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Examining the role of coefficients of oil supply shocks, demand shocks, and delays on exchange rate fluctuations

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Abstract

The purpose of this study is to investigate the impact of oil price shocks on the exchange rate fluctuations of selected Persian Gulf countries, including Saudi Arabia, Kuwait, Iraq, and Iran, from 2000 to 2023 using the structural autoregression (SVAR) model. The findings of this research showed that the coefficients of oil supply shocks are significant only in Saudi Arabia and are no longer statistically significant in the other three countries. Coefficients of delays are statistically significant only for the country of Saudi Arabia in the first Intermission. Furthermore, regarding the coefficients of total demand shocks on exchange rate fluctuations of these countries, it does not have a significant impact on any of the countries. The results regarding the interruptions of the demand shock also indicate that statistically only the first interruption is significant for Kuwait. In addition, the impact of specific oil demand shocks on exchange rate fluctuations is significant for Kuwait. Therefore, it can be said that no strong, stable, or long-term effects of the structural shocks of oil supply and demand were found in the currencies of these countries.

Keywords: supply and demand shock, oil price, exchange rate, Persian Gulf countries
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1 Introduction

The global energy market is one of the few markets that is continuously examined in detail by news and analytical bases, and countries, organizations, commercial companies, and even ordinary individuals update their current economic policies and forecasts based on this market and its associated variables with new information [10]. Natural resources, including oil, are one of the most important sources of national wealth in the world. Oil and the sources of income from its exports, play a vital role in the performance and development of oil-rich and oil-exporting countries. Today, more than 50 percent of the revenues of major oil-rich countries depend directly and indirectly on the export revenues of this raw material. Given that oil energy is the driving force behind any productive activity, the increasing dependence of human life on energy sources has led to these resources, having a special place in economic growth and development [24]. The increase in oil prices in consumer countries will lead to reduced consumption and increased energy efficiency. However, in producer countries that are faced with high oil revenues, initial excitement occurs, and the influx of oil dollars is considered a fortunate event [12]. It is generally believed that abundant revenues from natural resources create wealth and economic progress for a country, accelerating investment and reducing poverty. However,

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empirical observations have consistently shown the detrimental effects of governments' dependency on natural resource revenues, including oil. Over the years, oil has been recognized as a factor that could provide foreign exchange for Third World countries and could potentially act as a positive lever for economic growth and development for countries that have an exclusive and natural endowment of it. However, this has never actually happened. The World Bank has identified the utilization of oil shocks and revenues in a way that minimizes economic damage and maximizes economic development as the greatest challenge for developing countries that export crude oil [9]. The price in the oil market, like any other market, is influenced by two important factors: supply and demand. Oil supply and demand shocks can undoubtedly create uncertainty and consequently have adverse effects on the economy, particularly on the exchange rate. Oil price shocks are transmitted to the economies of countries through five channels. These five channels include the supply-side channel, the demand-side channel, the monetary policy channel, the trade channel, and the valuation channel. The effectiveness and net performance of each of these channels depend on the level of economic development of the country and whether it is an oil-importing or oil-exporting economy [11]. On the supply side, after oil shocks, production costs increase. This, in turn, leads to negative effects and relative price changes resulting in the reallocation of production inputs. On the demand side, oil price shocks raise the overall price level, which means less disposable income and consequently a decrease in demand [14]. In examining foreign studies, Forhad and Alam [10], in their investigation of the impact of structural oil demand and supply shocks using a structural vector autoregression model proposed by Kilian [14] on the real effective exchange rates (REER) for Indonesia, Malaysia, Singapore, Thailand, and the Philippines, found that the real effective exchange rates of these countries are not affected by oil supply shocks. Oil-specific demand shocks affect the real effective exchange rates of Thailand immediately and those of Indonesia, Singapore, and the Philippines with a one-month delay. However, oil-specific demand shocks lasting more than one month generally do not affect the exchange rates of these countries. Yildirim and Arifli [29], in their study of the macroeconomic effects of adverse oil price shocks in Azerbaijan (a small oil-exporting country) using a recursive VAR model and monthly data from 2006 to 2018, showed that Azerbaijan's economy is negatively impacted by a decrease in oil prices. The results of this study confirm that a negative oil price shock worsens the trade balance, devalues the currency, increases inflation, and reduces economic activity. Additionally, the findings indicate that the depreciation of oil, due to the oil price, shapes the inflationary and recessionary consequences of this shock. Additionally, the results of the studies by Suwannajak et al. [28], which examined the effects of oil shocks on exchange rates in BRICS countries using a Markov-switching approach in different economic conditions such as recession and economic boom, showed that the effects of oil shocks on real exchange rates vary depending on the economic conditions. Moreover, oil shocks have a strong impact on the real exchange rates in the three countries of India, Russia, and South Africa. Similarly, Musa and Maijama'a [21], in their examination of the causal relationship between domestic oil prices, exchange rates, and inflation rates in Nigeria from 1985 to 2019, found strong cointegration among the variables. The Granger causality results also indicate a long-term one-way relationship between exchange rates and inflation, but no causal relationship between exchange rates and domestic oil prices. Additionally, there is a long-term causal relationship between inflation rates and domestic oil prices, as well as between domestic oil prices and exchange rates. Additionally, in the field of domestic research, Rezazadeh [26] found in a study that the effects of oil supply and demand shocks on the exchange rate in Iran indicate that global demand and rising oil prices lead to a decrease in the exchange rate and an appreciation of Iran's national currency, resulting in Dutch disease in Iran's economy. Furthermore, based on the results obtained, it can be said that the effect of global oil supply shocks on the exchange rate is not significant and does not play a significant role in the fluctuations of Iran's foreign exchange market. Kazerouni et al. [13] investigated the impact of oil revenue volatility on the relationship between the exchange rate and the (non-oil) trade balance during the period 1973-2016 using the Markov-switching approach. They classified Iran's trade balance behaviour into three regimes (high deficit, low deficit, and medium deficit). They found that an increase in the exchange rate improves the trade balance in all three regimes. On the other hand, oil revenue volatility has a significant negative impact on the relationship between the exchange rate and the trade balance in all three regimes. In the present research topic, considering the observed studies, it seems that a new formulation will emerge. However, none of these existing works, both domestically and internationally, have precisely investigated the relationship between the exchange rate and oil supply and demand shocks in the countries of the Persian Gulf region. Therefore, considering this important point, it is crucial in the innovation aspect of this research to strive towards examining and evaluating the position of the exchange rate and oil supply and demand shocks in the countries of the Persian Gulf region in theoretical, methodological, and operational dimensions, to demonstrate the significance of this area for both domestic and foreign policymakers in various fields. Alongside this, the threats and opportunities arising from the subject are outlined for the Islamic Republic, and a series of practical measures based on economic rationality are proposed for better energy governance. Accordingly, the main question of this research is: "How is the impact of oil supply and demand shocks on the exchange rate of the Persian Gulf countries?"

2 Theoretical foundations

2.1 Factors affecting oil price fluctuations

One of the primary sources of energy is oil. The importance of oil as an energy source and its influence on the global economic system has continuously increased, and countries worldwide extensively utilize it [11]. Crude oil is a mixture of hydrocarbons that exists in solid, liquid, and gas states. The chemical properties and the costs of oil extraction and transportation are determined by geographical location. Consequently, the oil industry is examined based on this geographical position. The factors influencing oil prices overall can be divided into two main groups: fundamental factors and non-fundamental factors. Based on conducted studies, it can be said that supply and demand are among the fundamental factors, while financial markets are among the non-fundamental factors affecting oil prices. Consequently, any change in each of these factors leads to the occurrence of an oil shock by passing through these two channels. On the other hand, shocks affecting oil prices have various effects on the economies of countries, depending on their position in the global oil market, economic and institutional structures, and the level of economic development of the country [19].

Table 1: Factors affecting oil price fluctuations

Researcher	**Effective factors**
Barsky and Kilian [3]	1) Supply shocks; 2) Demand shocks; 3) Precautionary demand shocks
Kilian [15]	1) Global supply; 2) Global demand; 3) Precautionary demand in the oil market
Olovsson [23]	1) Demand shocks 2) Oil reserves in the world

Supply shocks, or shocks that affect the current physical access to crude oil resources. Total demand shocks refer to shocks affecting the current demand for oil due to fluctuations in the global business cycle. Precautionary demand shocks, arising from changes in precautionary demand [15]. Among these three shocks, the oil supply shock has been thoroughly examined considering global crude oil production statistics and data. Precautionary demand in the oil market arises due to the lack of confidence resulting from anticipated shortfalls in expected supply compared to expected demand. This demand indicates easy access to oil reserves and can provide energy supply security in the event of disruptions in oil supplies [25].

All three types of these shocks have different effects on the global oil price. For example, if precautionary demand for crude oil increases, the real price of crude oil immediately and steadily rises. If demand for industrial goods increases, it leads to a delayed but stable increase in the real price of oil. If disruptions occur in crude oil production, it causes a temporary, short-lived, and insignificant increase in the real oil price in the first year. Analyzing historical fluctuations in the global oil price, we realize that the shocks affecting the oil price are more influenced by a combination of total global demand shock and precautionary demand shock rather than solely supply shocks. The results of Kilian's study indicate that the impact of external events such as wars or revolutions on the global oil price is influenced by their effect on precautionary demand for oil. When crude oil production remains unchanged, these events can potentially have immediate and significant effects on the real price due to changes in uncertainty about future shortages in oil supply [15].

2.2 Factors affecting the supply and demand of oil

The modern civilization is built upon oil. Oil plays two fundamental roles in creating the new global system. On one hand, it is the most important factor in energy production and propulsion in household, industrial, and transportation sectors. On the other hand, it serves as the primary raw material for the production of most products such as various types of oils, lubricants, and so on. As we see, oil production and consumption are geographically separated. Therefore, in terms of international transportation and shipping, this commodity holds the most important and top rank in the world [22]. The impact of oil and oil revenues on shaping the modern world has been examined in various ways. For example, the role of oil in defence during the First World War period is so clear and prominent that Georges Clemenceau, the Prime Minister of France, stated on December 15, 1917, in his address to Wilson, the President of the United States: 'Our army is so dependent on fuel that it collapses if faced with a shortage, so an additional capacity equivalent to one hundred thousand tons of fuel must be provided for the French army. To prevent defeat, France must have the necessary fuel.' The importance of oil in shaping the international economy and trade after World War II is also very significant. After the establishment of the Bretton Woods system in 1944 and the establishment of a stable link between gold and the dollar, during the period from 1950 to 1969, concurrent with the economic improvement of Germany and Japan, America's share of economic production decreased by 10 percent. This, along with the Vietnam War, led to a decrease in the value of the dollar in the same decade of the 1960s [20].

In the following, some of the most important factors affecting oil supply and demand are briefly mentioned in tables 2 and 3.

Table 2: Factors affecting oil supply [27]

Effective factors	**Brief description**
Production costs	Changes in technology and innovation lead to changes in the costs of oil exploration and extraction, and as a result of these cost changes, oil supply will certainly undergo changes.
The structure of the oil market	The oil market structure initially started as an oligopoly, with a few companies actively involved. However, after OPEC gained power, a monopolistic pattern emerged. Over time, a free oil market was established. Now, the fundamental decision-making for oil prices is not solely in the hands of OPEC; rather, it is the decisions of buyers and sellers that determine oil prices globally.
Natural disasters and technical factors	Any factor that leads to the destruction or damage of oil reserves or facilities will result in a decrease in oil supply. For example, if loading docks suffer damage due to events like earthquakes or hurricanes and are closed, or if oil tankers encounter accidents, the oil supply will face difficulties. In this regard, Hurricane Katrina in 2004 can be mentioned, which led to a $5 increase in oil prices in America.
Discoveries and deposits	Commercial and strategic reserves, in addition to demand, also have an impact on supply. The global oil reserves, the status of these reserves, the level of exploratory potential, new discoveries, annual replacement rates of reserves, and the volume of developmental investments all influence the oil market.
Production capacities	After the 1970s, industrialized countries sought to minimize their dependency on OPEC production. Therefore, the relationship between potential production capacity and actual production levels was almost severed within the OPEC organization. This has led OPEC to always have surplus capacity.

Table 3: Factors affecting oil supply [7]

Effective factors	**Brief description**
Price elasticity of demand	The effect of price changes on the demand for a commodity is expressed through its price elasticity of demand. Crude oil and its derivatives are considered inelastic goods due to their significant importance in the economy of every country.
Lack of competition in the market	The likelihood of price stability for oil is higher in competitive markets than in other markets. So far, no substitute commodity for oil has been discovered, so the probability of substitute competition for oil is zero.
Global economic growth	Global economic growth leads to an increase in global oil demand. High demand and consumption of oil indicate a country's development. For example, in developed and industrialized countries that are members of the OECD, the impact of economic growth on demand is relatively constant, with approximately a 0.05% increase in energy demand predicted for every 1% of economic growth.
Relative oil price expectations	The expectation of rising oil prices in the future leads to an increase in oil demand, shifting the demand curve upwards.
Demand for oil storage	The oil market is a unified market, and if a problem arises, it affects all countries. Therefore, to maintain the security of the oil market, all consuming countries are obliged to accept their share and play their role in storage.

3 Research methodology

The research is analytical based on the subject and objective, and it uses a time series data method for its design and methodology. In this study, the method of collecting information and data will be library-based and documentary. For gathering information for the theoretical section, sources will include library references, reputable articles from specialized websites, documents, theses, and case studies (in both Persian and English), as well as energy balance sheets. Additionally, in the empirical section, the required information and data for this study to examine the manner and extent of the impact of exchange rates and oil supply and demand shocks in the Gulf countries will be collected from various national databases such as the Central Bank of the Islamic Republic of Iran, the Statistical Center of Iran, the World Bank's WDI database, IMF reports, and ultimately, the price of Brent crude oil or similar sources from the U.S. Energy Information Administration's statistical reports. In summary, all official government and global reports related to the research variables will be used. The statistical population of this research comprises the Gulf countries, including Saudi Arabia, the UAE, Qatar, Kuwait, Iraq, and Iran. The data in question will cover the period from 2000 to 2023 every month.

The first step in estimating an SVAR model is to use its reduced form. A reduced VAR model can be estimated using the OLS method, and the structural VAR parameters can be obtained from it. However, since the number of parameters in the two models is not equal, a total of $\frac{n(n-1)}{2}$ constraints must be applied to the model to identify all the unknown parameters of the model. Accordingly, six constraints are required for the complete identification of the model.

Identifying constraints in structural vector autoregressive (SVAR) models offers greater flexibility compared to the Cholesky decomposition method because the recursive structure resulting from the Cholesky decomposition is a special case of the SVAR model. It is important to note that in the traditional approach, the variance-covariance matrix of the disturbance terms is not subject to any constraints. In fact, this is the main difference between identification in the traditional method and the SVAR method. This methodology is sometimes referred to as shock and disturbance analysis. Typically, there are two types of constraints for identification. The first type consists of constraints applied to the short-term behaviour of the system components, and the second type consists of constraints applied to the long-term behaviour of the system. Using EVIEWS software, both types of constraints can be applied to the model. However, it is important to note that it is not possible to use both sets of constraints simultaneously in one VAR model; only one set of constraints can be applied. As a result, this research will identify the model by applying long-term constraints.

According to the VAR reduction form, if we assume ε to represent the vector of structural disturbances, which is serially and mutually uncorrelated, and also if e represents the reduced VAR disturbances, such that $e_t = \theta^{-1}e_t$, then the structural disturbances are determined by imposing long-term restrictions on the identification matrix. The desired model considers a block recursive structure on the simultaneous relationship between reduced disturbances and the corresponding structural disturbances [8]. Based on this, in this study, using the Blanchard and Quah [6] approach and following the studies of Blanchard and Galí [5], Kilian and Park [16], and Abouwafia and Chambers [2], we define the necessary matrix form to solve the SVAR model.

The Structural Vector Autoregression (SVAR) model is a multivariate time series model commonly used in econometrics to analyze the dynamic relationships among variables. The general form of an SVAR model can be expressed as follows:

$$Y_t = A_1Y_{t-1} + A_2Y_{t-2} + \dots + A_pY_{t-p} + \varepsilon_t \tag{3.1}$$

where, Y_t is a vector of endogenous variables at time t, $A_1, A_2, \dots, A_p$ are coefficient matrices corresponding to lagged values of the endogenous variables, and ε_t is a vector of error terms at time t, which captures the impact of exogenous shocks.

The SVAR model assumes that the errors ε_t are white noise processes and that the coefficients matrices $A_1, A_2, \dots, A_p$ are structural parameters that represent the contemporaneous causal relationships among the variables. Estimating the SVAR model involves identifying the coefficients matrices $A_1, A_2, \dots, A_p$ using statistical techniques such as ordinary least squares (OLS) or maximum likelihood estimation (MLE). Additionally, the SVAR model can be used to derive impulse response functions and forecast future values of the endogenous variables.

Ordinary Least Squares (OLS):

Given a set of observations (x_i, y_i) for $i = 1, 2, \dots, n$, where x_i are the independent variables and y_i are the dependent variables, the OLS estimator for the coefficients β in a linear regression model $y = \beta_0 + \beta_1 x + \varepsilon$ is given by:

$$\hat{\beta} = (X^TX)^{-1}X^Ty \tag{3.2}$$

where, $\hat{\beta}$ is the estimated coefficient vector, X is the design matrix of independent variables, y is the vector of dependent variables, X^T denotes the transpose of X, and $(X^TX)^{-1}$ is the inverse of the matrix X^TX.

Maximum Likelihood Estimation (MLE):

Maximum Likelihood Estimation is a method used to estimate the parameters of a statistical model by maximizing the likelihood function. In the context of linear regression with Gaussian errors, the likelihood function is given by:

$$L(\beta) = \prod_{i=1}^{n} f(y_i|x_i, \beta) \tag{3.3}$$

where, β is the vector of parameters to be estimated, and $f(y_i|x_i, \beta)$ is the conditional probability density function of the response variable y_i given the predictor variable x_i and the parameters β. Maximizing the likelihood function $L(\beta)$ with respect to β is equivalent to maximizing the log-likelihood function, which is usually more convenient:

$$\ell(\beta) = \sum_{i=1}^{n} \log f(y_i|x_i, \beta) \tag{3.4}$$

The estimates of the parameters β are obtained by finding the values that maximize the log-likelihood function $\ell(\beta)$, typically using numerical optimization algorithms like gradient descent or Newton's method.

1. Nominal variable shocks such as inflation do not have a long-term effect on real variables such as real exchange rates.
2. In the long run, oil shocks are not influenced by shocks to other variables except for their own shocks.
3. Stock market index shocks do not have any effect on other variables in the long run.
4. The orthogonality constraint indicates that in SVAR models, structural disturbances are orthogonal.

4 Results

In the present study, we employ a two-stage approach. The first stage, based on Kilian's method [15], is dedicated to calculating the structural shocks to oil supply and demand. To generate the structural shocks to oil supply and demand, we initially consider a Structural Vector Autoregression (SVAR) model.

The result of estimating the SVAR model with these constraints is to determine the oil supply shocks (ε_t^s), total demand shocks (ε_t^d), and oil-specific demand shocks (ε_t^o). These shocks are then used in the following model. Equation (4.1) is calculated for each country individually:

$$ER_t = \alpha_0 + \alpha_{1;i} \sum_{i=0}^{2} \varepsilon_{t-i}^s + \alpha_{2;i} \sum_{i=0}^{2} \varepsilon_{t-i}^d + \alpha_{3;i} \sum_{i=0}^{2} \varepsilon_{t-i}^o \tag{4.1}$$

in which ER_t represents the logarithm of exchange rate fluctuations in period t, ε_t^s represents oil supply shocks, ε_t^d represents total demand shocks, and ε_t^o represents oil-specific demand shocks.

The real price of oil in dollars per barrel was measured using the price of refined crude oil in American refineries, adjusted for inflation using the U.S. Consumer Price Index. Global crude oil production (in million barrels) and oil price information were obtained from the U.S. Energy Information Administration (USEIA). The Global Real Economic Activity Index (Kilian index) was also obtained from Professor Lutz Kilian's website. Exchange rate fluctuation data were collected from the International Settlements Bank. The data is collected every month. The SVAR model covers the period from January 2000 to May 2023. However, the time interval for estimating exchange rate shocks varies for different countries based on their data. Except for Iran, for other countries, the time interval starts from January 2000 and continues until May 2023. Iran is the only country where the interval ranges from January 2000 to August 2022.

Determining the optimal interval length

In the model under investigation, we first set the maximum order. Then, we reduce the order until the optimal pause is determined. To determine the number of these optimal pauses, criteria such as Akaike Information Criterion, Schwarz Information Criterion, Hannan-Quinn Information Criterion, prediction error, and maximum likelihood ratio can be used.

Akaike Information Criterion (AIC):

$$AIC = -2\log(L) + 2k \tag{4.2}$$

Schwarz Information Criterion (SIC):

$$SIC = -2\log(L) + k\log(n) \tag{4.3}$$

Hannan-Quinn Information Criterion (HQIC):

$$HQIC = -2\log(L) + 2k\log(\log(n)) \tag{4.4}$$

Prediction error:

$$\text{Prediction error} = \sum_{t=1}^{T}(y_t - \hat{y}_t)^2 \tag{4.5}$$

Maximum likelihood ratio:

$$\text{Maximum likelihood ratio} = \frac{max(likelihood)_1}{max(likelihood)_0} \tag{4.6}$$

Here, L represents the likelihood function, k is the number of parameters in the model, n is the number of observations, y_t is the actual value, and $\hat{y}_t$ is the predicted value.

Table 4: Optimal number of lags

LAG	**LOGL**	**LR**	**FPE**	**AIC**	**SC**	**HQ**
0	-2399.911	NA	8867.157	17.603	17.643	17.619
1	-1305.309	2157.127	3.117	9.650	9.809	9.714
2	-1234.634	137.726*	1.984*	9.198*	9.476*	9.310*
3	-1227.845	13.079	2.016	9.214	9.611	9.374
4	-1220.739	13.535	2.045	9.228	9.744	9.435
5	-1214.505	11.737	2.087	9.249	9.883	9.503
6	-1211.432	5.718	2.180	9.229	10.046	9.595
7	-1204.219	13.263	2.210	9.305	10.178	9.655
8	-1199.166	9.180	2.276	9.334	10.326	9.732

According to Table 4, all criteria indicate an optimal breakpoint of 2, marked with an asterisk *. Therefore, the SVAR model is estimated with 2 breakpoints.

Initial estimation of the model

It should be noted that in the specialized literature, the discussion of stationarity and non-stationarity of VAR models is unnecessary, and the use of research variables at any level will not pose any particular problem for the model [1]. Now, after determining the optimal breakpoint of 2, the vector autoregression model itself is estimated. The results are observable in Table 5.

Table 5: Initial estimation by vector autoregression method

	WOP	**K**	**LCOP**
WOP(-1)	0.932	-0.173	-0.011
	(0.059)	(1.175)	(0.005)
WOP(-2)	-0.006	-0.902	0.015
	(0.056)	(1.121)	(0.005)
K(-1)	-0.001	1.239	0.0001
	(0.002)	(0.058)	(0.005)
K(-2)	-0.002	-0.337	0.0001
	(0.002)	(0.059)	(0.000)
LCOP(-1)	3.239	0.668	1.393
	(0.589)	(11.66)	(0.053)
LCOP(-2)	-2.419	9.482	-0.459
	(0.604)	(12.05)	(0.054)
R-squared	0.960	0.931	0.971
Adj. R-squared	0.956	0.930	0.970

In vector autoregressive models, each variable is regressed on its own lags and other variables. Therefore, for each variable in the model, two equations are estimated based on the optimal breakpoints. It should be noted that, unlike other models, the coefficients of VAR patterns are not interpretable. The aim of the current study is not to interpret the coefficients but rather to obtain shocks using the SVAR method defined in the methodology section and the data.

The shocks to oil supply exhibit greater fluctuations over the period under study compared to the other two shocks, while the shocks to total demand have experienced greater fluctuations since 2006. Shocks to oil-specific demand initially had less fluctuation but increased in intensity over time, with the highest fluctuations occurring in the years 2021 and 2022.

Mean (μ):

$$\mu = \frac{\sum_{i=1}^{n}}{n} \tag{4.7}$$

Median:

$$Median = \begin{cases} x_{\frac{n+1}{2}}, & \text{if n is odd} \\ \frac{x_{\frac{n}{2}} + x_{\frac{n}{2}+1}}{2}, & \text{if n is even} \end{cases} \tag{4.8}$$

Standard Deviation (σ):

$$\sigma = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \mu)^2}{n}} \tag{4.9}$$

Skewness:

$$Skewness = \frac{\frac{1}{n}\sum_{i=1}^{n}(x_i - \mu)^3}{(\frac{1}{n}\sum_{i=1}^{n}(x_i - \mu)^2)^{\frac{3}{2}}} \tag{4.10}$$

Kurtosis:

$$Kurtosis = \frac{\frac{1}{n}\sum_{i=1}^{n}(x_i - \mu)^4}{(\frac{1}{n}\sum_{i=1}^{n}(x_i - \mu)^2)^2} \tag{4.11}$$

Table 6: Statistical summary of exchange rate changes for the six countries under study and calculated shocks

	Iran	Iraq	Kuwait	Qatar	Emirates	Saudi Arabia	Supply shock	Demand shock	Shock specific to oil
Mean	9.523	7.208	-1.22	1.291	1.300	1.321	0.0000	0.0000	0.0000
Median	9.258	7.076	-1.20	1.291	1.300	1.321	0.018	-0.045	0.015
Maximum	10.678	8.160	-1.17	1.291	1.300	1.323	2.647	4.607	8.441
Minimum	7.467	7.061	-1.32	1.291	1.300	1.316	-3.984	-4.074	-3.626
Std. Dev.	0.926	0.201	0.038	0.000	0.000	0.0004	0.989	0.989	0.989
Skewness	-0.630	1.471	-0.741	NA	NA	-7.892	-0.507	0.301	1.884
Kurtosis	2.917	4.627	2.598	NA	NA	100.869	4.169	6.068	21.583
Observation	272	278	281	281	281	281	279	279	279

Structural shocks have mean values close to zero, but their standard deviations have significant fluctuations. Regarding exchange rate fluctuations, it should be noted that Iraq and Iran experienced the highest changes in exchange rates, while the other four countries had very little fluctuations.

To estimate the equation, the stationarity of variables is first examined. The Augmented Dickey-Fuller (ADF) test is used to assess the stationarity of variables. The results are shown in Table 7.

The Augmented Dickey-Fuller (ADF) test is represented by the following equation:

$$\Delta y_t = \alpha + \beta t + \gamma y_{t-1} + \delta_1 \Delta y_{t-1} + \delta_2 \Delta y_{t-2} + ... + \delta_k \Delta y_{t-k} + \varepsilon_t \tag{4.12}$$

where, Δy_t is the difference time series at time t, α is the intercept term, β is the coefficient on the time trend, γ is the coefficient on the lagged level of the series, δ_k are the coefficients on the lagged differences of the series, ε_t is the error term, and k is the lag order chosen for the test.

According to the results in the table, the variables of supply shock, demand shock, and oil-specific shock exhibit stationarity of order zero. In other words, the variables are at a stationary level. Regarding exchange rate fluctuations, the results indicate that the logarithm of exchange rate fluctuations in Saudi Arabia is stationary. However, this variable is integrated of order one for the other three studied countries. Therefore, estimation for Saudi Arabia is conducted using Ordinary Least Squares (OLS) regression, while for the other three countries, Vector Error Correction Model (VECM) is employed. Now that the estimation method for each country is determined, the equations for the studied countries have been estimated, and the results are reported in Table 8.

The Vector Error Correction Model (VECM) can be represented by the following equations:

$$\Delta y_t = \Pi_0 + \Pi_1 y_{t-1} + \Pi_2 \Delta y_{t-1} + ... + \Pi_p \Delta y_{t-p+1} + \varepsilon_t \tag{4.13}$$

Table 7: The results of the generalized Dickey-Fuller test (Numbers in parentheses indicate P-Value)

Variable name	**The value of the test statistic at the significance level**	**The value of the test statistic at the first difference**	**Degree of co-accumulation**
Iran exchange rate fluctuation logarithm	-2.217 (0.202)	-3.381 (0.015)	I(1)
Iraq exchange rate fluctuation logarithm	-0.918 (0.784)	-8.192 (0.000)	I(1)
Kuwait exchange rate fluctuation logarithm	-1.844 (0.358)	-9.432 (0.000)	I(1)
Saudi Arabia exchange rate fluctuation logarithm	-8.962 (0.000)	—	I(0)
Supply shock	-16.321 (0.000)	—	I(0)
Demand shock	-16.516 (0.000)	—	I(0)
Shock specific to oil	-13.262 (0.000)	—	I(0)

where, Δy_t is the differenced y_t vector, Π_i's are coefficient matrices and ε_t is the residual term. The long-run relationship between the variables can be expressed as:

$$\Delta y_t = \alpha\beta' y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + \varepsilon_t \tag{4.14}$$

where, α is a matrix of parameters that describe the long-run equilibrium relationship, β' is the transposed vector of the cointegrating vector, Γ_i's are matrices of short-run dynamics parameters, and ε_t is the residual term.

Table 8: Estimated coefficients for the studied countries (Numbers in parentheses indicate P-Value. * Significance at the 90% level, ** Significance at the 95% level, *** Significance at the 99% level)

	Iran	**Iraq**	**Kuwait**	**Saudi Arabia**
Intercept	0.117** (0.026)	0.382*** (0.004)	-0.014** (0.05)	1.321*** (0.000)
Supply shock	0.001 (0.82)	-0.005 (0.158)	-0.0002 (0.387)	-5.06E-05** (0.042)
Demand shock	-0.0003 (0.942)	4.87E-05 (0.989)	0.0001 (0.480)	-4.05E-05 (0.103)
Oil-specific shock	0.004 (0.359)	0.001 (0.714)	-0.0004* (0.058)	-3.91E-05 (0.121)
First lag of the supply shock	0.004 (0.427)	0.004 (0.190)	0.0002 (0.339)	-5.74E-05** (0.023)
Second lag of the supply shock	0.001 (0.765)	0.006 (0.100)	-8.36E-05 (0.739)	-3.18E-05 (0.206)
First lag of the demand shock	-0.001 (0.764)	-0.001 (0.727)	-0.0004* (0.091)	-6.90E-06 (0.783)
Second lag of the demand shock	0.002 (0.604)	0.001 (0.719)	1.91E-05 (0.939)	7.17E-06 (0.775)
First lag of the oil-specific shock	0.003 (0.454)	0.001 (0.612)	-0.0001 (0.520)	-2.16E-05 (0.385)
Second lag of the oil-specific shock	7.33E-05 (0.988)	0.002 (0.536)	-0.0001 (0.559)	-2.28E-05 (0.364)

Based on the results in Table 8, the coefficients of oil supply shocks are only significant for Saudi Arabia and are not statistically significant for the other three countries studied. The lag coefficients are only statistically significant at the first lag for Saudi Arabia and are not statistically significant for the other countries. The coefficients of aggregate demand shocks do not have a significant impact on the exchange rate fluctuations of these countries. The lags of the demand shock are statistically insignificant, with only the first lag being significant for Kuwait. The impact of oil-specific demand shocks on exchange rate fluctuations is significant for Kuwait. Specifically, an increase in oil-specific demand (within a one-month period) causes the value of the Kuwait currency to decrease against the basket of major trading partner currencies. The one-month oil-specific demand shock (lags) is statistically insignificant for all countries.

5 Conclusion and suggestions

In this study, the impact of oil supply and demand shocks on exchange rate fluctuations in four Middle Eastern countries—Iran, Iraq, Kuwait, and Saudi Arabia—was examined. The results indicate that, overall, oil supply and demand shocks do not have a significant impact on the exchange rate fluctuations of these countries. These findings are contrary to the usual belief that oil prices affect the exchange rates of these countries. The researchers suggest that policies aimed at reducing the impact of oil market shocks on exchange rates should be approached with caution, especially if such interventions entail other costs. Adopting a strategy of patience and observation might help avoid the negative effects of strong and intense interventions in the foreign exchange market, particularly when the source of the shock is unclear.

Based on the results, it was observed that the coefficients of oil supply shocks are significant only in Saudi Arabia and are not statistically significant in the other three countries studied. The lag coefficients are only statistically significant at the first lag for Saudi Arabia and are not significant for the other countries. Regarding the coefficients of total demand shocks, they do not have a significant impact on the exchange rate fluctuations of these countries. The lags of the demand shock are also statistically insignificant, except for the first lag in Kuwait, which is statistically significant. The impact of oil-specific demand shocks on exchange rate fluctuations is significant for Kuwait. Specifically, a simultaneous increase in oil-specific demand (within one month) causes the value of the Kuwaiti dinar to decrease against the basket of major trading partner currencies. The one-month lags of oil-specific demand shocks are statistically insignificant for all countries. In other words, the results indicate that, overall, oil supply and demand shocks do not significantly impact the exchange rate fluctuations of these countries. These findings contradict the usual notion that oil prices affect the exchange rates of these countries. Researchers suggest that caution should be exercised in policies aimed at reducing the impact of oil market shocks on exchange rates, especially if such interventions have additional costs. A strategy of patience and observation might help avoid the negative effects of strong and aggressive intervention in the foreign exchange market, particularly when the source of the shock is unclear. Therefore, it can be confidently stated that no firm, robust, and long-term impact of structural oil supply and demand shocks on the exchange rates of these countries was found. In contrast, other studies on these same countries often show that oil prices do affect their exchange rates. These findings are consistent with the results of Kilian and Zhou [17] and Basher et al. [4]. The results regarding the coefficients align in most cases with the findings of Basher et al. [4]. These results also align with the findings of Kilian and Zhou [17], which suggest that a large portion of the exchange rate fluctuations of the U.S. relative to the global oil market are exogenous.

Based on the results, it must be said that our understanding of the role of oil market shocks in foreign exchange markets is still incomplete and there is still room for further research. One strategy is to further decompose oil supply and demand shocks, for example, by including variables related to oil consumption demand or oil storage in the SVAR model. Another strategy might be to use other restrictions in the SVAR model, such as sign restrictions, to better link the empirical model to its theoretical and logical foundations. While Kilian and Zhou [17] have recently refined SVAR models for advanced economies like the U.S., it is necessary to test other smaller open economies in the same manner. Kilian and Zhou [18] have provided very good explanations about recent advancements in the econometrics of the oil market, and studying this research can enhance our understanding of oil markets.

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