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Macroeconomic impacts of oil price shocks on inflation and real exchange rate: Evidence from selected MENA countries

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Abstract

In this paper, we attempt to analyze, during the period spanning from January 2000 to July 2015, the impact of oil price shocks on inflationand the real exchange rate in a set of oil importers and exporters MENA countries: Tunisia, Morocco, Algeria, Bahrain, Saudi Arabia and Iran (MENA-6) using a Structural VAR model. The impulseresponse functions reveal that, in the long run, oil price fluctuations havethe major impact on real exchange rate of the oil-importing countries (Tunisiaand Morocco) while the impact on inflation is smaller and absorbed by the rigidity of subsidized products prices. The variance decomposition results also assertthat oil price shocks do not explain notably thevariation in the twoconsidered variables in Algeria and Iran.We further identify an impact on the two variables that is both statistically significant and economically large in the rest of countries.

Keywords: Oil Shocks; Macro economic variables; MENA region

JEL Classification: E31, F41, G10

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1. **Introduction**

Over the past two decades, oil markets suffered from spectacular oil price swings. Prices fluctuations of such vital energy source, depends much more than any other commodity on the supply changes over time (shortage or oversupply). The structural changes of oil supply and demand, due to diverse economic and political factors, is argued to exacerbate volatility and raise the likelihood of oil-price shocks. From the early 1970s to the early 1980s, the price of oil rose dramatically associated with disruptions in the supply of oil from the Middle East countries. Until the mid-1970s, the crude oil price was more or less in a steady fluctuating around $3.00 bbd (barrels-per-day). With the Iranian crisis in 1979, a main disruption in oil supplies started. This led to a spectacular rising in oil price to stand at the pick level of 106.36$ (inflation adjusted) per barrel in 1980. The year 1981 was the start date of the oil price drop and continued for long period. This continuous decrease can be attributed to several factors such as the decline of oil demand due to the economic slowdown that occurred in most industrialized nations coupled with the adoption of more energy-efficient operation by large number of firms. All these factors have contributed to a considerable demand decline forcing the market to lower the price. Furthermore, during the same period the supply of oil raised as new and important oil fields such as North Sea in Europe was discovered. The combination of the demand decline and supply rise, reduced significantly the world oil price to reach $17.10 per barrel (inflation adjusted) in 1998.

In 1999, the oil-price started a new wave of increasing, which peaked in the second trimester of 2008. It reached $99.07 per barrel (inflation adjusted). This spectacular increase was due firstly to the growing use of modern transportation modes such as automobiles in emerging economies which increases the oil demand. Secondly, the galloping industrialization process that have occurred in emerging and developing countries put upward pressure on oil demand. Thirdly, in developing countries the primary economic sector, agriculture including farming and irrigation, has become more mechanized and demand much more oil as source of energy. These are some of main causes that have contributed to the rise of petroleum price recently. For the last decade, the price fluctuation was around $100 per barrel, which is considerably higher than the normal price level around $20 per barrel until the late 1990s. Since 2002, oil prices have risen exponentially causing considerable volatilities in international markets (Conget al., 2008). These changes in oil prices directly affect transportation costs, heating bills, and the prices of goods made with petroleum products. Oil price spikes induce greater uncertainty about the future, which may lead to firms and households delaying purchases and investments.

Changes further lead to reallocations of labor and capital between energy intensive sectors of the economy and those that are not energy-intensive (Sill, 2007). It is recognized that the oil price fluctuation has a considerable impact in the stability of major macroeconomic variables of different countries oil-exporters and -importers.

The importance of oil, as a main source of energy for the overall economy has attracted the attention of several researchers in economics energy literature. Several studies have focused on the oil price impacts on macroeconomic performance. Nevertheless, results remain inconclusive as argued by Chang and Wong (2003).Since the first main oil shock in 1973, many studies have focused on the empirical association between oil prices and macroeconomic fundamentals. Hamilton (2011) argued that 10 out of 11 post World War II downturns have followed or were accompanied by an acute raise in crude oil prices. In this respect, the uncertainty and large volatility of oil price have boosted an active line of research into the liaison between oil price and macroeconomic variables.

At this stage, many questions that we attempt to reply in this paper, can be asked: what are the oil price shocks effects on economy of a country? Are the responses to these oil price shocks differ from a country to another? How can we pin down the link between oil prices and the macroeconomic performance indicators? Are oil prices hikes and drops have the same effects on economic development?

Dogrul and Soytas (2010) argued that raises in oil prices may lead to an increase of the production costs in various sectors; this might have adverse effects on productivity, competitiveness unemployment, and inflation particularly if the economy is dependent on importing materials and intermediate products. Oil-price increases, thus, may lead to significant slowdowns in economic growth. In this regard, a common agreement in the literature is that a sharp increases in oil price have a larger negative impact on economic development than positive effects of oil prices falls (See for more details, Davis and Haltiwanger, 2001; Hamilton, 2003; Hooker, 1996, 2002; Jones and Leiby, 1996). A number of researches provide important insights about the main cause of such asymmetry. Hamilton (1988) demonstrates that adjustment costs to varying oil prices could be the origin of this asymmetry. Bohi (1990, 1991), Bernanke and al. (1983) demonstrate that monetary policy is an additional channel of this asymmetry.

Using nonlinear dynamic relations, Balke et al. (2002), proves that monetary policy and adjustment cost could account too for the asymmetry. Though asymmetry is at present quite well accepted, recently only some studies have raised some concerns with regard to the

robustness of the conclusion. Herrera et al. (2011) illustrate that larger asymmetric effect acts at the disaggregate level than at the aggregate scale. Moreover, the nonlinearity impact is stronger for samples beginning before 1973, than samples after 1973. Using data for 1973Q2-2007Q4, Kilian and Vigfusson (2011), as well, illustrate no evidence against the null of symmetric responses to oil price shocks for the real GDP. More specifically, some studies have examined the macroeconomic instability origins in purely oil-exporting countries context. They found that oil price shocks are the main cause of output fluctuations (see Mehrara and Oskoui, 2007; El Anshasy and Bradley, 2012). On the contrary, Iwayemi and Fowowe (2011) illustrate that the impact of oil price shocks on Nigerian (a purely oil-exporting country) macroeconomic variables is low.

Most studies mentioned above are either based on OCDE data and ASEAN industrialized nations or oil-exporting nations. There isn't similar studies concerning MENA nations with both exporters and importers countries. One of the studies linked to ASEAN nations is by Chang and Wong (2003). They find a negative impact of oil price shocks on Singapore's macroeconomic performance. Rafiq et al. (2009) examined the impact of oil price volatility on key macroeconomic variables in Thailand. The empirical findings suggest that, in most of the cases, oil price volatility has an impact in the short run only and most notably on investment and the unemployment rate. Another study is by Ahmed and Wadud (2011) for Malaysia. Their findings suggest an asymmetric effect of oil price shocks on Malaysian industrial production and inflation. Their variance decomposition analysis reconfirms that volatility of oil price is the second most important factor to explain the variance of industrial production after its own shocks. This finding is consistent with Mehrara (2008), who report a nonlinear and asymmetric relationship between oil prices and economic growth of oil-exporting countries.

The principal aim of the current paper is to study the impact of oil price movements on the inflation and real exchange rate in a selected set of MENA countries. Thus, the main contribution of this paper is the following: First, we attempt to investigate the linkages between oil prices movements (shocks) and the overall macroeconomic performance using monthly data of six oil-importers and exporters in MENA countries (Tunisia, Morocco, Saudi Arabia, Iran, Algeria, and Bahrain) between 2000M1 and 2015M7. This period included the most recent increase in the oil price occurred since 2014M9.Second, as another contribution to the current literature, we employ the SVAR technique in order to investigate the origins of asymmetry between hikes and drops of oil prices in the selected sample of countries. Given the challenges

that MENA countries face, the empirical results of this study could be timely and helpful for policymakers.

The remaining part of the paper is organized as follows. In Section 2, we provide a detailed description of the data and methodology used to investigate the macroeconomic impacts of oil price shocks on inflation and real exchange rate in each of the considered country. Section 3 presents the empirical analysis and the main results. Some concluding remarks and policy implications are provided in Section 4.

2. Data and Methodology

2.1. Data

In this study we use monthly series data for six oil importers and exporters in MENA countries over the period of 2000M1 and 2015M7. This period includes the most recent increase in oil price since 2014M9. The data series included oil price (oilp) measured by the spot market price of West Texas Intermediate (WTI) crude oil, which is considered as the benchmark for world oil prices, world oil production (Qp), and macroeconomics variables that are inflation (CPI) and the real exchange rate. All series data are collected from the International Financial Statistics (IFS) and the Energy information administration (EIA) and expressed in natural logarithm form.

Methodology

In our analysis, a Structural VAR (SVAR) model is used to examine the impact of oil price shocks on real exchange rate and inflation. Following the studies of Baumeister and Peersman (2013), we consider the SVAR model:

$$A_0 X_t = A_1 X_{t-1} + A_2 X_{t-2} + \cdots + A_q X_{t-q} + \epsilon_t \quad (1)$$

where$X_t = (\Delta oilp, \Delta proil, \Delta rEx, CPI)$ an $(n * 1)$ vector including oil price, oil production, real exchange rate and inflation. $A_i$is the $(4 * 4)$ matrix of coefficients for $i = 0, 1, \dots, q$ and $\epsilon = (\varepsilon_t^{oilp}, \varepsilon_t^{proil}, \varepsilon_t^{rEx}, \varepsilon_t^{CPI})$ represent the vector of structural disturbances. The reduced form of equation 1 is:

$$X_t = B(L)X_t + \mu_t \quad (2)$$

Where $B(L) = A_0^{-1}A_1(L)$ and $A_1(L)$ is a matrix of polynomial in the lag operator.

In order to proceed with identification of oil price shock we impose the short-run restrictions on the endogenous variables included in SVAR.

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ b_{21} & 1 & 0 & 0 \\ b_{31} & b_{32} & 1 & 0 \\ b_{41} & b_{42} & b_{43} & 1 \end{bmatrix} \begin{bmatrix} \mu_{oilp} \\ \mu_{proil} \\ \mu_{rEx} \\ \mu_{CPI} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \epsilon_{oilp} \\ \epsilon_{proil} \\ \epsilon_{rEx} \\ \epsilon_{CPI} \end{bmatrix}$$

The oil price is assumed to be exogenous and the error term of international oil price will be equal to its structural error term. The reduced error term for oil price can be expressed as follows:

$$\mu_{oilp} = \varepsilon_{oilp} \quad (3)$$

For the real exchange rate and inflation, oil price fluctuation can have a contemporaneous effect on them because an increase (decrease) in oil price can raise (reduce) the cost of production and distribution of good and service. Thus, the reduced error term of the real exchange rate and inflation can be expressed as follows:

$$\mu_{rEX} = -b_{31}\mu_{oilp} - b_{32}\mu_{proil} + \varepsilon_{proil} \quad (4)$$

$$\mu_{CPI} = -b_{41}\mu_{oilp} - b_{42}\mu_{proil} - B_{43}\mu_{rEx} + \varepsilon_{CPI} \quad (5)$$

The equations (4) and (5) allows us to establish the impact of oil price variation on real exchange rate and inflation of the selected MENA countries.

3. Empirical Results

3.1. Unit root tests

The unit root test aims to verify the hypothesis of non-stationary of the data series. In this study two types of unit root tests are applied. Augmented Dickey-Fuller (ADF), Phillips-Perron (PP). The results are reported in Table 1 and shows that all variables are stationary in their first difference. The exception is the CPI of Morocco and Algeria which seem to be stationary at the level. After examination of the stationarity proprieties of the variables, we proceed with the presentation of the effect of oil supply shock and oil price shock in selected MENA countries for the monthly period 2000M1 to 2015M7.

Table 1: Unit root tests

	ADF		PP	
	Levels	First difference	Levels	First difference
Algeria				
CPI	-3.079	-10.237***	-3.446**	-13.536***
rEx	-2.298	-9.026***	-2.516	-11.109***
oilp	-2.231	-6.967***	-1.696	-10.135***
proil	-0.633	-11.463***	-1.631	-27.664***
Bahrain				
CPI	-0.948	-6.605***	-0.764	-9.895***
rEx	-0.922	-6.778***	-0.517	-9.338***
Iran				
CPI	-1.448	-6.456***	-1.225	-8.308***
rEx	-2.259	-9.661***	-2.209	-13.471***
Saudi Arabia				
CPI	-3.037	-6.440***	-3.795**	-10.094***
rEx	-0.574	-5.756***	-0.057	-9.963***
Morocco				
CPI	-4.932***	-12.834***	-4.277***	-11.479***
rEx	-2.956	-10.072***	-3.135	-14.825***
Tunisia				
CPI	-1.963	-9.005***	-1.699	-10.667***
rEx	-1.338	-8.863***	-1.040	-11.682***
Critical value				
1% level		-4.008		
5% level		-3.434		
10% level		-3.141		

Notes: ***, ** and * indicate significant at 1, 5and 10% level respectively.

3.2. Oil price shock

In order to examine the effect of oil price shocks on inflation and real exchange rate, we used the impulse response test. This test traces the effect of onetime shock to the oil price on the present and future path of the variables. The results of this test are reported in Figure 1 (a-d) and Figure 2 (e-f).

Figure 1(a-b) display the response of the Algerian and Bahrain inflation and real exchange rate,respectively to structural one standard deviation innovation in oil price. It observed that the immediate response of real exchange rate to a one time positive shock to oil price is negative. However, it begins to increase after the first month and become positive in the third month for Algeria and after the fifth month for Bahrain. This result indicates that an increase in the oil price appreciates the currency of an oil-exporting country because the demand for its currency increases in the foreign exchange rate (Hamilton, 1996; Cebula, 2000; Issa et al., 2008). As expected, the contemporaneous effect of a positive oil price shock on the Algerian inflation shows a statistically negative response for up to the first sixth months. After, this period, the

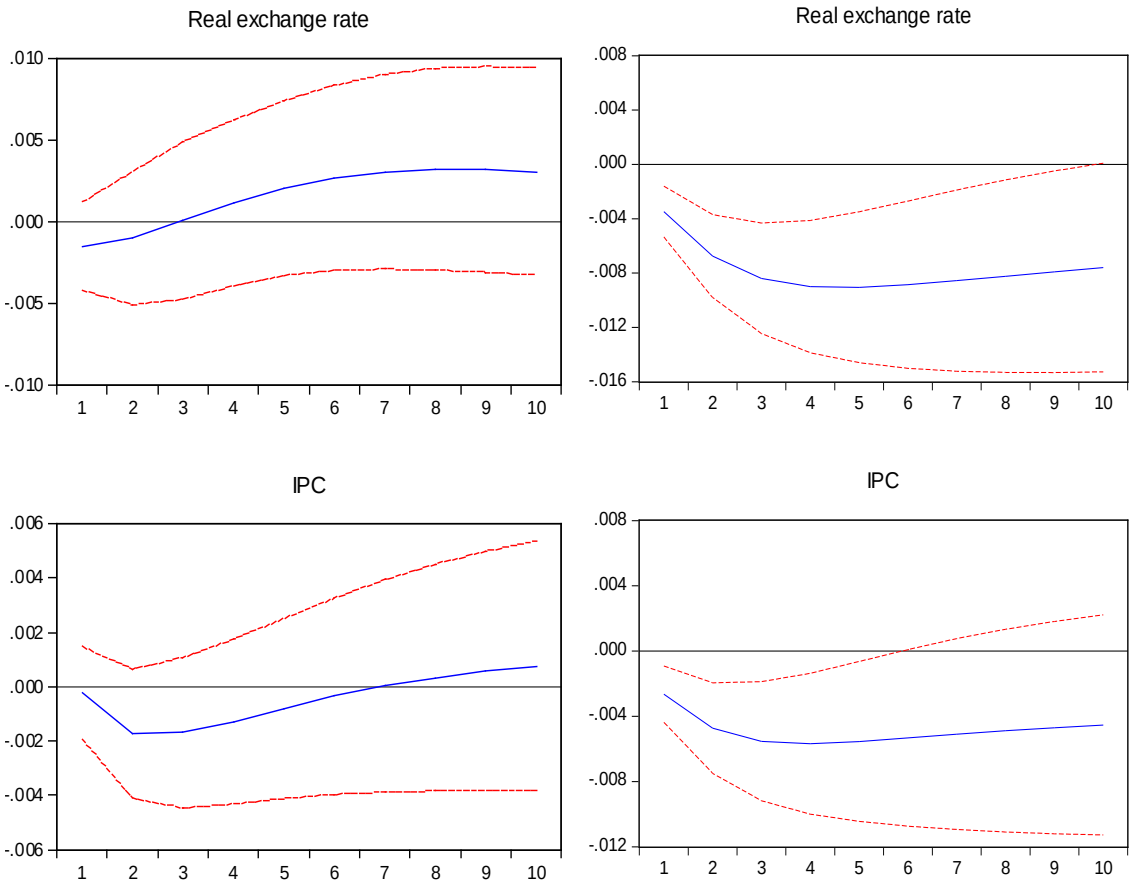
response of inflation becomes positive. For Bahrain, the reaction of inflation to the shock in oil price is positive.

The impulse responses of Iran and Saudi Arabia real exchange rate display a similar result (Figure 1c and 1d). It is observed that the immediate response of real exchange rate to a positive oil price shock is negative. In the long run the currency of both countries is stable. However, the reaction of Saudi Arabia inflation to the shock in oil price is positive after the first month. Unlike the case of Saudi Arabia, a positive shock oil price has a negative effect on the inflation of Iran for the first three months. After this period, it begins to raise slowly. This effect is statistically significant during the 10 months horizon. This finding is disagree with Farzanega and Markwardt (2009) who show an inflationary effect and an appreciation of the domestic currency.

The results of the impulse response test for Morocco and Tunisia two oil-importing countries are reported in Figure 2 (e-f). The Morocco and Tunisian real exchange rate shows a statistically negative response to positive shock of oil price. This results indicate that an increase in oil price depreciates the currency of Morocco and Tunisia as the supply of its domestic currency in the foreign exchange market increases (Amano and Norden, 1998).

As expected, a positive oil price shock increases the overall price level in the Morocco. The oil is the main sources for manufacturing production and for distribution of the goods and services. Therefore, an increase in the oil price can increase the cost of production and distribution. This eventually feeds into the price level and increase the inflation rate. It is fair to say that oil-importing countries are found to have an adverse impact of oil price shock. However, there is no significant impact of oil price shock to inflation in Tunisia.

a. c.



b. **d.**

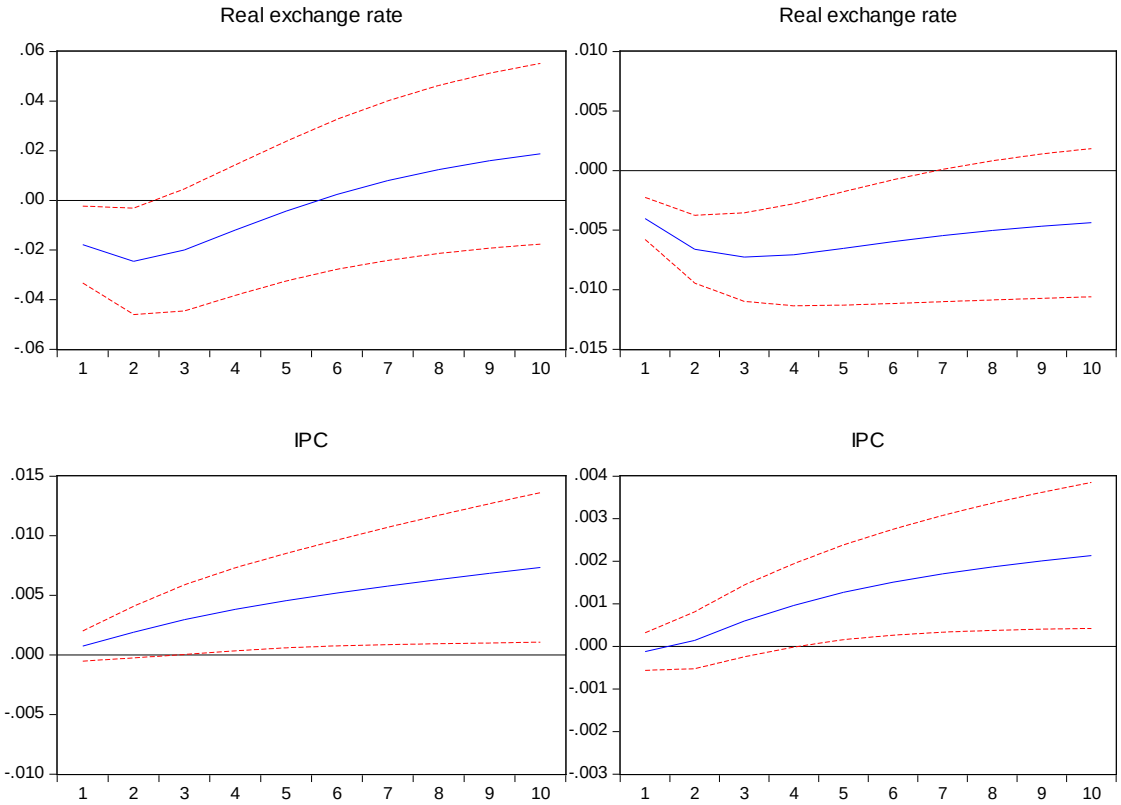


Figure 1.impulse response functions of (a) Algeria, (b) Bahrain,(c) Iran and (d) Saudi Arabia to an oil price shock

e. **f.**

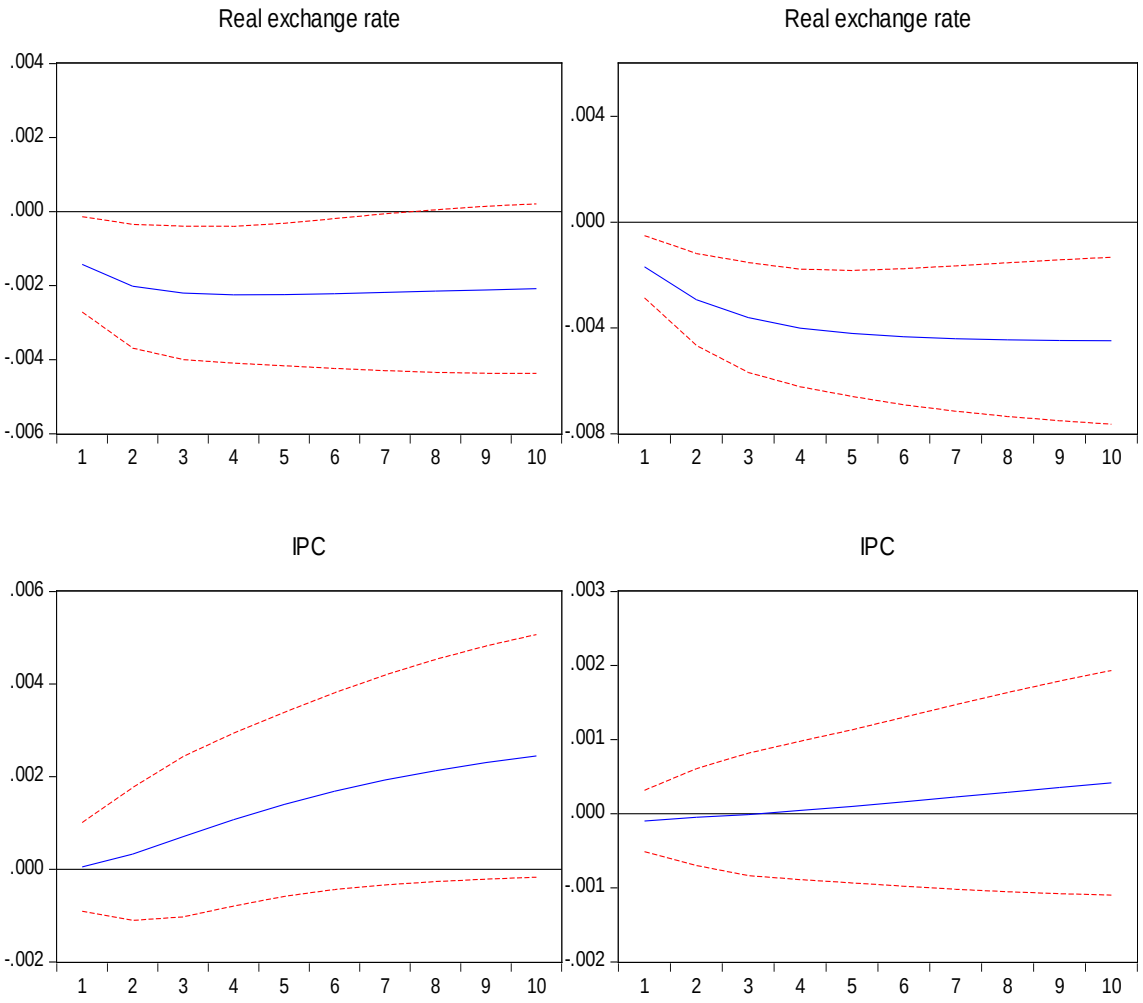


Figure 2.impulse response functions of (e) Morocco and (f) Tunisia to an oil price shock

3.3. Variance decomposition

The variation decompositions of real exchange rate and inflation in the selected MENA-6 countries due to oil price shock are reported in table 2. The results show that oil price shock explain the fluctuation of the real exchange rate in Algeria around 0.28 and 2.15% during the 10 months of the horizon. Also, the oil price innovation contributes very minimum in the forecast error variation in Algeria inflation (0.78 in the tenth months).

In the case of Bahrain, Iran and Saudi Arabia, the oil price shock explains approximately the same level of variation in inflation during the 10 months horizon. It contributes a significant fluctuation (9.72, 12.38 and 12.03% in the tenth months for the Bahrain, Iran and Saudi Arabia respectively) to the inflation. Also, 19.33% of variation in the real exchange rate in Bahrain is explained by oil price innovation. For the Saudi Arabiareal exchange rate, more than 17% of fluctuation in the fourth months and 14% in the tenth months is explained by oil price shock.

However, almost 3% of the variation in the real exchange rate in Iran is explained by oil price shock.

In the case of selected MENA oil importing countries (Morocco and Tunisia), oil price shock explains a significant portion of forecast errors variation in the real exchange rate. It accounts around 12 and 26% variation in the real exchange rate during the 10 months horizon for the Morocco and Tunisia respectively. However, for the Morocco there is no significant impact of oil price shock in the inflation fluctuation in the first four months. After this period, the impact becomes relatively significant and reached 6.12% in the tenth months. Like in Morocco, oil price shock does not exert a significant impact in inflation fluctuation in the first sixth months (it explains less than 1% of fluctuation in the inflation) in Tunisia. After, the sixth months, the oil price shock explain relatively a significant portion of forecast errors in the inflation.

The Variance decomposition results suggest that oil price shocks have a major impact on real exchange rate fluctuation for selected MENA oil exporting and importing countries (Bahrain, Saudi Arabia, Morocco and Tunisia),except Algeria and Iran when the oil price fluctuation do not have an important effect in the short and long run. However, the result indicates that oil price shock do not have a major significant impact on the inflation variation in the MENA-6 countries. This results due probably to the energy price regulation and government subsidization.

Table 2. Variance decomposition

countries	Period	Real exchange rate	Inflation (IPC)
Algeria	1	.6598	.0377
	2	.4188	1.155
	3	.2819	1.492
	4	.3087	1.45
	5	.509	1.278
	6	.8215	1.098
	7	1.188	.9561
	8	1.552	.8599
	9	1.882	.8047
	10	2.158	.7813
Bahrain	1	7.228	4.929
	2	12.44	7.779
	3	15.66	9.261
	4	17.55	9.941
	5	18.6	10.19
	6	19.15	10.21
	7	19.4	10.14
	8	19.48	10.02
	9	19.44	9.872
	10	19.34	9.723

Table 2 (continued)

Iran	1	2.827	.7447
	2	4.208	1.903
	3	4.225	3.182
	4	3.694	4.505
	5	3.149	5.83
	6	2.761	7.152
	7	2.579	8.469
	8	2.587	9.782
	9	2.749	11.09
	10	3.03	12.39
Saudi Arabia	1	10.66	.1618
	2	14.8	.1643
	3	16.6	1.127
	4	17.13	2.668
	5	16.97	4.479
	6	16.52	6.27
	7	15.94	7.958
	8	15.36	9.483
	9	14.79	10.84
	10	14.26	12.04
Morocco	1	2.616	.0061
	2	4.496	.1131
	3	5.972	.4004
	4	7.17	.8792
	5	8.189	1.528
	6	9.087	2.312
	7	9.902	3.194
	8	10.65	4.141
	9	11.36	5.127
	10	12.02	6.13
Tunisia	1	4.336	.122
	2	7.714	.0586
	3	11.03	.0363
	4	14.18	.0302
	5	16.95	.04
	6	19.37	.0691
	7	21.45	.1183
	8	23.25	.1886
	9	24.8	.2796
	10	26.15	.3907

4. Conclusion and policy implications

This paper investigates the impact of oil price shocks on real exchange rate and inflation of the MENA-6 by using the structural VAR. The result of impulsion response function shows that an oil price shock induce an appreciation in domestic currency for Algeria and Bahrain in the short-run and remain fairly stable in the long-run. However, the response of real exchange rate to oil price shock is negative and remain stable after the two months. Also, the results show that the oil price fluctuation reduce the domestic currency in Tunisia and Morocco immediately and the

effect remain stable in the long-run. However, Iran and Saudi Arabia display similar responses contemporaneously does not induce a major impact on the real exchange rate in the long-run. The real exchange rate remain fairly stable after sixth monthsThe Variance decomposition results reveal that oil price fluctuation explain a significant portion of forecast errors term of real exchange rate, with exception to the real exchange rate in Algeria and Iran. Nevertheless, the oil price shock does not explain any significant portion of inflation fluctuation in Tunisia and Algeria.

The findings of this paper provide some policy implications for the MENA-6 countries. First, for the oil-importing countries (Morocco and Tunisia), the real exchange rate show a significant change following oil price fluctuation in the long horizon. In this case, each of country must put a mechanism to prevent a depreciation of domestic currency.

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