure
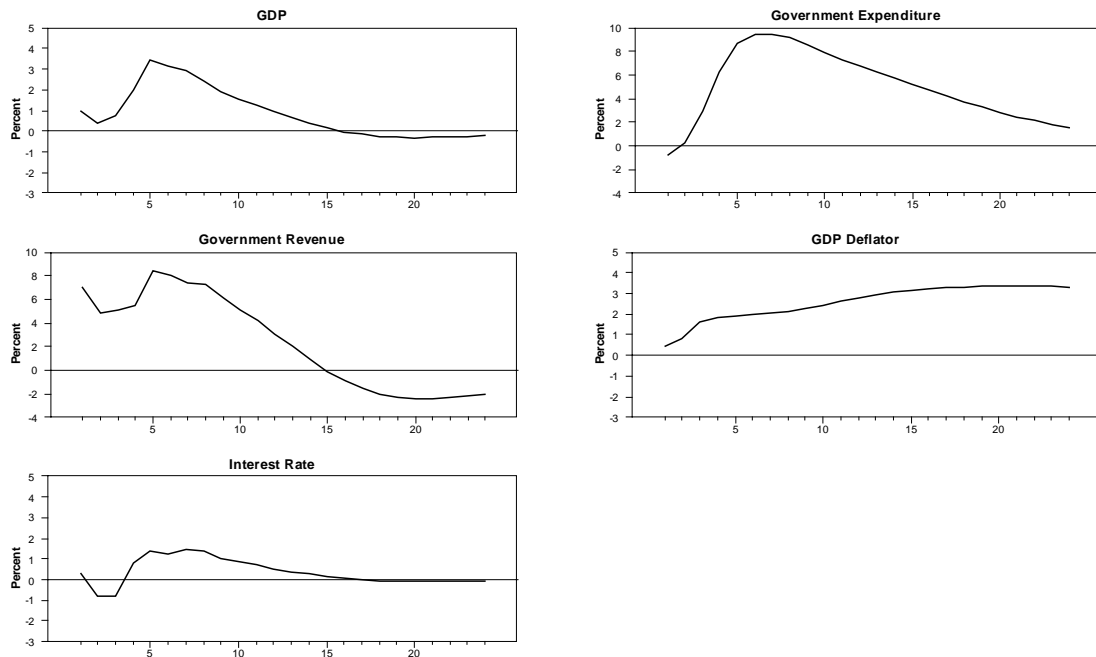
Government Revenue

GDP Deflator

Interest Rate

Fig.6a - Fiscal Dummy Variable Approach - Spending Shock

Consumption

Investment

Nominal Wage

Employment