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DOES MONETARY POLICY RESPOND DIFFERENTLY TO OIL PRICE SHOCKS? NEW EVIDENCE FROM THE GULF COOPERATION COUNCIL COUNTRIES[1]

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Abstract

This paper investigates the role of oil supply and demand shocks in monetary policy stance among the Gulf Cooperation Council (GCC) countries using a panel vector autoregressive (P-VAR) framework and annual panel data over the period 1980-2019. The impulse response functions show that under the symmetric definition of oil shocks (‘all’ shocks), the inflation shock leads to a contractionary monetary policy in GCC countries. Nevertheless, based on asymmetric supply-driven and demand-driven specifications, we find clear evidence of a differentiated reaction of monetary policy to asymmetric oil-induced inflation shocks. Following an oil demand-induced inflation shock, the monetary policy stance remains neutral or becomes accommodative (Dovish). On the other side, the real interest rate in GCC countries increases in response to the anticipated oil supply-induced inflation shock, suggesting that monetary policy stance may become contractionary (Hawkish). With regard to policy implications, as previously experienced, the monetary policy stance in GCC countries must be sensitive to the source of the oil-induced inflation shocks.

Keywords: Gulf Cooperation Council (GCC) countries; Oil demand shocks; Oil supply shocks; Monetary policy; Panel vector autoregressive models.
JEL Classifications: C33, E31, E52, Q41.

ملخص

تبحث هذه الورقة في دور صدمات العرض والطلب على النفط في موقف السياسة النقدية بين دول مجلس التعاون الخليجي باستخدام إطار عمل متجه ذاتي (P-VAR) وبيانات المسوح السنوية خلال الفترة 1980-2019. تظهر وظائف الاستجابة الدافعة أنه بموجب التعريف المتماثل للصدمات النفطية («جميع» الصدمات)، تؤدي صدمة التضخم إلى سياسة نقدية انكماشية في دول مجلس التعاون الخليجي. ومع ذلك، واستنادا إلى المواصفات غير المتماثلة التي يحركها العرض والطلب، نجد دليلا واضحا على وجود رد فعل متباين للسياسة النقدية إزاء صدمات التضخم غير المتماثلة الناجمة عن النفط. بعد صدمة التضخم الناجمة عن الطلب على النفط، يظل موقف السياسة النقدية محايدًا أو يصبح ملائمًا (دوفيش). على الجانب الآخر، يرتفع سعر الفائدة الحقيقي في دول مجلس التعاون الخليجي استجابة لصدمة التضخم المتوقعة الناجمة عن العرض النفطي، مما يشير إلى أن موقف السياسة النقدية قد يصبح انكماشيًا (هوكيش). وفيما يتعلق بالآثار المترتبة على السياسات، كما حدث سابقا، يجب أن يكون موقف السياسة النقدية في بلدان مجلس التعاون الخليجي حساسا لمصدر صدمات التضخم الناجمة عن النفط.

1. Introduction

During the COVID-19 pandemic (2020-21), the Gulf Cooperation Council (GCC) countries—Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates (UAE)—experienced many challenges, including a negative demand shock of oil caused by global economic difficulties and the disturbance of global value chains (reduction of labor, travel restrictions, quarantine efforts, reduction in supply of materials, and capital and intermediate inputs). In addition, the breakdown in negotiations between the Organization of the Petroleum Exporting Countries (OPEC) and its allies in the first week of March 2020 led to a collapse in oil prices. Consequently, the dual negative oil price supply-demand shock hit the GCC countries (like other oil-exporting countries) particularly hard at a time when the fossil fuel industry is facing a critical challenge as the world increasingly shifts toward clean energy.

The recovery from the COVID-19 pandemic and the start of the Russia-Ukraine conflict in 2022 caused significant disruptions to supply chains as well as economic fluctuations. Accordingly, oil crude prices—and, therefore, inflation—rose sharply in many countries in 2021-22, fueled by a combination of: (1) labor shortages and supply disruptions; (2) sanctions and trade restrictions imposed on Russian banks, businesses, and individuals; and (3) surging energy, food, and commodity prices.

The GCC countries are major players in the global oil market (22.8 percent of world oil production and 31.5 percent of world oil reserves in 2019). Therefore, any oil supply fluctuations from the region can have a significant impact on global oil prices. On the other hand, oil price fluctuations lead to volatility in GCC government revenues, GDP, and inflation. The Russia-Ukraine conflict further fueled additional disruptions to energy markets and the international sanctions placed on Russia led to economic dislocation.

As shown in the literature, oil shocks are not without impact on the economic growth and inflation of oil-exporting countries (Alekhina and Yoshino, 2018; Hamilton, 2009; Kilian, 2009; Alsalman and Karaki, 2018; Herrera et al., 2019).

This research attempts to empirically investigate the monetary policy reaction to oil price shocks and its transmission lag to the real economy and inflation in the GCC countries. Our paper employs a panel vector autoregression (P-VAR) framework and examines the causal links between real oil crude prices, the real gross domestic product (GDP) of GCC countries, the real GDP of GCC trading partners, the real fiscal balance, inflation, and the real interest rate from 1980 to 2019. To assess the asymmetric response of monetary policy to oil demand and supply shocks, we estimate the P-VAR model in two variations with distinct specifications tailored for oil price shocks. The initial version adopts a symmetric approach encompassing all oil price shocks, while the subsequent version takes an asymmetric stance by distinguishing oil supply (Oss) from oil demand shocks (Ods). Following the estimation of these two iterations of the P-VAR model, we compute impulse response functions (IRFs) by utilizing the orthogonalized disturbance derived from the moving average rendition of each P-VAR model.

Our paper is related to the growing literature focusing on the asymmetry in monetary policy responses to oil price shocks in oil-exporting countries. Several studies such as Hamilton (2009), Killian (2009), Alsalman and Karaki (2018), and Herrera et al. (2019), among others, examine the nexus between energy prices and economic activity. One of the limitations of the existing empirical studies on GCC countries is the differentiation between the response of monetary policy to oil supply disturbances from oil demand shocks. Our research contributes to the literature by investigating the asymmetric response of monetary policy in GCC countries to demand-driven and supply-driven oil shocks using a new specification of oil shocks in a P-VAR model.

The remainder of this paper is organized as follows. Section 2 reviews the literature, while section 3 describes the data and applied methodology and presents the preliminary analysis. Section 4 discusses the empirical results. Finally, section 5 concludes and provides policy recommendations.

2. Literature review

The oil supply shock of 1973-74 and the second one in 1979-80 were both followed by a combined worldwide recession and long episodes of inflation. Bruno and Sachs (1985) investigate the impact of the 1970s oil prices on output and inflation in the most industrial countries. The authors indicate that wage price spirals induced by oil price shocks lead to the inflation and reduction of economies' value-added. Hamilton (1983, 1996) measures the impact of oil prices on US macroeconomic aggregates, showing that most of the US recessions were preceded by increases in oil prices, suggesting that oil price increases play an essential role as one of the main causes of recessions.

Several pieces of literature evaluating the relation between energy prices and macroeconomic performance emphasize the need to determine the reason behind oil price changes, whether due to demand or supply shocks, rather than taking for granted that oil price variations are independent of the developments in global economic activity (Hamilton, 2009; Kilian, 2009; Alsalman and Karaki, 2018; Herrera et al., 2019).

Olamide and Maredza (2021) investigate the short- and long-run dynamics between monetary policy, oil price volatility, and economic growth in the oil-producing countries in the Central African Economic and Monetary Community (CEMAC). The study employs a panel autoregressive distributed lag model for the short- and long-run dynamics using data for the period 1980-2018. The authors also use a structural vector autoregressive (SVAR) model for shocks and spillover effects. The results find that the highly influential variables on monetary policy in the long run are oil price volatility, GDP growth rate, and exchange rate. The only variables that have significant short-run influences on monetary policy rates in the region are the exchange rate and GDP growth rate.

El Anshasy and Bradley (2012) explore the role that oil prices play in determining fiscal policy action in a set of 16 oil-producing countries for the period 1972-2007 using the generalized method of moments (GMM) approach. The results emphasize that oil price shocks have a direct impact on government spending growth in the short and long run. Furthermore, higher oil price volatility induces government prudence by reducing the growth rate in government spending, especially during inflationary periods.

Choi et al. (2018) analyze the impact of international oil price movements on local inflation in 72 advanced and emerging countries by using unbalanced panel data for the period 1970-2015. The authors demonstrate the positive and significant impact of oil prices on inflation in the investigated countries, with the effect fading after two years for both developed and developing countries.

Cashin et al. (2014) employ the sign restriction approach to a global VAR model to differentiate between supply-driven and demand-driven global oil price shocks across major oil exporters (38 countries and regions) over the period 1979-2011 (quarterly data). The results of their work highlight the importance of oil price origin in analyzing the macroeconomic imbalances of oil-importing countries and the main commodity producers. They show that it is only essential to differentiate between net oil-importing countries from oil-exporting countries when exploring the macroeconomic consequences of a supply oil price shock. Oil-importing countries typically experience a prolonged plunge in economic activity after oil price supply shocks; however, the effect is positive on big oil-exporting countries. On the demand side in the global oil market, there are no cross-country distinctions. The study shows that the real output reacts positively in the short term to the demand-driven oil shock in almost all the examined countries and deals with the supplementary cost of inflation.

3. Data, methodology, and preliminary analysis

In this section, we delineate the data and econometric methodologies employed for the purpose of conducting our empirical investigation.

3.1. Data description

To identify the relationship between crude oil prices and interest rate with the other macroeconomic variables in the GCC countries, we use a panel vector autoregressive (P-VAR) model based on annual data from an unbalanced panel of the six GCC member states. When available, the data covers the period 1980-2019. This period covers about 40 years since the establishment of the GCC, which was concluded on 25 May 1981.

Our endogenous variables include real world crude oil prices (OP), the output gap (POG) of trading partners as a proxy of the foreign demand to GCC countries, the domestic output gap (OG), real fiscal balances as a percentage of GDP (FB), imports (IMP), inflation (INF), and short-term interest rate (IR).

The output gaps for GCC countries (OG) and their trading partners (POG) variables are computed as the difference between the actual real GDP (output) and potential GDP as a percentage of potential GDP. The output gap variable is used in monetary policy to measure economic activity. This variable measures how far the economy is from its productive potential. In other words, the output gap indicates the imbalance between the demand and supply components of economic activity and is commonly used to measure the degree of inflationary pressure. A positive output gap is associated with excess demand in the economy; in other words, the economy is operating above its capacity to sustain that degree of production owing to excess demand. This implies an overheating economy and upward pressure on inflation. A negative gap indicates that there is excess supply, which implies a slack economy and downward pressure on inflation (Alichi, 2015; Billi, 2020).

The inflation (INF) variable is computed as the annual growth of the Harmonized Consumer Price Index (HCPI) of each GCC country. This variable is used to investigate the transmission channels of oil price shocks to real economic activity and therefore fiscal policy through domestic prices. The data for HCPI and the real GDP of GCC countries and their trading partners are obtained from national statistical offices in the GCC and the International Monetary Fund's (IMF) International Financial Statistics (IFS) database.

The real fiscal balance (FB) variable is computed as fiscal balance deflated by HCPI and divided by nominal GDP. In our panel study, we use real fiscal balance instead of fiscal balance to avoid the impact of inflation on each GCC country.

The imports (IMP) variable is computed as the annual growth of the Import Value Index (IVI) of each GCC country. The IVI is presented as the current value of imports converted to USD and expressed as a percentage of the average for the base period (2000). The data of IVI is obtained from statistics from the United Nations Conference on Trade and Development (UNCTADstat). We note that, on average, 77 percent of GCC imports are intended for local consumption and around 23 percent are re-exported (2010-20).[5]

The real short-term interest rate (IR) variable for each GCC country is computed as the three-month interbank rate deflated by HCPI inflation. The use of short-term interest rate in our model is motivated by the fact that policymakers in GCC countries react to the inflation pressures induced by oil price shocks by raising the nominal interest rate. This response generates an

[5] Authors' calculations based on data from GCC National Statistical Offices.

indirect impact of oil crude price shocks on real activity and, consequently, on inflation. The data for IR and FB are obtained, respectively, from the national central banks and the ministries of finance.

We compute the real crude oil prices (*roil*) as the nominal average spot price of Brent, Dubai, and West Texas Intermediate, equally weighed and deflated by the US producer price index. The data for oil prices and the US producer price index are obtained from the IMF's IFS database.

According to prior empirical research that examined the origins of fluctuations in oil prices (Baumeister and Peersman, 2009; Hamilton, 2009a, 2009b; Kilian, 2009; Kilian and Park, 2009; Peersman and Van, 2009; Cunado and Perez de Gracia, 2014; Dhaoui and Saidi, 2017), oil price shocks can be categorized into three main types: shocks in oil supply, shocks in aggregate demand, and shocks in oil-specific demand. Supply oil shocks are induced by a change in the world oil production, while demand oil shocks arise from a surge in the overall demand for crude oil, influenced by global real economic activity. On the other hand, an oil-specific demand shock occurs due to a spike in the demand for crude oil as a reaction to heightened uncertainties regarding expectations of oil supply shortages.

In the literature and in practice, there are several methods on how to differentiate oil supply shocks from demand shocks. For example, Kilian (2009) and Peersman and Van (2009) utilize sign restrictions within the estimated VAR models to discern shocks when examining the stock market's reaction to oil shocks. Cunado and Perez (2014) employ an alternative approach in shock identification by examining the fluctuations in oil price and production volume. When these variables exhibit simultaneous movements, the price shocks are deemed to stem from the demand side. Conversely, if they move in opposite directions, the price shocks are attributed to supply shocks.

In this study, we follow Cunado and Perez (2014) by differentiating oil shocks into *oil demand shocks* and *oil supply shocks* by employing P-VAR methodology. Our aim is to investigate the existence of possible asymmetry in the reaction of monetary policy in GCC countries against inflation shocks induced by oil fluctuations.

We define the oil demand shock and oil supply shock as follows (Cunado and Perez de Gracia, 2014; Dhaoui and Saidi, 2017):

Let

$$OP_t = \Delta(\%)roilprice_t = 100 * \frac{roilprice_t - roilprice_{t-1}}{roilprice_{t-1}}$$

This relation specifies the annual percentage change (%) of real oil prices, denoted OP_t.

Let also $\Delta yoil_t = yoil_t - yoil_{t-1}$ define the specification of the annual variation of world oil production, including natural gas liquids.

The oil supply shock (Oss_t) and oil demand shock (Ods_t) are computed, respectively, as follows:

$$\begin{cases} Oss_t = OP_t = \Delta(\%)roilprice_t, & if\ sign(\Delta(\%)roilprice_t) \neq sign(\Delta yoil_t); \\ 0, & otherwise. \end{cases} \quad (1)$$

$$\begin{cases} Ods_t = OP_t = \Delta(\%)roilprice_t, & if\ sign(\Delta(\%)roilprice_t) = sign(\Delta yoil_t); \\ 0, & otherwise. \end{cases} \quad (2)$$

From equations 1 and 2, a variation in oil price (in %) corresponds to an oil supply shock if the signs of oil price variation and oil production variation are different. If the signs of oil price change and oil production change are the same, the variation in oil price is classified as an oil demand shock. In other words, an oil price rise (decrease) simultaneously with a world oil production rise (decrease) is classified as a demand shock. In the opposite case, an oil price rise (decrease) followed by a world oil production decrease (increase) is identified as a supply shock. Cunado and Perez de Gracia (2014) as well as Dhaoui et al. (2018) employ a comparable methodology to investigate the effects of oil price fluctuations on stock market performance in European nations and the OECD, respectively, by applying VAR and VECM time series models.

3.2 Methodology

3.2.1 Estimation methods of the output gaps

The estimation of the output gap is not achieved through direct observation but rather through the process of estimation. Nevertheless, various methodologies for calculation frequently result in disparate estimations of the output gap. In the context of our statistical discourse concerning the methodologies utilized for estimating output gaps for GCC countries (OG) and their trading partners (POG), we examine three well-known univariate filter-based techniques within our P-VAR framework. These methods include Hodrick-Prescott (HP), Band-Pass (BP), and Kalman Filter (KF), which are attributed to Hodrick and Prescott (1997), Christiano and Fitzgerald

(2003), and Kalman and Bucy (1961), respectively.[6] The primary objective of our methodology is to analyze the policy implications of univariate GDP filtering in order to determine the most suitable approach that ensures a coherent interpretation of our empirical findings in alignment with existing empirical literature and economic principles.[7]

3.2.1 The Model

In this research, we use the P-VAR methodology pioneered by Holtz-Eakin et al. (1988) and evolved by Abrigo and Love (2016) to explore the causal nexus among external demand, oil prices, GDP, fiscal balance, inflation, and short-term interest rates in GCC member countries. P-VARs are considered the extension of the standard vector autoregressive model by introducing a cross-sectional dimension. P-VARs are a more efficient tool for dealing with important linked policy issues such as the transmission of shocks across borders. Moreover, the VAR approach addresses the endogeneity problem in panel data by allowing for the endogenous interaction between the variables in the system. One of the main advantages of the VAR approach from panel-data framework is that it enables us to calculate the IRFs, which describe one variable's reaction in response to changes in another variable in the system, as all other shocks are held equal to zero.

On the other hand, the panel approach makes it possible to include fixed-effects coefficients to also account for the time invariant characteristics intrinsic to each country in our sample. In other words, the P-VAR methodology combines the standard VAR framework and panel-data framework, considering all the variables as endogenous and permitting for unobserved individual heterogeneity by introducing fixed effects, resulting in an enhanced reliability of the estimation (Love and Zicchino, 2006). The P-VAR model can be specified as follows:

$$X_{it} = X_{it-1}A_1 + X_{it-2}A_2 + \ldots + X_{it-p}A_p + u_i + e_{it} \tag{3}$$

where $X_{it} = (OP_{it}, POG_{it}, OG_{it}, FB_{it}, IMP_{it}, INF_{it}, IR_{it})$ is a vector of dependent variables;[8] u_i and e_{it} are (1×7) vectors of dependent variable-specific panel fixed-effects and idiosyncratic errors, respectively. The (7×7) matrices $A_1, A_2, \ldots, A_{p-1}, A_p$ are parameters to be estimated. We assume that the innovations have the following characteristics: $E[e_{it}] = 0$, $E[e_{it}' e_{it}] = \Sigma$ and $E[e_{it}' e_{is}] = 0$ for all $t > s$.

We use the GMM-style instruments method to estimate our P-VAR model as proposed by Holtz-Eakin, et. al (1988). The advantage of this method is that the instrument lags with missing values

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[6] Large surveys of implementations of state space models in econometrics are presented in Hamilton (1994a, Chapter 13; 1994b) and Harvey (1989, Chapters 3, 4).

[7] To reduce the sensitivity of potential output to the output in 2019 (end-point problem), we use IMF WEO output projections until 2024.

[8] These variables are described in subsection 3.1.

are replaced with zeros. This enhances the estimation sample, which results in the best estimation efficiency.

3.3 Data preliminary analysis

In Table 1, we present the correlation coefficients between the estimated output gaps of GCC countries (OG) using the three approaches of Kalman, BP, and HP on the one hand,[9] and the output gaps of their trading partners (POG), fiscal balance (FB), short-term interest rate (IR), oil price (OP), inflation (INF), and imports growth (IMP) on the other hand.

Based on the economic literature, we anticipate a positive correlation for OG with POG as the excess oil demand of the GCC's economic partners brings the aggregate demand to exceed the output capacity, opening a positive output gap. In the same direction, we anticipate a positive correlation between OG and FB, OP. The impact of IR on OG is expected to be negative since the inter-bank interest rates in GCC countries are strongly correlated with the US rates (Peg exchange rate regime). Prasad and Espinoza (2012) show that an increase of the Federal funds rate decreases non-oil GDP in GCC countries. Based on the economic growth theory, we expect that OG is negatively correlated to INF since inflation decreases output growth by lowering productivity growth and investment (Fisher, 1993; Andrés and Hernando, 1997). We also expect that OG is negatively correlated to IMP since imports are intended mostly for local consumption.

By comparing and contrasting the signs of the calculated correlation coefficients of the different output gap measures (Kalman, BP, and HP) with the anticipated signs (Table 1), we can conclude that the Kalman filter gives the best indication of the state of the macroeconomy of the GCC countries. In the rest of the paper, we use the Kalman filter for OGs and POGs.

Table 1. Contemporaneous correlation coefficients of estimated OGs

Variable	Correlation with POG (*) (+)	Correlation with FB (+)	Correlation with IR (-)	Correlation with OP (+)	Correlation with INF (-)	Correlation with IMP (-)
OG (Kalman)	0.010	0.069	-0.152	0.016	-0.145	-0.099
OG (BP)	-0.021	-0.087	-0.006	0.057	-0.084	-0.042
OG (HP)	-0.012	0.002	-0.075	-0.021	-0.197	-0.113

OG: output gap; POG: trading partners' output gap; FB: real fiscal balance (% of GDP); IR: short-term interest rate; OP: real oil price growth INF: inflation; IMP: imports growth; (*): same filter as OG; (-/+): anticipated sign of correlation.

[9] See subsection 3.2.1 for more details.

Table 2 gives a summary of some statistical properties of real world oil prices (OP), output gap (OG), trading partners' output gap (POG), real fiscal balance (FB) as a percentage of GDP, imports growth (IMP), inflation (INF), and short-term interest rate (IR).

Table 2. Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max	Saphiro-Wilk test for normality (Prob>z)
OP	234	1.65	21.64	-46.76	48.44	0.00
POG	240	0.02	0.32	-1.16	1.63	0.00
OG	240	-0.03	2.01	-20.28	7.76	0.00
FB	187	3.08	15.56	-36.71	60.81	0.00
IMP	234	7.29	17.18	-36.96	76.34	0.00
INF	237	2.18	3.29	-7.36	15.80	0.00
IR	240	1.74	3.02	-3.06	13.35	0.00

OP: real oil price growth; POG: trading partners' output gap; OG: output gap; FB: real fiscal balance (% of GDP); IMP: imports growth; INF: inflation; IR: short-term interest rate. OG and POG are calculated using univariate Kalman filter.

Table 3 presents the average level of each variable per decade. The OG in GCC countries was significantly negative (on average) in the first two decades (1980-89 and 1990-99), close to zero in the third decade (2000-09), and significantly positive in the last decade (2010-19). This is potentially explained by the fall trend of crude oil prices between 1980 and 1999 (1986 collapse), that mitigated the evolution between 2000 and 2009 (global financial crisis of 2008) and the increase of GCC countries' oil production between 2010 and 2019 in their efforts to compensate for the disruption in the oil supplies of Libya and Iran (oil prices averaged USD 76.5 per barrel in the same period).

The inflation rate (INF) was moderate over the period 1980-2019 ($\simeq$ two percent) except the sub-period 2000-09 ($\simeq$ three percent). It is worth noting that inflation was less volatile in the last decade (2010-19). Fiscal balance (as a percentage of GDP) recorded a deficit over the period 1980-2019 except for the sub-period of 2000-09 due to the high oil price growth (11.8 percent). The real short-term interest rate fell gradually between 1980 to 2019 and recorded a negative average over the last decade 2010-19 (-0.5 percent). The potential GDP has seen a constant improvement from one decade to another, rising from 3.8 percent in 1980-89 to 5.1 percent in 2010-19 (Table 3). Further, the Shapiro-Wilk normality test ($p<0.05$) reveals a statistically significant deviation of the data from normality (Table 2).

Table 3. Average level of variables per decade (1980-2019)

	1980-1989		1990-1999		2000-2009		2010-2019	
Variable	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
OP	-7.40	19.40	0.69	18.92	11.80	21.41	0.62	22.02
POG (*)	-0.16	0.46	0.07	0.17	-0.01	0.28	0.20	0.13
OG (*)	-0.20	2.59	-0.32	2.85	-0.03	0.88	0.43	0.48
FB	-9.70	19.39	-2.53	11.80	14.69	14.72	-1.06	11.38
IMP	0.78	14.67	6.75	17.24	16.62	19.15	4.36	12.45
INF	2.01	3.89	1.98	3.15	2.83	3.94	1.88	1.50
IR	9.38	2.74	6.37	1.42	3.52	1.73	1.35	0.75
Potential GDP Growth (*)	3.83	2.09	4.14	2.05	4.63	2.04	5.10	2.08

OG: output gap; INF: inflation; FB: real fiscal balance (% of GDP); IR: short-term interest rate; OP: real oil price growth; POG: trading partners' output gap. (*) calculated using univariate Kalman filter.

3.3.1 Unit root test results for stationarity

The efficiency of the panel VAR estimators requires that the variables in the panel data are stationary. To verify the stationarity of all variables of our model (OP_{it}, POG_{it}, OG_{it}, FB_{it}, IMP_{it}, INF_{it}, IR_{it}), we use the Fisher-ADF and Fisher-PP Panel unit root tests of Choi (2001); the IPS test of Im et al. (2003); the LLC test of Levin et al. (2002); and the stationarity test of Hadri (2000). Our results show that all panel calculated variables seem stationary in level (Table 4).

Table 4. Panel unit root tests

Variables	ADF-Fisher χ^2	PP-Fisher χ^2	IPS-*W*-stat	LLC-*t**	Hadri - *Z*stat
OP	33.2659***	34.5808***	-4.4031***	-8.3826***	0.6035
POG	14.2713***	8.0943***	-6.2054***	-4.9526***	8.1065
OG	24.9597***	22.8483***	-6.8434***	-5.9151***	0.7954
FB	8.8670***	2.9864***	-2.4413***	-1.7723***	0.5676
IMP	26.7192***	24.5288***	-7.4345***	-6.5551***	0.3898
INF	15.8367***	9.7043***	-4.9570***	-5.2627***	0.3204
IR	72.4529***	76.7933***	-6.4533***	-6.6988**	1.0551

The null hypothesis of these tests is that the panel series has a unit root (non-stationary series) except for the Hadri test which has no unit root in panel series (stationary series). ***, **, * denotes rejection of null hypothesis at the 1%, 5% and 10% level of significance, respectively. ADF (PP)-Fisher: Choi (2001); IPS W-stat: Im, Pesaran and Shin {2003); LLC-t: Levin, Lin and Chu, (2002); Hadri- Z stat: Hadri (2002).

3.3.2 Granger causality analysis

We use the selection criteria proposed by Andrews and Lu (2001) and recommended by Abrigo and Love (2016) to select the optimal lag length *p* of our estimated P-VAR model. Based on our results, the preferred model was the first-order (*p* = 1) panel VAR since it has the smallest value of Modified Bayesian Information Criteria (MBIC), Akaike's Information Criterion (MIAC), and Modified Hannan-Quinn Information Criteria (MQIC). Then, we estimate the model with one lag (*p* = 1):

$$X_{it} = X_{it-1}A_1 + u_i + e_{it.} \qquad (4)$$

We continue the check of stability condition of the first-order estimated model. The resulting table and graph of eigenvalues[10] confirm that the estimate is stable. To investigate the potential bidirectional causal relationships between the endogenous variables (OP_{it}, POG_{it}, OG_{it}, FB_{it}, IMP_{it}, INF_{it}, IR_{it}) of the estimated model, we perform the panel Granger Non-Causality Test (GNC).[11] The results are presented in Table 5.

[10] Not presented here, available upon request.

[11] A variable Z is said to Granger-cause X if the past values of Z are statistically significant predictors of future values of X.

Table 5. Panel VAR-Granger non-Causality Wald test

Ho: Excluded variable does not Granger-cause Equation variable
Ha: Excluded variable Granger-causes Equation variable

Equation \ Excluded		chi2	df	Prob > chi2
OP				
	POG	7.28	1	0.01
	OG	79.59	1	0.00
	FB	0.77	1	0.38
	IMP	6.08	1	0.01
	INF	18.82	1	0.00
	IR	6.84	1	0.01
	ALL	217.65	6	0.00
POG				
	OP	9.62	1	0.00
	OG	15.95	1	0.00
	FB	103.08	1	0.00
	IMP	8.81	1	0.00
	INF	31.09	1	0.00
	IR	127.49	1	0.00
	ALL	376.37	6	0.00
	OP	9.62	1	0.00
OG				
	OP	13.58	1	0.00
	POG	0.27	1	0.60
	FB	6.14	1	0.01
	IMP	15.04	1	0.00
	INF	26.88	1	0.00
	IR	4.77	1	0.03
	ALL	62.37	6	0.00
FB				
	OP	74.63	1	0.00
	POG	16.71	1	0.00
	OG	9.40	1	0.00
	IMP	24.28	1	0.00
	INF	63.45	1	0.00
	IR	0.14	1	0.71
	ALL	149.21	6	0.00

The null hypothesis of a bidirectional non-causality relationship is rejected in most of the cases. Regarding the other cases, the non-causality hypothesis is not only robustly rejected: from real fiscal balance (FB) to world real oil prices (OP), from trading partners' output gap (POG) to the domestic output gap of GCC countries (OG), from real short-term interest rate (IR) to real fiscal balance, from trading partners' output gap (POG) to imports (IMP) and from imports (IMP) to real short-term interest rate (IR). When we take all variables together, the results of the GNC test show that all the seven endogenous variables contribute significantly (at one percent) to the explanatory power of the equations of the estimated P-VAR.

Table 6. Panel VAR-Granger non-Causality Wald test (cont.)

Ho: Excluded variable does not Granger-cause Equation variable

Ha: Excluded variable Granger-causes Equation variable

Equation \ Excluded		chi2	df	Prob > chi2
IMP				
	OP	35.13	1	0.00
	POG	0.09	1	0.76
	OG	53.58	1	0.00
	FB	31.79	1	0.00
	INF	37.75	1	0.00
	IR	23.86	1	0.00
	ALL	303.40	6	0.00
INF				
	OP	41.02	1	0.00
	POG	19.29	1	0.00
	OG	25.53	1	0.00
	FB	29.06	1	0.00
	IMP	49.11	1	0.00
	IR	29.03	1	0.00
	ALL	288.02	6	0.00
IR				
	OP	37.60	1	0.00
	POG	105.69	1	0.00
	OG	37.72	1	0.00
	FB	38.41	1	0.00
	IMP	1.68	1	0.19
	INF	85.82	1	0.00
	ALL	287.29	6	0.00

4. Results of the Empirical Analysis

The way in which monetary policy in net oil-importing economies responds to inflation pressures driven by oil price shocks is well established in the empirical literature. However, little research has been focused on how monetary policy in GCC countries reacts to the surge in inflation due to supply-driven or demand-driven oil shocks.

Based on the IRFs, this section investigates the potential existing asymmetries in the dynamic effects of inflation shocks on the monetary policy stance in GCC countries. To determine whether the effect of oil price surges on the monetary policy reaction to inflation shocks in GCC countries is symmetric or asymmetric, we estimate the P-VAR model in two distinct versions by employing varying specifications to capture oil price shocks. The first version is symmetric (all oil price shocks, OP_{it}) and correspond to the model described by equation 3 and the second version discriminates oil supply disturbances from oil-demand shocks as defined in equations 1 and 2, respectively. Upon the two estimated versions of P-VAR model, the IRFs are computed using the orthogonalized disturbance from their moving average (reduced form) representation. The IRFs describe the response of one variable to a shock in the innovations of another variable in the VAR system, while keeping all other shocks identical to nullity. We employ the Monte Carlo simulations to generate the confidence intervals based on the distribution of the estimated coefficients of P-VAR and the standard errors.

Based on the symmetric oil price shock definition, Figure 1 illustrates the impulse response of the key macroeconomic variables of GCC countries, presented in the estimated P-VAR model, resulting from one standard deviation shock to inflation shock whereas Figure 2 presents the impulse response to the monetary policy shock (section 4.1). Figures 3 and 4 present the impulse responses to the oil price shocks based on the asymmetric definition (oil demand and oil supply shocks) (section 4.2).

4.1. Monetary policy reaction to inflation shock under the symmetric oil price definition (all shocks)

Figure 1 shows that the real interest rate (IR) reacts positively to the inflation shock (INF) after two to four years with a peak of 0.5 (after three years), suggesting that monetary policy responds to the inflation shock by increasing its policy interest rate. Veritably, most central banks among GCC countries follow the US Federal in raising interest rates to fight inflation pressures and, at the same time, maintain their currencies' pegs to the USD or to a basket of currencies dominated by the USD (case of Kuwait).

Figure 1. Impulse responses to an inflation shock

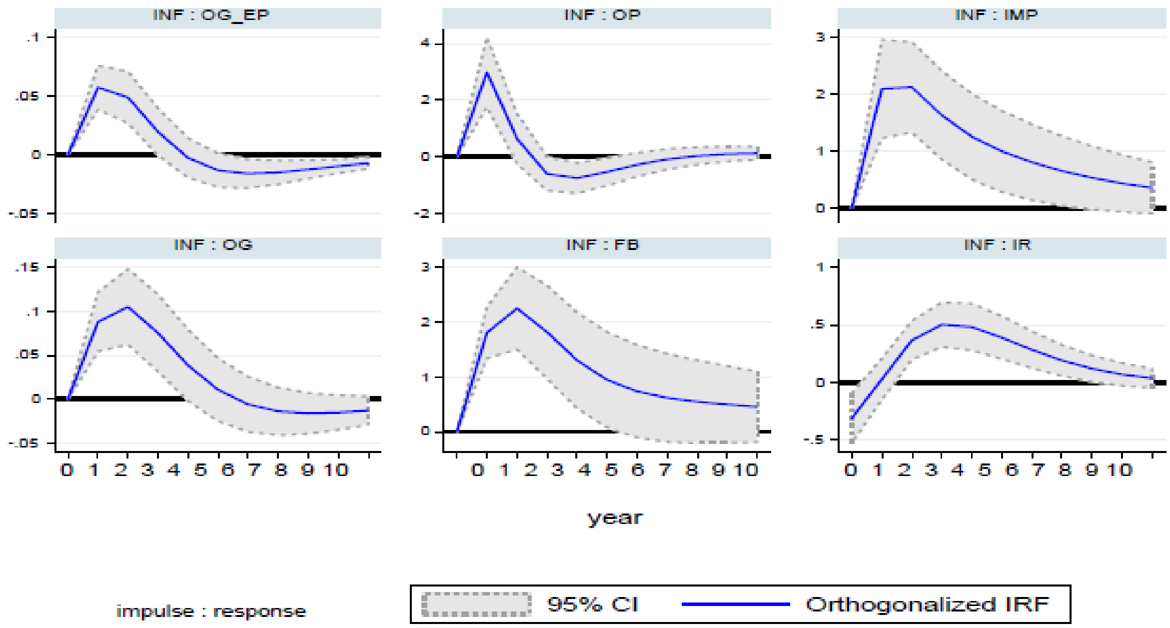
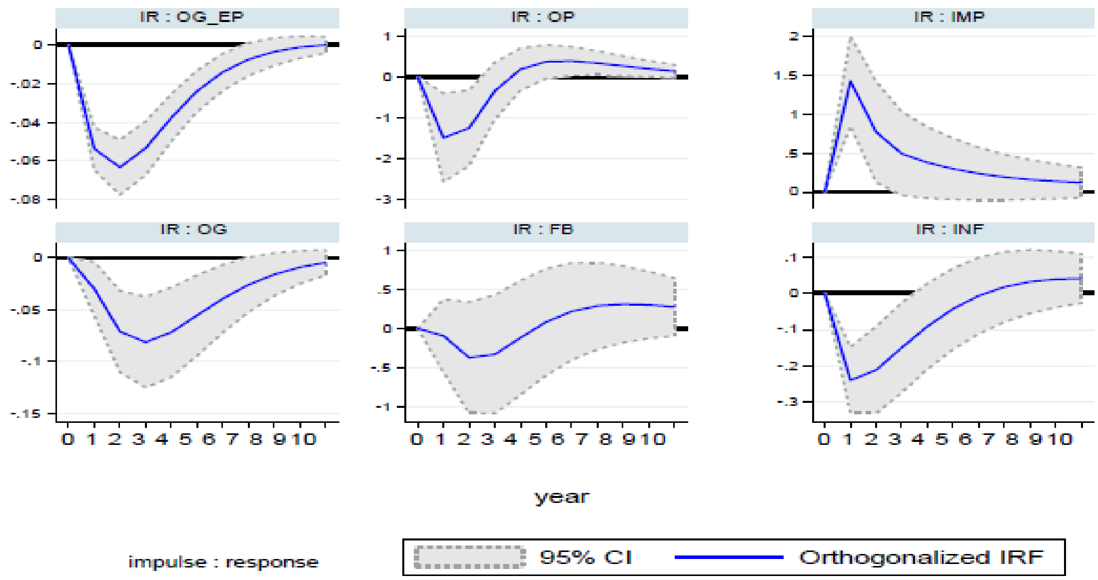


Figure 2 depicts the response of GCC macroeconomic variables to monetary policy shock (IR). The output gap of GCC trading partners (POG) react negatively to the monetary policy shocks (US monetary tightening). Due to the decline of demand, the oil price (OP) decreases after one to two years. In the same context, and as GCC central banks broadly follow US Fed decisions, the monetary policy shock in GCC countries (IR) negatively impacts the output gap (OG) and inflation (INF) after one or two years. Driven by higher interest rates and global prices, the GCC import value index (IMP) reacts positively to the monetary shock after one year, then the effect of the (IR) shock falls to zero quickly thereafter. Finally, the monetary policy shock does not significantly affect fiscal balance in GCC countries.

Figure 2. Impulse responses to an interest rate shock



4.3. Monetary policy reaction to inflation under asymmetric oil price shock specification

In line with previous findings in the literature (Hamilton, 2003, 2009; Kilian, 2009; Herrera et al., 2019; Alsalman and Karaki, 2018; Cashin et al., 2014), we introduce a new oil demand-supply shock specification in the P-VAR model, initially introduced by Cunado and Perez de Gracia (2014) and Dhaoui and Saidi (2017) for VAR and VECM models successively. To investigate the presence of possible asymmetries in monetary policy responses to the oil-induced inflation shocks in GCC countries, we analyze the IRFs computed using the second version of our estimated P-VAR model, which differentiates oil supply disturbances from oil demand shocks as defined in equations 1 and 2.

4.3.1 Monetary policy reaction to oil demand-induced inflation shock

Figure 3 shows the computed IRFs of the key macroeconomic variables of GCC countries to oil demand shocks (Ods). As expected, the demand-driven increases in oil crude price positively impact the output gap of trading partners (POG) during the first three years. In fact, oil demand shocks (Ods) represent the variation of the global needs for shipping, traveling, and other activities. Therefore, if crude oil price shocks come from the demand side (Ods), it can be regarded as an optimistic sign for the global economic conditions expected to positively stimulate POG.

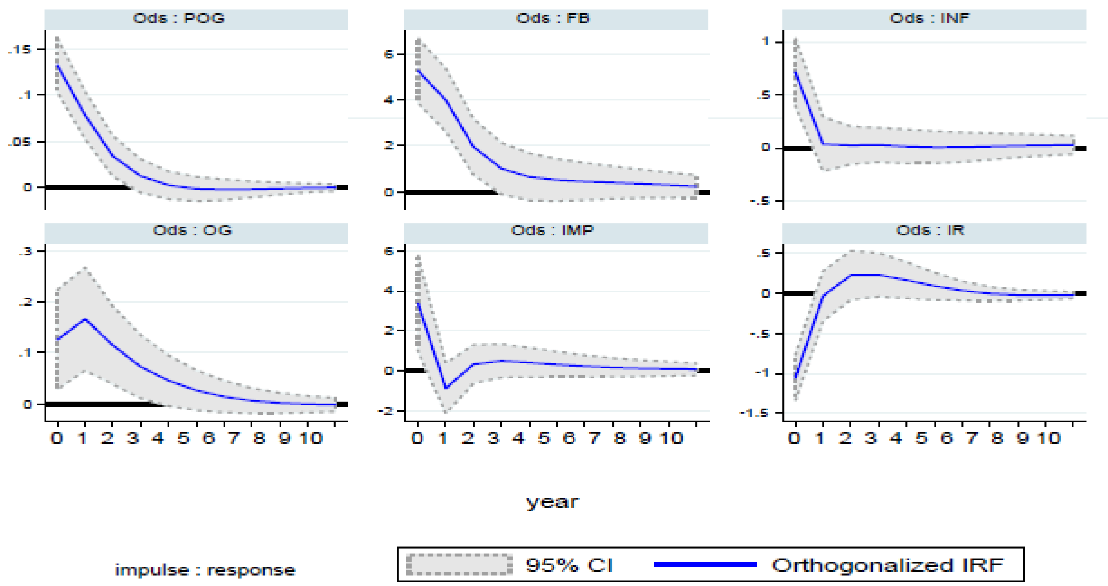
In the same direction, oil demand shocks have a significant and positive effect on the fiscal balance of GCC countries during the same period (first three years). Stimulated by the excess of foreign demand (POG), the OG of GCC countries reacts positively with a peak after one year. As the oil revenues of GCC countries are partially recycled into demand for goods and services, the

GCC imports variable (IMP) reacts positively to the oil demand shock the same year.

Inflation in GCC countries reacts positively in the same year to oil price demand shocks. In fact, the demand-driven appreciation of oil prices is expected to affect, for example, the commodity prices of food and agriculture as the energy-intensive inputs may transmit into higher cost of production of food and agriculture so that prices of final foods also increase.

The real interest rate, which is calculated as the difference between nominal interest rate and inflation, reacts simultaneously with inflation but negatively to oil price demand shocks. These findings show that, generally, and in anticipation of a future economic downturn due to the rising production costs, monetary policy seems to remain expansionary or at least neutral in keeping its policy rate at a neutral rate since the inflationary pressures are not expected to persist over time.

Figure 3. Impulse responses to an oil demand-induced inflation shock



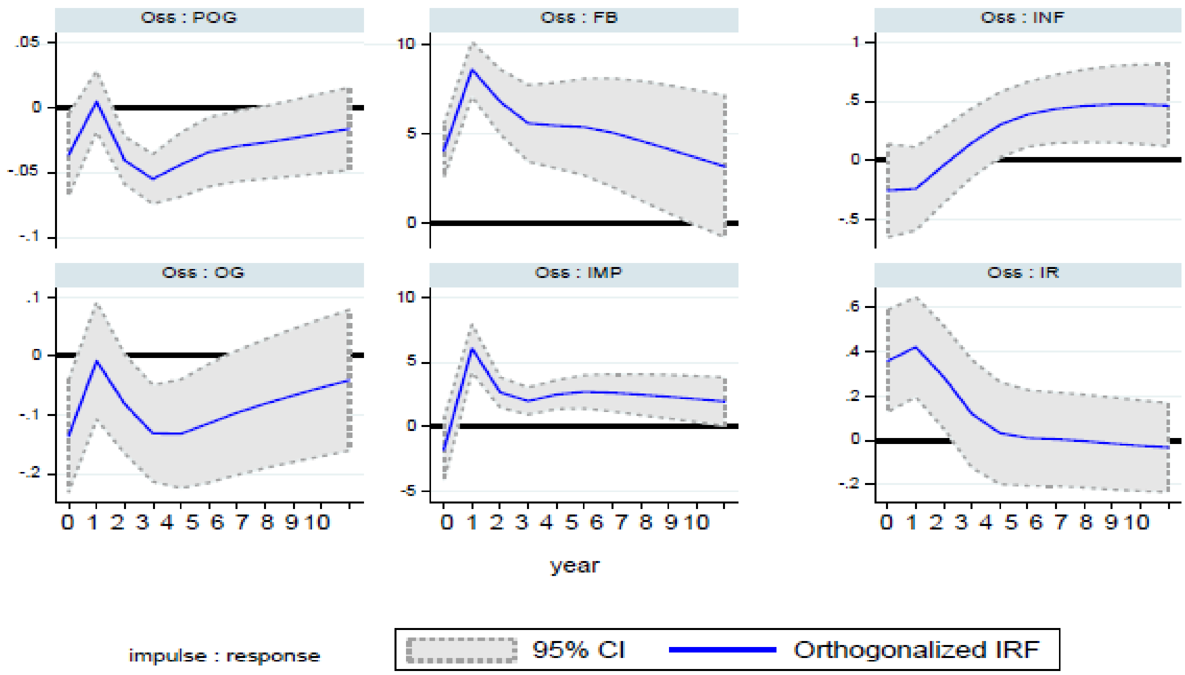
4.3.2 Monetary policy reaction to oil supply-induced inflation shock

Figure 4 depicts the IRFs of the key macroeconomic variables of GCC countries to oil supply shocks (Oss). Unlike the positive effect oil demand shocks, oil price supply shocks (Oss) negatively affect both the output gaps of GCC countries (OG) and their trading partners (POG) in the short/medium term. This is explained by the fact that following the oil supply shock and in the presence of rigidities in product and labor markets (prices and wages), production costs increase, and, at the same time, oil consumption decreases in all demand sectors (industrial, transportation, residential, commercial, and electric power) under the effect of the drop of oil supply. On the other hand, oil supply shocks are expected to cause a decline in labor demand as oil usage decreases.

Fiscal balance in GCC countries reacts positively to the oil supply shock with a peak after one year, which would result in an imports peak (IMP) in the same period. Compared to that of the oil demand shock, the oil supply shock effect is more persistent on fiscal policy.

Inflation is expected to react positively to oil supply shocks in the long term. Under these conditions, monetary policy responds to the anticipated future inflation by increasing its policy rate (i.e., forward-looking rules).

Figure 4. Impulse responses to an oil supply-induced inflation shock



5. Conclusion and Policy Implications

This paper attempts to empirically investigate the monetary policy reaction to oil price shocks and its transmission lag to real economy and inflation in GCC countries. Our paper employs the P-VAR framework and focuses on examining the causal links among real oil crude prices, the real GDP of GCC countries, the real GDP of GCC trading partners, real fiscal balance, inflation, and real interest rate from 1980 to 2019. To assess the asymmetric response of monetary policy to oil demand and supply shocks, we estimate the P-VAR model in two variations with distinct specifications tailored for oil price shocks. The initial version adopts a symmetric approach encompassing all oil price shocks, while the subsequent version takes an asymmetric stance by distinguishing oil supply shocks (Oss) from oil demand shocks (Ods). Following the estimation of these two iterations of the P-VAR model, we compute IRFs by utilizing the orthogonalized disturbance derived from the moving average rendition of each P-VAR model.

The IRFs computed using the first version of the P-VAR model show that, under the symmetric oil shock definition (all shocks), monetary policy in GCC countries reacts to inflation shock after two to four years by increasing its policy interest rate. On the other hand, the monetary policy shock in GCC countries negatively impacts the output gap and inflation after one to two years (transmission lag length).

The IRFs derived from the subsequent iteration of our estimated P-VAR model, incorporating the asymmetric categorization of oil prices (supply shock and demand shock), demonstrate a distinct impact of oil price disturbances. In the short term, inflation exhibits a positive response to the oil demand shock, while reacting negatively in the long term to the oil supply shock. Following an oil supply shock, monetary policy demonstrates a positive response (Hawkish stance), whereas it maintains a neutral position during a surge in oil demand shocks (Dovish stance).

Our findings indicate that the response of monetary policy stance in GCC countries should lean toward contractionary measures in times of oil supply shock occurrences, while remaining neutral or adopting expansionary measures during periods of oil demand shocks. A potential avenue for future research would involve examining the significance of floating exchange rate regimes in influencing the asymmetrical nature of monetary policy reactions to oil-induced inflation, with a specific focus on a cohort of nations that engage in inflation-targeting practices and are reliant on oil exports.

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