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Asymmetric effect and dynamic relationships between oil prices shocks and exchange rate volatility: Evidence from some selected MENA countries

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Abstract

The aim of this paper is to investigate the exchange rate consequences of oil-price fluctuations across selected MENA countries (including both commodity importers and exporters) and to examine the dynamic relationship between such shocks. We employed the asymmetry of volatility through the GJR-GARCH model using daily time series data covering the period between 2001 and mi-2015. We refer to impulse responses functions in order to test the dynamic relationships.

Empirical results reveal that foreign exchange market and crude oil exhibit asymmetric and no asymmetric in the return series. Additionally, the findings show asymmetric response of volatilities to positive and negative shocks. Furthermore, the results suggest that there is a dynamic relationship among oil price shocks and exchange rate volatility. Indeed, in the short run, oil prices shocks had a significant impact on exchange rate changes. Finally, we found that in the case of oil-exporting country, the oil prices rise may experience exchange rate appreciation, while, the decrease of oil price leads to appreciation of the currency of oil importing countries. This implies that oil prices are a key variable in determining the strength of the currency and its volatility. Therefore, policy makers of most MENA countries should consider exchange rate and oil price fluctuations on their macroeconomic policies and diversify more their economics.

Keywords: Oil price shocks; Exchange rate volatility; GJR-GARCH model; Asymmetries; Causality test; Impulsion function; MENA countries

JEL Classification: F31, G01, Q43

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1. Introduction

Oil is one of the most important forms of energy and is a significant determinant of global economic performance. In fact, since the oil price shocks of the 1970s, the price of crude oil and its consequences on various economic magnitudes have continued to attract interest from economists and policy makers. Such topic has a great interest in international economics and still debated.

In particular, the exchange rate is considered as the primary channel through which the fluctuations of oil prices traded in US dollars are transmitted to the real economy and financial markets (Reboredo, 2012). Indeed, an oil price increase will have an effect on a nation's wealth as it leads to a transfer of income from oil importing to oil exporting countries through a shift in the terms of trade. Through a shift in the balance of trade, exchange rates are also expected to change.

In this area, the consequence of oil prices on exchange rate movements have been noted by Amano and van Norden (1998) and recently is renewed by several authors as Kin and Courage (2014), Oriavwote and Eriemo (2012), Basher et al. (2012), Aziz (2009). Such studies argue that increases in the oil price of the oil-exporter (oil importer) will lead to an increase (decrease) in the relative price of commodities. This leads to an appreciation (depreciation) of exchange rate (Chaudhuri and Daniel, 1998).

Others show that a rise in the oil price can lead to either an appreciation or depreciation of the exchange rate (Benassy-Quere et al. (2007)). Indeed, the effect of such an oil price increase will depend on the oil intensity of both sectors in the country: if the non-tradable sector is less (more) energy intensive, then the exchange rate will depreciate (appreciate).

Also, the literature showed that a nonlinear relationship can exist between open price and exchange rate. In this sense, Akram (2004) finds that fluctuations of oil price affect the Norwegian exchange rate in a negative non-linear way, especially when oil prices are below 14 USD. Some other literature finds the opposite direction of causation as Cooper (1994), Benhmad, (2012) and Brahmasrene (2014).

While, the literature which concerning the impact of oil prices on exchange rates is mostly available for oil-producers, neglecting small open emerging countries and oil-importers.

More specifically, oil plays a significant role in most MENA countries, which are particularly sensitive to those changes in oil prices (both oil producers and dependent on petroleum as consumers). Little evidence exists, however, on the effects of oil prices shocks on exchange rates fluctuations in the MENA context.

To fill this gap in literature, this paper seeks to investigate the exchange rate consequences of oil-price fluctuations across selected MENA countries (including both commodity importers and exporters) and to detect the asymmetric relationship between such connections. The GJR Generalized Autoregressive Conditional Heteroscedasticity (GARCH) test introduced by Glosten et al. (1993) was performed to test the asymmetric effect of oil prices shocks and exchange rate volatility for MENA countries, using daily time series data covering the period between 2001 and mid-2015. We refer to impulse responses functions in order to test the dynamic relationships between these shocks.

2. Literature review

This section provides a discussion on the theoretical literature by reviewing the main channels which explain the effect of oil prices on the exchange rate. It also focuses on the empirical studies done.

2.1- Theoretical Literature

Oil prices affect exchange rates mainly through a two way transition mechanism which includes both supply and demand strands (Nikbakht 2009). On the supply side, oil price increases affect production negatively since oil is a basic factor of production. Any increase in the price of a factor of production will raise the cost of production of non-tradable goods so it will lead to an increase in prices of non-tradable goods, so an appreciation of the exchange rate. Contrarily, from the demand side, the exchange rate is indirectly affected through its relation with disposable income (Nikbakht 2009). Thus, a rise in oil prices reduces the consumers spending power. This will reduce the demand for non-tradables leading to a fall in their prices and ultimately depreciating the exchange rate.

This literature provides a theoretical nexus oil prices and exchange rate through many channels which identified to explain the impact of oil price on exchange rates (Benassy-Quere et al., 2007; Beckman and Czudaj, 2013). The mains strands investigating the information transmission between oil prices and exchange rates, are terms of trade and balance of payments and international portfolio choices approaches:

Terms of trade channel: is derived from the work of Amano and van Norden (1998). They suggest a model with two sectors: tradables and non-tradables. Both sectors use a tradable input which is oil, and a non-tradable input which is labor. Inputs are mobile between the sectors. The model also assumes that the output price of the tradable sector is fixed internationally.

Benassy-Quere et al. (2007) assume that if a rise of oil price affects the output prices of tradable and non-tradable sector, an increase of the oil price can lead to either an appreciation or depreciation of the exchange rate. It is depend to the oil intensity of both sectors. As a result of this, the real exchange rate corresponds to the output price in the non-tradable sector. Indeed, in the case where non-tradable sector is more (less) energy intensive than the tradable one, its output price rises (fall) and real exchange rate appreciates (depreciates).

The balance of payments and international portfolio choices: called also ‘wealth transmission channel. The key idea originally initiated by Krugman (1983) and Golub (1983) is that oil price changes execute an impact on international portfolio decisions and trade balances. This view acknowledges that higher oil prices will transfer wealth from the oil importers to oil exporters.

More precisely, Krugman (1980) employed a model to investigate the effect of an oil price increase on US dollar. He showed that that US dollar will appreciate in the short run, however in the long run it will depreciate (Benassy-Quere, Mignon and Penot, 2007). He argued the differences in the response of foreign exchange markets to oil shocks seen in 1970's especially by the portfolio choices of oil importing and oil exporting countrie**s.**

Initially the relation would be positive because oil profits are invested in US dollar assets, but it might turn to negative in the long run since over time OPEC's spending rises, as a result of the wealth from higher oil prices, with a preference for manufactured products from industrial countries. If such OPEC imports come from countries other than the US, the US dollar will appreciate in the short run but not in the long run.

The elasticity approach: the impact of oil prices on the exchange rate depends on the elasticity of import demand of the importing country. Price elasticity of demand is a measure of the responsiveness of quantity demanded to a change in price (Jehle and Reny 2011). If quantity demanded is highly responsive (not responsive) to a change in price, then demand is said to be relatively elastic (inelastic). When a nation's commodities prices (oil) rise, they become relatively more expensive in the global market (Nkomo 2006). Hence importing countries will reduce their import of oil. But, the evolution of imports depends to elasticity of imports. Indeed, if import demand of oil is highly inelastic, a rise in oil prices will cause depreciation in the currency of the importing country. An increase (decrease) in the oil price will mean that the importing country will require more (less) of its currency in order to buy the same amount of oil it used to buy before. Hence there would be deprecation (appreciation) in the currency of the importing country.

This interaction between oil prices and real exchange rate implies that this link is linear after the first oil shock (Hamilton, 1983). Also, the literature showed that a nonlinear relationship can exist between open price and exchange rate. In this sense, Raymond and Rich (1997) conducted a model with Markov switching regime to evaluate and compare the impact of trends in rising and falling oil prices on fluctuations of U.S. economic aggregate before and after the world war applying the model chosen on two sub-periods. More recently, Akram (2004) finds that fluctuations of oil price affect the Norwegian exchange rate in a negative non-linear way, especially when oil prices are below 14 USD.

Ultimately the question concerning which one of these factors dominates should be approached empirically.

2.2- Empirical Literature

This section reviews empirical studies that have been conducted into the oil price-exchange rate nexus.

Many early empirical studies were conducted for advanced economies and these used cointegration and causality analysis. Chaudhuri and Daniel, (1998); Huang and Guo, (2007); Benassy-Quere et al., (2007) found that a rise of oil price lead to an appreciation of the exchange rate. Contrary, Chen and Chen (2007) found that oil prices lead to depreciation of exchange rates in G7 countries. For Norden, (1998b), there is a mixed results found.

Akram (2002) explored the possibility of a non- linear relationship between oil prices and the Norwegian exchange rate. The results of the study revealed a negative relationship between oil prices and the value of the Norwegian exchange rate, and that it was relatively strong when oil prices were below 14 dollars and were falling.

Ozturk et al. (2008) studied the link between international oil prices and the exchange rate in a small open industrial economy. The cointegration and Granger causality tests were used to analyse the relationship between the period of December 1982 to May 2006. They found out that the international real crude oil prices Granger cause the United States (USD)/ Turkish Lira (YTL) real exchange rate.

More recently, many studies have adopted GARCH models and wavelets and copulas, and there has been an increase in studies conducted for emerging economies.

Ghosh (2011) examined the oil price – exchange rate nexus for India. The authors used GARCH and EGARCH models and the results showed that oil price increases lead to a depreciation of the exchange rate.

Reboredo and Rivera-Castro (2013) studied the relationship between oil prices and U.S. dollar using wavelet multi-resolution analysis. The results showed no evidence of a relationship prior to the global crisis, while in the post-crisis period, there was negative dependence between oil prices and exchange rates.

Aloui et al. (2013) used the copula-GARCH approach to examine the relationship between oil prices and the U.S. dollar exchange rates of 5 foreign exchange markets – Eurozone, Canada, Britain, Switzerland, and Japan. They showed that oil price increases are associated with the depreciation of the currency.

Tiwari et al. (2013a) used wavelet decomposition to test linear and nonlinear causality within different frequency bands. The results showed no relationship at lower time scales. However, bi-directional causality was found at higher scales. Tiwari et al. (2013b) examined the effect of oil prices on the real effective exchange rate in Romania using a discrete wavelet transform approach. The results showed that oil prices have a strong causal effect on real effective exchange rate in both the short run and long run.

Wu et al. (2012) perform a dynamic copula-GARCH analysis of the dependence between crude oil and USD exchange rate returns. The authors find that the dependence structure becomes negative and decreases continuously after 2003.

Oriavwote and Eriemo (2012) employed Johansen cointegration test and the Granger Causality test using Nigerian time series data for the period between 1980 and 2010. Their findings from the GARCH test suggest persistence of the volatility between the real oil prices and the real effective exchange rate.

Turhan et al. (2013) examined the effects of oil prices on the exchange rates of 13 emerging economies – Argentina, Brazil, Colombia, Indonesia, Mexico, Nigeria, Peru, Philippines, Poland, Russia, South Africa, South Korea and Turkey. They showed that with the exception of Argentina and Nigeria, after the global crisis, oil price shocks lead to depreciation of the exchange rates. The generalized impulse response functions were employed to find the impact on three different times. The findings showed that oil price dynamics impact on exchange rate changes over time and the impact was more pronounced after the 2008 financial crises.

Salisu and Mobolaji (2013) investigate volatility transmission between oil price and US-Nigeria exchange rate by using a VAR-GARCH model accounting for structural breaks. Their results establish a bi-directional spillovers transmission between oil and foreign exchange markets

Buetzer et al. (2012) investigated whether oil shocks matter for global exchange rate configurations. The paper was based on data on real and nominal exchange rates as well as on an exchange market pressure index for 44 advanced and emerging countries. Using VAR models, they found no evidence that exchange rates of oil exporters systematically appreciate against those of oil importers aftershocks that raise the real oil price. However, oil exporters experienced significant appreciation pressures following an oil demand shock, which they tend to counter by accumulating foreign exchange reserves.

Basher, Haug and Sadorsky (2012) also examined the relationship between oil prices, exchange rates and emerging markets stock prices via SVAR models for the period of 1988 to 2008. The authors study the relationship between oil prices and exchange rates and offer limited support for the relationship between these variables. In addition the authors find that while responding negatively to a positive oil price shock, oil prices respond positively to a positive emerging market shock.

Mendez-Carbajo (2010) studied the impact of oil prices on floating exchange rate of the Dominican peso during the 1990-2008 period. The vector error correction model was employed in investigating the relationship. The findings showed that 10% rise in the price of gas coincides with a 1.2% depreciation of the peso in the long run and that the causality runs from gas prices to the peso.

3. Econometric methodology: Univariate GJR-GARCH model

In this article, we employed the asymmetry of volatility through the GJR-GARCH model and we analyzed the dynamics of shocks through the impulse responses functions.

The GJR-GARCH model was named after the authors who introduced it, Glosten, Jagannathan & Runkle (1993). It extends the standard GARCH (p,q) to include asymmetric terms that capture an important phenomenon in the conditional variance of equities: the propensity for the volatility to rise more subsequent to large negative shocks than to large positive shocks (known as the “leverage effect”).

The GJR-GARCH (p,q) process is defined as:

$$r_t = \mu_t + \varepsilon_t , \tag{3.1.1}$$

$$\sigma_t^2 = w + \alpha_1 \varepsilon_{t-1}^2 + \varphi I_{\varepsilon_{t-1}<0} \varepsilon_{t-1}^2 + \beta_1 \sigma_{t-1}^2 \tag{3.1.2}$$

$$I_{\varepsilon_{t-1}<0} = \begin{cases} 1 \text{ si } \varepsilon_{t-1} < 0 \\ 0 \text{ si } \varepsilon_{t-1} \geq 0 \end{cases}$$

Where μ_t can be any adapted model for the conditional mean and $I_{\varepsilon_{t-1}<0}$ is an indicator function that takes the value 1 if $\varepsilon_{t-1} < 0$ and 0 otherwise. The parameters of the GJR-GARCH, like the standard GARCH model, must be restricted to ensure that the fit variances are always positive. This set is difficult to describe for a complete GJR-GARCH (p,q) model although it is simple of a GJR-GARCH (1,1).

$\alpha_1 \geq 0$, $w > 0$, $\alpha_1 + \varphi \geq 0$ and $\beta_1 > 0$. If the innovations are conditionally normal, a GJR-GARCH model will be covariance stationary as long as the parameter restriction are satisfied and $\alpha_1 + \frac{1}{2}\ \varphi + \beta_1 < 1$.

4. Data and preliminary analyses

Our data include daily WTI crude oil price and eight exchange rates expressed in dollar (USD). All data are sourced from the (http//www.eia.com) and (http//www.Oanda.gov). The sample covers a period from January 01, 2001 until August 31, 2015, leading to a sample size of 3826 observations. For each exchange rate and crude oil, the continuously compounded return is computed as $r_t = 100\ \times \ln(p_t/p_{t-1})$ for $t = 1,2, \dots , T$, where p_t is the price on day t. The chosen period permits to analyse the sensitivity of international exchange market returns to the recent oil price increase in 2007-2008.

Summary statistics for crude oil and exchange market returns are displayed in Table 1 (Panel A). From these tables, (WTI) is the most volatile, as measured by the standard deviation of 2.3791%, while USD/AED is the least volatile with a standard deviation of 0.0204%. Besides, we observe that USD/AED has the highest level of excess kurtosis, indicating that extreme changes tend to occur more frequently for the exchange rate. In addition, all exchange market returns exhibit high values of excess kurtosis. To accommodate the existence of “fat tails”, we assume student-t distributed innovations. Furthermore, the Jarque-Bera statistic rejects normality at the 1% level for all exchange rate and crude oil. Moreover, all exchange market return series and oil price are stationary, I(0). Finally, they exhibit volatility clustering, revealing the presence of heteroskedasticity and strong ARCH effects.

Table 1
Summary statistics for all series (returns).

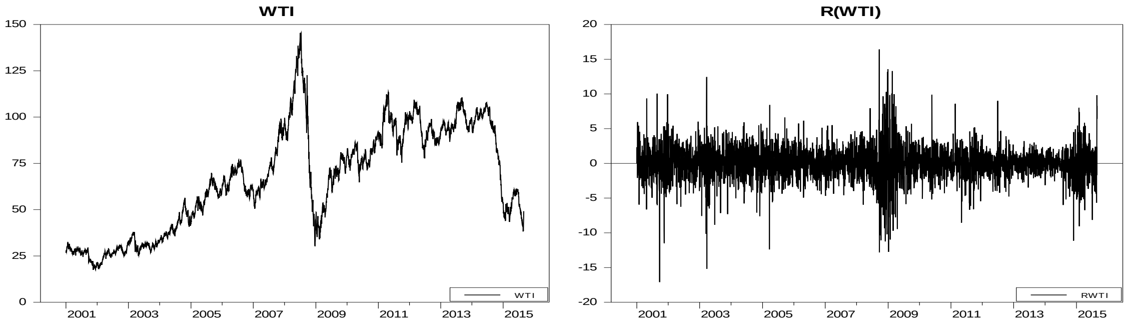
	WTI	**USD/TND**	**USD/MAD**	**USD/JOD**	**USD/EGP**	**USD/AED**	**USD/QAR**	**USD/SAR**
Panel A: descriptive statistics								
Mean	1.59E-02	0.0093	-0.0023	-5.91E+0	1.85E-02	-3.5587	-2.9465	-1.3244
Maximum	16.414	14.828	6.134	1.3306	15.603	0.7245	6.916	0.5691
Minimum	-17.092	-15.146	-5.4007	-1.2507	-5.3093	-0.6319	-6.8885	-0.5051
Std. Deviation	2.3791	1.8284	0.7961	0.1367	0.5796	0.0204	0.2865	0.0421
Skewness	-0.1549*	-0.086**	0.136***	0.116***	5.6726***	3.5420***	4.0155*	2.1475**
	0.0009	0.0298	0.0005	0.0031	0.0000	0.0000	0.0938	0.0398
ExcessKurtosis	5.289***	28.11***	5.4526***	19.49***	163.99***	664.22***	201.95***	54.10***
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Jarque-Bera	4475.1**	1.2597***	4751.3***	60610***	4.3079***	7.0342***	6.5014***	4.666***
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

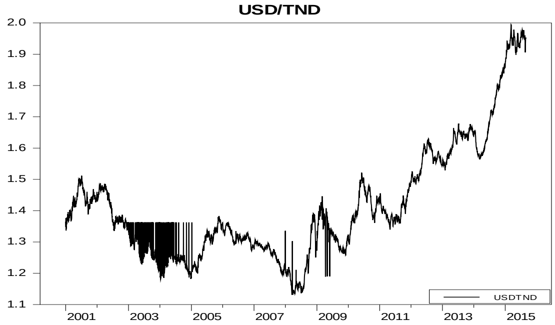
Panel B: Serial correlation and LM-ARCH tests								
$LB(20)$	46.608**	4313.29**	489.121**	635.319*	452.971**	1453.93**	1077.84**	726.669*
	0.0006	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
$LB^2(20)$	1932.53*	4240.21**	864.986**	763.778*	13.9556	1146.95**	739.38***	2277.1**
	0.0000	0.0000	0.0000	0.0000	0.8327	0.0000	0.0000	0.0000
ARCH 1-10	54.909**	170.74***	46.60***	58.375**	13.489*	227.18***	1.8091***	175.08**
	0.0000	0.0000	0.0000	0.0000	0.0981	0.0000	0.0538	0.0000
Panel C: Unit Root tests								
ADF test statistic	-34.488*	-56.8195*	-42.5311*	-56.1456*	-42.2202*	-52.0812*	-44.9301*	-48.6012*
	-1.9409	-1.9409	-1.9409	-1.9409	-1.9409	-1.9409	-1.9409	-1.9409

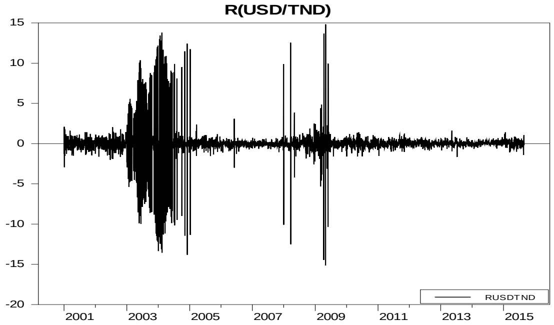
Notes: Crude oil and exchange market returns are in daily frequency. Observations for all series in the whole sample period are 3826. The numbers in brackets are t-statistics and numbers in parentheses are p-values. ***, **, and * denote statistical significance at 1%, 5% and 10% levels, respectively. $LB(20)$and$LB^2(20)$ are the 20th order Ljung-Box tests for serial correlation in the standardized and squared standardized residuals, respectively.

Figure 1 illustrates the evolution of oil prices and exchange rates during the period from January 1, 2001 until August 31, 2015. The figure shows significant variations in the levels during the turmoil, especially at the time of Lehman Brothers failure (September 15, 2008) and at the European sovereign debt crises. Specifically, when the global financial crisis triggered, there was a decline for all prices. The figure shows that all exchange rates and crude oil trembled since 2008 with different intensity during the global financial and European sovereign debt crises. Moreover, the plot shows a clustering of larger return volatility around and after 2008. This means that exchange rate are characterized by volatility clustering, i.e., large (small) volatility tends to be followed by large (small) volatility, revealing the presence of heteroskedasticity. This market phenomenon has been widely recognized and successfully captured by ARCH/GARCH family models to adequately describe exchange market returns dynamics. This is important because the econometric model will be based on the interdependence of the exchange markets in the form of second moments by modeling the time varying variance-covariance matrix for the sample.

Figure 1: Oil prices and exchange rate behavior over time (raw series and returns).
during the period from January 1, 2001 until August 31, 2015 for some MENA countries.




USD/TND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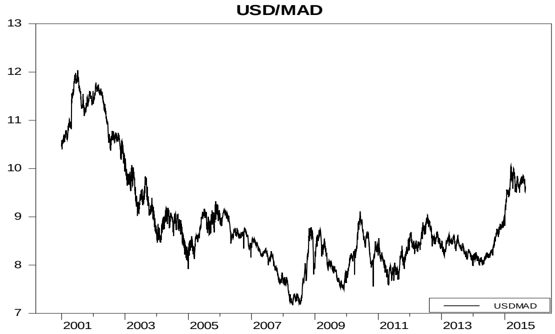
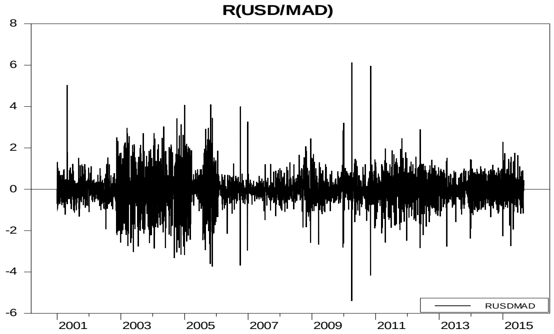
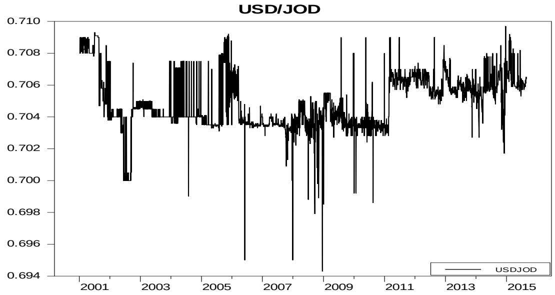
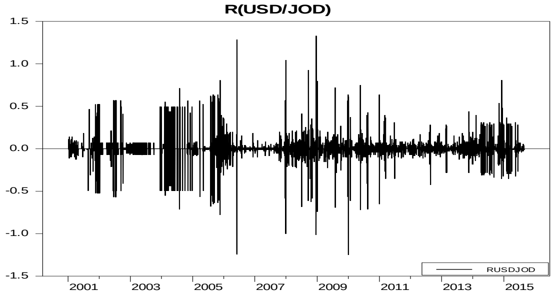

USD/MAD


R(USD/MAD)


USD/JOD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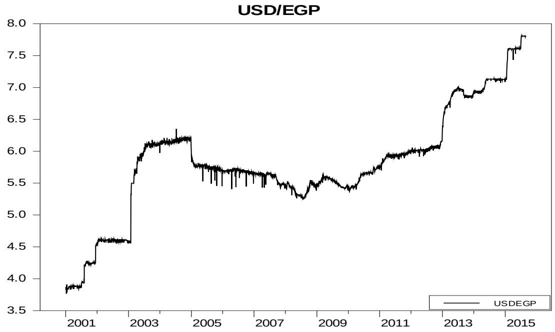
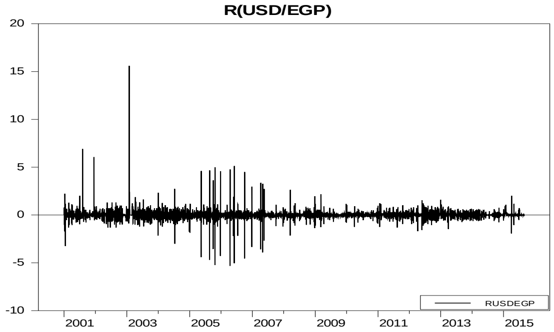
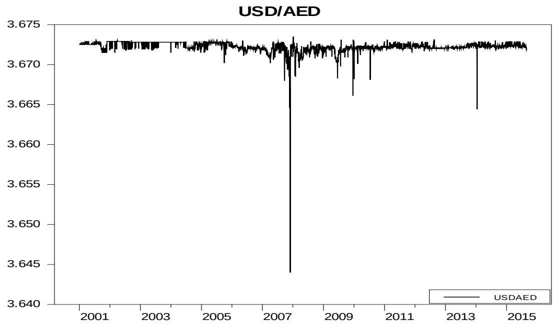
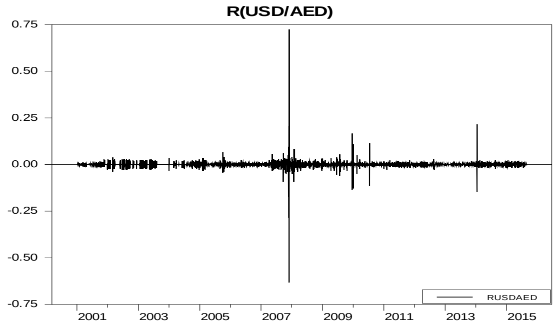
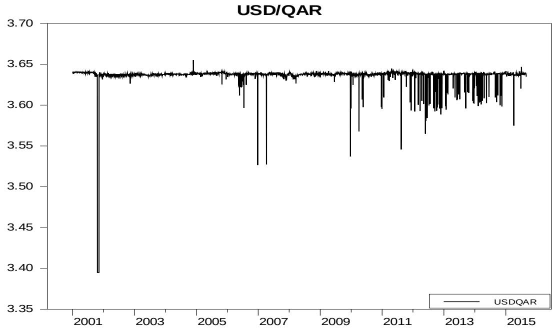
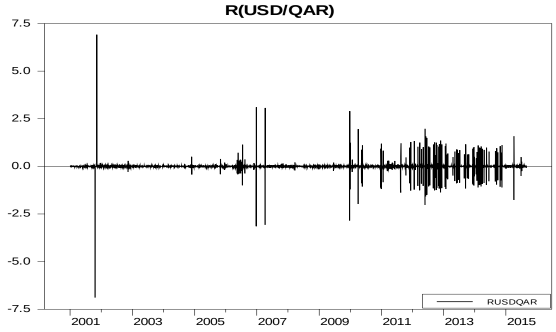

USD/EGP

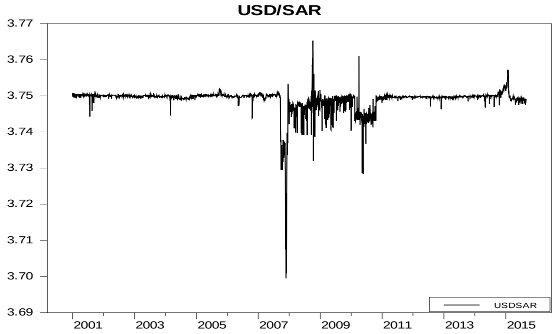

R(USD/EGP)

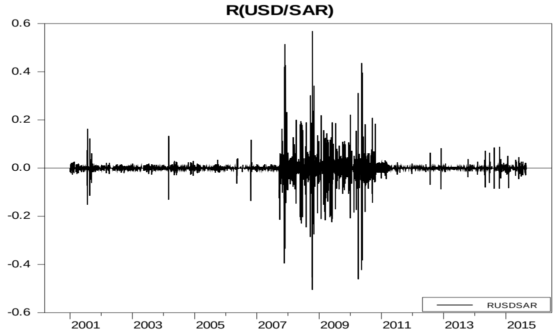












5. Empirical Results

5.1- Tests for sign and size bias

Engle and Ng (1993) propose a set of tests for asymmetry in volatility, known as sign and size bias tests. The Engle and Ng tests should thus be used to determine whether an asymmetric model is required for a given series, or whether the symmetric GARCH model can be deemed adequate. In practice, the Engle-Ng tests are usually applied to the residuals of a GARCH fit to the returns data.

Define S_{t-1}^{-} as an indicator dummy variable such as:

$$S_{t-1}^{-} = \begin{cases} 1 & \text{if } \hat{z}_{t-1} < 0 \\ 0 & \text{otherwise} \end{cases} \tag{5.1.1}$$

The test for sign bias is based on the significance or otherwise of ϕ_1 in the following regression:

$$\hat{z}_t^2 = \phi_0 + \phi_1 S_{t-1}^{-} + \nu_t \tag{5.1.2}$$

where $\nu_t$is an independent and identically distributed error term. If positive and negative shocks to $\hat{z}_{t-1}$ impact differently upon the conditional variance, then ϕ_1 will be statistically significant.

It could also be the case that the magnitude or size of the shock will affect whether the response of volatility to shocks is symmetric or not. In this case, a negative size bias test would be conducted, based on a regression where S_{t-1}^{-} is used as a slope dummy variable. Negative size bias is argued to be present if ϕ_1 is statistically significant in the following regression:

$$\hat{z}_t^2 = \phi_0 + \phi_1 S_{t-1}^{-} z_{t-1} + \nu_t \tag{5.1.3}$$

Finally, we define $S_{t-1}^{+} = 1 - S_{t-1}^{-}$, so that S_{t-1}^{+}picks out the observations with positive innovations. Engle and Ng (1993) propose a joint test for sign and size bias based on the following regression:

$$\hat{z}_t^2 = \phi_0 + \phi_1 S_{t-1}^{-} + \phi_2 S_{t-1}^{-} z_{t-1} + \phi_3 S_{t-1}^{+} z_{t-1} + \nu_t \tag{5.1.4}$$

Significance of ϕ_1 indicates the presence of sign bias, where positive and negative shocks have differing impacts upon future volatility, compared with the symmetric response required by the standard GARCH formulation. However, the significance of ϕ_2 or ϕ_3 would suggest the presence of size bias, where not only the sign but the magnitude of the shock is important. A joint test statistic is formulated in the standard fashion by calculating TR^2 from regression (5.1.4), which will asymptotically follow aχ^2 distribution with 3 degrees of freedom under the null hypothesis of no asymmetric effects.

Table 2 reports the results of Engle-Ng tests. First, the individual regression results show that the residuals of the symmetric GARCH model for the RWTI series do not suffer from negative size bias and exhibit sign and positive size bias. Second, for the RUSD/TND series, the individual regression results show that the residuals of the symmetric GARCH model exhibit positive size bias and do not suffer from sign and negative size bias. From the RUSD/MAD and RUSD/JOD, the individual regression results show that the residuals of the symmetric GARCH model exhibit negative and positive size bias and do not suffer from sign bias. The RUSD/USD series do not suffer from sign, negative and positive size bias tests. The individual regression results show that the residuals of the symmetric GARCH model for the RUSD/AED, RUSD/QAR and RUSD/SAR series do not suffer from sign and positive size bias and exhibit negative size bias.

Finally, the $\chi^2(3)$ joint test statistics for WTI, USD/TND, USD/MAD, USD/JOD, USD/AED and USD/SAR have p-values of 0.0000, 0.0816, 0.0000, 0.0630, 0.0530 and 0.0023, respectively, demonstrating a very rejection of the null of no asymmetries. The results overall would thus suggest motivation for estimating an asymmetric volatility model for these particular series. For USD/EGP and USD/QAR, we accept the null hypothesis of no asymmetries. The results overall would thus suggest motivation for estimating symmetric and asymmetric GARCH volatility models, respectively, for these particular series.

Table 2 Tests for sign and size bias for crude oil and exchange rate return series.

	WTI			**USD/TND**			**USD/MAD**			**USD/JOD**		
Variables	Coeff	StdError	Signif	Coeff	StdError	Signif	Coeff	StdError	Signif	Coeff	StdError	Signif
ϕ_0	0.7116***	0.0800	0.0000	0.6827***	0.2553	0.0075	1.0525***	0.1068	0.0000	0.6747***	0.2197	0.0021
ϕ_1	0.3692***	0.1075	0.0006	0.0373	0.3693	0.9193	-0.2453	0.1492	0.1002	0.2515	0.2550	0.3240
ϕ_2	-0.0925	0.0702	0.1878	-0.4526	0.2995	0.1308	-0.411***	0.0985	0.0000	-0.2799*	0.1667	0.0932
ϕ_3	0.1758**	0.0821	0.0323	0.4850**	0.2303	0.0353	-0.2218**	0.1132	0.0501	0.3266**	0.1571	0.0377
$\chi^2(3)$	24.5557***	_	0.0000	6.7125*	_	0.0816	25.2076***	_	0.0000	7.2939*	_	0.0630

	USD/EGP			**USD/AED**			**USD/QAR**			**USD/SAR**		
Variables	Coeff	StdError	Signif	Coeff	StdError	Signif	Coeff	StdError	Signif	Coeff	StdError	Signif
ϕ_0	0.4667	0.4144	0.2602	0.9294***	0.1729	0.0000	0.7489***	0.2748	0.0064	0.5627	0.3706	0.1289
ϕ_1	0.9244	0.5808	0.1115	-0.1910	0.3242	0.5556	-0.3428	0.6746	0.6113	0.3925	0.4093	0.3376
ϕ_2	0.0865	0.4578	0.8500	-0.476***	0.1832	0.0094	-0.5846*	0.3272	0.0740	-0.554***	0.1654	0.0008
ϕ_3	0.1209	0.3895	0.7561	-0.0165	0.2539	0.9479	-0.2934	0.6655	0.6593	0.1094	0.4255	0.7970
$\chi^2(3)$	2.7178	_	0.4371	7.6837**	_	0.0530	3.3948	_	0.3346	14.425***	_	0.0023

Note : The superscripts *, ** and *** denote the level significance at 1%, 5%, and 10%, respectively.

5.2- The univariate AR(1)-GJR-GARCH (1.1) and the AR(1)-GARCH (1.1) estimates

Table 3 reports the estimation results of the univariate AR(1)-GARCH(1,1) and the AR(1)-GJR-GARCH(1.1) model for each exchange market and crude oil return series of our sample.

The estimates of the constants in the mean are statistically significant at 1% level or better for all the series except for the USD/MAD and USD/SAR. Besides, the constants in the variance are significant except for USD/TND, USD/AED and USD/SAR currencies. The ARCH and GARCH parameters of the univariate GARCH and GJR-GARCH are significant, justifying the appropriateness of these models.

In addition, for all currencies, the estimates of the parameter (φ) are statistically significant, indicating an asymmetric response of volatilities to positive and negative shocks. In all cases, the estimated degrees of freedom parameter (v) is highly significant and leads to an estimate of the Kurtosis which is equal to $3(\mathrm{v}-2)/(\mathrm{v}-4)$ and is also different from three. According to the values of the Ljung-Box tests for serial correlation in the standardized and squared standardized residuals, there is no statistically significant evidence, at the 1% level, of misspecification in almost all cases except for the USD/JOD, USD/TND and USD/QAR exchange markets.

Table 3
Univariate AR(1)-GARCH(1,1) and AR(1)-GJR-GARCH (1.1) models.

	WTI		**USD/TND**		**USD/MAD**		**USD/JOD**	
	Coefficient	t-prob	Coefficient	t-prob	Coefficient	t-prob	Coefficient	t-prob
Estimate								
$\boldsymbol{c}$	0.0508*	0.0646	0.0102***	0.0000	-0.0119	0.1270	0.0003***	0.0000
AR (1)	-0.0407**	0.0128	-0.0225**	0.0247	-0.142***	0.0000	-0.1910***	0.0001
$\boldsymbol{\omega}$	0.0239**	0.0189	450.2407	0.1459	0.0074***	0.0016	0.0002***	0.0011
$\boldsymbol{\alpha}$	0.0240***	0.0011	0.3661**	0.0359	0.0494***	0.0006	0.5853**	0.0102
$\boldsymbol{\beta}$	0.9518***	0.0000	0.6759***	0.0048	0.9034***	0.0000	0.2566***	0.0000
$\boldsymbol{\varphi}$	0.0401***	0.0004	-1999.9***	0.0036	0.0771***	0.0002	-0.2638***	0.0003
$\boldsymbol{v}$	6.2941***	0.0000	2.0001***	0.0000	5.0859***	0.0000	2.4109***	0.0000
Diagnostics								
$\boldsymbol{LB}(20)$	7.9915	0.9867	992.408***	0.0000	264.273***	0.0000	49.5058***	0.0001
$LB^2(20)$	25.9096	0.1018	399.849***	0.0000	11.296	0.8813	162.664***	0.0000
	USD/EGP		USD/AED		USD/QAR		USD/SAR	
	Coefficient	t-prob	Coefficient	t-prob	Coefficient	t-prob	Coefficient	t-prob
Estimate								
$\boldsymbol{c}$	0.0049***	0.0002	0.0003***	0.0022	0.0008**	0.0107	-0.0004	0.1102
AR (1)	-0.292***	0.0022	-0.4947**	0.0102	-0.1977***	0.0028	-0.1961***	0.0032
$\boldsymbol{\omega}$	48.1724***	0.0001	0.0004	0.1204	6.6163***	0.0024	96.3109	0.1207
$\boldsymbol{\alpha}$	0.3552	0.1423	0.4744	0.1057	0.82222	0.1802	0.3600***	0.0001
$\boldsymbol{\beta}$	0.3804***	0.0018	0.3187***	0.0014	-0.0004***	0.0038	0.4750***	0.0007
$\boldsymbol{\varphi}$	_	_	1.1850***	0.0001	_	_	3387.989***	0.0018
$\boldsymbol{v}$	2.0001***	0.0000	2.2865***	0.0000	2.0950***	0.0000	2.0001***	0.0000
Diagnostics								
$\boldsymbol{LB}(20)$	65.4445***	0.0000	0.6254	1.0000	577.262***	0.0000	151.784***	0.0000
$LB^2(20)$	0.1856	1.0000	0.288	1.0000	772.101***	0.0000	2.3579	0.9999

Notes: For each exchange ratesand crude oil, $\boldsymbol{LB}(\mathbf{20})and\boldsymbol{LB}^{\mathbf{2}}(\mathbf{20})$ indicate the Ljung-Box tests for serial correlation in the standardized and squared standardized residuals, respectively. $\boldsymbol{v}$denotes the the t-student degrees of freedom.parameter ***, ** and * denote statistical significance at 1%, 5% and 10% levels, respectively.

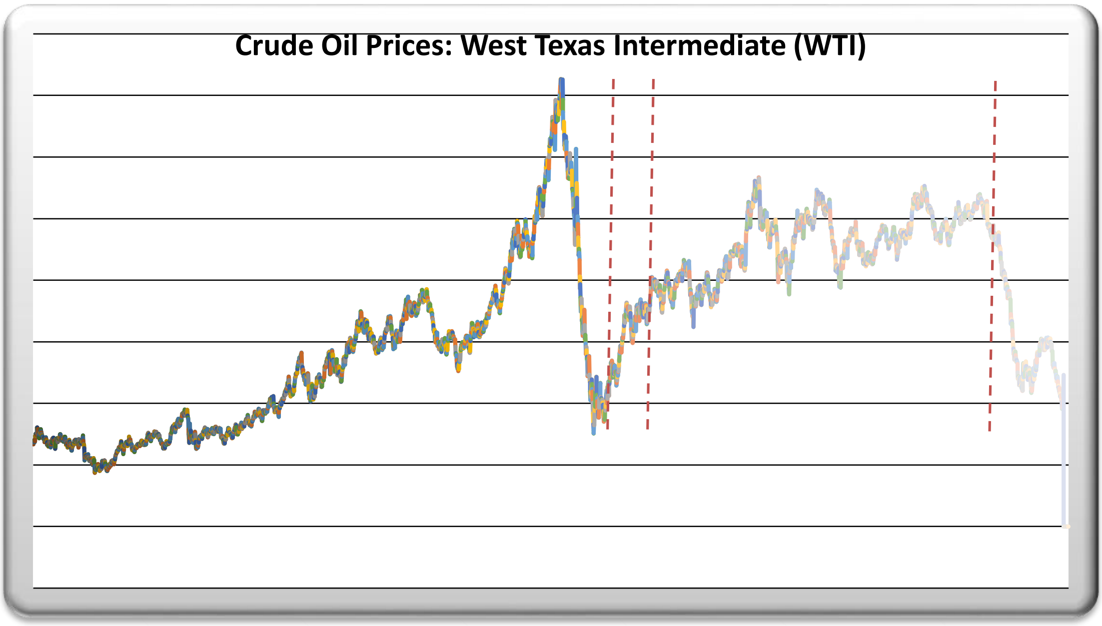
5.3- Causality and Impulse Response on the Relationship between oil price and Exchange rate

5.3-1. Preliminary analysis

Several studies considered oil price as exchange rate determinants. In this section, we analyze the relationship between crude oil prices and nominal exchange rates volatilities of selected MENA countries. We use a standard procedures such vector autoregressive (VAR) analysis followed by granger causality test and impulse response function. The following empirical analysis uses 5-day week daily time series data for the period 06/12/2000-01/09/2015. All data are converted to logged returns. The oil price series (in USD per barrel) is the spot price of the West Texas Intermediate crude oil. This data come from the International Energy Agency. For exchange rates, we consider the price of US dollar against 7 MENA currencies, that are Tunisia (TUD), Morocco (MAD), Jordan (JOD), Egypt (EGP), United Arab Emirate (AED), Qatar (QAR), and Saudi Arabia (SAR) currencies, downloaded from the OANDA database.

The complete sample is divided into the following sub-samples: subsample1 (01/01/2001- 02/07/2008), subsample2 (03/07/2008-26/12/2008), subsample3 (29/12/2008-25/06/2014) and subsample4 (26/06/2014-31/08/2015). The sub-sample periods are selected according to the major trend breaks of oil prices that can be seen in Figure 2. We divide data from start to 02/07/2008 during which there is an upward trend in oil. Then starting at the peak date 03/07/2008 and ending at the trough date 26/12/2008 we observe a declining trend in oil price. The crude oil prices fell sharply in the second half of 2014 after a period of relative stability. Figure 2 shows oil prices reached a post-recession peak in 2011, remained relatively stable for a few years, and then declined about 50 percent in the second half of 2014. In the first half of 2015, oil prices reaching down in March before rising about 40 percent through mid-June.

Figure 2 Oil price behavior



Source: International Energy Agency

As mentioned above, this section examines the relationship between oil prices and exchange rates of selected MENA countries. To study the dynamic link between log returns of oil prices and each exchange rate, we employed the vector autoregressive (VAR) method.

5.3-2. Empirical results

We estimate four VAR systems for each country and report the Granger causality tests results in Table 4. The Granger causality technique measures the information given by one variable in explaining the latest value of another variable. According to these results, the direction of causality generally runs from oil prices to the exchange rate.

Table 4 Granger causality test

	01/01/2001- 02/07/2008		**03/07/2008-26/12/2008**		**29/12/2008-25/06/2014**		**26/06/2014-31/08/2015**	
	Statistics	**P-value**	**Statistics**	**P-value**	**Statistics**	**P-value**	**Statistics**	**P-value**
Tunisia	**3.31** (4)	0.01***	**5.27** (1)	0.02***	**2.9** (3)	0.01***	1.67 (3)	0.17
Morocco	0.9 (4)	0.45	**6.25** (1)	0.01***	**12.6** (4)	0.004***	0.69 (1)	0.4
Jordan	0.6 (4)	0.65	0.41 (2)	0.65	**3.29** (4)	0.01***	**3.56** (3)	0.01***
Egypte	0.4 (2)	0.66	0.92 (1)	0.33	0.55 (4)	0.69	0.95 (4)	0.33
EMA	**1.97** (4)	0.09**	0.92 (2)	0.39	0.39 (4)	0.81	1.7 (2)	0.14
Qatar	0.21 (4)	0.93	0.35 (2)	0.7	1.63 (4)	0.16	0.13 (4)	0.96
Saudi	**5.48** (3)	0.01***	0.34 (1)	0.55	1.18 (4)	0.31	3.09 (1)	0.07**

Note: The bold face numbers indicate the rejection of the null hypothesis[5] at the 1% (***), 5% (**) and 10% (*)

According to the results presented in table 4, in the first period, there are 3 countries for which the test statistic appears significant: Tunisia, United Arab Emirate and Saudi. For the second period, where oil price tend to decline, we cannot reject the hypothesis that oil prices does not granger cause exchange rate for Tunisia and Morocco. After the financial crises of 2008, the oil price is relatively stable. In this period, the test statistics for Tunisia, Morocco and Jordan are significant at 1%. The oil price can improve the forecasts of exchange rate returns in these countries. In the end of the 2014, the oil prices tend to decline. Indeed, the oil prices have fallen 65% from their peak in August 2014. In this period, the Granger causality test appears significant for Jordan and Saudi.

5.3-3. Analyses of the impulsion responses functions

To see the dynamic response of each exchange rate to a standardized shock in oil price we employ generalized impulse response graphs. In contrast with impulse response functions for structural models, generalized impulse responses do not require that we identify any structural shocks. Accordingly, generalized impulse responses cannot explain how exchange rate reacts to an oil prices shock. Instead, generalized impulse responses provides a tool for describing the dynamics in a time series model by mapping out the reaction in exchange rate to a one standard deviation shock to the residual in the oil prices. We trace out the generalized responses of each exchange rate to a one standard deviation shock in oil price for all four time frames separately in Figures 3-9.

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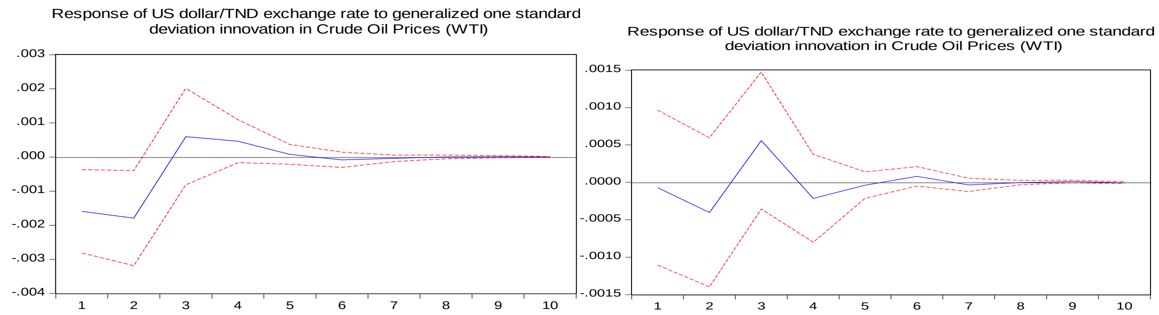
[5] Null Hypothesis of Granger causality test: oil price does not Granger cause exchange rate

Figure 3: Impulse responses due to a generalized standard deviation innovation in crude oil price: the case of Tunisia

01/01/2001- 02/07/2008 **03/07/2008-26/12/2008**



29/12/2008-25/06/2014 **26/06/2014-31/08/2015**

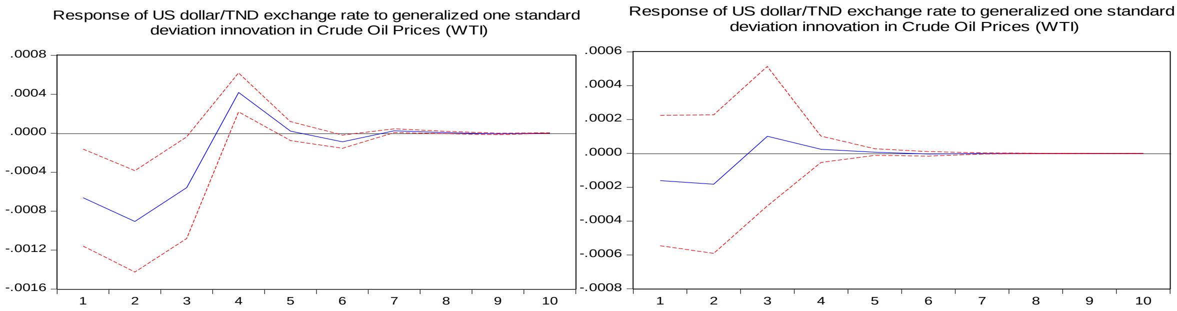
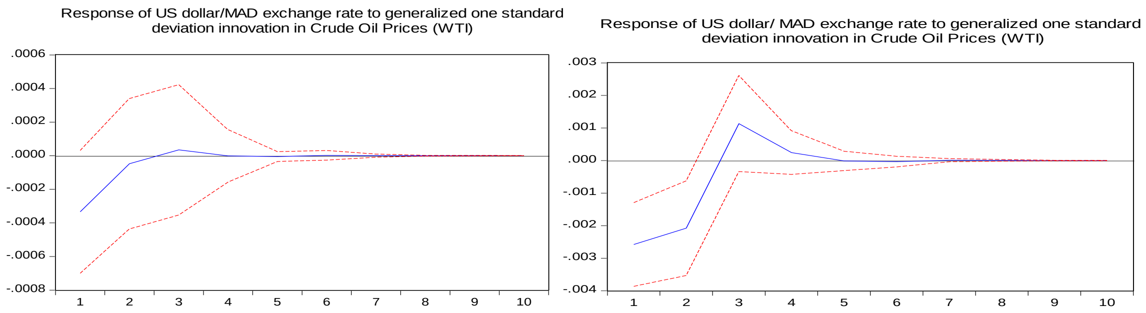
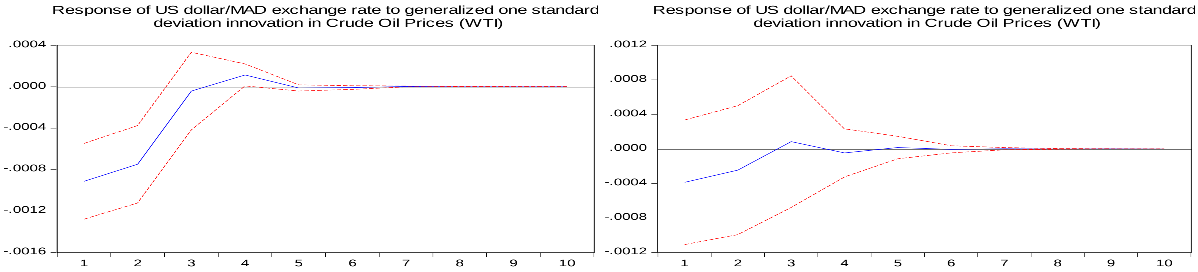


Figure 4: Impulse responses due to a generalized standard deviation innovation in crude oil price: the case of Morocco

01/01/2001- 02/07/2008 **03/07/2008-26/12/2008**

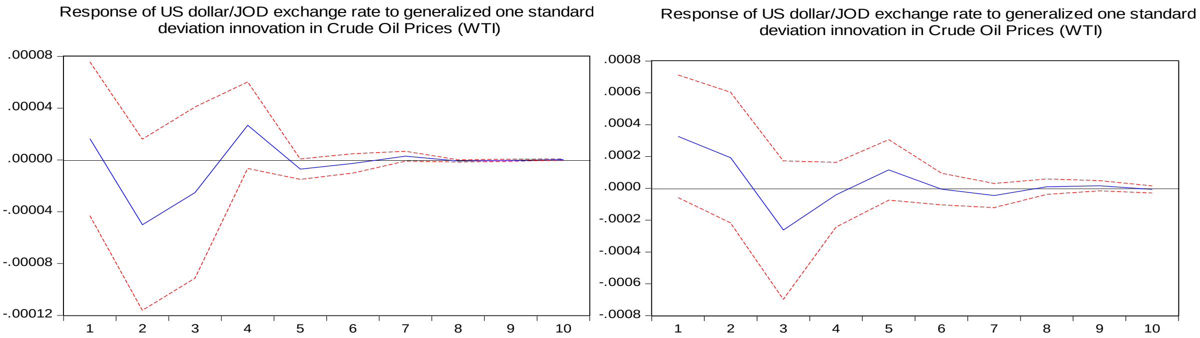


29/12/2008-25/06/2014 **26/06/2014-31/08/2015**



01/01/2001- 02/07/2008 **03/07/2008-26/12/2008**

Figure 5: Impulse responses due to a generalized standard deviation innovation in crude oil price: the case of Jordan



29/12/2008-25/06/2014 **26/06/2014-31/08/2015**

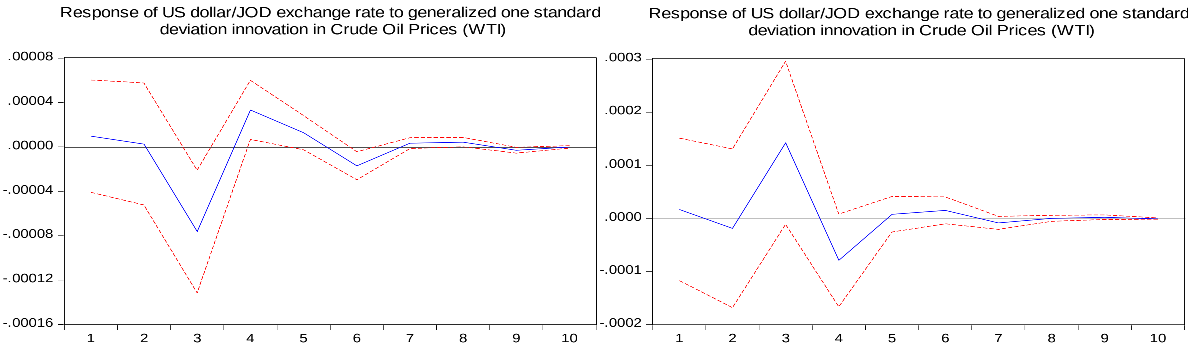
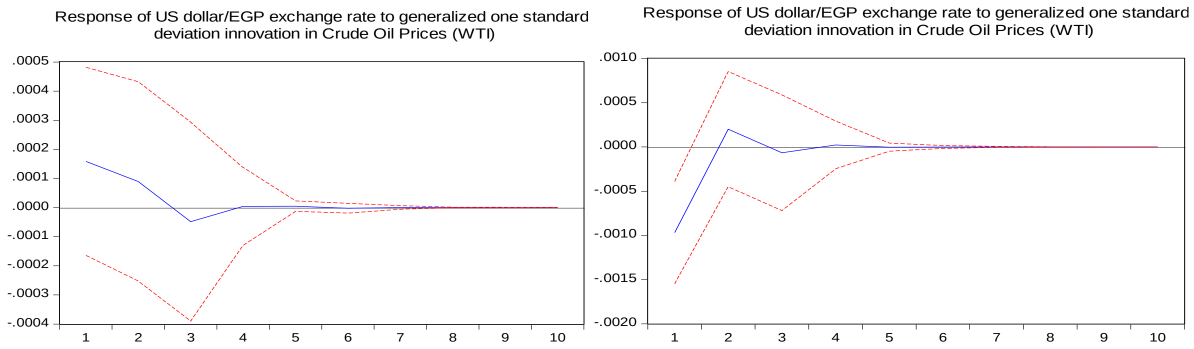


Figure 6: Impulse responses due to a generalized standard deviation innovation in crude oil price: the case of Egypt

01/01/2001- 02/07/2008 **03/07/2008-26/12/2008**



29/12/2008-25/06/2014 **26/06/2014-31/08/2015**

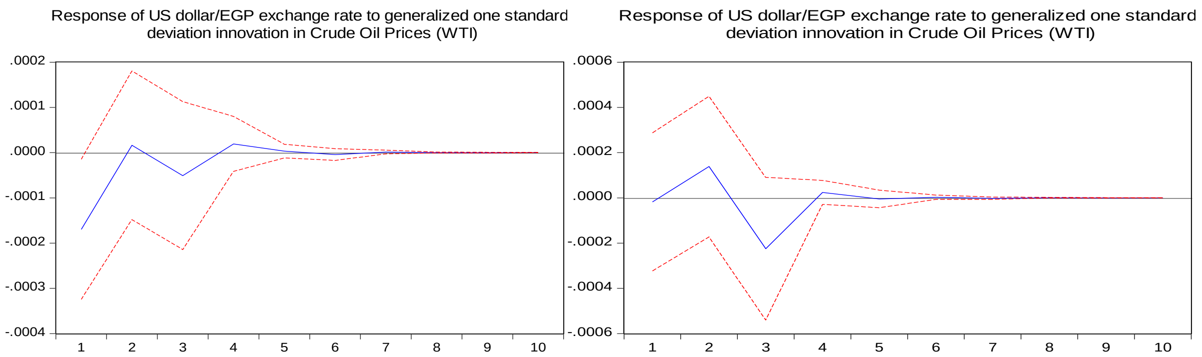
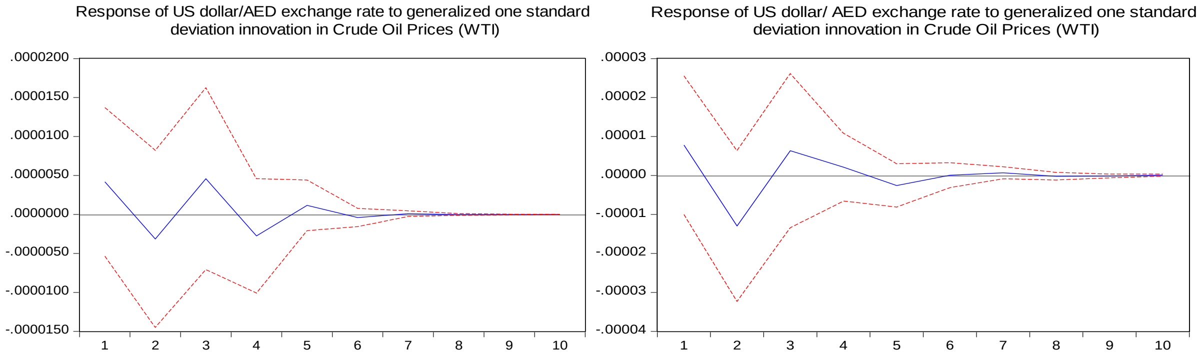


Figure 7: Impulse responses due to a generalized standard deviation innovation in crude oil price: the case of United Arab Emirate

01/01/2001- 02/07/2008 **03/07/2008-26/12/2008**



29/12/2008-25/06/2014 **26/06/2014-31/08/2015**

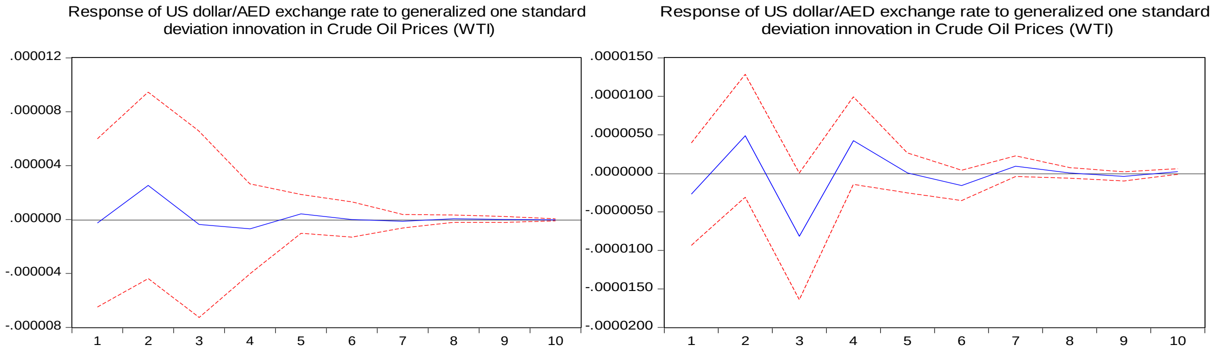
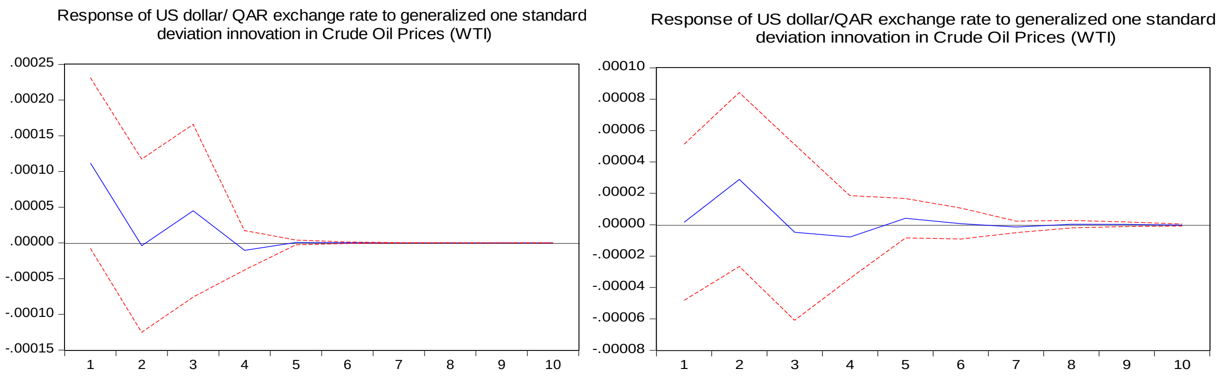
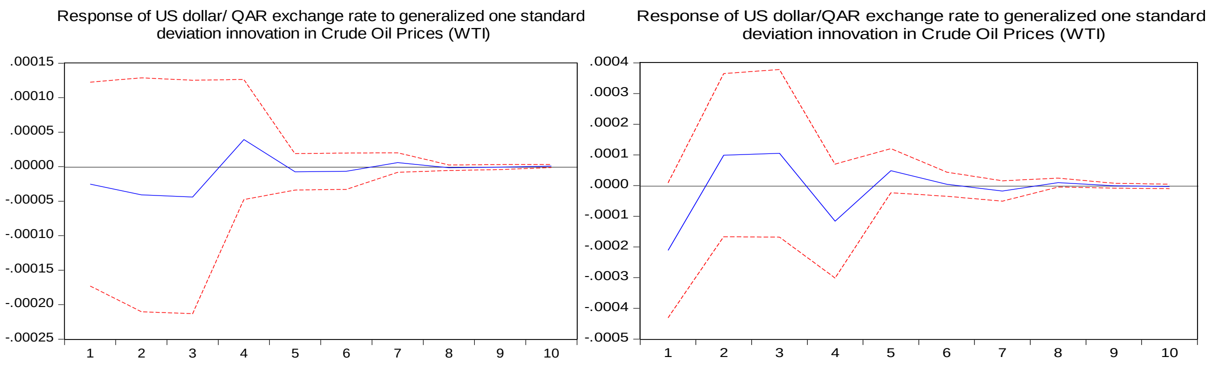


Figure 8: Impulse responses due to a generalized standard deviation innovation in crude oil price: the case of Qatar



01/01/2001- 02/07/2008

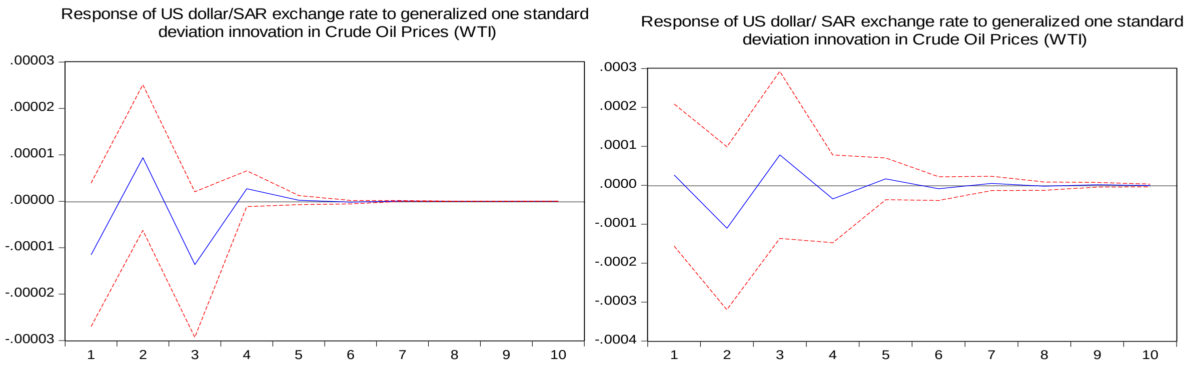
03/07/2008-26/12/2008



29/12/2008-25/06/2014

26/06/2014-31/08/2015

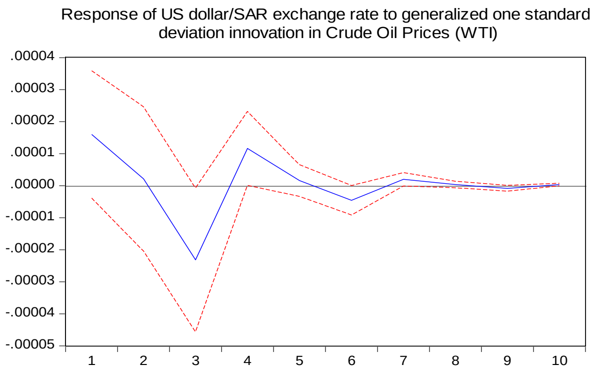
Figure 9: Impulse responses due to a generalized standard deviation innovation in crude oil price: the case of Saudi



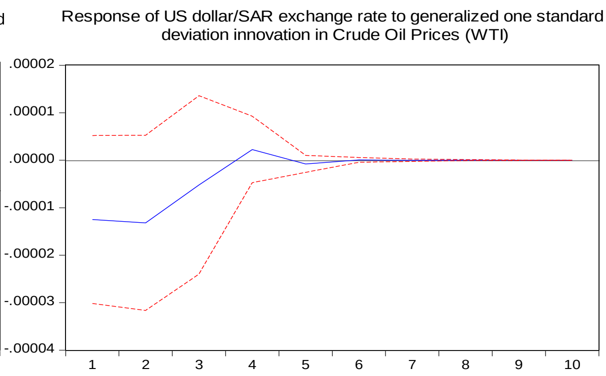
01/01/2001- 02/07/2008

03/07/2008-26/12/2008

29/12/2008-25/06/2014



26/06/2014-31/08/2015



In the first period, a positive one standard error shock to oil prices has a significant negative effect on exchange in the short term in most countries (except for Egypt and Qatar). In the last period, all exchange rates, except for Egypt, become more sensitive to oil prices shocks. In this period, the oil price shock has generally a negative impact. In the second period, while oil prices are in the downward trend, one standard error shock to oil prices cause an appreciation for Tunisia, Morocco, Egypt and cause an depreciation for United Arab Emirate, Qatar and Saudi. Generally, a positive shock on the oil price is translated by a negative effect on the exchange rate during the first day. This effect disappears then in slow motion before finding its long-term level. The reaction of exchange rate in the face of this shock nullifies in the five or six day to return quickly to its normal level. Figures 2-8 illustrate, generally, the appreciation of MENA currencies against the U.S dollar.

Oil Price and Exchange Rate: A comparative study between Oil Exporting and Oil Importing Countries

Theoretically, an oil-exporting country may experience exchange rate appreciation (fall in exchange rates) when oil prices rise and depreciation (increase in exchange rates) when they fall. Literature has generally found a negative relationship between oil price and exchange rate in oil-exporting countries. In this section we analyse the effect of oil price on the exchange rate of the 7 MENA countries, distinguishing between oil importing and exporting countries. We estimate two panels: Panel A consists of oil importing countries: Tunisia, Morocco, Egypt and Jordan, while Panel B it consists of oil exporting countries: United Arab Emirate, Qatar and Saudi. We used three different estimators: OLS (fixed effect and deterministic effect) Dynamic OLS (DOLS) and Mean Group (MG). Table 5 and Table 6 summarize the results of the three estimators for all four time frames separately.

Table 5. Oil price and exchange rate in oil importing countries

Panel A : Oil-importing countries

	OLS				DOLS		MG	
	Fixed effects		Deterministic effects					
	coef	t-stat	coef	t-stat	coef	t-stat	coef	t-stat
Rprice_sub1	0.023	0.26	0.02	0.29	0.017	0.87	0.02	0.97
Rprice_sub2	**-0.15**	**-2.14**	**-0.13**	**-2.4**	**-0.07**	**-2.84**	**-0.14**	**-1.7**
Rprice_sub3	**-0.09**	**-1.65**	**-0.08**	**-1.65**	**-0.19**	**-13.6**	**-0.07**	**-1.81**
Rprice_sub4	-0.01	-0.96	-0.014	-0.96	-0.002	-0.75	-0.01	-1.06

Table 6. Oil price and exchange rate in oil exporting countries

Panel B : oil-exporting countries

	OLS				DOLS		MG	
	Fixed effect		Deterministic effect					
	coef	t-stat	coef	t-stat	coef	t-stat	coef	t-stat
Rprice_sub1	**-0.004**	**-1.98**	**-0.005**	**-1.98**	**-0.0035**	**-13.08**	**-0.004**	**-1.66**
Rprice_sub2	0.0001	0.33	0.0001	0.33	0.001	1.63	0	0.81
Rprice_sub3	-0.0001	-0.1	-0.0001	-0.13	**-0.02**	**-1.67**	-0.001	-0.03
Rprice_sub4	-0.006	-1.34	-0.007	-1.38	-0.01	-1.65	-0.006	-1.15

In the first subsample, the oil price tends to rise. In this period, for oil exporting countries, an increase in oil prices leads to an appreciation of the domestic currency. Whereas, for oil importing countries, the price increase has no effect on exchange rate. In the second period, (03/07/2008-26/12/2008), the oil price falls to 40$ per barrel. In this period, the decrease of oil price leads to appreciation of the currency of oil importing countries. For the third subsample, the oil price is relatively stable, the currencies of oil importing countries continued to appreciate but in the oil exporting countries, the oil price has no effect on exchange rate. In the last period, the oil price has no effect on exchange rate in the oil-exporting and importing countries.

6. Conclusions

While asymmetries of foreign exchange rate and crude oil price have seen voluminous research. In this paper, we consider in one hand, the univariate GJR-GARCH model to detect the asymmetric effect of volatility. We used the crude oil (WTI) and nominal exchange rate of some selected MENA countries, namely Tunisia, Morocco, Egypt, Jordan, UAE, Qatar and Saudi Arabia. In the other hand, we employed the VAR model to analyze the dynamic of shocks in the short run and the long run. We adopt the impulsion responses function to detect the nature of shocks.

Our empirical results indicate that foreign exchange market and crude oil exhibit asymmetric and no asymmetric in the return series. Additionally, the findings show asymmetric response of volatilities to positive and negative shocks. Therefore, the results point to the importance of applying an appropriately flexible modeling framework to accurately evaluate the interaction between exchange market and oil price.

Furthermore, the results suggest that there is a dynamic relationship among oil price shocks and exchange rate volatility. In the short run, oil prices shocks had a significant impact on exchange rate changes. However, in long run the impulse response of the exchange rate variable to a crude oil price shock was statistically insignificant.

Finally, we found that in the case of oil-exporting country, the oil prices rise may experience exchange rate appreciation, while, the decrease of oil price leads to appreciation of the currency of oil importing countries.

Our empirical findings seem to be important to researchers and practitioners and especially to active investors and portfolio managers who include in their portfolios equities from the foreign exchange markets. Moreover, our findings lead to important implications from investors' and policy makers' perspective. They are of great relevance for financial decisions of international investors on managing their risk exposures to exchange rate and oil price fluctuations and on taking advantages of potential diversification opportunities that may arise due to lowered dependence among the exchange rates and crude oil.

Finally, taking into account the effect of oil price shocks on exchange rate, most MENA countries, namely the oil exporters, are called to further diversify their economies and not be limited to oil budget, in order to avoid any adverse effects of a significant drop in oil prices on their currencies and thus on their economic performance. Such diversification should be studied to also solve other economic problems in the MENA region, namely unemployment.

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