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Modelling Inflation Dynamics and Global Oil Price Shocks in OAPEC Countries: TVP-VAR

Marwa Elsherif*

Helwan University, Cairo, Egypt. *Email: marwassem@yahoo.com

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ABSTRACT

This paper aims to examine the dynamic pass-through effect of oil price shocks on inflation in OAPEC countries using quarterly data ranging from 1990:Q1 to 2022:Q4. The incorporation of the TVP-VAR model along with the Markov Chain Monte Carlo method with stochastic volatility estimation offers a robust framework for capturing the time-varying nature of the relationship. Additionally, the analysis of the Impulse Response Function provides valuable insights into the short-term and long-term dynamics following oil price shocks. The results demonstrate a significant positive pass-through effect of oil prices on inflation in the sample member states, with heterogeneous magnitude and persistence. These variations are attributed to diversity in oil dependency, exchange rate regimes, monetary policy frameworks and the degree of openness to global markets. The study suggests the need for effective inflation management strategies and appropriate policy responses to oil price fluctuations. Furthermore, policymakers may consider adjusting exchange rates, interest rates, or trade policies to manage inflationary pressures effectively.

Keywords: Inflation, Oil Price Shocks, TVP-VAR Model, Markov-Switching, OAPEC
JEL Classifications: C22, C32, E31, Q40

1. INTRODUCTION

Oil plays a crucial role in the expansion of the industrial base of any economy and also in its indigenous consumption. Oil shocks have continuously been a major concern for economists, academics and policymakers due to their considerable impact on the macroeconomic variables. Various supply and demand factors are considered to drive oil prices. Fluctuations in oil price levels can affect the economy in multiple means depending on which factor forces the change (Kilian, 2009; Ratti and Vespignani, 2013; Basak and Pavlova, 2016; Rizwan et al., 2023). The ability to deduce the exact drivers has significant implications for determining the proper policy that evolves the macroeconomic conditions from both domestic and global standpoints (Gospodinov and Ng, 2013; Filardo and Lombardi, 2014; Filardo et al., 2018, Iftikhar et al., 2022).

As evident from the oil shock and the stagflation of the 1970s, raising oil prices can trigger a wage-price spiral, which in turn affects the prices of various commodities that rely on oil as an input. Oil price shocks have conceived cost-push inflation across countries, which drops production levels and diverts the terms of trade (Blinder et al., 2008). Notwithstanding, due to developed countries' steadiness of their economic conditions, they can maintain the adversities of oil price shocks. On the contrary, the volatile nature of oil prices in developing nations is critical, this is attributed to the lack of oil-conserving technologies combined with the deficiency of oil substitutes for production (Cashin et al., 2000)[1].

Over the past years, oil prices have oscillated and experienced intensive upturns and shrinkages. During the oil shock of the 1970s, it has been witnessed that oil prices rose from $3 per barrel in 1970 to around $40 per barrel in 1979 (OECD, 2014).

1 According to Cashin et al. (2000) study on the impact of higher oil prices on the global economy, they revealed that a $5 per barrel increase in oil price led to a reduction in the economic growth of the industrial countries by 0.3%, further excavating the inflation in the short run.

Fluctuations in oil prices are in some cases owed to political aspects disrupting supply chains, such as the Iran-Iraq war in 1980 which led to spiking oil prices (Gately, 1986). As a result of the Persian Gulf crisis, there was a temporary increase in oil prices in the 1990s, the price of crude oil doubled from $20 per barrel in July 1990 to $40 per barrel in October 1990 (Renner and Aarts, 1991). During 1998-2008 oil prices rose from $15 per barrel to almost $140 per barrel, likewise, inflation witnessed a global dramatic increase, spiking from 164.30 (January 1999) to 214.82 (April 2008) (World Bank, 2015)[2]. In contrast, the Asian financial crisis that hit several Asian economies in 1997 resulted in a sharp drop in oil demand, leading to a decline in oil prices. Crude oil prices fell from around $25 per barrel in late 1997 to below $10 per barrel in late 1998 (IMF, 1998b). Moreover, the bursting of the dotcom bubble in the early 2000s led to a global economic downturn (Mills, 2011), which resulted in reduced oil demand, crude oil prices declined from around $30 per barrel in 2000 to below $20 per barrel in 2002 (IMF, 2003).

However, the global financial crisis caused a severe economic recession, oil prices steadily rose with a sharp spike in 2008, followed by an even larger decline and a rebound (Kilian, 2008; Joo et al., 2000). It plummeted from around $147 per barrel in July 2008 to around $30 per barrel in December 2008 due to an acute decline in global oil demand (IMF, 2009). Elevated volatility in these developments has raised concerns that oil prices could again spill over into higher overall inflation (ECB, 2012; IEG, 2012). In the fourth quarter of 2014, however, global oil prices fell sharply again, raising deflationary pressures on headline inflation in most economies (Baffes et al., 2015). Furthermore, political uprisings and civil unrest in several Middle East and North African countries (MENA) during 2010 and 2011, collectively known as the Arab Spring, raised concerns about oil supply disruptions. Prices surged, with Brent crude oil reaching around $126 per barrel in April 2011 (Hsiao et al., 2016).

Following a nearly decade, the global pandemic caused by the outbreak of the novel COVID-19 led to widespread lockdowns and travel restrictions, severely impacting oil demand. Oil prices collapsed in April 2020, with WTI crude oil briefly trading in negative territory for the first time in history (World Bank, 2020a). As reported by OECD (2020), the blow of the coronavirus combined with the oil price shocks is a double hit for oil-exporting developing countries. The International Energy Agency (IEA) estimated a severe drop between 50% and 85% in 2020 oil and gas revenues for several key producers compared to the year before (IEA, 2020). During the end stage of the Covid-19 pandemic compounded by the conflict in Ukraine, inflation surged around the world, and there has been a significant focus on high inflation in discussions about macroeconomic policy (Reinhart and Von Luckner, 2022)[3].

In various countries, inflation rates have reached their highest levels in several decades, such as 8.6% in the United States in May 2022 (the highest in 40 years) and 8.1% in the Euro area (the highest since the creation of the Euro). This rise in inflation had already occurred in other advanced and emerging market economies even earlier (IMF, 2022a). As reported by Celasun et al., two primary factors driving the current surge in inflation are commodity prices and supply bottlenecks (2022). The war in Ukraine has further increased commodity prices and exacerbated supply bottlenecks, which were already worsened by COVID-19 (IMF, 2022c).

There is a large body of existing research examining the dynamic relationship between oil prices and the rate of inflation, amongst Mork (1989, 1994); Mork et al. (1994); Lee et al. (1995); Hamilton (1996); Hooker (1996); Bhattacharya and Bhattacharya (2001); Davis and Haltiwanger (2001); Brown and Yücel (2002); Cunado and Gracia (2003); Jones et al. (2004); Tang et al. (2010); Gómez-Loscos et al. (2012); Varghese (2017); Zhang et al. (2018); Odhiambo (2020); Ross (2022); Sharma and Dahiya (2023); Neifar and Kammoun (2022). This article contributes to the existing literature primarily on multiple grounds. Firstly, this paper investigates the oil-inflation nexus in the Organization of Arab Petroleum Exporting (OAPEC thereafter) countries based on country-specific analysis to identify the variations across different economies (net oil-exporters and net oil-importers). Furthermore, this work employs the Structural Vector Autoregressive (VAR) model to disentangle the impact of oil price shocks on inflation and estimates the responses of various control variables in the short-term and long-term with a focus on a sample of six OAPEC countries. Moreover, the findings of this paper could improve economic forecasting and contribute to the broader literature on energy economics.

The remainder of this paper is organized as follows: Section 2 reviews the related literature, sections 3 and 4 describe the data and methodology to estimate the impact of oil price shocks as one of the key determinants of inflation, section 5 provides empirical results and discussions and finally, section 6 illustrates the conclusion of the article.

2. RELATED LITERATURE

The literature concerned with the impact of oil price fluctuations on the economy is extensive. The oil price receives remarkable attention, not only because it represents a crucial input in manufacturing but also due to its prominent transmission into inflation. A large strand of the empirical literature is devoted to determining the impact of oil price shocks on macroeconomic variables such as real economic activity (Kim and Loungani 1992; Das et al., 2018; Widarjono and Susantun, 2020; Lee and Cho, 2021), economic growth (Jiménez-Rodríguez and Sánchez, 2005; Ghalayini, 2011; Abdelsalam, 2023), unemployment (Doğrul and Soytas, 2010; Cheratian et al., 2019; Almutairi, 2020) and external balances (Kilian et al., 2009; Vespignani and Raghavan, 2019).

However, the impact of oil prices on inflation is a particularly active topic in the literature, and mixed results are presented. For example, some authors found clear effects of oil prices transmitting into domestic inflation (Barsky and Kilian, 2004; Du et al., 2010;

2 The base year of 1982, compiled by the US Bureau of Labour Statistics.

3 In 15 out of 34 advanced economies, the 12-month inflation through December 2021 ran above 5%. Such a symmetric jump in domestic inflation has not been seen for more than 20 years (IMF, 2022a).

Sek et al., 2015; Salisu and Isah, 2017; Choi et al., 2018; Nusair; 2019). Others argued that among economic practitioners and policymakers, oil price shocks have at least a partial pass-through effect on inflation in both developed and emerging/developing economies (Mirzaei and Al-Khouri, 2016; Živkov et al., 2018). Another batch of literature observed that this pass-through effect has decreased over time (Hooker, 2002; Doroodian and Boyd, 2003; Blanchard and Gali, 2007; De Gregorio et al., 2007; Chen, 2009; Alvarez et al., 2011; Valcarcel and Wohar, 2013). While other studies indicated that there is a short-run, but no long-run influence of oil prices on inflation (Cologni and Manera, 2008; Anh et al., 2021). In contrast, Rafiq and Salim (2014) detected no evidence of oil prices influencing inflation in some countries. In short, the heterogeneous results stem from multiple reasons such as differences in countries studied, estimation techniques, data samples and frequencies.

Another parallel strand of the literature has focused on the effects of oil shocks on oil-importing countries (Hamilton, 1983; Bernanke et al., 1997; Kilian, 2009; Kilian and Murphy, 2014; Allegret et al., 2015). Although some studies claimed that the impact of oil prices on the macroeconomic variables has decreased for oil-importing countries over the past two decades. On the contrary, oil-exporting countries continue to be concerned about the consequences of oil price shocks. These countries are highly dependent on oil revenues, making them more vulnerable to exogenous oil price fluctuations (Mamipour et al., 2021). Oil-exporting countries suffer from inflationary pressures with both positive and negative oil price shocks (Farzanegan and Markwardt, 2009; Emami and Adibpour, 2012).

With positive oil price shocks and increasing oil revenues, petrodollars have to be exchanged for local currency, thus, positive oil price shocks increase the real effective exchange rate and appreciate domestic currency, which is one of the syndromes of a "Dutch disease" (Abounoori et al., 2014; Davari and Kamalian, 2018; Adebayo, 2020; Amiri et al., 2021)[4]. The spending effects occur because higher oil prices lead to higher wages or profits in oil-related sectors, consequently increasing the effective purchasing power and aggregate demand in the economy (Oomes and Kalcheva, 2007). While the price of the tradable sector in international markets is determined exogenously, the price of the non-tradable sector is determined in the domestic market. A component of the increase in demand is shifted towards the non-tradable sector, resulting in high demand inflation in these sectors (Alquist et al., 2013).

It is noteworthy to highlight that the relationship between oil price fluctuations and their economic consequences is asymmetrical (IMF, 2016b). Specifically, when oil prices decrease, the cost of production is generally diminished, particularly for industries heavily reliant on oil as an input. This reduction in production costs can potentially yield advantages such as improved competitiveness, increased profitability and reduced financial burdens for these industries. Conversely, when oil prices rise, the resulting escalation in the price level often triggers inflationary tendencies within the economy. The amplified costs of oil, being a fundamental input across various sectors including manufacturing, transportation and agriculture, can propagate through supply chains and prompt higher production costs. This is largely due to the downward price rigidity as highlighted by Lacheheb and Sirag (2019) and Nusair (2019).

This unequal effect of oil price changes to inflation is what is referred to as the "asymmetric effect." Nusair (2019) discovered that there is an asymmetric relationship between oil prices and inflation, with significant oil price increase and insignificant oil price decrease on inflation, by investigating the non-linear effect on the Gulf area using ARDL, NARDL and PMG for the period (1970-2016). While Atil et al. (2014) and Salisu and Isah (2017) found that an asymmetric effect of oil price change on inflation, with oil price increase exerting more effect than the oil price decrease. Furthermore, Lacheheb and Sirag (2019) examined the oil price change-inflation relationship in Algeria (1970-2014) using the non-linear autoregressive distributed lag (NARDL) method. The findings indicate that an increase in oil prices has a positive and significant effect on the inflation rate in the investigated economy.

Choi et al. (2018) tested the impact of the global increase in oil prices on domestic inflation in a panel of 72 developed and developing countries over the period (1970-2015) by using the Impulse Response Function (IRF) by local projections. The findings show that global oil price changes are positively affecting domestic inflation. Sek et al. (2015) investigated the impact of oil price changes on inflation for the two sets of countries they categorized as low-oil-dependents (industrialized) and high-oil-dependents (oil exporting) nations by applying a pooled mean group (PMG) method on annual data for the period (1980-2010). The findings indicate that oil price has a positive and significant effect on inflation in low-oil-dependency countries (oil exporters).

Adapting economic policies to oil shocks has mitigated the inflationary effects of oil shocks over time (Lily et al., 2020; Chen and Zhu, 2021). It is claimed by Anh et al. (2021) that the appreciation of the domestic currency, a more active monetary policy in response to inflation, and a higher degree of trade openness are found to explain the decline in oil price pass-through. It is noted by Aastveit et al. (2023) that inflation expectations and the associated pass-through of oil price shocks depend on demand and supply conditions underlying the global oil market. They identified transmissions of oil demand and supply shocks through real oil prices to both expected and actual inflation and demonstrated that economic activity shocks have a significantly longer-lasting effect on inflation expectations and actual inflation than other types of real oil price shocks, and resolve disagreements around the role of oil prices in explaining the missing deflation puzzle of the Great Recession.

Another relevant aspect regarding the oil inflation relationship is that of market power. In uncompetitive markets characterized by dominant corporations, market power leads to higher prices

4 Dutch disease is a phenomenon that can explain the inflationary effects of positive oil price changes in oil-dependent countries using "spending effects" proposed by Corden (1984).

(Vaitilingam, 2022)[5]. The oil market is uncompetitive, therefore, the market power of oil producers may be an important mechanism through which the oil-inflation relation is affected (Colgan, 2014).

In summary, the relationship between oil prices and inflation is intricate, and the consequences can vary depending on specific circumstances and contextual factors. Economic considerations, market dynamics, and government policies all contribute to shaping the overall effects of oil price fluctuations on the economy.

3. DATA AND VARIABLES SELECTION

The primary objective of this study is to examine the intricate linkage between oil price shocks and inflation within member states of OAPEC. The study employs quarterly data spanning from 1990:Q1 to 2022:Q4. OAPEC serves as a multi-governmental organization that facilitates the coordination of energy policies among 11 oil-producing Arab nations[6]. This study focuses on specific six countries: Algeria, Egypt, the Kingdom of Saudi Arabia (KSA), Kuwait, Tunisia and the United Arab Emirates (UAE). They represent diversified structures, experiences and policy measures, allowing for a broader understanding of the dynamics between oil price shocks and inflation in different contexts. The chosen countries represent different regions within the OAPEC membership. Kuwait, KSA and UAE represent the Arabian Gulf or Arabian Peninsula, while Egypt, Algeria and Tunisia represent North Africa. This selection ensures regional diversity and captures potential variations in economic and policy contexts. Furthermore, Kuwait, KSA and UAE are major oil producers and exporters, playing significant roles in global energy markets, however, Algeria's experiences can shed light on the mechanisms through which oil price changes impact inflation. Including these countries provides insights into the relationship between oil prices and inflation dynamics in economies heavily reliant on oil revenues. On the contrary, Egypt and Tunisia are not major oil producers but have experienced economic impacts from oil price fluctuations. Studying their experiences can provide insights into the effects of changes in oil prices on inflation in countries with different economic structures. The selected countries have implemented various policy measures to manage the impact of oil price fluctuations on inflation. KSA and UAE, for example, have established sovereign wealth funds and implemented fiscal policies to mitigate the effects of oil price volatility, Kuwait has implemented subsidy reforms, while Egypt has implemented energy pricing reforms. Analysing the effectiveness of these policy measures can provide valuable insights for policymakers.

The chosen variables in the model aim to capture the key factors that could affect inflation dynamics and global oil price shocks in the sample countries. These specific variables were likely chosen based on their theoretical relevance and empirical evidence regarding their impact on inflation dynamics. The dependent variable, the Consumer Price Index (CPI thereafter), is a widely used measure of inflation and provides insights into the overall price level changes in the economy. The independent variables include the Global Price of Dubai Crude Oil (OP), Official Exchange Rate (ER), GDP Growth (GDP), Lending Interest Rate (IR) and Oil Net Export (NX). These variables are selected based on their potential influence on inflation and oil price shocks. For example, OP as a key driver for inflation has been shown to have significant effects for both oil-importing and oil-exporting countries. ER reflects the exchange rate dynamics, which can impact import and export prices and subsequently affect inflation. GDP growth represents the economic activity and income levels, which can have implications for aggregate demand and inflationary pressures. Conversely, variables such as IR can impact borrowing costs for households and businesses, higher interest rates can discourage borrowing and investment, leading to reduced aggregate demand and potentially lower inflation. Additionally, NX provides insights into the financial and energy sectors, which are closely linked to inflation and oil price dynamics. By including these variables, the model aims to capture the multifaceted nature of the relationship between inflation, oil prices, and various economic factors in OAPEC countries. Data descriptions and sources can be seen in Table 1, while data trends are expressed in Figure 1.

To provide insights into the variability and distribution of the variables, some descriptive measures are computed, such as mean, minimum, maximum and standard deviation. According to Table 2, the average CPI across the observed period is 95.88, with a standard deviation of 48.61, this indicates a significant degree of variability in consumer price levels. The minimum value of 14.49 suggests that there were periods of relatively low inflation, while the maximum value of 386.11 indicates instances of high inflation. The large standard deviation suggests that there may have been periods of both stable and volatile inflation rates. However, the average OP is 45.57, with a standard deviation of 30.69, this shows volatility in oil prices. The minimum and maximum values are 9.44 and 113.68 respectively, which highlight the significant volatility in global oil prices.

Both ER and IR show a wide range of fluctuations, 29.9 ER standard deviation points to significant variability in exchange

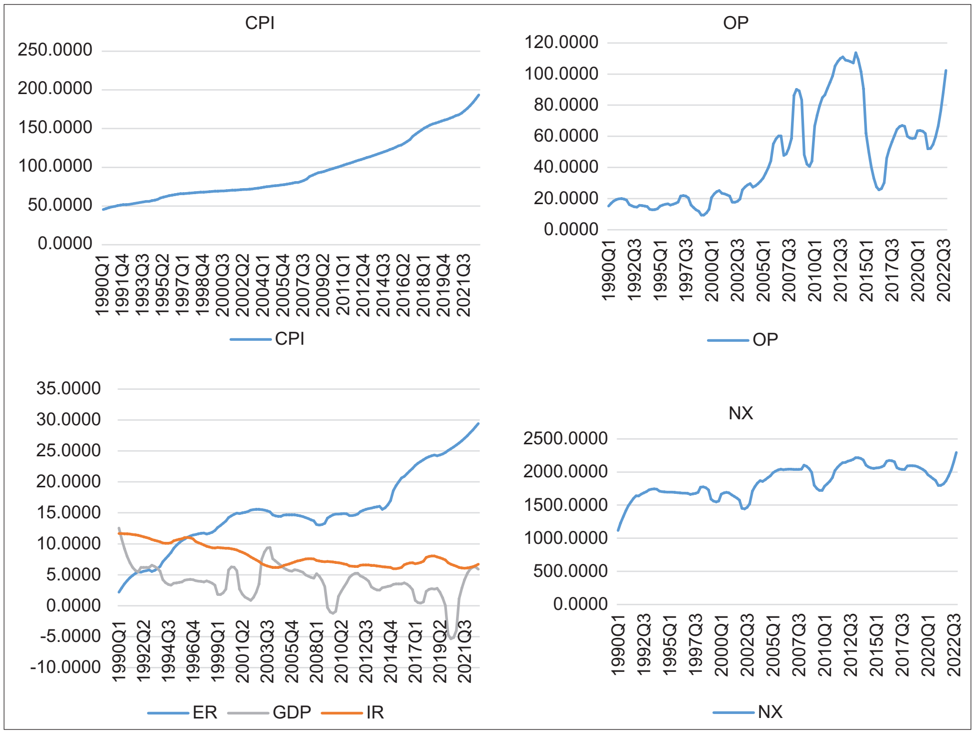
Table 1: Descriptions and sources of the selected variables

Symbols	Descriptions	Sources
Dependent variable		
CPI	Consumer price index (2010=100)	International Monetary Fund (IMF) and International Financial Statistics (IFS) datasets
Independent variables		
OP	Global price of Dubai Crude, U.S. Dollars per Barrel, Quarterly, Not Seasonally Adjusted	OPEC
ER	Official exchange rate (LCU per US$, period average)	IMF and IFS datasets
GDP	GDP growth (annual %)	World Bank, national accounts data
IR	Lending interest rate (%)	IMF and IFS datasets
NX	Net Export: Exports minus imports of crude oil (1,000 b/d)	OPEC

5 Such as the Organization of the Petroleum Exporting Countries (OPEC), the Organization of Arab Petroleum Exporting Countries (OAPEC), the Arabian American Oil Company (Aramco) and the China National Petroleum Corporation (CNPC) do exert market influence.

6 It has 11 member countries, 6 of which are also OPEC members.

Figure 1: Time path plot for the data series



Source: Author's preparation

rates, while 4.29 IR standard deviation suggests varying levels of borrowing costs over the observed period. The average GDP growth rate and the standard deviation are 3.92 and 4.74 respectively, which implies moderate fluctuations in economic growth, the minimum value of −9.73 suggests the possibility of economic contractions, while the maximum value of 35.82 indicates periods of robust economic expansion. Besides, there is significant variability in NX levels among sample countries, the value of standard deviation is 2290.80, which shows the potential for both trade deficits and surpluses.

On the other hand, analysing the mean of the variables provides insights into the average values and differences in these variables among countries studied. Thus, Table 3 shows that the highest average CPI is observed in Egypt (110.215), indicating relatively higher inflation compared to other countries, while the lowest average CPI is found in Kuwait (90.028). Algeria has the highest average in both ER (74.935) and GDP growth (2.512), pointing toward a stronger local currency relative to the US dollar on average, alongside relatively resilient economic growth. Additionally, Egypt has the highest average lending IR (14.025), which suggests higher borrowing costs on average, compared to UAE which has the lowest average IR (3.966). KSA has the highest average NX (6633.509), indicating a significant surplus in the trade balance, whereas Egypt has the lowest average NX (135.179), justifying the deficit in the trade balance.

Thereafter, correlation analysis is conducted to check for the multicollinearity among variables. Hence, correlation coefficients presented in Table 4 denote weak association between assigned variables.

Table 2: Descriptive statistics of the data series

	Descriptive statistics				
	N	Minimum	Maximum	Mean	SD
CPI	792	14.49	386.11	95.88	48.61
OP	792	9.44	113.68	45.57	30.69
ER	792	0.27	144.30	15.23	29.95
GDP	792	−9.73	35.82	3.92	4.74
IR	792	1.33	20.54	8.08	4.29
NX	792	−124.13	8132.62	1860.51	2290.80

Source: Author's computation

Table 3: Mean of the variables across the sample countries

Country	CPI	ER	GDP	IR	NX
Algeria	91.783	74.935	2.512	10.533	589.874
Egypt	110.215	7.151	4.429	14.025	135.179
KSA	93.193	3.750	3.603	4.512	6633.509
Kuwait	90.028	0.295	5.143	6.553	1487.259
Tunisia	97.175	1.571	3.382	8.896	141.339
UAE	92.876	3.672	4.480	3.966	2175.900

Source: Author's computation

Table 4: Correlations estimates for the data series

	Correlations					
	CPI	ER	GDP	IR	NX	OP
CPI	1					
ER	0.183**	1				
GDP	−0.129**	−0.111**	1			
IR	−0.146**	0.136**	−0.012	1		
NX	−0.027	−0.218**	−0.017	−0.590**	1	
OP	0.491**	0.099**	−.0116**	−0.285**	0.077*	1

**Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed).

Source: Author's computation

As selected OAPEC countries in this study experienced fluctuations in most of the assigned variables over the observed period, this can be used as a foundation for further analysis and modeling of the relationships between these variables.

4. ECONOMETRIC MODEL

This paper aims to investigate the dynamics between oil price shocks and inflation within the OAPEC, which comprises major oil-exporting countries that play a crucial role in global markets. Building upon the work of Živkov (2019) and Rafei et al. (2022), this study implements the Time-Varying Parameter Vector Autoregressive (TVP-VAR) Model. By incorporating the TVP-VAR model into stochastic volatility, the analysis effectively captures potential shifts in the fundamental structure of the economy and enhances the accuracy of the estimations. The estimation of the TVP-VAR model with stochastic volatility is conducted using the Markov Chain Monte Carlo method.

Primarily, structural VAR (SVAR) is described. SVAR is a model class that examines the evolution of a set of interconnected and observable time series variables, such as economic data or asset prices. It assumes that all variables in fixed proportion depend on past values of the set and new structural shocks. In other words, the observable variables are endogenous, while shocks represent the impulses that transfer the system. These shocks can have economic interpretation, such as unexpected policy changes or disruptions in production. The SVAR model allows for the inclusion of multiple types of shocks, equal to the number of time series variables in the set. Unlike regression models, where a shock is assigned to a specific observable variable, any structural shock in the SVAR model can impact any variable within the set. The SVAR model can be represented as follows:

$$P = \begin{bmatrix} P_{11} & P_{12} \\ P_{21} & P_{22} \end{bmatrix} \quad t = s + 1, \ldots, n \tag{1}$$

Where Y_t expresses the vector $k \times 1$ of the observed variables, $A, F_1, F_2, \ldots, F_2$ is the matrix $k \times k$ of the parameters and U_t shows the vector $k \times 1$ of the structural shocks. The simulation connection between structural shocks is established by assuming that matrix A is a lower triangular with its main diagonal elements set to one.

$$A = \begin{bmatrix} 1 & 0 & 0 & 0 \\ a_{21} & 1 & \cdots 0 & 0 \\ \vdots & \vdots & \vdots & \vdots \\ a_{k1} & a_{k2} & \cdots a_{k,k-1} & 1 \end{bmatrix} \tag{2}$$

The modified version of VAR is expressed as follows:

$$Y_t = B_1 Y_{t-1} + B_2 Y_{t-2} + \ldots + B_s Y_{t-s} + A^{-1} \sum \varepsilon_t \,.\, \varepsilon_t \sim N(0, I_k) \tag{3}$$

Where $B_i = A^{-1} F_i i = 1, \ldots, s$

$$\sum = \begin{bmatrix} \sigma_1 & 0 & 0 & 0 \\ 0 & \sigma_2 & \cdots 0 & 0 \\ \vdots & \vdots & \vdots & \vdots \\ 0 & 0 & \cdots 0 & \sigma_k \end{bmatrix} \tag{4}$$

Whereas, σ_i (i=1,…,k) is the standard deviation of structural shocks. The modified form is as follows;

$$Y_t = X_t \beta + A^{-1} \sum \varepsilon_t \tag{5}$$

Where $X_t = I_k \otimes [Y'_{t-1} Y'_{t-2} \ldots Y'_{t-s}]$ and $\otimes$ are Kronecher products, all parameters are fixed in the VAR model. In the TVP-VAR model, the estimation coefficients can vary across time. According to Primiceri (2005) Nakajima et al. (2009) and Nakajima (2011a, 2011b), it is assumed that all parameters change over time. Consequently, equation (1) is processed as shown below:

$$Y_t = X_t \beta_t + A_t^{-1} \sum\nolimits_t \varepsilon_t \text{ where } t = s+1, \ldots, n \tag{6}$$

The coefficients β_t, the parameters A_t and elements of variance-covariance matrix $\sum_t$ are all varying in time. It is assumed that time-varying parameters follow a stochastic process.

$$\beta_{t+1} = \beta_t + u_{\beta t}$$

$$a_{t+1} = a_t + a_{ut} \begin{bmatrix} \varepsilon_t \\ u_{\beta t} \\ u_{at} \\ u_{ht} \end{bmatrix} \sim N \left(0, \begin{bmatrix} I & 0 & 0 & 0 \\ 0 & \sum_\beta & 0 & 0 \\ 0 & 0 & \sum_a & 0 \\ 0 & 0 & 0 & \sum_h \end{bmatrix} \right) \tag{7}$$

$$h_{t+1} = h_t + u_{ht}, t = s + 1, \ldots, n$$

Moreover, it is assumed that there is no correlation between the time-varying parameters h_t, a_t and β_t, while $\sum_\beta$, $\sum_a$ and $\sum_h$ are diagonal matrices, besides, $a_{s+1} \sim N(\mu_{a_0}, \sum_{a_0})$, $\beta_{s+1} \sim N(\mu_{\beta_0}, \sum_{\beta_0})$ and $h_{s+1} \sim N(\mu_{h_0}, \sum_{h_0})$

Nonetheless, the Markov Switching Autoregressive (MS-AR) model is adopted, a major advantage of the MS-AR model is its flexibility in modelling time series subject to regime shifts. All parameters of the conditional model are assumed to be dependent on the state s_t of the Markov Chain. the subclasses of MS-AR models are: MS in mean intercept (MSI); autoregressive parameters (MSA); and heteroscedasticity (MSH). In this paper, the optimal number of regimes and shift parameter types are selected by Akaike Information Criterion (AIC).

Based on the basic MS-AR, a stationary time series (y_t) can be modelled by an AR(p) with regime shifts in intercept, which is labelled as MSI(m)-AR(p) process:

$$y_t = a(s_t) + \sum_{i=1}^{p} \varphi_i y_{t-1} + \varepsilon_t \tag{8}$$

Where ϕ_i are the autoregressive coefficients, $a(s_t)$ is the intercept depending on the regime s_t at time t, y_t represents the oil price, $s_t \in$ {1,m is a hidden Markov state and ε_t is IIDN (0,1).

Regime-switching models are characterized by the notion that the parameters of an autoregressive process are contingent upon an unobservable regime variable, denoted as $s_t \in$ 1, m. The fundamental concept is to estimate the evolution of regimes based on the available data by assuming a stochastic process for the unobservable regimes. In the case of MS-AR models, the regime-generating process is modeled as an ergodic Markov Chain with a finite number of states (s_t). The transition probabilities as outlined by Mumtaz and Surico (2009) and Krolzig and Sensier (2000), the likelihood of transitioning between these states is as follows:

$$P_{ij} = \Pr(S_{t+1} = j \mid s_t = i) \tag{9}$$

$$\sum_{j=1}^{m} P_{ij} = 1 \;\; \forall i,j \in \{1,\ldots,m\}$$

For a two-state, $s_t = \{1,2\}$, the transition matrix is:

$$P = \begin{bmatrix} P_{11} & P_{12} \\ P_{21} & P_{22} \end{bmatrix}$$

Each element of the transition matrix represents a conditional probability of transitioning from one-regime to another within a Markov Chain. The transitions of the s_t (regimes) are presumed to be ergodic and intricate first-order Markov-process. This means impacts of earlier observation(s) for the r_t and regime(s) is/are completely captured in the recent r_t regime(s) observations.

5. RESULTS AND DISCUSSION

In the preliminary stages of time series analysis, it is essential to validate the assumption of stationarity. Stationarity, which refers to the absence of a unit root, is commonly assessed using the Augmented Dickey-Fuller (ADF) test and the Phillips-Perron (PP)[7] test. By calculating relevant statistics and P-values at the primary level, these tests are applied to ascertain whether a given data series exhibits stationarity or not. Consequently, the results of the ADF and PP tests are presented individually for each country under consideration in Tables 5 and 6 respectively. Based on the results, it is observed that all variables are stationary at the first difference, this is with a confidence level of 95%, this conclusion is drown because the p-value associated with the variables is < 5% at their level forms.

Prior to implementing the switching model, the preliminary step involves testing the null hypothesis of the absence of regime shifts (Linear Autoregressive model). This null hypothesis is pitted against the alternative hypothesis of a regime-switching model, which corresponds to the MS-AR model, thus, the Likelihood Ratio (LR) test is employed. To decide the optimum lag length, this study utilizes sequential modified LR test statistic (each test at the 5% level), Final Prediction Error (FPE), Akaike Information Criterion (AIC), Schwarz Information Criterion (SC) and Hannan-Quinn Information Criterion (HQ) methods (Widarjono, 2018). The test values are examined and the optimal lag length for each test method is compared. Consequently, the selection of the most suitable MS models (characterized by varying regime shift parameters and the number of regimes) is accomplished through the lowest value of AIC, which is generally considered the optimal choice.

As depicted in the subsequent Table 7, the best lag length is 1 lag, so the results are analysed through the switching-AR(1) model. The test results indicate a significant LR test statistic (very high), leading to the rejection of the null hypothesis. Therefore, the optimal model is determined to be the MSI(2)-AR(1) model which consists of two regimes and one autoregressive lag order.

It is worth mentioning that the Johansen Cointegration method is used to determine the long-run relationships between LCPI, LOP, LER, LGDP, LIR and LNX. The cointegrating vectors between the variables are examined using the maximum eigenvalue statistics. After determining the optimal lag and confirming the non-existence of a long-run relationship between the variables, the Impulse Response Function (IRF) of the model variables is analysed for 24 periods by the TVP-VAR model.

As mentioned earlier, MS intercepts VAR are estimated for the sample countries, results presented in Table 8 remark the following observation: the intercepts of regime 1 in Algeria, KSA and Tunisia are larger (measuring −3.54, 2.46 −0.98 respectively) compared to regime 2, which are (−4.742, −0.29 and −1.21). This suggests that regime 1 has a higher baseline level of the CPI in those countries. On the contrary, the intercepts of regime 1 in Egypt, Kuwait and UAE (22.11, 0.03 and 0.05 respectively) are lower than the intercepts of regime 2 (23.56, 0.42 and 6.15). This implies that regime 1 has a lower baseline level of the CPI compared to regime 2. The analysis indicates a significant positive impact of OP on CPI in all sample countries, with the highest magnitude in Egypt (0.103427) and the lowest in Kuwait and Tunisia (0.008509 and 0.007180 respectively), with a confidence level of 95% supported by the absolute z-value exceeding 2.

Concerning the explanatory variables, the analysis reveals that ER has a significant positive association with CPI in Algeria, Egypt and Tunisia. This result is consistent with ross Mokhtar and Sowaidi (2004), Helmy et al. (2018), Mehibel and Yacine (2018), Solieman and El-Naggar (2018), Mouhcene and Manaa (2019), Ali (2021), Dekkiche (2022) and Laourari and Abderrahim (2022). They found that the nominal effective exchange rate determines inflation variations, thus, the effect of a depreciation/devaluation of the domestic currency has a greater impact on inflation than on import prices. For Kuwait, KSA and UAE, they peg their currencies to the U.S. dollar. This peg helps maintain exchange rate stability and ensures a predictable environment for international trade and investment. As suggested by Yildirim and Arifli (2021),

7 The ADF test holds prominence in the literature as a widely employed unit root test.

Table 5: ADF test results for the data series

Variable	Algeria	Egypt	KSA	Kuwait	Tunisia	UAE
CPI	1.1868	3.227	0.4638	−1.0666	3.096	0.648
ΔCPI	−4.117***	−4.293***	−4.679***	−4.3615***	−4.875***	−3.359***
OP	−1.512	−1.398	−1.397	−1.398	−1.543	−1.398
ΔOP	−3.843***	−3.796***	−3.796***	−3796***	−3.876***	−3.796***
ER	−0.184	0.806	-	−1.339	2.386	−2.113
ΔER	−4.476***	−3.173**	-	−3.3877**	−3.923***	−5.549***
GDP	−2.049	−2.6417*	−3.855***	−2.939**	−0.501	−3.3922**
ΔGDP	−3.196**	−5.121***	−4.0166***	−3.5936***	−4.413**	−4.812***
IR	−1.984	−3.966**	−2.385	−2.0207	−2.208	−1.958
ΔIR	−3.66***	−3.4337**	−4.731***	−3.679***	−3.743**	−3.385**
Nx	−1.6938	−1.519	−1.434	−1.869	−1.542	−0.4932
ΔNX	−4.168***	−4.519***	−4.03***	−4.7885***	−4.432***	−4.274***

*10%, **5%, ***1% significance. ADF t-statistic reported. The ADF tests include an intercept. The appropriate lag lengths were selected according to the Schwartz Bayesian criterion, also P-value are calculated using MacKinnon (1996) one-sided P-values

Source: Author's computation using Eviews version 12

Table 6: PP test results for the data series

Variable	Algeria	Egypt	KSA	Kuwait	Tunisia	UAE
CPI	1.244	6.3563	0.8153	−1.5176	8.505	0.6342
ΔCPI	−4.045***	−4.169***	−5.826***	−4.1529***	−4.045***	−4.786***
OP	−1.146	−1.1247	−1.1247	−1.125	−1.137	−1.125
ΔOP	−5.153***	−5.182***	−5.182***	−5.182***	−5.267***	−5.182***
ER	−0.6544	0.5832	-	−1.558	2.186	−1.751
ΔER	−5.098	−4.415***	-	−5.62***	−5.098***	−3.123***
GDP	−2.502	−3.662***	−3.432**	−2.7398*	−3.238**	−5.81***
ΔGDP	−7.07***	−5.647***	−5.8283	−6.4223***	−7.82***	−8.365***
IR	−1.167	−2.114	−2.328	−1.219	−3.15**	−1.76
ΔIR	−4.081***	−3.5827***	−4.54***	−3.679***	−47.187***	−5.1176***
Nx	−1.9034	−1.378	−1.619	−1.679	−1.876	−1.421
ΔNX	−6.088***	−5.866***	−5.072***	−5.843***	−6.187**	−4.741

*10%, **5%, ***1% significance

Source: Author's computation using Eviews version 12.

Table 7: VAR lag length selection criteria

Lag	LogL	LR: Sequential modified LR test statistic (each test at 5% level)	FPE: Final prediction error	AIC: Akaike information criterion	SC: Schwarz information criterion	HQ: Hannan-Quinn information criterion
Algeria						
0	−2915.873	NA	1.18e+13	47.12698	47.26344	47.18241
1	−1533.285	83.33731*	123.2352*	21.72902*	24.35687*	25.79588
2	−1322.135	378.0273	259.8745	22.58282	26.36308	23.30348*
Egypt						
0	−2692.671	NA	3.23e+11	43.52695	43.66341	43.58238
1	−1193.779	107.7004*	0.486618*	16.19466*	19.33444*	20.31997
2	−1010.744	327.6914	1.712185	17.56039	20.88718	18.28105
Kuwait						
0	−1577.482	NA	83660.22	25.52390	25.63762	25.57010
1	−359.3111	2.53e–05*	2.53e–05*	2.53e–05*	5.001662*	4.258889*
2	−177.5453	331.2828	2.93e–05	3.750731	6.961537	6.556388
KSA						
0	−2559.982	NA	6.38e+11	41.37067	41.48439	41.41687
1	−1506.947	137.9236*	1398.986*	21.37876*	25.47180	25.06665
2	−1372.558	244.9352	6891.762	23.02513	24.27606*	23.53329
Tunisia						
0	−2240.888	NA	2.21e+08	36.24013	36.37660	36.29557
1	−945.3838	0.003537*	0.003537*	0.003537*	16.88080	16.31359
2	−761.9883	328.3371	0.030980	13.54820	15.32225*	14.26886
UAE						
0	−1584.368	NA	5562.702	25.65110	25.78756	25.70654
1	−427.0603	134.9266*	1.92e–06*	3.750002*	8.799216	5.801111*
2	−258.1870	302.3377	9.16e-06	5.422371	7.196419*	6.143031

*Indicates lag order selected by the criterion.

Source: Author's computation using Eviews version 12

Table 8: Results of Markov switching intercepts VAR estimates

Markov Switching Intercepts VAR Estimates (BFGS / Marquardt steps)
Sample (adjusted): 1990Q2 2022Q4
Included observations: 131 after adjustments
Number of states: 2
Initial probabilities obtained from ergodic solution
Standard errors & covariance computed using observed Hessian
Random search: 25 starting values with 10 iterations using 1 standard deviation
Standard errors in ( ) & z-statistics in [ ]

	Algeria	Egypt	Kuwait	KSA	Tunisia	UAE
			CPI			
C-regime 1	−3.541200	22.11288	0.033138	2.460171	−0.985148	0.056622
	(1.05083)	(5.70731)	(0.00696)	(0.79029)	(0.20333)	(0.00986)
	[−3.36990]	[3.87449]	[4.75882]	[3.11299]	[−4.84508]	[5.74550]
C-regime 2	−4.741670	23.56328	0.428185	−0.290383	−1.213057	6.153205
	(0.93818)	(11.3761)	(0.07118)	(1.79049)	(0.17757)	(1.46593)
	[−5.05409]	[2.07129]	[6.01585]	[−0.16218]	[−6.83155]	[4.19746]
CPI(-1)	0.988520	0.632443	−0.002634	0.984333	0.997551	4.96E-06
	(0.00792)	(0.08349)	(0.00132)	(0.00393)	(0.00225)	(0.00012)
	[124.794]	[7.57487]	[−1.99661]	[250.318]	[444.209]	[0.04068]
OP(-1)	0.014079	0.103427	0.008509	0.013678	0.007180	0.069000
	(0.00321)	(0.03605)	(0.00239)	(0.00255)	(0.00114)	(0.01745)
	[4.38229]	[2.86885]	[3.56556]	[5.37019]	[6.27629]	[3.95415]
ER(-1)	0.046397	0.004589	0.000196	-	2.174582	0.001337
	(0.00951)	(0.00103)	(0.00021)	-	(0.14829)	(0.00137)
	[4.88024]	[4.46305]	[0.93242]	-	[14.6644]	[0.97719]
IR(-1)	0.309807	−3.707794	3.332266	0.250713	0.040577	0.000996
	(0.04187)	(0.38923)	(1.03022)	(0.11906)	(0.01737)	(0.00596)
	[7.39969]	[−9.52586]	[3.23452]	[2.10581]	[2.33652]	[0.16702]
GDP(-1)	0.085649	0.008357	−0.000231	−0.011101	−0.007634	−472.8225
	(0.03519)	(0.04218)	(8.6E-05)	(0.02058)	(0.01529)	(0.11170)
	[2.43379]	[0.19815]	[−2.68686]	[−0.53941]	[−0.49921]	[−4233.11]
NX(-1)	0.000116	−0.035001	14.70060	0.057305	−0.008428	128.6100
	(0.00057)	(0.00272)	(3.35882)	(0.01583)	(0.00079)	(0.03044)
	[0.20200]	[−12.8466]	[4.37672]	[3.61914]	[−10.7267]	[4225.51]
Log likelihood	−525.523	−482.578	−626.0739	−500.3091	−525.523	−482.578
Akaike info criterion	8.466	7.7034	10.87136	8.019986	8.466	7.7034
Schwarz criterion	9.102	8.18634	12.75889	8.568688	9.102	8.18634

Source: Author's computation using Eviews version 12

when oil prices rise, the countries' export revenues increase, leading to a stronger inflow of foreign currency. This influx of foreign currency allows the central banks to manage the exchange rate and potentially reduce imported inflationary pressures by keeping the value of the domestic currency relatively stable.

On the other hand, lending IR has a significant negative impact on CPI in Egypt, a significant positive relationship with CPI in Algeria, Kuwait, KSA and Tunisia, and insignificant linkage in UAE. It is noted that the relationship between IR and CPI is not straightforward, and it can be both positive and negative depending on the specific circumstances. The overall impact is contingent upon the broader economic context and the interplay of various economic factors (Gruen, 1991; Mishkin, 1996). Some argue that higher IR can have a negative effect on inflation, as it discourages investments in productive activities and slows down economic growth. If the economy is operating below its potential, an increase in IR could further dampen economic activity, leading to lower demand for goods and services that contributes to disinflationary or deflationary pressures as investigated by Noureldin (2008), Cochrane (2016), and Domit et al. (2016). On the contrary, when IR is high, borrowing becomes more expensive, and individuals and businesses are less likely to take out loans for investment purposes. This decrease in borrowing leads to a slowdown in supply, which in turn can put upward pressure on prices, contributing to inflation (Garcia-Schmidt and Woodford, 2015; Julio et al., 2016; Tala and Hlongwane, 2023).

Findings suggest that GDP has a significant negative impact on the CPI in both Kuwait and UAE. As oil prices rise, these countries experience increased oil export revenues, leading to greater economic activity and higher GDP growth. However, as investigated by Nusair (2016, 2019) the impact on inflation is mitigated due to specific factors related to their oil-dependent economies. Historically, they implemented subsidies and price controls on essential goods and services, for instance energy, food and housing, thereby mitigating potential inflationary pressures that could arise from increased consumer spending and demand. In addition to diversification efforts that help mitigate inflationary pressures by creating new sources of employment, increasing competition, and expanding the supply of goods and services.

Results indicate that NX has a significant positive association with CPI in Kuwait, KSA and UAE (aligned with Alqenaie, 2016; Aloui et al., 2018), and a significant negative relationship in Egypt and

Tunisia (as proved by Azad and Serletis, 2020; Abdelsalam, 2023), while an insignificant impact in Algeria (as noted by Benmoussa, 2022). The impact of NX on inflation differs for oil-exporting and oil-importing countries due to their distinct economic dynamics. The specific context and economic policies of each country shape the overall impact on inflation, this includes the degree of oil price fluctuations, the degree of oil import dependency, the flexibility of exchange rates and the inflation-targeting framework adopted by central banks.

Regarding the regime analysis, the results indicate that the regimes in Algeria, Egypt and Tunisia are persistent since the probability of remaining in the same regime is lower (P00) compared to the probability of changing regimes (P11). This indicates a higher likelihood of remaining in a single regime rather than transitioning between regimes. However, Kuwait, KSA and UAE are not persistent as (P00) is higher than (P11), This suggests that there is a tendency for the regime to switch rather than remain the same over time, please see Table 9.

Figure 2 demonstrates the results of the MSI(2)-AR(1) model in the sample countries, where CPI and OP of Dubai Crude are categorized into two distinct regimes. It is noteworthy that Kuwait regime change took place precisely after 2009Q2 (regime 1: 1990Q1 to 2009Q2 and regime 2: 2009Q3 to 2022Q4), KSA reveals the change at 2008Q2 (regime 1: 1990 to 2008Q2 and regime 2: 2008Q3 to 2022Q4), while UAE change occurred precisely after 2008Q2 (regime 1: 1990Q1 to 2008Q2 and regime 2: 2008Q3 to 2022Q4). The switching regimes in these countries were nearly at the same time, the specific dynamics within each of the three countries (Kuwait, KSA and UAE) are complex and multifaceted. This can be attributed mainly to a combination of internal and external factors. Internally, economic diversification efforts, generational shifts in leadership and societal aspirations for change, played significant roles. Whereas externally, global events mainly as the 2008 financial crisis and regional dynamics, influenced the trajectory of these countries.

Prior to 2008, the economies of both Kuwait and KSA heavily relied on oil exports and experienced significant economic growth due to high oil prices. While UAE was diversifying beyond oil and focusing on sectors such as finance, real estate and tourism, additionally, it was providing a business-friendly environment which makes it relatively progressive compared to some of its neighbouring countries. After 2008, KSA witnessed some notable changes, a series of significant reforms amongst "Vision 2030"[8], these reforms aimed to diversify the economy, reduce dependence on oil and promote social changes such as lifting some restrictions on women's rights (IMF, 2023b). UAE continued to experience economic growth and diversification, in particular, became a global business and tourism hub, it made efforts to position itself as a global destination, embracing modernity and hosting various cultural events. However, Kuwait faced challenges in implementing economic reforms and diversifying its oil-dependent economy.

8 Please see: Vision 2030. (2016), Vision 2030: Kingdom of Saudi Arabia. Available at: https:// www.vision2030. gov.

Table 9: Transition probabilities for the selected countries

	Algeria	Egypt	Kuwait	KSA	Tunisia	UAE
p_{00}	0.945	0.841	0.927	0.945	0.921	0.941
P_{11}	0.957	0.940	0.877	0.894	0.924	0.933

Source: Author's computation using Eviews version 12

In Algeria, the change in regimes occurred precisely after the fourth quarter of 1997 (regime 1: 1990Q1 to 1997Q4 and regime 2: 1998 Q1 to 2022Q4). This is owed in large part to the steadfast implementation of the fund-supported programs, Algeria's macroeconomics improved dramatically (IMF, 2000). Algeria is highly dependent on its hydrocarbon resources, in 1995-97 hydrocarbon revenue accounted for 95% of exports and 60% of total budgetary revenue, even though the share of this sector in GDP is 30%[9]. As a result, fluctuations in oil prices have a major impact on the overall macroeconomic equilibrium and complicate the formulation of economic policy (IMF, 1998a)[10].

In Egypt, it is notable that the change in regimes occurred immediately after 2017Q2 (regime 1: 1990Q1 to 2017Q2 and regime 2: 2017Q3 to 2022Q4). This is attributed to the 2016 devaluation, the Central Bank of Egypt (CBE) by November 2016 floated the Egyptian pound in an attempt to stabilize the economy, which had been set back by a shortage of foreign currency inflows and political instability[11]. The steady devaluation of the Egyptian pound has compounded the increase in inflation rates (please see IMF, 2017).

The classification of CPI and OP into two regimes in Tunisia occurred precisely after 2018Q3 (regime 1: 1990Q1 to 2018Q3 and regime 2: 2018Q4 to 2022Q4). Monetary tightening started in 2017 and contained inflation from July 2018[12]. A clear change in the Central Bank of Tunisia's (CBT) monetary policy occurred in 2018, whereas, the macroprudential policy was tightened at the end of 2018 (Khatat et al., 2020)[13].

Moreover, the results of the maximum eigenvalue statistic using the Johansen cointegration model as described in Table 10 indicate

9 The recovery continued in the first semester of 2022, supported by non-hydrocarbon activity and crude oil production (please see World Bank, 2023b)

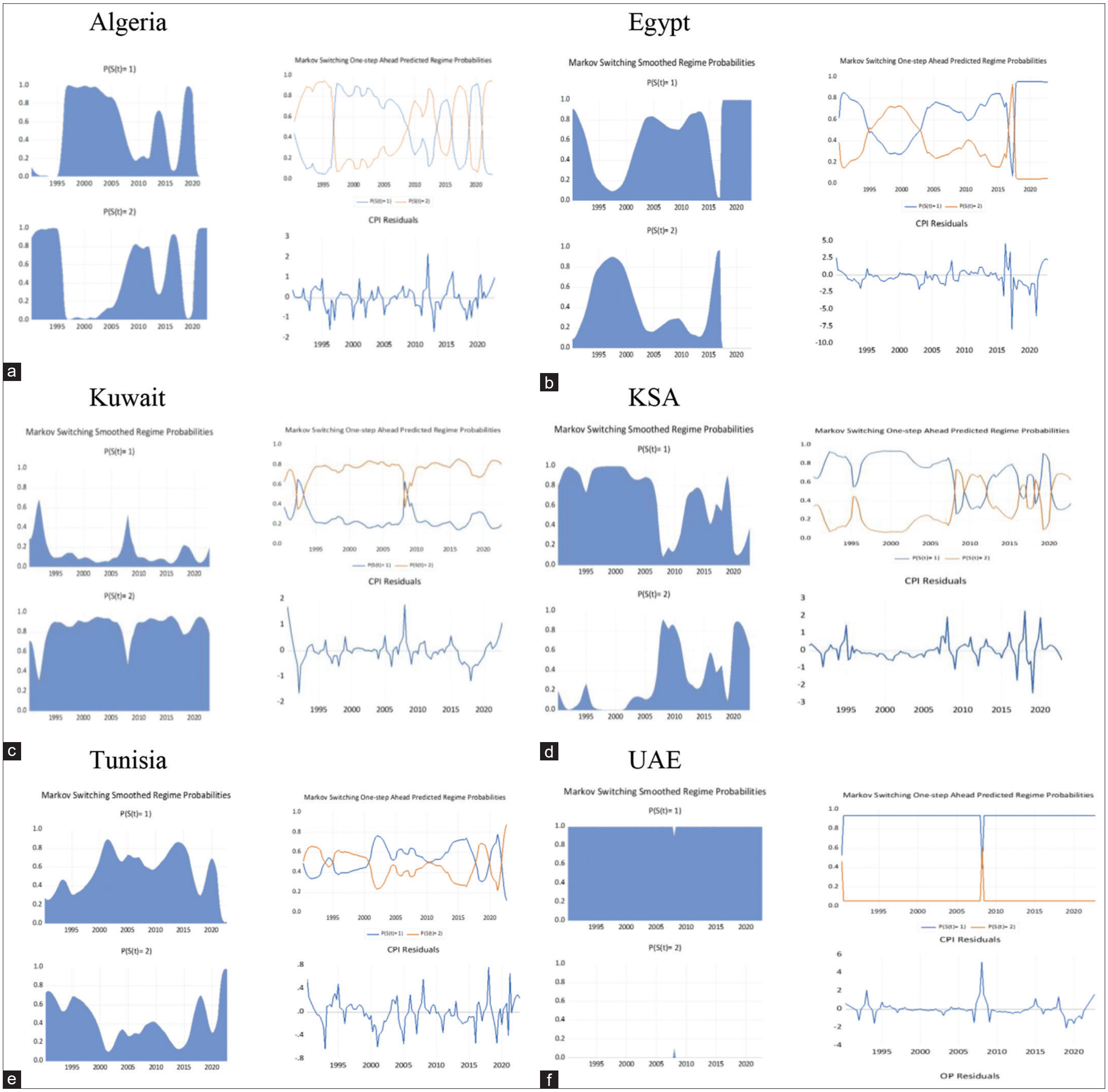
10 During 1996-97, Algeria benefited from relatively high oil prices (the highest since the Gulf conflict in the early 1990s) which helped achieve the objectives of its adjustment program. In particular, the authorities were able to strengthen dramatically the country's external position by saving most of the windfall from higher than expected oil prices and bringing the level of international reserves to about 10 months of imports by early 1998, from the equivalent of 2 months of imports in 1994 when the Fund-supported program started.

11 Among the key goals behind the floatation was to meet one of the key demands of the IMF to secure a $12 billion loan, boost external competitiveness through a weaker currency, encourage foreign investors back to the country through a more transparent economy and to end the currency black market which was trading at double the price set by the CBE at the time of floatation (IMF, 2016a).

12 Firstly, the policy rate increased in April 2017, but its growing liquidity injections continued to pursue the objective of easing the credit supply. Negative real interest rates, an increasing volume of refinancing, and the collateral policy accommodated the money demand of economic agents and especially the demand for cash and foreign currency fuelled by depreciation expectations (Brandao-Marques, et al., 2020).

13 The policy rate was increased in gradual steps from 5% in early 2018 to 7.75% in February 2019, slowing the demand for credit.

Figure 2: (a-f) Results of MSI(2)-AR(1) model for the selected countries



Source: Author's computation using Eviews version 12

that: in Algeria, Egypt and Tunisia there is one cointegration equation in the long-run relationship between the variables; KSA confirms the presence of two cointegration equations representing the long-term relationship between the variables; while Kuwait and UAE point the absence of cointegration equations, which implies that there is no stable long-run relationship among the variables under examination. Additionally, as the TVP-VAR model is employed, the IRF varies over time as expected.

With respect to IRF results as illustrated in Figure 3. In Algeria, throughout the entire period of study, OP shocks have a positive effect on CPI, resulting in inflationary pressure. The positive effects are not constant but have diminished over time during the first regime period, while they have increased during the second period, see Figure 3a. Due to the unprecedented increase in oil prices since 2001, the Algerian government has adopted huge programs aimed at boosting economic development. To back up the government's efforts, the Bank of Algeria, in contrast to the previous stage, conducted an expansionary policy by decreasing the discount rate and raising the money supply growth rate (M2) from 22.3% in 2001 to a historical record (24.2%), just before the financial crisis onset in 2007. That evolution in money supply exceeded the absorptive capacity of the domestic economy, which in consequence, sent the inflation rate to go up 3.67%. To dampen inflation, the Bank of Algeria decreased the money

Table 10: Unrestricted cointegration rank test (Maximum Eigenvalue)

Hypothesized No. of CE (s)	Eigenvalue	Max-Eigen statistic	0.05 critical value	Prob.**
Algeria				
None*	0.283829	43.06490	40.07757	0.0224
At most 1	0.207908	30.06696	33.87687	0.1334
Egypt				
None *	0.338573	53.73624	40.07757	0.0008
At most 1	0.215281	31.51584	33.87687	0.0932
Kuwait				
None *	0.239262	35.55061	40.07757	0.1483
At most 1	0.193821	28.00847	33.87687	0.2131
KSA				
None *	0.319121	49.96824	33.87687	0.0003
At most 1*	0.252576	37.84596	27.58434	0.0017
At most 2*	0.126838	17.63250	21.13162	0.1442
Tunisia				
None *	0.373995	60.42317	40.07757	0.0001
At most 1	0.229164	33.57600	33.87687	0.0543
UAE				
None	0.095902	13.10632	14.26460	0.0756
At most 1	0.017235	2.260027	3.841465	0.1328

Source: Author's computation using Eviews version 12

supply in 2008, but the advent of the global financial crisis forced the central bank to re-increase the money supply (La Banque d'Algérie, 2008). The Bank of Algeria, in its decision to increase the money supply, depended on the expectations of a continued high oil price. However, once the price began to sour in early 2009, the economy deteriorated causing inflation to skyrocket (8.9%) in 2012, exceeding the rate targeted (La Banque d'Algerie, 2015). Since 2009 the Bank of Algeria has announced 4% as an inflation target to achieve currency stability (Hamrit and Manaa, 2009). Nevertheless, CPI picked up in late 2020 and continued to accelerate through 2021 and most of 2022, reaching 9.5% in August 2022-a level not seen in twenty-five years (IMF, 2023a). However, the achievement of this goal remains difficult due to the vulnerability of the economic environment to oil price fluctuations, which makes fluctuations in currency and local prices a daily phenomenon that affects the investment environment negatively (World Bank, 2023b).

With a focus on Egypt, the effect of oil price shocks on CPI is positive in the total period, indicating that oil shocks have an inflationary impact, this positive effects are not fixed but have increased over time as highlighted in Figure 3b. In the first period, inflation rates in Egypt had witnessed their lowest levels during the 1990s, as a result of many economic reforms that have been adopted to combat aggregate demand and reduce inflation. These programs have successfully reduced inflation rates to reach their lowest level in 1999 as it reached 1%[14] (El-Sakka and Ghali, 2005). In the early 2000s, Egypt implemented further reforms, including reducing fuel subsidies, developing a banking system and liberalizing markets (IMF, 2008). These reforms have helped in strengthening the solidity of the Egyptian economy to grow at reasonable rates. However, from around 2003 to 2008 global oil prices experienced a significant increase reaching record levels, this spike in oil prices has contributed to indirect inflationary pressures in Egypt, particularly through higher transportation costs and food and commodity prices (Bahloul, 2018). The decline in oil prices after the global financial crisis in 2008 helped to alleviate inflationary pressures in Egypt (2007-2009)[15]. As a result, the direct pass-through effect of oil prices on domestic inflation might have been relatively lower during this period.

In the second period, the impact of oil price shocks on inflation dynamics after the 2016 devaluation can be analysed through many factors[16]. As Egypt is a net importer of oil, higher oil prices are passed on to consumers in the form of higher prices for imported goods and services. Additionally, to reduce the strain on public finances, Egypt has implemented reforms that included reducing energy subsidies, thus, energy prices surged, which had a direct impact on inflation (World Bank, 2020b). Recently, in 2022 CBE devalued the Egyptian pound by 14% after foreign investors pulled $20 billion out of Egypt because of the war in Ukraine. The Russian-Ukraine tension was a catalyst for the economic crisis[17]. The corresponding energy crisis hit the Egyptian economy hard[18]. The prolonged economic spiral also led to a shortage of foreign currency, with net international reserves plunging 19% during 2022 (World Bank, 2022). As stated by the World Bank, the dollar shortage, exacerbated by the depreciation of the Egyptian pound has created a backlog of imports worth $9.5 billion, further decreasing market supply and contributing to rising prices. The increase in oil prices has elevated the cost of importing oil to Egypt, which consequently was reflected in the state's general budget, especially regarding to the fuel subsidy item (World Bank, 2023a)[19]. The Egyptian government has tried multiple solutions to mitigate the crisis, CBE raised interest rates multiple times over the past years to combat inflation[20]. In addition, increasing Egyptian gas exports mitigates the impact of high oil prices and reduces pressure on

14 The monetary policies which have been adopted in the 1990s were mainly aimed at achieving the highest levels of price stability and controlling the increases in domestic liquidity using indirect monetary instruments.

15 Inflation rates have increased during this period especially in 2007 when it recorded its highest level during this decade and reached 13% despite the official shifting of the central bank in 2003 towards a more flexible exchange rate regime to enable the monetary policy to shift gradually towards targeting inflation and achieving the required price stability. This shifting in the monetary policy mainly aimed at containing inflation pressures and availing more flexibility to the exchange rate regime to achieve the highest levels of price stability.

16 Several studies have contributed to the linkage between the exchange rate and inflation in Egypt, please see: Khodeir (2011), Kandil and Dincer (2007), Hosny (2013) and Bahloul (2018).

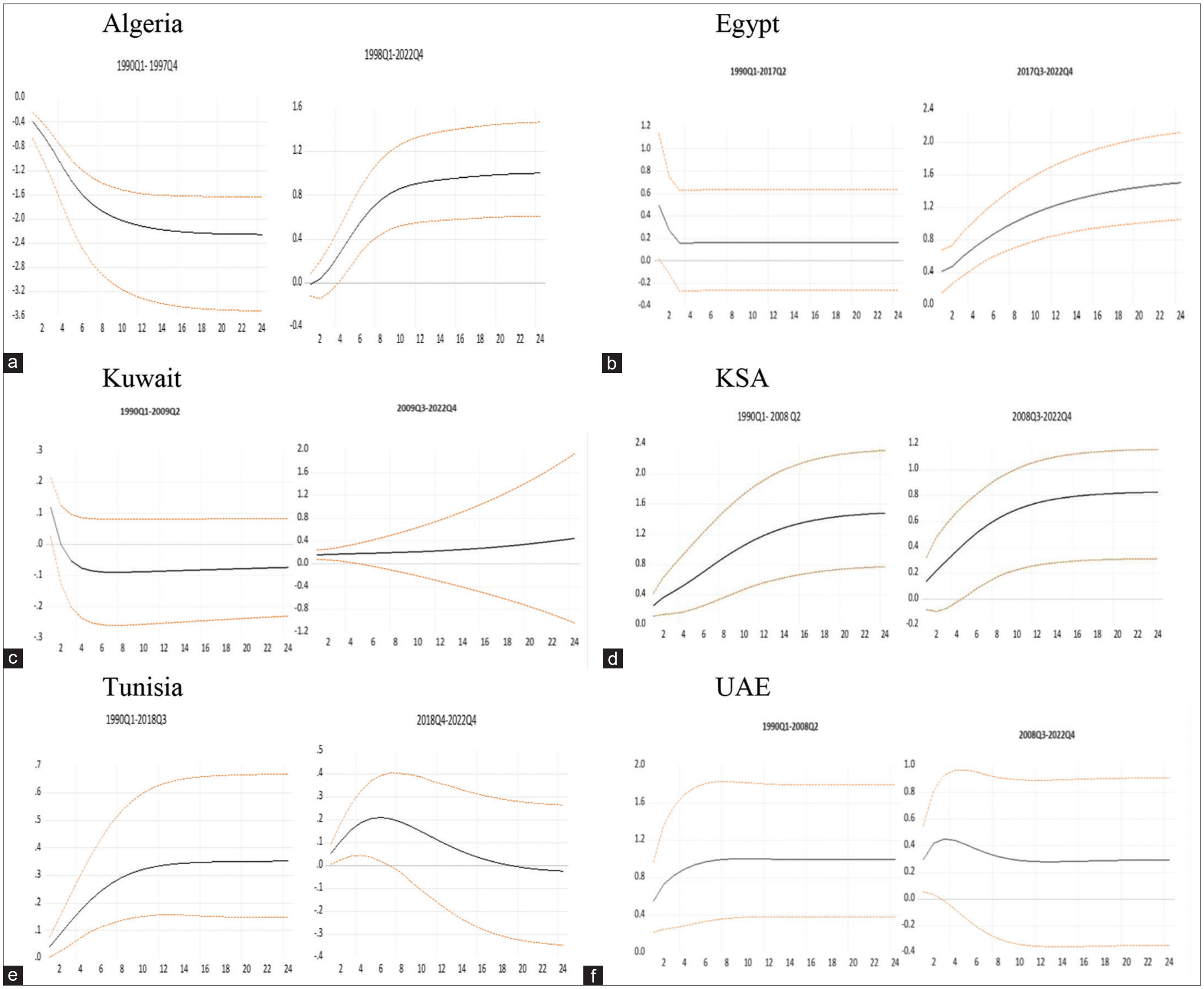
17 Egypt relies on Russia and Ukraine for 80% of its wheat imports, and the restriction of the global grain market caused wheat import prices to double.

18 Egypt imports approximately 100 million barrels of crude oil annually, and the spike in prices has increased production and manufacturing costs across the board.

19 Moreover, the Egyptian Ministry of Finance estimates a barrel of Brent crude in its general budget for fiscal year (FY) 2021/22 at $60, however, the current price exceeds this level by $50-55 per barrel. Every $10 increase in the global oil price over the estimated price in Egypt's budget will result in an increase in the gross GDP deficit by 0.2% to 0.3%.

20 The government has also been seeking assistance from the international community and reached a preliminary deal with the IMF for a loan of $3 billion. However, Egypt is committed to establishing a relatively flexible exchange rate, immediately causing the Egyptian pound to further depreciate.

Figure 3: (a-f) Results of the impulse response function of two regimes TVP_VAR model for the selected countries



Source: Author's computation using Eviews version 12

the public budget and inflation[21]. Overall, the specific magnitude and duration of oil price shocks and the government's response to them also affect the overall impact on inflation.

To shed light on KSA[22], Kuwait and UAE, oil price shocks have nearly symmetric effect on inflation throughout the entire period of study. As oil exporters are more vulnerable and susceptible to oil price fluctuations, such changes can directly affect various sectors of the economy, including inflation. The rises in crude oil prices induce higher inflation in both the short and long run. While oil production does have a positive effect on the real economy[23], the flip side is that it makes these countries very dependent on their oil sector, with a lack of economic diversification. During oil shocks where prices rise rapidly, countries experience inflationary pressures. The primary driver behind this phenomenon is the fact that oil revenues account for a substantial portion of the

21 The rise in natural gas prices worldwide gives Egypt a greater share of Europe's imports, Egypt's exports of natural gas and LNG reached $3.9 billion in 2021, with a growth rate of 550%. This was achieved by to Idku and Damietta liquefaction plants with a total production capacity reaching 12 million tons per year (mmt/y), according to the Ministry of Petroleum and Mineral Resources.

22 KSA is the fastest growing G20 economy in 2022. It produces the most crude oil among OPEC members, and it accounted for the largest share of OPEC's total revenue in 2022. It is estimated that KSA's net export revenue was $311 billion, which accounted for about 35% of all OPEC oil revenue in 2022 (please see EIA, 2023).

23 Higher oil prices/production improved the current account of KSA to a 10-year high surplus last year. Higher exports—primarily from oil and accompanied by a record level of non-oil exports (a fifth of total exports) and strong tourism inflows—continue to surpass the strong import growth and large remittance outflows although marginally lower than the level observed in 2021. The 13.6% of GDP surplus in 2022—equivalent to $150.8 billion—only led to a $4.5 billion increase in reserves over 2021. More recently, reserves have further declined by about $17.7 billion in May 2023 relative to 2022, primarily due to large amortizations.

country's income and government budget, enabling an increase in government spending and investment. This injection of funds into the economy fuels inflationary pressures, as increased spending leads to higher aggregate demand, pushing prices upward. Additionally, higher oil prices lead to increased production costs-cost-push inflation, which is often passed on to consumers through higher prices for goods and services, thus contributing to inflationary pressures. And vice versa when oil price shocks are negative.

Since 1990, oil prices have experienced periods of significant volatility. From 1990 to 2000, the oil price dynamics were relatively stable, but after 2000, they became more unpredictable. From 2000 to 2008 oil prices rose dramatically from $25 per barrel to $150 per barrel. This increase is attributed to production cuts by OPEC coupled with higher oil demand from emerging economies. However, the global financial crisis in 2008 led to a decline in oil demand, causing the price to drop to $40 per barrel. As the economy started to recover, oil prices climbed back up to $100 per barrel and eventually reached $125 per barrel in 2014[24]. However, in the fourth quarter of 2014, oil prices experienced a sudden decline due to an oversupply of oil[25]. Additionally, the shale oil revolution resulted in a substantial decrease in their oil imports, putting downward pressure on oil prices[26].

Figure 3c-f demonstrates that in KSA and UAE the positive effects are not constant and have increased over time in the first regime period and to a lesser extent in the second period, with the increase being more prominent in the first period. During the first regime, several factors have contributed to a higher impact of oil price shocks on inflation. This period witnessed significant volatility in global oil prices, as sudden and large changes in oil prices disrupted economic activity and led to more pronounced price adjustments. Additionally, the diversification efforts to reduce dependency on oil were not as advanced as they have been in recent years, therefore, the economy was more susceptible to oil price fluctuations, making the impact on inflation more significant. Also, the monetary and fiscal policies pursued during this period were reactive, leading to a stronger transmission of oil price movements to inflation. Unlike the scenario of Kuwait, it experienced a significant shock due to the Gulf War (1990-1991) and its repercussions, which led to a decline in oil production and exports. The war disrupted economic activities, and the government had to undertake reconstruction efforts. The decrease in oil prices during this time was attributed to the reduction in oil supply and the overall geopolitical instability. Moreover, the economy was grappling with other challenges.

During the second period, KSA and UAE have made significant strides in diversifying their economies and reducing dependence on oil. Several initiatives have aimed to promote non-oil sectors, attract foreign investment, tourism and foster economic growth in various industries. Governments have implemented various policy measures to manage oil price shocks and their impact on inflation, such as building reserves, implementing fiscal reforms and adopting inflation-targeting frameworks. These measures helped to stabilize their economies and reduce the pass-through of oil price movements to inflation. Furthermore, this period witnessed several global economic events, such as the global financial crisis of 2008, the COVID-19 pandemic and Russian-Ukraine tension. These events had broader implications for global oil demand and supply dynamics. Additionally, advancements in technology and extraction techniques, such as shale oil production and OPEC's decision not to reduce production levels have influenced global oil markets and potentially dampened the impact of oil price shocks on inflation.

According to the IMF (2022b) report, oil revenues in KSA averaged 75% of total budget revenues since 2010 with large variations, peaking at 93% in 2011 and falling to 53% in 2020 as the COVID-19 crisis pushed global oil demand down. As a result, fiscal balances have also varied with oil prices, with large surpluses during booms and considerable deficits during times of depressed oil prices. In line with the Energy Information Agency (2023) estimates, the UAE is among the world's ten largest oil producers. About 96% (roughly 100 billion barrels) of the country's proven oil reserves are located in Abu Dhabi, ranking number six worldwide. The UAE produces an average of 3.2 million barrels of petroleum and liquids per day. Recently, IMF (2023c) highlighted that the headline CPI averaged 2.5% in 2022 for Gulf countries, with inflation partly contained by domestic subsidies/price cap and the strength of the U.S. dollar-with the latter more recently declining[27], spurred by favourable base effects. The continued increase in rents is offset by declining contributions from transport and food prices. On the other hand, wages for low-skilled workers rose by 12% in 2022Q4, and inflationary pressures have been limited as average wages have been contained-because of a relatively elastic supply of expatriate workers and increased labour force participation.

As depicted in Figure 3e, the impact of oil price shocks on CPI in Tunisia is positive throughout the entire period, the positive effects are not constant but have increased over time in the first regime period, while they decrease in the second period. Tunisia is highly dependent on oil imports to meet its energy needs. From 1990 to 2018, global oil prices experienced significant volatility, including notable price increases during this period, which affected the prices of not only energy-related products but also other goods and services that rely on oil as an input or transportation. This pass-through effect led to a broad-based increase in prices across the economy, resulting in higher inflation (as demonstrated by Jbir and Zouari-Ghorbel, 2009; Guenichi and Benamou, 2010; Helali and Kalai, 2015; El-Hamiani, 2018). A relative decrease in the impact of oil prices on inflation from 2019 to 2022 can be attributed to several factors as suggested by Gritli (2021) and El-Hamiani et al. (2020): monetary policy measures; government subsidies; demand-supply dynamics; and structural reforms.

24 Oil prices estimates obtained from OPEC, please see: https://www.opec.org/opec_web/en/

25 The slowdown in Chinese economic growth played a significant role in reducing oil demand from countries like India and Brazil.

26 The shale oil revolution in the United States has had a significant impact on global oil prices, as well as the relationship between oil prices and the Saudi Arabian economy. KSA has the ability to withstand low oil prices for an extended period and may even exert pressure on the U.S. and Canada to curtail their expensive oil production methods.

27 Despite an uptick in early 2023 to 3.4%, headline inflation has fallen again to 2.8% in May 2023.

6. CONCLUSION

Oil is a crucial commodity that has a significant impact on the global economy. Its price is subject to fluctuations due to diverse economic and political factors, making it important to understand its effects on various macroeconomic indicators, particularly on inflation. This paper aims to quantify the effect of changes in the global price of Dubai crude oil on inflation in six OAPEC nations: Algeria, Egypt, Kuwait, KSA, Tunisia, and UAE. The study utilizes quarterly data from 1990Q1 to 2022Q4. The methodology employed in this study involves the use of the TVP-VAR model to examine the dynamics of the pass-through effect of oil price shocks on the CPI in the countries under investigation. The TVP-VAR modelling approach allows for a comprehensive understanding and analysis of how oil price shocks affect CPI, taking into account the time-varying nature of the parameters. The estimation of the TVP-VAR model with stochastic volatility is conducted using the MS method. After determining the optimal lag length and confirming the absence of a long-run relationship between the variables, the IRF of the model variables is analysed for 24 periods.

The findings reveal that the optimal model for this study is determined to be the MSI(2)-AR(1), which comprises two regimes and one autoregressive lag order. The estimated MS intercepts VAR coefficients for the countries under examination indicate that regime 1 in Algeria, KSA and Tunisia exhibits higher baseline inflation compared to regime 2. Conversely, in Egypt, Kuwait, and UAE, regime 1 demonstrates lower baseline inflation relative to regime 2. The shift in regimes in Kuwait, KSA and UAE occurred around the same time following the 2008 global financial crisis. However, the specific dynamics within each of these three countries are intricate and multifaceted, resulting from a combination of internal and external factors. In Algeria, the change in regimes took place after 1997, primarily due to the steadfast implementation of the fund-supported programs. In Egypt, the shift occurred in 2017, following the devaluation of the Egyptian pound. In Tunisia, it transpired during 2018 as a consequence of monetary tightening. Overall, throughout the entire study period, oil price shocks exerted a significant positive impact on the CPI, leading to inflationary pressures in all sample countries, albeit with varying magnitude and persistence.

Moreover, this paper examines the influence of a set of control variables that are considered to be key determinants of inflation, namely ER, GDP, IR and NX. The results indicate that the ER is positively associated with CPI in Algeria, Egypt, and Tunisia. It should be noted that the relationship between the IR and CPI is not straightforward and can exhibit both positive and negative effects depending on specific circumstances. Additionally, GDP has a significant negative impact on CPI in both Kuwait and UAE. Lastly, NX demonstrates a significant positive association with CPI in Kuwait, KSA, and UAE.

The findings of this study have several policy implications for OAPEC countries. Firstly, the analysis highlights the importance of considering global oil price shocks in understanding inflation dynamics. Policymakers need to closely monitor and manage the impact of oil price fluctuations on consumer prices to ensure price stability and mitigate any adverse effects on the economy. Furthermore, the analysis reveals the relationship between various independent variables and CPI. This provides policymakers with insights into the factors influencing inflation and allows them to design appropriate policy measures. For example, policymakers may consider adjusting exchange rates, interest rates, or trade policies to manage inflationary pressures effectively. Moreover, the analysis highlights the differences in CPI, ER, GDP and IR across countries. Policymakers can use this information to benchmark their country's performance against others and identify areas for improvement. Overall, the findings of this study contribute to a better understanding of inflation dynamics and the impact of global oil price shocks in OAPEC countries, providing valuable insights for policymakers in formulating effective economic policies.

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