Economic Modelling 29 (2012) 1774–1779

Contents lists available at SciVerse ScienceDirect

Economic Modelling

journal homepage: www.elsevier.com/locate/ecmod

Oil income shocks and economic growth in Iran

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ARTICLE INFO

Article history:
Accepted 25 May 2012

Keywords:
Oil shocks
Output growth
SVAR

ABSTRACT

The aim of this paper is to study the relationship between oil revenue shocks and output growth in Iran by Adopting an SVAR model over the period 1959–2008. The results indicate that positive and negative oil revenue shocks significantly affect output growth positively and negatively respectively and these effects are asymmetric. While negative oil revenue shocks adversely affect the economic growth, the resource curse impedes the expected positive effects of positive oil shocks. In order to overcome the harmful effects of oil booms and busts, the establishment of oil stabilization and saving funds, diversifying economy, delinking government expenditure from oil revenues and introducing fiscal rules into the budget seems crucial for Iran economy.

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1. Introduction

Oil revenue in some developing oil exporting countries such as Iran, is the main source of financing physical and social infrastructures. This dependence on oil has caused oil shocks to be the main source of macroeconomic fluctuations which, in turn, have important effects on both macroeconomic policy and economic activities in most oil exporting countries. In such countries oil income accrues to the governments; it will have significant effects on the economic performance with regards to its impacts on government expenditure, money supply, inflation, real exchange rate and imports (Strum et al., 2009). Therefore, oil shocks have important effects on both monetary and fiscal policies, but the effects of such shocks on the output resulted from fiscal and monetary policies have not been given enough consideration in different studies. Most studies about the impacts of oil shocks on the economy have been carried out for oil importing countries. Hamilton (1983), considering a linear specification for oil shocks, concluded that during 1949–1973, oil shock has been an important factor in all recessions happened in the US. Burbridge and Harrison (1984) showed in their study that oil shocks have had significant negative effects on the industrial production of Canada, Germany, Japan, UK and the United States. Following these studies, other researchers assessed the effects of oil shocks on the economy (e.g., Balke et al., 1999; Cologni and Manera, 2008; Cunado and De Gracia, 2003; Davis and Haltiwanger, 2001; Hamilton, 1996, 2003; Hooker, 1996; Huang et al., 2005; Lardic and Mignon, 2006; Lee et al., 1995; Mork, 1989; Mork et al., 1994). Despite considerable attention to oil importing countries, oil exporters have not been sufficiently attended to by researchers; however recently few studies have been done for these countries. Eltony and Al-Awadi (2001), in their study for Kuwait, found that oil price shocks are major determinants in economic activities. Olomola and Adejumo (2006) showed that oil price shocks do not have any substantial effects on output and inflation, but they are significant determinants of real exchange rate and money supply in Nigeria. Berument and Ceylan (2007), in their study using a structural vector autoregressive model, examined the effects of oil price shocks on the economies of some selected MENA countries. The results indicated that the effect of a positive oil price shock on the output of most oil producing countries is positive and significant, but for some of them there are no significant effects. Mehara (2008), in his study about oil exporting countries, found that oil revenue shocks tend to affect the output in asymmetric ways. While oil booms or positive oil shocks have a limited role in the economic growth, negative shocks decrease it significantly. Farzanega and Markwardt (2009), in their study on the Iranian economy, indicated that oil price fluctuations have significant effects on industrial production, inflation and effective exchange rate and the effects of oil price shocks on output are asymmetric. Mehrara (2009), in his study regarding some oil exporting countries, examined the relationship between the oil revenue and the output growth. His results suggested the existence of a threshold beyond which the oil revenue growth imposed a negative effect on the output. The assessed threshold for oil exporting countries was around 18-19% above which the oil revenue growth rate significantly slowed the economic growth. Iwayemi and Fowowe (2011) showed that oil price shocks do not have a major impact on most macroeconomic variables in Nigeria. Their results indicated that different measures of linear and positive oil shocks do not cause output, government expenditure, inflation, and the real exchange rate. The tests support the existence of

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doi:10.1016/j.econmod.2012.05.035

asymmetric effects of oil price shocks because negative oil shocks can cause significant output and the real exchange rate. Cologni and Manera (2011) studied the effects of oil shocks and the expansionary fiscal policy on the business cycle of some major oil exporting countries using the Real Business Cycle (RBC) model. Results revealed that the expansion of government size can explain a considerable part of the negative effects of oil revenue shocks on the private sector. However, since the public sector growth is more than the private sector reduction, an increase in oil revenues will boost the total output. Nevertheless, the transmission mechanism of oil shocks in such countries has been less in focus of different studies.

The aim of this study is to assess the impact of oil revenue shocks on the output by considering several channels through which the oil revenue shocks affect the economy of an oil exporting country. For this purpose, the effects of structural shocks on the output have been assessed using a Structural Vector Auto Regressive (SVAR) Model and impulse response functions.

This paper has been structured as follows: Section 2 discusses some theoretical background, Section 3 presents the data and methodology, Section 4 provides some empirical results and, finally, Section 5 concludes the whole work.

2. Theoretical background

Several studies have documented various transmission channels through which oil price shocks affect economic activities in developed oil importing countries. Brown and Yucel (2002) have surveyed theory and evidence linking fluctuations in energy prices to those in aggregate economic activities. But, regarding oil exporting countries, there are few such studies. Oil revenue shocks can affect macroeconomy of developing oil exporting countries from different aspects. An oil boom, for oil exporting countries, stimulates economic activities from both the supply and the demand sides. The first Impact originates from governments use of petro dollars for financing their expenditure; therefore, with increasing oil revenues, fiscal policy will be expansionary. In these circumstances, if public expenditure is considered as an input to private production, then government spending on public goods and infrastructure can stimulate investment and output (Barro and Sala-i-Martin, 1992). On the other hand, Dar and Amirkhalkhali (2002) have mentioned another way that government expenditure influences investment. According to them, government expenditure has the effects of diminishing returns; and, over-expanding by crowding out of private investment will decrease economic growth. Moreover, inefficiency, distortion in allocation of resources and corruption are other channels that have negative effects on output. On the other hand, when oil revenues fall, with limitations on the access to capital and intermediary imports, economy will suffer from under-capacity, particularly in the presence of capital market imperfections (Haussmann and Ribogon, 2003).

Second transmission channel through which oil revenue shocks affect output is money supply. With increasing oil revenues and government expenditure, petro dollars have to be exchanged for local currency; therefore, the central bank should sell them at the domestic exchange rate market; selling all of them will cause depreciation of foreign exchange rate and the price of imported goods will be cheaper for domestic consumers and import will increase causing bankruptcy of domestic firms—hence an increase in unemployment. To prevent this phenomenon, some of these petro dollars will not be sold in the domestic exchange rate market. This way, the central bank increases its foreign reserve and money base the overall outcome of which is an increase in the money supply. According to the transmission mechanism of the monetary policy, an increase in money supply will lead to an increase in output via asset price and credit channels. For example, by increasing bank reserves and deposits, the expansionary monetary policy will increase loans paid to firms which will cause investment and output to rise. Surveys of the credit view can be found in Bernanke and Gertler (1995). On the contrary, with oil revenue bust, expansion in money supply will be lower[1] and contraction in money supply decreases the output deeply.

Another transmission channel of oil shocks is the Dutch disease which is a combination of two effects. The first is the appreciation of real exchange rate caused by the rise in oil export and the second is the draw of resources such as labor and capital from industry and agriculture sectors which, by rising production costs, will lead to a decline in the output and export of these sectors (Auty and Gelb (1986), Benjamin et al. (1989)). Therefore, rise of production costs, increase in imports (which is an outcome of the appreciation of real exchange rate) and inflation caused by aggregate demand pressures due to the implementation of expansionary fiscal and monetary policies, will decrease domestic production and economic growth.

Aside from Dutch disease, on the basis of several empirical studies, economic growth in some resource abundant countries tends to be slower than that in countries without natural resources (Auty, 2001; Gelb, 1988; Sachs and Warner, 1995, 1999). This phenomenon is known as the "resource curse". Strum et al. (2009) point out to four main explanations of the resource curse. The first is the Dutch disease mentioned above and the second is reduced incentive to develop non resource sectors; resource abundance may reduce the incentives to use accumulated skills and human resources (Auty, 2001). The third is high volatility of resource revenues with which (as an example of resource abundance economies) public sector and external balance will face higher volatility which increases uncertainty and reduces investment and, with impeded implementation of a balance fiscal policy, retards economic growth. The forth explanation is political economy effects; rents related to natural resources can be a source of conflict, political instability, corruption, weak institution (Boschini et al., 2007) and inequality. The overall outcome of these phenomena has affected GDP growth of oil exporting countries and it has been below the expected levels compared to emerging market economies.

3. Data and Methodology

In this section, the objective is to examine the dynamic relationship between output, government expenditure, liquidity and oil revenue shocks in Iran using the annual data over the period 1959–2008. To assess the relationship between the series, we adopt the K variable SVAR and start with VAR Model as follows:

$$y_t = A_0 + A_1 y_{t-1} + \ldots + A_p y_{t-p} + u_t \tag{1}$$

Where $y_t = (y_{1t}, \ldots, y_{Kt})'$ is a $(K\times1)$vector of endogenous variables, $A_0$is a $(K\times1)$ vector of intercepts, $A_i(i=1,\ldots,p)$ are $(K\times K)$ coefficient matrices and $u_t$is a $(K\times1)$ white noise error vector with zero mean and non-singular covariance matrix $\sum_u$. To identify the structural innovations that induce the effects of structural shocks in the system variables y_t, we can write the following structural specification for Eq. (1):

$$Ay_t = A_0^* + A_1^* y_{t-1} + \ldots + A_p^* y_{t-p} + \varepsilon_t \tag{2}$$

where ε_t is a $(K\times1)$ vector of structural disturbances with zero mean and covariance matrix $\sum_\varepsilon$. Premultiplying system (2) by A^{-1} gives the reduced form of Eq. (1) where $A_j = A^{-1}A_j^*(j=1,\ldots,p)$and:

$$u_t = A^{-1}\varepsilon_t = B\varepsilon_t \tag{3}$$

[1] Because of rigidity in government expenditure when oil revenues fall, increase in government debt to central bank will increase monetary base and money supply, but in general, increase in money supply is lower than those of oil booms periods.

which relates the reduced form disturbances u_t to underlying structural shocksε_t. Variance-covariance matrix of the reduced form residuals can be retrieved by Eq. (3). Under the standard assumption that the structural shocks are not correlated and have unit variances we can have:

$$\sum_u BB' \tag{4}$$

The minimum number of restrictions required for unique specification of K^2elements of B is equal to$K(K-1)/2$.

Taking the data from the Central Bank of Iran data base, the endogenous variables used in this study are: first differences of natural logarithm of real gross domestic product (GDP), real Government expenditure (G), real liquidity (M2) (all based on constant local currency), first difference of logarithm of real exchange rate (R) calculated through multiplying the nominal exchange rate by the ratio of OECD consumer price index to Iran consumer price index, the proxy of positive oil revenue shock (posoil) and the proxy of negative oil revenue shock (negoil). To measure oil revenue shocks, use has been made of the definition of oil price shocks drawn from Mork (1989) that distinguishes between positive and negative log-differences of the relative oil price as follows:

$$\begin{aligned} \text{posoil} &= \max(0, \Delta \,\text{lnoil}r_t) \\ \text{negoil} &= -\min(0, \Delta \,\text{lnoil}r_t) \end{aligned}$$

Δ is a difference operator and lnoil$r$ is the natural logarithm of real oil revenues in constant local currency.

To derive the set of identifications, use can be made of the economic theory which imposes a set of over-identifying restrictions on the coefficients of matrix B in Eq. (3). Considering the existence of six endogenous variables, $y_t=$(dlogGDP, dlog$G$, dlogM2, dlog$R$, posoil, negoil)', we have six equations. The relationships considered among the reduced form disturbances and the structural shocks showing arrays of B as $b_{ij}$where i and j indicate rows and columns are as follows:

$$u^{\text{GDP}} = b_{11}\varepsilon^{\text{GDP}} + b_{12}\varepsilon^{\text{G}} + b_{13}\varepsilon^{\text{M2}} + b_{15}\varepsilon^{\text{posoil}} + b_{16}\varepsilon^{\text{negoil}} \tag{5}$$

$$u^{\text{G}} = b_{22}\varepsilon^{\text{G}} + b_{25}\varepsilon^{\text{posoil}} + b_{26}\varepsilon^{\text{negoil}} \tag{6}$$

$$u^{\text{M2}} = b_{31}\varepsilon^{\text{GDP}} + b_{32}\varepsilon^{\text{G}} + b_{33}\varepsilon^{\text{M2}} + b_{35}\varepsilon^{\text{posoil}} + b_{36}\varepsilon^{\text{negoil}} \tag{7}$$

$$u^{\text{R}} = b_{43}\varepsilon^{\text{M2}} + b_{44}\varepsilon^{\text{R}} + b_{45}\varepsilon^{\text{posoil}} + b_{46}\varepsilon^{\text{negoil}} \tag{8}$$

$$u^{\text{posoil}} = b_{55}\varepsilon^{\text{posoil}} \tag{9}$$

$$u^{\text{negoil}} = b_{66}\varepsilon^{\text{negoil}} \tag{10}$$

Eq. (5) indicates the economic growth; in an oil exporting economy, output shocks, government expenditure shocks, money shocks, and oil shocks have large effects on output; therefore, the restriction imposed on the coefficients of matrix B is $b_{14}=0$ which means that the real exchange rate is excluded from economic growth equation. Eq. (6) specifies government expenditure; in an oil exporting country such as Iran, oil revenue is the main source of financing government expenditure, so restrictions imposed on the coefficients of matrix B are $b_{21}=b_{23}=b_{24}=0$, i.e. exclusion of output, money and real exchange rate. Eq. (7) indicates demand for real money; here the main deriving variables are assumed to be output, government expenditure and oil shocks. These assumptions correspond to restriction $b_{34}=0$. Eq. (8) is the real exchange rate relationship; here, only money supply and oil shocks are assumed to affect the real exchange rate. This specification imposes restrictions $b_{41}=b_{42}=0$ on the coefficients of matrix B which means that output and government expenditure are excluded from the exchange rate equation. Eq. (9) is the positive oil shocks relation. None of the variables can affect positive oil revenue shocks; therefore, this specification imposes restrictions $b_{51}=b_{52}=b_{53}=b_{54}=b_{56}=0$ on matrix B. Finally, Eq. (10) is the negative oil shocks relation wherein, too, none of the variables can affect negative oil revenue shocks; thus, the restrictions imposed on matrix B are $b_{61}=b_{62}=b_{63}=b_{64}=b_{65}=0$. Positive and negative oil shocks specifications introduce them as exogenous variables.

By these restrictions, we may have an over-identified structural VAR with two degrees of freedom. Rewriting these restrictions in a matrix form we may have:

$$B = \begin{bmatrix} b_{11} & b_{12} & b_{13} & 0 & b_{15} & b_{16} \\ 0 & b_{21} & 0 & 0 & b_{25} & b_{26} \\ b_{31} & b_{32} & b_{33} & 0 & b_{35} & b_{36} \\ 0 & 0 & b_{43} & b_{44} & b_{45} & b_{46} \\ 0 & 0 & 0 & 0 & b_{55} & 0 \\ 0 & 0 & 0 & 0 & 0 & b_{66} \end{bmatrix}$$

To analyze the relationships between variables with the SVAR model, we will test over-identifying restrictions using Log-Likelihood statics, and then, by estimating matrix B, the coefficients of structural shocks will be recovered and their impacts on the system will be investigated through impulse responses.

4. Empirical results

As a first step of the empirical analysis, we carried out unit root tests for all of the variables and to avoid spurious regression problem, we utilized Augmented Dickey Fuller (ADF) and Philips and Perron (PP) tests. The results of unit root tests are presented in Table 1. Based on the obtained results, the first difference of logarithms of all the variables are integrated of order zero or I(0); therefore, all the variables considered here are stationary.

In the second step, the lag length criteria were employed to select optimal lag order of a VAR model. This order was selected according to Akaike Information Criterion, Final Prediction Error and Hannan–Quinn Criterion. Assuming a maximum lag order of 4, the lag length suggested was 2 for which the diagnostic tests were conducted. Table 2 shows autocorrelation, normality and ARCH effects tests in the VAR residuals. Portmanteau test, which is preferable for large lag lengths, does not show autocorrelation, but Breusch–Godfrey LM test which is useful for low order residuals shows some sign of residual autocorrelation; however, at the 90% there is no autocorrelation. It is worth mentioning that Jarque–Bera and ARCH tests do not show non-normality and ARCH effects respectively. Stability analysis for VAR (2) model reveals that CUSUM and CUSUM of squares are well inside the uncritical region and Chow test with 1.17 test static (p-value $=0.32$) shows stability of parameters.

Table 1
Unit root test results.

Variables	ADF		PP	
	Intercept	Intercept and trend	Intercept	Intercept and trend
dlogGDP	-3.82^{*}	-3.91^{**}	-3.82^{*}	-3.90^{**}
dlogG	-3.39^{**}	-3.84^{**}	-4.07^{*}	-4.36^{*}
dlogM2	-3.43^{**}	-3.71^{**}	-3.56^{**}	-3.92^{**}
dlogR	-4.07^{*}	-4.11^{**}	-4.11^{*}	-4.11^{**}
posoil	-6.47^{*}	-6.48^{*}	-6.48^{*}	-6.49^{*}
negoil	-6.42^{*}	-6.45^{*}	-6.52^{*}	-6.51^{*}

*, ** indicate significance at 1% and 5% levels respectively.

Table 2
Diagnostic tests for VAR (2).

Test	Q_{16}	FLM_2	JB	$MARCH_{LM(5)}$
	449.94 (0.95)	1.40 (0.06)	17.53 (0.13)	908.3 (0.26)

Note: p-values in parentheses.

The resulting structural parameter estimates of matrix B are given by the following Matrix. Likelihood Ratio test for over-identifying restrictions do not reject our identifying restrictions at conventional significance levels.

$$B=\begin{bmatrix} 0.0032 & 0.0275^{*} & 0.0379^{*} & 0 & 0.0138^{**} & -0.0255^{**} \\ (0.023) & (0.006) & (0.0044) & - & (0.007) & (0.0073) \\ 0 & 0.0579^{*} & 0 & 0 & 0.0485^{*} & -0.0235^{**} \\ - & (0.006) & - & - & (0.0098) & (0.0088) \\ 0.0718 & 0.0212^{***} & 0.0077 & 0 & 0.0244^{***} & -0.0154 \\ (0.087) & (0.0108) & (0.044) & - & (0.0113) & (0.0111) \\ 0 & 0 & -0.0244^{***} & 0.0999^{*} & -0.0208 & 0.0245^{***} \\ - & - & (0.0148) & (0.0103) & (0.0152) & (0.0152) \\ 0 & 0 & 0 & 0 & 0.1091^{*} & 0 \\ - & - & - & - & (0.0113) & - \\ 0 & 0 & 0 & 0 & 0 & 0.0994^{*} \\ - & - & - & - & - & (0.0102) \end{bmatrix}$$

Note: Likelihood Ratio test for over-identification is $\chi^2(2)=5.1227$[p-value$=0.0722$]. Values in parentheses are standard errors of parameter estimates. *, **, *** denote significance of the coefficients at the 1%, 5% and 10% levels respectively.

The first row of matrix B indicates the economic growth relation. According to our estimate such shocks as output, government expenditure, money and positive oil shocks have positive effects on the economic growth; however, the output shock is not significant and negative oil shock decreases the economic growth significantly. Moreover, coefficient of negative oil revenue shock is greater than that of the positive oil shock coefficient which means asymmetric effects of oil revenue shocks on output.[2] According to the estimated coefficients of the government expenditure relation, positive oil shocks and government expenditure shocks have increasing effects on government expenditure, but negative oil shocks have significant negative effects. The estimated effects of structural shocks on money demand are given in the third row of matrix B. The estimated coefficient of the output shock in money demand is positive, but statistically insignificant. Other parameters in the money demand relation have the expected sign. Government expenditure shocks, money shocks and positive oil shocks have positive effects on money demand, but the effects of negative oil shocks are negative; however, the coefficients for money shock and negative oil shocks are not significant. The forth row of matrix B represents the real exchange rate relation. Our results indicate that the real exchange rate shock and negative oil shocks have positive effects on the real exchange rate, but the effects of money shocks and positive oil shocks on the real exchange rate are negative and all the coefficients except positive oil shocks are statistically significant. Decreasing effect of positive oil shock on the real exchange rate is a sign of Dutch disease. In the last two rows of the above matrix, estimated coefficients of oil shocks indicate that positive oil shocks and negative oil shocks have positive effects on both positive oil shocks and negative oil shocks respectively.

[2] Likelihood Ratio to test the hypothesis related to the comparisons of the oil shocks in output equation is $\chi^2(1)=203.8$(p-value$=0.0$) that means equality of oil shock coefficients is rejected at conventional significance levels and therefore oil shocks asymmetrically affect output growth.

We will now illustrate the dynamics of adjustment by the impulse responses. Fig. 1 gives the responses of output, government expenditure, money supply and real exchange rate to positive oil revenue shock. According to our estimate, a positive oil shock increases output with maximum response after three years, and gradually drives down; however, this effect is significant only for three years. A positive oil shock leads to an increase in government expenditure and money supply but these effects are significant about five years for government expenditure and seven years for money supply. A positive oil shock has a significant negative impact on real exchange rate for about two years after the shock has occurred. This result conforms to the positive oil shock coefficient estimated and is a sign of Dutch disease.

Fig. 2 shows the responses of output, government expenditure, money supply and real exchange rate to a negative oil revenue shock. A negative oil shock leads to a drop in output; however, this effect is not significant. The point estimates suggest that a negative oil revenue shock drives government expenditure, money supply and real exchange rate down. These effects for money supply and real exchange rate are significant only for one year. Overall, the results seem compatible with the theoretical background presented in previous sections.

5. Conclusions

The aim of this research was to study how output growth, government expenditure, money supply and real exchange rate respond to oil revenue shocks in Iran. By employing the SVAR Procedure and imposing over-identified restrictions, the coefficients of structural shocks were estimated. The results indicated that the impact of a positive oil revenue shock on output growth is positive while a negative one decreases output, and the effects of negative oil shock are greater than positive shocks. While positive oil shocks have limited impacts on stimulating output growth, negative ones deeply affect output growth. One possible explanation for these different effects is the resource curse. By increasing oil revenues, Dutch disease and volatility in public balances as our finding indicated, retard output performance. Our results conform to those of Mehara (2008), Mehrara, (2009) for some oil exporting countries; they also suggest that government expenditure and money supply have positive effects on output growth. Among factors affecting the economic growth, positive oil shocks have the least effect on output which confirms the resource curse hypothesis mentioned above. The impact of positive oil shocks on government expenditure and money supply is positive, but the effects of negative ones on both of them are negative. These results suggest that government expenditure and money supply -hence fiscal and monetary policies have high dependence on oil revenue shocks that are determined extremely exogenous, therefore these policies are passive in Iran's economy to a very great extent. In addition, positive oil shocks are the most important determinants of the real exchange rate; this agrees with Farzanega and Markwardt (2009) results.

In some oil exporting countries, oil revenues without a stabilizing mechanism to cushion oil shocks, would expose the economy to booms and busts during oil revenues. In fact some oil exporting countries suffer from a weak and undiversified economy with a high dependency to oil revenues originated from abroad, and impose challenges such as volatility, uncertainty and exhaustibility. These challenges tend to be greater with a larger share of oil revenues in the government's budget. In order to minimize the harmful impacts of oil booms and busts, policy makers can practice institutional responses including the establishment of oil stabilization and saving funds. Other remedies are: diversifying the domestic economy, delinking government expenditure from oil revenues and introducing fiscal rules into the budget balance.

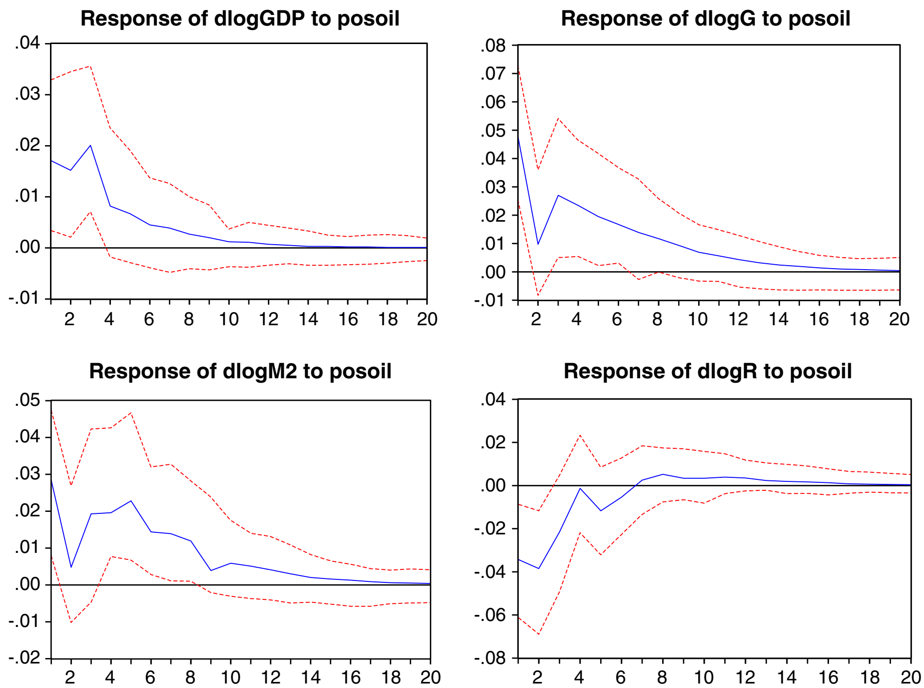

Fig. 1. responses to positive oil shocks with 95% confidence intervals based on 100 replication of the Hall bootstrap.

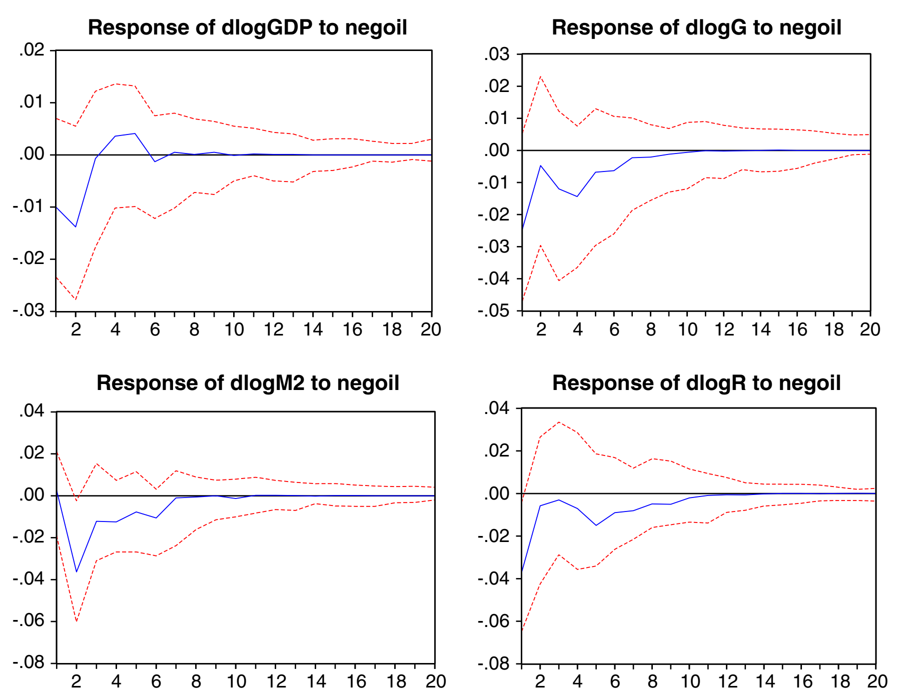

Fig. 2. responses to negative oil shocks with 95% confidence intervals based on 100 replication of the Hall bootstrap.

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