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Dynamic Effects of Fiscal Policy in Japan: Evidence from a Structural VAR with Sign Restrictions*

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Abstract

In this paper, we employ structural vector autoregression (VAR) with sign restrictions to identify the dynamic effects of fiscal policy shocks in Japan. We find that (i) an increase in government spending has positive effects on consumption and wages in the short run, but these effects are not persistent, and the effects on GDP are almost zero. We also find, surprisingly, that (ii) an increase in government revenue has significant positive effects on GDP, consumption, and investment in the medium and long run although it has negative effects in the short run. Finally, (iii) the balanced-budget spending policy scenario is better than deficit-spending and deficit-financed tax-cut policy scenarios.

Keywords: fiscal policy; government revenue; government spending; sign restrictions; structural VAR

JEL Classification: C32; E60; E62; H20; H50; H60

1 Introduction

What are the effects of fiscal policy in Japan? Further, which is the best fiscal policy scenario, a deficit-financed tax cut, deficit spending, or spending with a balanced budget? These are not only classic fiscal policy questions, but also important contemporary concerns in Japan. This is because, to stimulate a Japanese economy depressed by the recent US financial crisis and the effects of the Tohoku Region Pacific Coast Earthquake, Japanese Prime Minister Shinzo Abe has decided in his economic policy package, known as Abenomics, to increase fiscal spending in 2013 and to increase the rate of consumption tax from 5% to 8% in 2014.

This paper identifies the fiscal policy shocks in the Japanese economy and investigates the dynamic effects of these shocks. For this purpose, we employ a structural vector autoregression (VAR) with sign restrictions as developed by Uhlig (2005) and Mountford and Uhlig (2009). The main advantage of our strategy is that we are able to identify government revenue and spending shocks while controlling for generic business cycle and monetary policy shocks. This is novel because, in existing VAR analyses, it is difficult to distinguish between the movements of fiscal variables given fiscal policy shocks from automatic movements in response to other shocks, such as business cycle or monetary policy shocks. However, in our analysis it is possible to identify these because of the selected sign restrictions and the assumption that the government revenue and spending shocks are orthogonal to the business cycle and monetary policy shocks. To make this analysis possible, we construct the quarterly data for government revenue following Watanabe, Yabu, and Ito (2008).

We find that (i) an increase in government spending has positive effects on consumption and wages in the short run, but these effects are not persistent, and the effects on GDP are almost zero. In addition, surprisingly, (ii) an increase in government revenue has significant positive effects on GDP, consumption, and investment in the medium and long run, whereas it has negative effects in the short run. Our result concerning the response to a government revenue shock is then consistent with non-Keynesian effects, as in Giavazzi and Pagano (1990). Finally, we also find that (iii) a balanced-budget spending policy is better than deficit-spending and deficit-financed tax-cut policies.

Uhlig (2005) proposes the sign restriction method for VARs in his investigation of the effects of monetary policy in the US economy. Mountford and Uhlig (2009) extend the method in Uhlig (2005) in order to investigate the effects of fiscal policy in the US economy. In the Japanese economy, Braun and Shioji (2006a, 2006b) employ these sign restrictions to investigate the effects of monetary policy. Many studies investigate the effects of fiscal policy in Japan. For example, Ihori, Nakazato, and Kawade (2002) apply a nonstructural VAR to Japanese data, while Kuttner and Posen (2001, 2002), Kato (2003), and Watanabe, Yabu, and Ito (2008) examine these same data using structural VARs à la Blanchard and Perotti (2002). Lastly, recent studies by Morita (2012) and Vu (2012) apply VARs with sign restrictions to investigate the effects of anticipated government spending shocks.

The remainder of this paper is organized as follows. Section 2 discusses the methodology used for the identification of shocks. Section 3 describes the dataset and the main results. Section 4 draws our main conclusions.

2 Methodology for the identification of fiscal policy shocks

Following Mountford and Uhlig (2009), we define four structural shocks in Table 1. Suppose that a shock affects the economy in period 1. The business cycle shock increases real GDP, real consumption, real nonresidential investment, and government revenue in periods k =1, 2, 3, and 4. The monetary policy shock increases the nominal interest rate and decreases total reserves and prices in periods k =1, 2, 3, and 4. The government revenue shock increases government revenue in periods k =1, 2, 3, and 4. Finally, the government spending shock increases government expenditure in periods

k =1, 2, 3, and 4. We assume that the monetary policy shock is orthogonal to the business cycle shock, and that the fiscal policy shocks are orthogonal to the business cycle and the monetary policy shocks.

The main reason to include the business cycle and monetary shocks is to filter out the effects of these shocks on the fiscal variables. In existing VAR analyses, it is difficult to distinguish the movements of fiscal variables associated with fiscal policy shocks from automatic movements in response to other shocks such as business cycle or monetary policy shocks. However, in our analysis, we can identify these because of the sign restrictions.

The formal explanation of our method is as follows. A reduced VAR system is given by:

$$\boldsymbol{X}_t = \sum_{j=1}^{p} \boldsymbol{B}_j \boldsymbol{X}_{t-j} + \boldsymbol{u}_t, \tag{1}$$

where X_t is an $m \times 1$ vector; p, the lag length of the VAR; $\boldsymbol{B}_j$, $m \times m$ coefficient matrices; and $\boldsymbol{u}_t$, reduced form errors where $E_t[\boldsymbol{u}_t' \boldsymbol{u}_t] = \boldsymbol{\Sigma}$. The following definition of the impulse vector is from Uhlig and Uhlig (2009).

Definition 1 *An impulse matrix of rank n is an $n \times m$ submatrix of some $m \times m$ matrix $\boldsymbol{A}$, such that $\boldsymbol{A}\boldsymbol{A}' = \boldsymbol{\Sigma}$. An impulse vector $\boldsymbol{a}$ is an impulse matrix of rank 1, i.e. is a vector $\boldsymbol{a} \in \mathbb{R}^m$ such that there exists some matrix $\boldsymbol{A}$, where a is a column of $\boldsymbol{A}$ such that $\boldsymbol{A}\boldsymbol{A}' = \boldsymbol{\Sigma}$.*

Uhlig (2005) and Mountford and Uhlig (2009) show that any impulse vector $\boldsymbol{a}$ can be $\boldsymbol{a} = \tilde{\boldsymbol{A}}\boldsymbol{q}$, where $\tilde{\boldsymbol{A}}$ is the lower triangular Cholesky factor of $\boldsymbol{\Sigma}$, and $\boldsymbol{q} = [q_1, \cdots, q_m]$ and $||\boldsymbol{q}|| = 1$. Given an impulse vector $\boldsymbol{a}$, the appropriate impulse response is calculated as follows. Let $r_a(k)$ be the m-dimensional impulse response at horizon k to the impulse vector $\boldsymbol{a}$. Let $r_i(k) \in \mathbb{R}^m$ be the vector response at horizon k to the i-th shock in a Cholesky decomposition of Σ. The impulse response for $\boldsymbol{a}$, $r_a(k)$ can be written as a linear combination of the impulse responses to the Cholesky decomposition:

$$r_a(k) = \sum_{i=1}^{m} q_i r_i(k). \tag{2}$$

In this analysis, we employ the penalty-function approach following Mountford and Uhlig (2009):

$$f(x) = \begin{cases} x & \text{if } x \leq 0 \\ 100 * x & \text{if } x \geq 0 \end{cases}. \tag{3}$$

Let s_j be the standard error of variable j, $J_{S,+}$ be the index set of variables, restricted to be positive impulse responses, and $J_{S,-}$ be the index set of variables, restricted to be negative impulse responses. Under this setting, we solve:

$$\boldsymbol{a} = \text{argmin}_{\boldsymbol{a}=\tilde{\boldsymbol{A}}\boldsymbol{q}} \Psi(\boldsymbol{a}), \tag{4}$$

where the criterion function $\Psi(\boldsymbol{a})$ is

$$\Psi(\boldsymbol{a}) = \sum_{j \in J_{S,+}} \sum_{k=1}^{4} f\left(-\frac{r_{j,a}(k)}{s_j}\right) + \sum_{j \in J_{S,-}} \sum_{k=1}^{4} f\left(\frac{r_{j,a}(k)}{s_j}\right), \tag{5}$$

by using a simplex algorithm. For example, to identify a business cycle shock impulse vector $\boldsymbol{a}$, we minimize $\Psi(\boldsymbol{a})$ set $J_{S,+} = \varnothing$ and $J_{S,-} = \{$GDP, consumption, investment, government revenue$\}$.

We assume that the monetary policy shock is orthogonal to the business cycle shock and that the fiscal shocks are also orthogonal to the business cycle and monetary policy shocks. In this case, the procedure is as follows. Let $[\boldsymbol{a}^{(1)}, \boldsymbol{a}^{(2)}]$ be an impulse matrix, where the first shock is a business cycle shock and the second is a monetary policy shock. To identify the second shock, we solve:

$$\boldsymbol{a} = \text{argmin}_{\boldsymbol{a}=\tilde{\boldsymbol{A}}\boldsymbol{q}, \boldsymbol{q}' \boldsymbol{q}^{(1)}=0} \Psi(\boldsymbol{a}), \tag{6}$$

given the first shock, $\boldsymbol{a}^{(1)} = \tilde{\boldsymbol{A}}\boldsymbol{q}^{(1)}$. The procedure to identify the fiscal shocks is similar.

For computation, we employ a Bayesian approach as in Uhlig (2005) and Mountford and Uhlig (2009) where 1,000 draws are taken from the posterior of the VAR coefficients and the variance–covariance matrix, and the shocks are identified using the criteria. We plot the confidence bands based on this sample of 1,000 draws for the impulse responses.

3 Empirical results

3.1 Data

The dataset is quarterly for the period from 1975Q2 to 2007Q4, and accordingly does not include the possible trend break associated with the first oil shock in 1973–74 and the major economic movement that resulted from the US financial crisis. We specify the following ten variables in our analysis, namely: real GDP, real consumption, real government expenditure, real government revenue, real investment, the GDP deflator, government bond yields, the monetary base, the corporate goods price index, and the real wage. We do not include the call rate because the sample period includes the effects of Japan's zero nominal interest rate policy.

For GDP, consumption, government expenditure, investment, and the GDP deflator, we use seasonally adjusted data from the System of National Accounts (SNA) published by the Cabinet Office, Government of Japan. GDP, consumption, government expenditure, and investment are expressed in real terms using the GDP deflator. We calculate the real wage using the nominal wage per hour and the GDP deflator. In turn, we calculate the nominal wage per hour using the nominal wage per month and monthly hours per worker, sourced from the *Monthly Labor Survey* by the Japanese Ministry of Health, Labor and Welfare. We source the government yields and the corporate goods price index from the Bank of Japan. While the latter is seasonally adjusted, the former is not. The monetary base is the sum of "Banknotes in Circulation" (Nihon Ginkouken Hakko Daka), "Coins in Circulation" (Kahei Ryutsu Daka), and "Reserves"

(Junbi Yokin Gaku), also sourced from the Bank of Japan and also seasonally adjusted.

Government revenue is the sum of national, prefectural, and municipal taxes. The national taxes are “Tax and Stamp Duty Revenues” (Sozei Oyobi Inshi Syunyu), which is from the *Ministry of Finance Statistics Monthly* (Zaisei Kin-yu Tokei Geppo). The prefectural taxes are from the *Survey on Prefectural Tax Collection* (Doufuken Zei Chosyu Jisseki Shirabe). Following Watanabe, Yabu, and Ito (2008), we construct the data on municipal taxes from the *Survey on Prefectural Tax Collections* and the *Survey on Local Government Finances* (Chiho Zaisei Yoran). These data are seasonally adjusted.

In the estimation of the VAR model, we set the number of lags to four following Watanabe, Yabu, and Ito (2008). Following Uhlig (2005) and Mountford and Uhlig (2009), we do not include a constant or a time trend. All variables except for the interest rate are the logarithms of the level multiplied by one hundred.

3.2 Impulse responses to shocks

In this subsection, we report the impulse response functions to shocks obtained by the sign restrictions. The circled lines are point estimates, and the dashed lines show 67% confidence intervals. The shaded areas indicate the impulses directly restricted by the sign restrictions.

The business cycle shock: Figure 1 depicts the responses to a business cycle shock.

[Insert Figure 1]

These are similar to the findings by Mountford and Uhlig (2009) for the US economy. By construction, output, consumption, investment and government revenue increase in the first four quarters as responses to the business cycle shock, and these positive effects are persistent following the periods of the restrictions. The effects on revenue are very large, about 3.6% in average. Government expenditure is not countercyclical, and the point estimates are positive with respect to the business cycle shock. The monetary variables, namely, interest rates, the monetary base, and prices, fluctuate according to the business cycle shocks. These movements could result from a systematic monetary policy rule, for example, the Taylor rule.

The monetary policy shock: Figure 2 illustrates the responses to a monetary policy shock.

[Insert Figure 2]

By construction, the interest rate increases while reserves and prices decrease in the first four quarters as responses to the monetary policy shock. The monetary policy shock has negative effects on investment. However, there are small positive effects on consumption and wages. It is also interesting that the effect on expenditure is positive during periods 2 to 8. The effect on revenue is relatively large, but not significant. Government revenue oscillates as a response to the monetary policy shock. The effect on GDP is not significant, and this neutrality result is similar to the findings by Uhlig (2005) and Mountford and Uhlig (2009) for the US economy.

The government revenue shock: Figure 3 shows the responses to a government revenue shock.

[Insert Figure 3]

By construction, government revenue increases in the first four quarters as a response to the government revenue shock. Surprisingly, it has positive effects on GDP, consumption and investment in the medium and long run, although GDP, consumption, investment, and wages decrease in the first several quarters. There is a slightly negative effect on government expenditure. Our short-run result is consistent with the existing results by Mountford and Uhlig (2009) using sign restrictions for the US economy and those by

Watanabe, Yabu, and Ito (2008) using the identification method in Blanchard and Perotti (2002) for the Japanese economy. However, the medium- and long-run effects are very different.

Our result highlights the non-Keynesian effect described in Giavazzi and Pagano (1990). Here, an increase in government revenue is helpful for fiscal health conditions, for example, in reducing the debt–GDP ratio. If the debt–GDP ratio improves in the medium and long run, it makes households and firms more optimistic about the future, and in response they increase consumption and investment. Yun (2013) finds that the output gap is negatively correlated with the debt–GDP ratio, and there is a significantly negative term for the debt–GDP ratio in the New Keynesian IS curve for the US economy. This theory could plausibly explain our findings.

The government spending shock: Figure 4 depicts the responses to a government spending shock.

[Insert Figure 4]

By construction, government expenditure increases in the first four quarters as a response to the government revenue shock. There are positive effects on consumption and wages, and a small negative effect on investment in some quarters. Crowding-out effects could account for this negative movement in investment. In contrast, there are no significant effects on GDP, even in the short run.

This effect on GDP is different from that found by Watanabe, Yabu, and Ito (2008) for the Japanese economy. In their paper, the government spending shock increases output significantly in the short run. A possible explanation is that the effect of the business cycle shock is included in their result. The business cycle shock increases both output and spending, as in Figure 1, while they assume that there is no effect on spending. This comovement of output and spending could account for the response to the government spending shock found in Watanabe, Yabu, and Ito (2008).

3.3 Policy analysis

Here, we consider three fiscal policy scenarios—deficit spending, a deficit-financed tax cut, and balanced-budget spending—as in Mountford and Uhlig (2009). To assess the effects of these scenarios, we consider the effects of linear combinations of the fiscal policy shocks found in the previous subsection. For example, in the deficit government spending scenario, government spending increases by 1% over four quarters while government revenue does not change during the same period. This is a result of a linear combination of the sequence of government spending and revenue shocks. Formally, letting $r_{j,a}(k)$ denote the response at horizon k of variable j to the impulse vector $\boldsymbol{a}$, we consider the scenario that:

$$0.01 = \sum_{j=1}^{k} \left[r_{G,G}(k-j)\varepsilon_{G,j} + r_{G,T}(k-j)\varepsilon_{T,j} \right] \quad \text{for } k = 1, \cdots, K$$

$$0 = \sum_{j=1}^{k} \left[r_{T,G}(k-j)\varepsilon_{G,j} + r_{T,T}(k-j)\varepsilon_{T,j} \right] \quad \text{for } k = 1, \cdots, K$$

where $K = 4$, G and T denote government spending and revenue, and $\varepsilon_{G,j}$ and $\varepsilon_{T,j}$ denote shocks to government spending and revenue. Given there are $2K$ equations and $2K$ shocks for each scenario, all shocks can be identified.

First, the dynamic effects for a deficit-spending fiscal policy scenario are shown in Figure 5.

[Insert Figure 5]

In this case, we impose the restriction where government spending increases by 1% for four quarters and government revenue does not change during the same period. While investment decreases in the short run, there are significant positive effects on consumption and wages, and positive, but not significant, effects on GDP in the medium and long run.

Second, the dynamic effects for a deficit-financed tax-cut fiscal policy scenario are shown in Figure 6.

[Insert Figure 6]

In this case, we impose the restriction where government revenue decreases by 1% for four quarters and government spending does not change during the same period. A deficit-financed tax cut increases GDP, consumption, wages and investment in the short run, but in the medium and long run, they decrease. This is consistent with the effects of a government revenue shock in the previous section.

Finally, the dynamic effects for a balanced-budget spending fiscal-policy scenario are shown in Figure 7.

[Insert Figure 7]

In this case, we impose the restriction where both government spending and revenue increase by 1% for four quarters. While investment decreases in the short run, it has significant positive effects on GDP and consumption. Investment also increases, but not significantly, in the long run. We can interpret this result as follows. An increase in government revenue has positive effects on GDP and consumption in the medium and long run, but it has a significant negative effect on consumption and wages in the short run. A balanced-budget spending policy buffers this short-run pain by increasing government spending, and this has a positive effect on consumption and wages in the short run.

Which is the best policy scenario among these three? It is obvious that a deficit-financed tax cut is undesirable since this policy is harmful in the medium run. Both deficit spending and balanced-budget spending policies have positive effects on GDP and consumption in the medium and long run. To compare the effects, we calculate the present value multipliers on GDP and consumption of both policies as:

$$\text{(The present value multiplier with period } k) = \frac{\sum_{j=1}^{k}(1+i)^{-(j-1)}y_j}{\sum_{j=1}^{k}(1+i)^{-(j-1)}g_j}\frac{1}{g/y},$$

where i denotes the average interest rate (government yields) over the sample; y_j, the response of output (or consumption) at period j; g_j, the response of expenditure at period

j; and g/y, the average expenditure–output (or expenditure–consumption) ratio over the sample. The point estimates are used to calculate the multipliers, and these are shown in Figure 8.

[Insert Figure 8]

While both the present value multipliers are similar and there are few differences in the first four quarters, those of the balanced-budget spending policy are larger than those of the deficit-spending policy after period 6. Therefore, the balanced-budget spending is the best among these policy scenarios.

4 Conclusion

This paper investigated the effects of fiscal policy in Japan using the structural VAR model with sign restrictions à la Mountford and Uhlig (2009). Because of the sign restrictions, we distinguished between movements of fiscal variables given fiscal policy shocks from automatic movements in response to other shocks, such as business cycle or monetary policy shocks.

We found that (i) an increase in government spending has positive effects on consumption and wages in the short run, but these effects are not persistent, and the effects on GDP are almost zero, and surprisingly (ii) an increase in government revenue has significant positive effects on GDP, consumption, and investment in the medium and long run but negative effects in the short run. Our result concerning the response to government revenue shock is consistent with the non-Keynesian effects discussed in Giavazzi and Pagano (1990). We also found that (iii) a balanced-budget spending policy is better than deficit-spending and deficit-financed tax-cut policies. An increase in revenue has positive effects on consumption, investment, and wages in the medium and long run, but negative effects in the short run. Given an increase in spending has a positive effect on consumption and wages, the balanced-budget spending policy weakens the pain in the short run from the increase in revenue, and obtains medium- and long-run benefits.

Our result suggests the importance of fiscal health for the economy. To ensure medium and long-run growth in the Japanese economy, it would be necessary to increase revenue and to improve the debt–GDP ratio.

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Table 1: Sign restrictions on shocks

	T	G	Y	C	X	R	M	P
Fiscal policy shocks								
government revenue	+							
government spending		+						
Other shocks								
business cycle	+		+	+	+			
monetary policy						+	−	−

Notes: T: government revenue, G: government spending, Y: GDP, C: consumption, X: investment, R: interest rates, M: monetary base, and P: prices. "+" indicates that the impulse response of the variable in question is restricted to be positive for four quarters following the shock, including the quarter of impact. "-" indicates a negative response. A blank space indicates that no restrictions have been imposed.

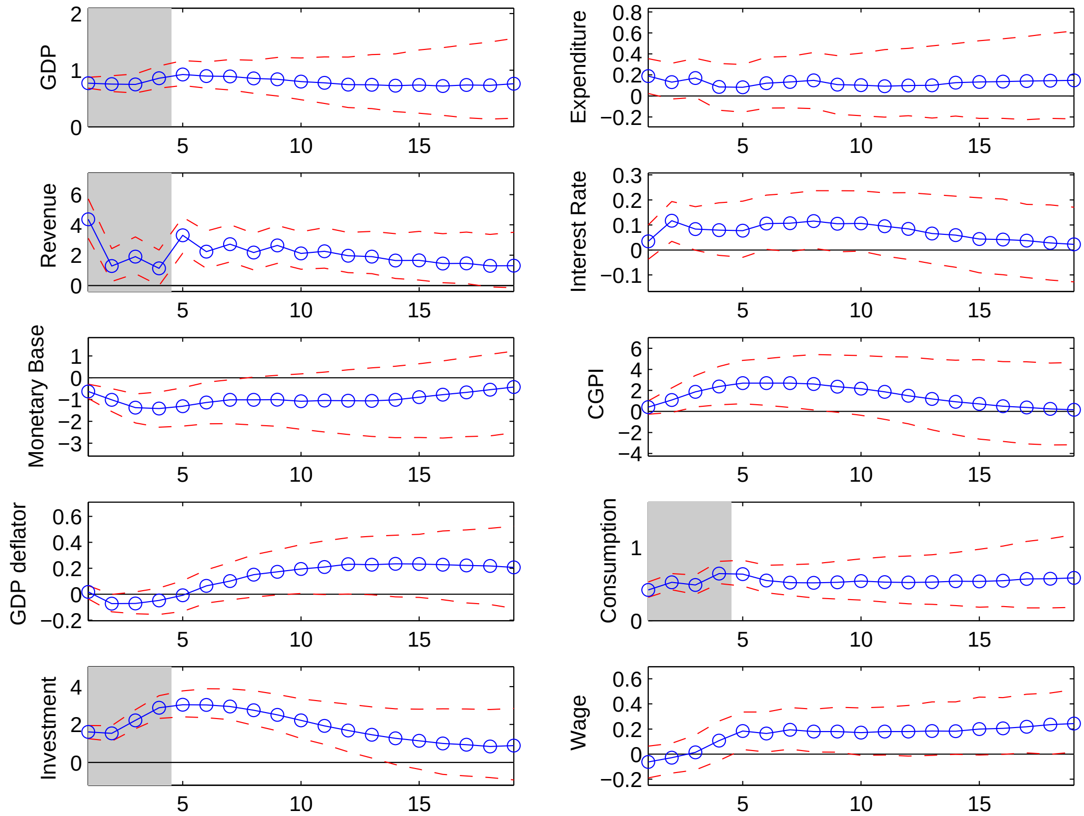

Figure 1: Impulse responses to the business cycle shock

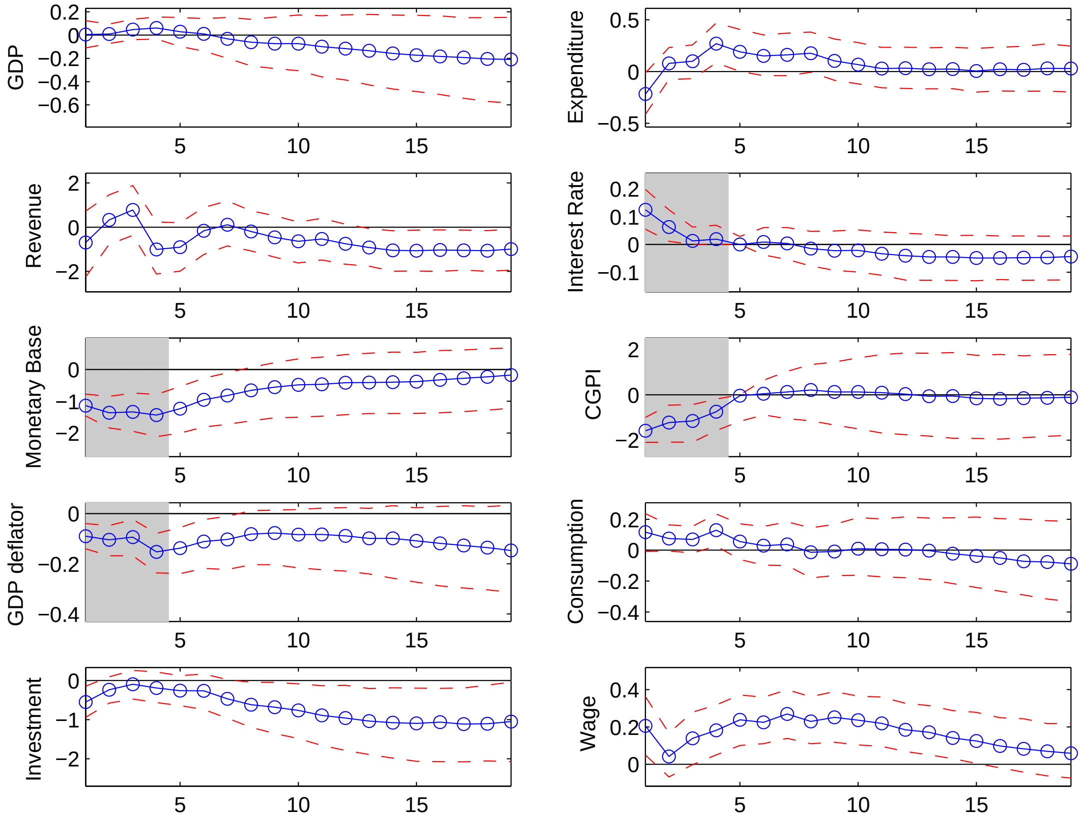

Figure 2: Impulse responses to the monetary policy shock

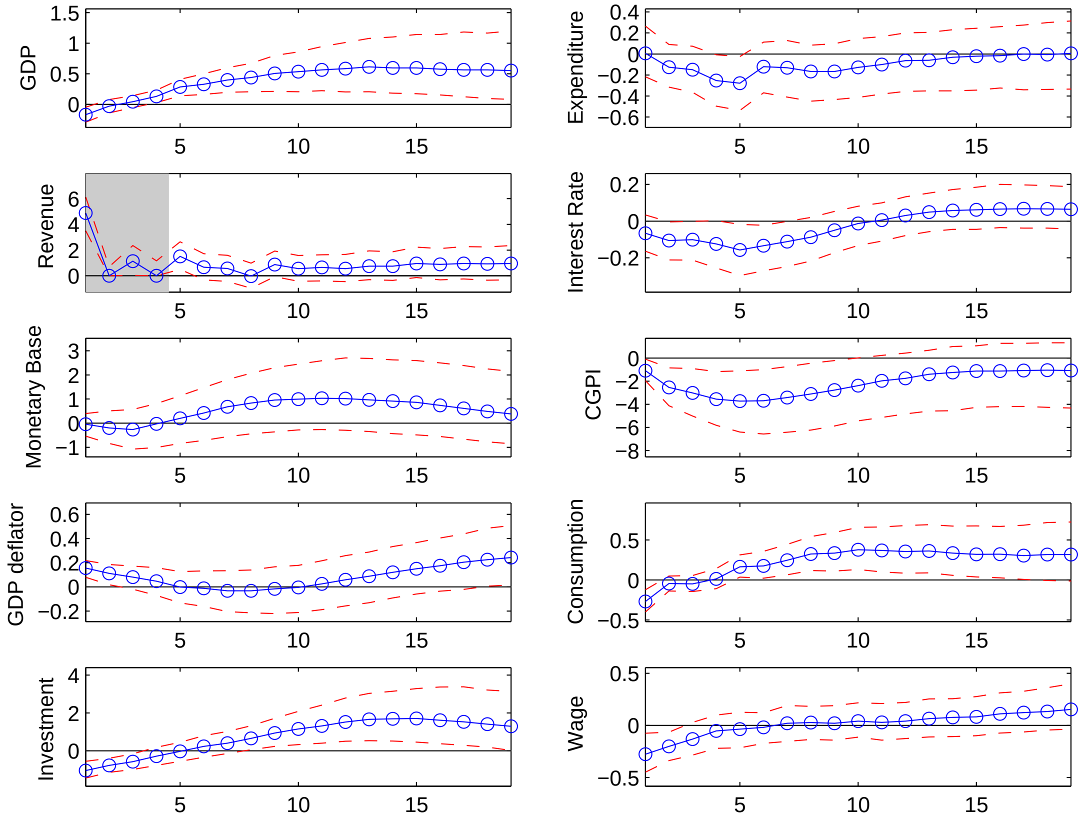

Figure 3: Impulse responses to the government revenue shock

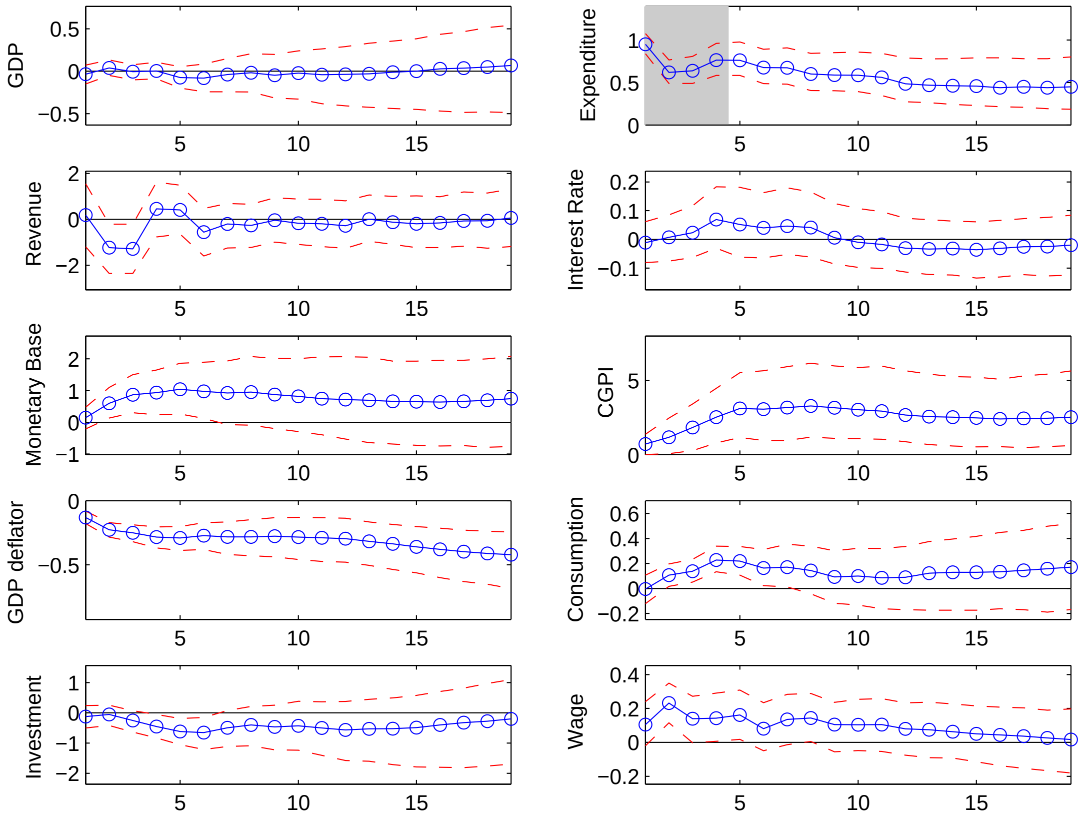

Figure 4: Impulse responses to the government spending shock

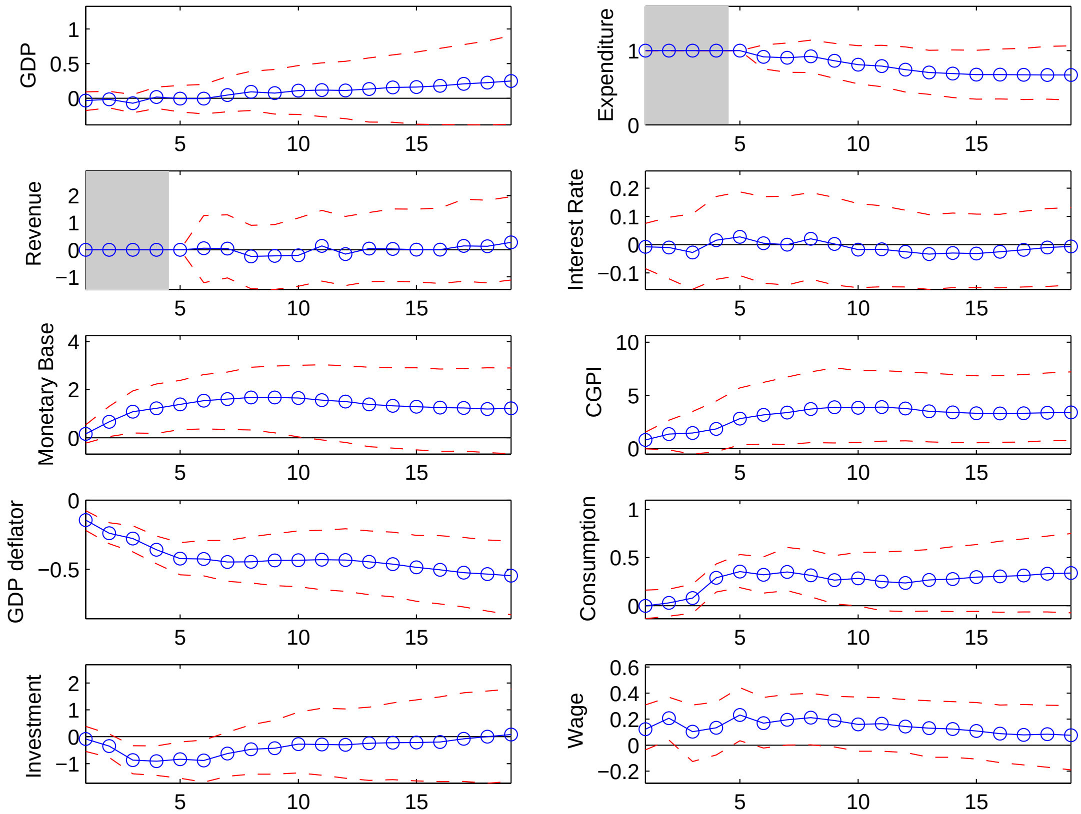

Figure 5: Dynamic effects of the deficit-spending policy

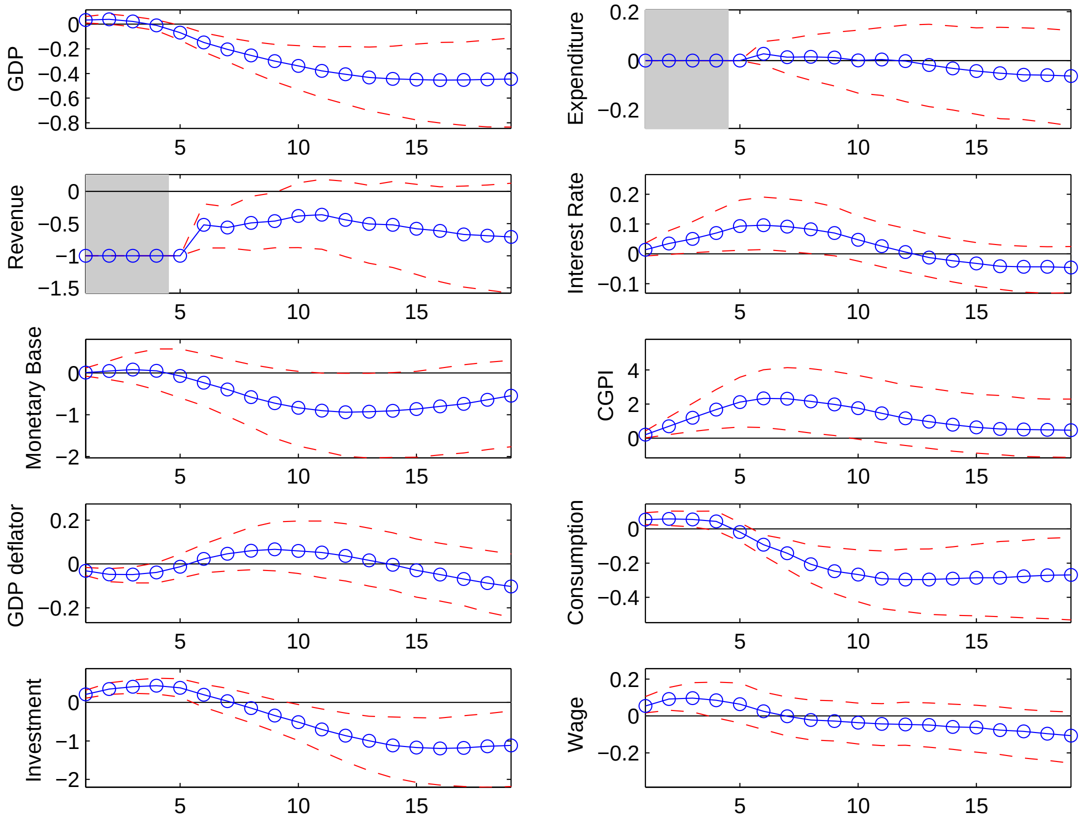

Figure 6: Dynamic effects of the deficit-financed tax-cut policy

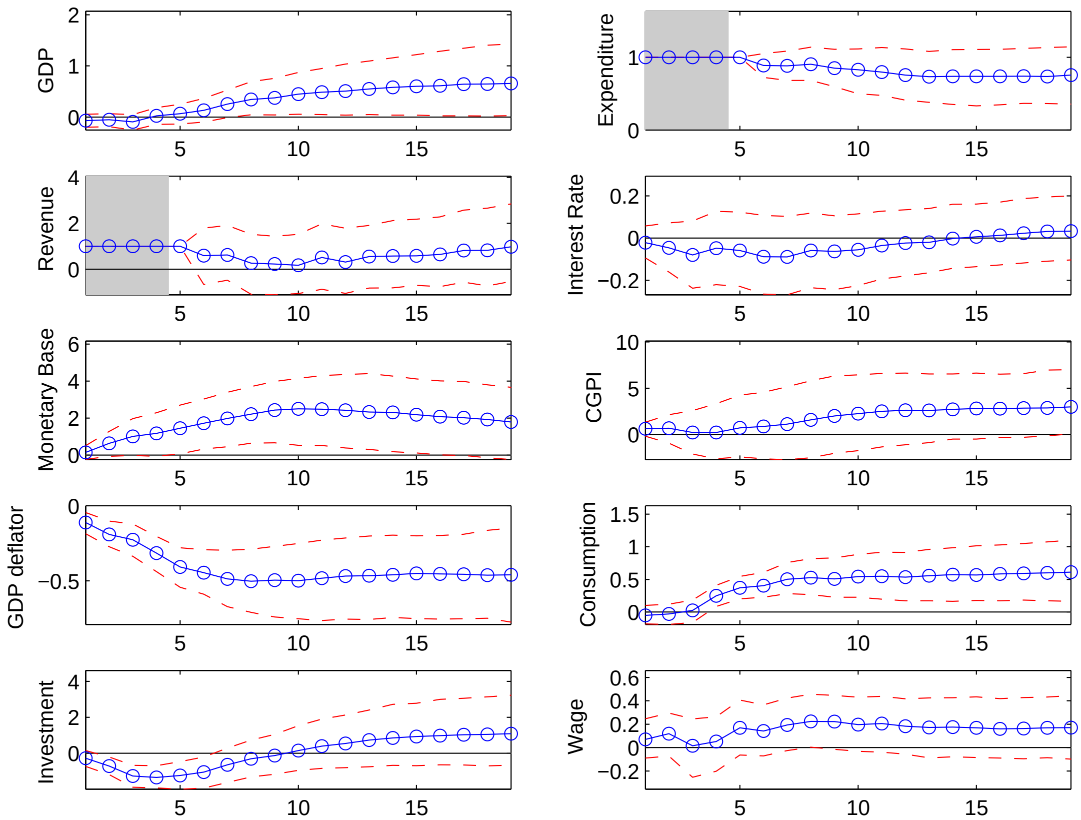

Figure 7: Dynamic effects of the balanced-budget policy

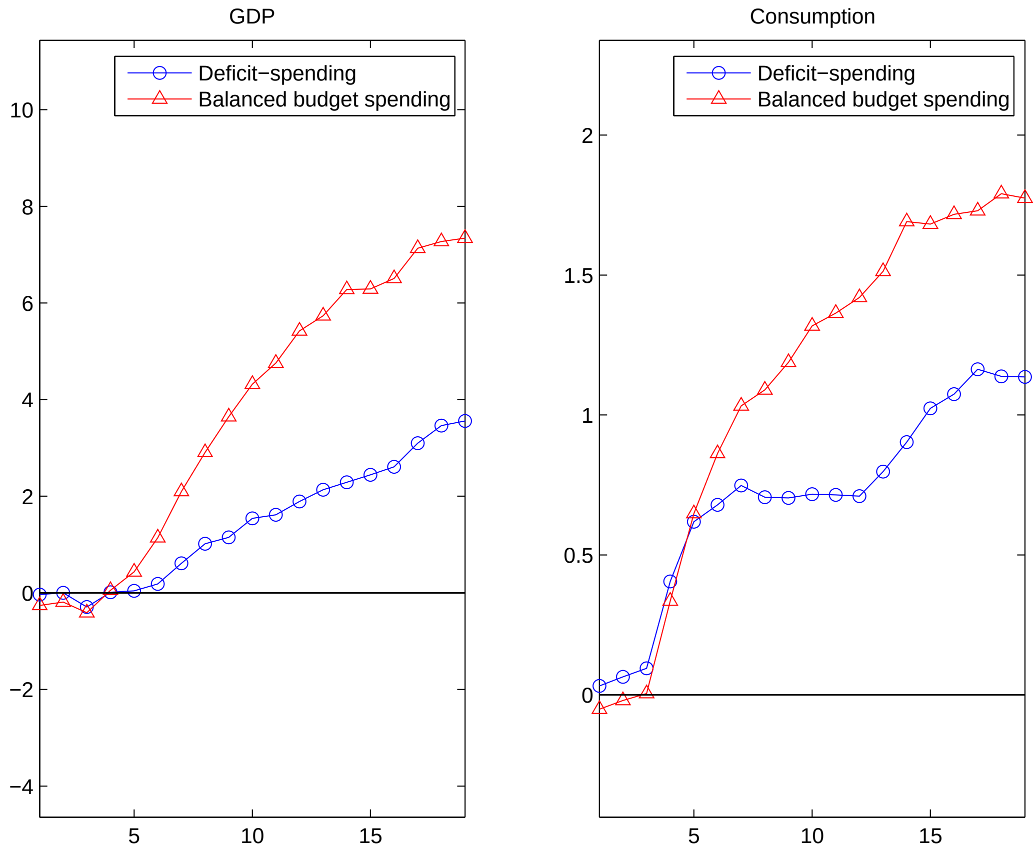

Figure 8: Present value multipliers of the deficit and balanced-budget spending policies