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Bouoiyour, Jamal and Selmi, Refk

CATT, University of Pau, ESC, Business School of Tunis

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GCC Countries and the Nexus between Exchange Rate and Oil Price: What wavelet decomposition reveals?

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Jamal BOUOIYOUR[1] and Refk SELMI[2]

Abstract: We employ wavelet decomposition and nonlinear causality test to investigate the nexus between the real oil price and the real effective exchange rate in three GCC countries : Qatar, Saudi Arabia and UAE. We find strong evidence in favor of a feedback hypothesis in Qatar and UAE and of a neutrality hypothesis in Saudi Arabia. The first observation outcome means that Qatar and UAE should reinforce the downward effect of oil price on real exchange rate by improving diversification policy. The second one implies that the behavior of Saudi Arabia as a price maker may allows it to maintain a quick recovery under oil shocks.

Keywords: real oil price, real effective exchange rate, wavelets, nonlinear causality.

[1] CATT, University of Pau, France. E-mail: jamal.bouoiyour@univ-pau.fr

[2] ESC, Business School of Tunis, Tunisia. E-mail: s.refk@yahoo.fr

1. Introduction

Questions of the relative importance of real oil price movements in explaining real exchange rate volatility still have no widely convincing answers despite the pool of existing literature on this subject; for example Dibooglu (1996), Amano and van Norden (1998), Camarero and Tamarit (2002), Chen and Chen (2007), Narayan et al. (2008), Gosh (2011) and Mansor (2011), among others. Most of these studies focus on the argument that oil price variability has intense effects on exchange rate.

Various studies have been conducted in the context of developed countries; for example Zhou (1995), Amano and van Norden (1998) and Bénassy-Quéré et al. (2007), among others. Research concerning oil price's effects on real exchange rate volatility in the context of developing countries is very limited, particularly GCC countries whereas their great dependency to oil (Sester, 2007). Nevertheless, since these economies are presently experiencing a greater oil supply security, a thorough investigation of the possible effects of changes in oil price on those of real exchange rate in Qatar, Saudi Arabia and UAE is warranted.

These countries serve as suitable cases for four main reasons. Firstly, oil represents the most substantial component of these countries' total exports. Secondly, assuming that oil-exporting countries have a great preference for dollar-denominated, oil price may be considered as a dominant source of real exchange rate movements. Thirdly, the rise or the fall in oil prices is viewed as a wealth pass-through from oil-importing countries to oil-exporting countries, which means that the considered relationship depends significantly on the distribution of oil imports across oil-importing countries. Fourthly, these countries are importers of manufactured products from developed and emerging countries. Therefore, oil price variability can indirectly impact these countries through their influence on imported prices indicative of inflationary pressure transmitted then to real exchange rate.

The structure of the article is as follows: In the next section we update a brief overview of exchange rate and oil policy in GCC countries. In section 3, we present our data and the methodological framework. Section 4 reports our main results and some economic implications while the last section offers some concluding remarks.

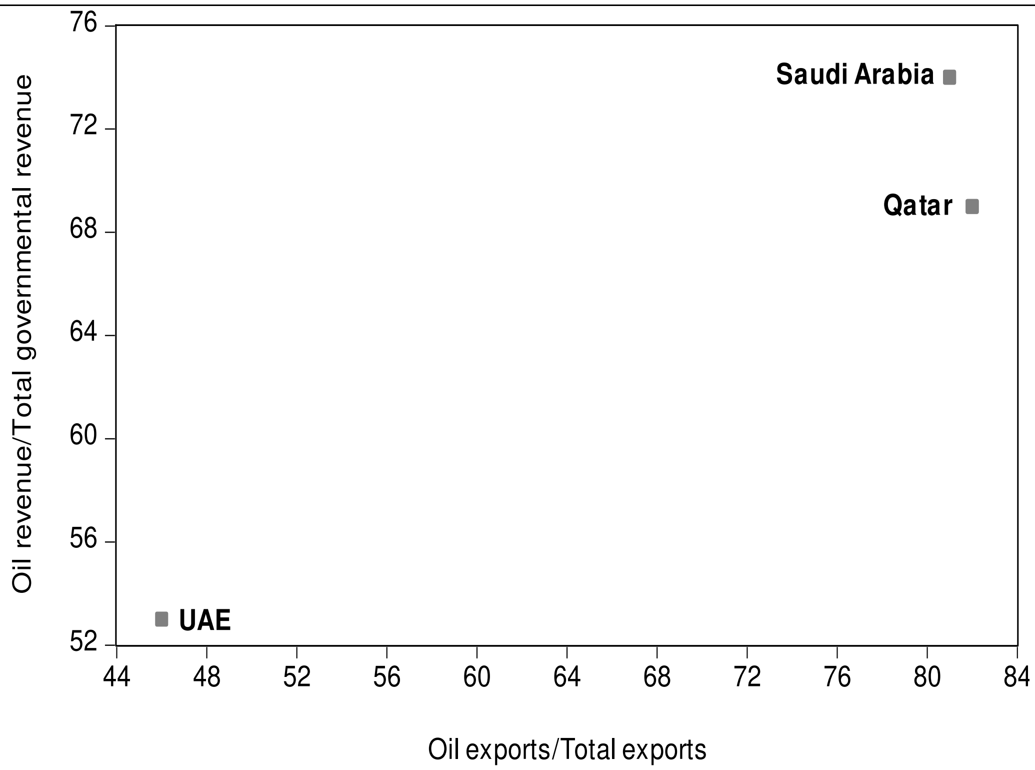
2. GCC countries and exchange and oil policies

Small open economies like Qatar, Saudi Arabia and UAE where there are dominant in oil export sector can be subject to severe exogenous shocks. It is therefore greatly important to evaluate their oil policies; in particular, oil price shocks pass-through to exchange rate.

Qatar, Saudi Arabia and UAE pursue the same conduct in terms of exchange policy while they differ in terms of oil policy. During the period from 1987 to 2009, these countries adopted a fixed peg arrangement against a single currency (Mohaddes and Williams, 2011, see Appendix 1). Under fixed exchange regime, foreign exchange reserves play an important role in money supply fluctuations, which prompts the transmission of foreign disturbances into the domestic economy (Dibooglu, 1996).

In addition, these countries produce about 20% of all world oil, control 36% of world oil exports and possess 47% of proven reserves (CIA, World Factbook). Qatar, Saudi Arabia and UAE are major exporters of oil in global energy market and important OPEC members and their economies are very dependent on oil. Figure 1 confirms this and reveals that UAE is less dependent in oil than Qatar and Saudi Arabia.

Figure 1: Degree of oil dependency



Source: Staff of International Monetary Fund.

Besides, the Saudi market is the biggest stock market in the region: it makes up more than 40% of all Arab OPEC markets and one third of all Arab markets that can break the impact of oil crude on real exchange rate. This country plays a leading role in worldwide energy markets. Saudi Arabia is the world's largest exporter of total petroleum liquids and is currently the world's second largest crude oil producer behind Russia (Arouri and Rault, 2010). However, the inflation rate is higher in Qatar and UAE than Saudi Arabia (see Table 1). This latter has an oil-based economy ranks as the largest exporter of petroleum, and plays a leading role in OPEC. The petroleum sector accounts 90% of export commodities.

Table 1. GCC countries comparison to the world

	Qatar	Saudi Arabia	UAE
Inflation rate	45	118	36
Oil production	20	1	8
Oil exports	22	1	19
Oil imports	67	70	26
Oil in % GDP	73%	69.1%	53.9%
Oil in The basket of exports	85%	90%	45%

Source: CIA, the World Factbook.

Furthermore, these economies share several common patterns. Asia is the predominant destination for oil exports, while the EU accounts for nearly one-third of these countries' exports (see Table 2). However, on the imports side, the Europe provided more than 31 percent of these countries' imports, which makes it the biggest trading partner. Asian countries, on the other hand, accounted for only one-third of these countries' imports (see Table 3). Hence, because Qatar, Saudi Arabia and UAE are importers of manufactured products from developed and emerging countries, oil price movements can affect indirectly these markets through their influence on the prices of imported products.

Table 2. Exports partners of GCC countries

	Qatar	Saudi Arabia	UAE
China		13.1%	
Japan	30.3%	14.3%	17.1%
India	8%	8.3%	13.1%
Iran			6.1%
South Korea	13.1%	8.8%	6.1%
Singapore	7.7%	4.5%	
Thailand			5.1%
United States		13%	
United Kingdom	4.2%		

Source: CIA, the World Factbook.

Table 3. Imports partners of GCC countries

	Qatar	Saudi Arabia	UAE
China	4.2%	11.1%	14%
France	4.5%	6.1%	
Germany	9%	7.1%	5.6%
Japan	5.6%	6.9%	4.8%
India		4.7%	17.5%
Italy	5.3%		
Saudi Arabia	5.4%		
South Korea	6.5%	4.2%	
UAE	7.3%		
United States	15.5%		7.7%
United Kingdom	6.1%		

Source: CIA, the World Factbook.

3. Methodology

Our study seeks to assess the assumption about the existence of short and long cycles in the interaction between oil price movements and those of real exchange rates in oil exporting countries using wavelet decomposition and causality test controlling nonlinearities.

3.1.Wavelet decomposition

Wavelet analysis is a technique initiated by Mallat (1989) enables to separate each variable into its constituent frequency components. There are several wavelet functions including Symmlet and Morlet, among others. The choice of the best function depends on the particularity of considered application (Crowley, 2007).

In various researches done up to date on the issue of real exchange rate-oil price nexus, it has been difficult to satisfactorily separate out different time scales in output data to identify frequency-to-frequency variation in the focal relationship. This method is of interest as it relates the considered relationship' outcomes to the frequency at which activity in the time series occurs. There are at least two types of wavelets: father wavelet ϕ which represents the low frequency and mother wavelet ψ which captures high-frequency components.

$$\int \phi(t)dt = 1, \int \psi(t)dt = 0 \tag{1}$$

$$\phi(x) = \sqrt{2}\sum_k l_k \phi(2x-k) \tag{2}$$

$$\psi(x) = \sqrt{2}\sum_k h_k \phi(2x-k). \tag{3}$$

Furthermore, wavelets analysis consists on distinguishing between low-pass l_k and high-pass h_k. filter coefficients.

$$l_k = \frac{1}{\sqrt{2}}\int \phi(t)\phi(2t-k)dt \tag{4}$$

$$h_k = \frac{1}{\sqrt{2}}\int \psi(t)\phi(2t-k)dt. \tag{5}$$

A wavelet decomposition of a function $f(t)$ can be defined as a sequence of projections into father and mother wavelets $s_{J,k}$, $d_{J,k}$,….., $d_{1,k}$, which can be expressed as follows:

$$s_{J,k} \approx \int \phi_{J,k}(t)f(t)dt \tag{6}$$

$$d_{j,k} \approx \int \psi_{j,k}(t)f(t)dt, \text{ for j=1,2,……. } J. \tag{7}$$

where $s_{J,k}$ is the smooth behaviour of the signal at a specific time scale. The coefficients $d_{j,k}$ represent deviations from the trend.

At this stage, the wavelet decomposition can be written as follows:

$$f(t) = \sum_k s_{J,k}\phi_{J,k}(t) + \sum_k d_{J,k}\psi_{J,k}\ (t) + \sum_k d_{J-1,k}\psi_{J-1,k}(t) + ... + \sum_k d_{1,k}\psi_{1,k}(t) \qquad (8)$$

where J is the number of multi-resolution levels.

3.2. Nonlinear causality

In order to test for nonlinear Granger causality in the nexus between oil price and real exchange rate, various nonparametric methods are developed. Baek and Brock (1992) propose a nonparametric statistical method for detecting nonlinear Granger causality using correlation integral between key variables. These latter are assumed to be mutually and individually independent and identically distributed. Based on the drawbacks on the spirit of Granger (1969) (i.e. restrictive assumptions of linearity), Hiemstra and Jones (1994) develop a modified test statistic for the nonlinear causality while trying to display short-term temporal dependence. To follow up these researches, Peguin and Terasvirta (1999) make a distinction between the behavior of frequencies through the studied period by carrying out the wavelet decomposition.

Throughout the rest of our study, we try to assess whether there is a significant nonlinear causal relationship between oil price and real exchange rate and if this depends to frequency-to-frequency variation.

4. Empirical assessment

4.1. Data

We use monthly data set of real exchange rate (source: Econstats and International Monetary Fund) and that of US oil price (source: Energy Information Administration) from 1980:M1 to 2009:M10. We depict in Table 4 the descriptive statistics of oil price and real exchange rate returns. The sample means of real exchange rate returns are positive while those of oil price are negative. The measures of skewness and kurtosis indicate that distributions of returns for oil prices and US dollar are positive, which implies that the returns of key variables are skewed and leptokurtic relative to a normal distribution. The Jarque–Bera normality test indicates a high level for all considered series, which means a reject of normality. In addition, the results of the augmented Dickey–Fuller (ADF) and Phillips–Perron (PP) tests reported in Table 5 reveal that all time series in question are integrated in order one.

To remove nonstationarity of the series, the monthly returns were calculated as the differences of the considered variables logarithms of successive months.

Table 4. Descriptive statistics

	Oil	$REER_{Emirates}$	$REER_{Qatar}$	$REER_{SaudiAra}$
Mean	-0.003212	0.000413	0.000447	0.000898
Median	-0.005130	-0.001018	-0.001039	0.000000
Maximum	0.988372	0.204708	0.344613	0.157419
Minimum	-0.938222	-0.04486	-0.049271	-0.04749
Std. Dev.	0.130029	0.018503	0.023407	0.016730
Skewness	0.317678	3.269578	7.635770	1.969827
Kurtosis	19.97611	37.49807	113.1570	20.59316
J-Bera	4304.829	21472.62	215405.7	5661.116
Probability	0.000000	0.000000	0.000000	0.000000

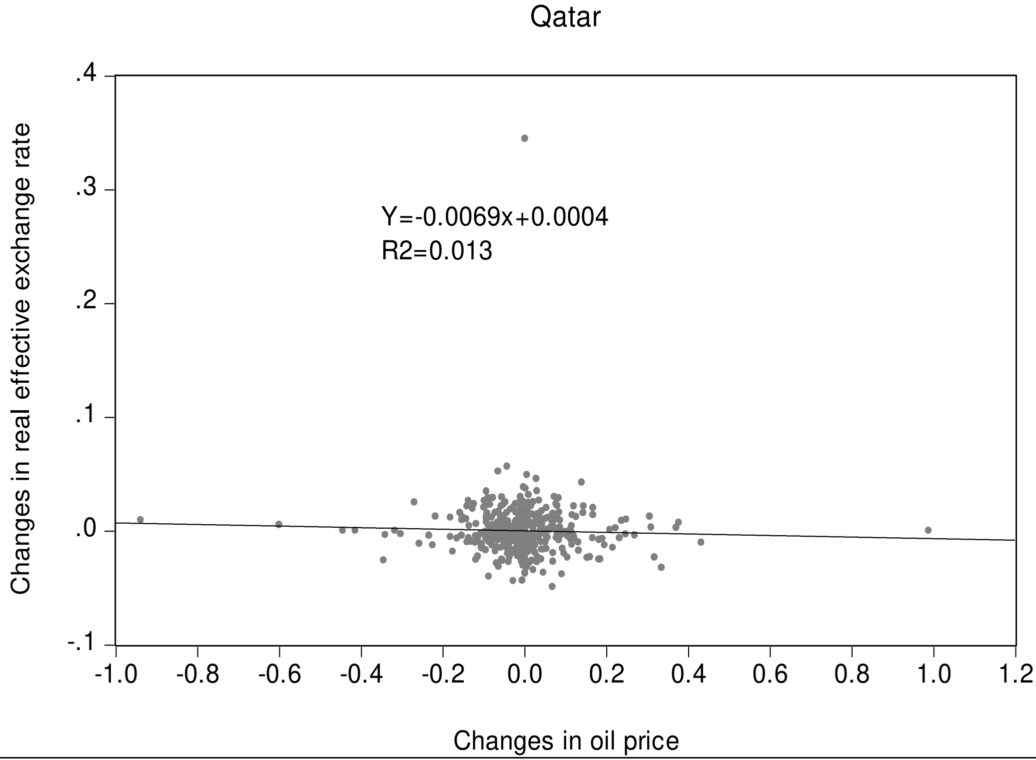
Note: Descriptive statistics are for log return series; oil :real oil prices; $REER$:real exchange rate.

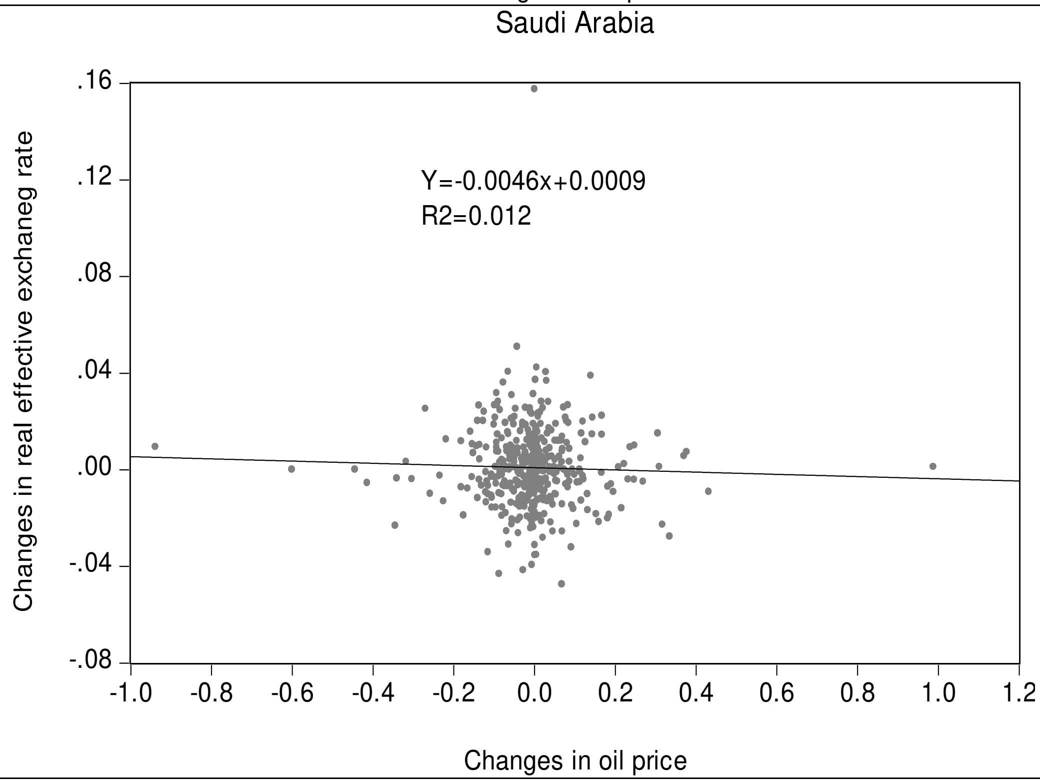
Table 5. Stationnarity tests

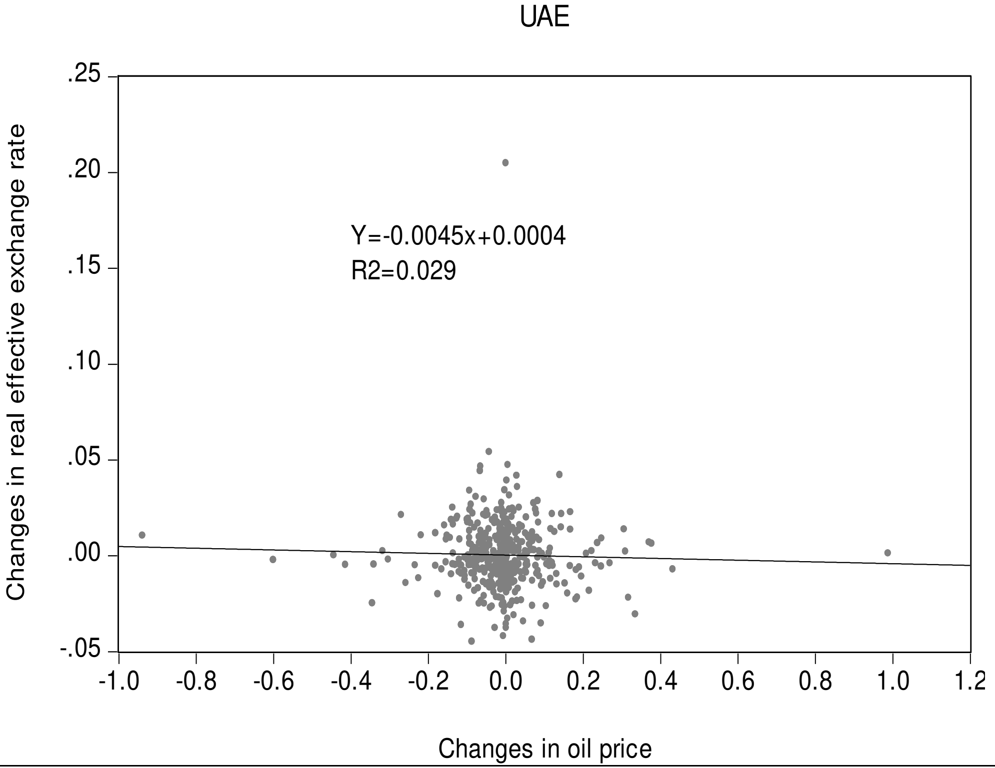
	ADF	*PP*
$L(Oil)$	0.9532	1.0267
$DL(Oil)$	-17.4536**	-17.9082***
$L(REER_{Emirates})$	0.8271	0.9452
$DL(REER_{Emirates})$	-15.0935***	-15.6728***
$L(REER_{Qatar})$	0.9321	0.9765
$DL(REER_{Qatar})$	-17.0046**	-17.1208***
$L(REER_{SaudiArabia})$	0.8765	0.9238
$DL(REER_{SaudiArabia})$	-15.1244***	-15.6472***

It is also well shown from Figure 2 that the relationship between the changes in oil price and those in real effective exchange rate differs from one country to another.

Figure 2. Correlation between changes in oil price and changes in real exchange rate







To sum up, this preliminary investigation of the data set find evidence of country-by-country variation in terms of oil price effects on exchange rate movements. At this stage, we cannot confirm the occurrence of nonlinearity in the nexus between changes in real oil price and those of real exchange rate. Indeed, we try to check throughout the rest of this study the existence of a significant nonlinear causal link between oil price and real effective exchange rate that differs from one time scale to other by decomposing the key variable into different frequencies (see Table 6 and Appendix 2).

Table 6. Frequency scale bands

Scales	Monthly frequencies
D1	2-4
D2	4-8
D3	8-16
D4	16-32
D5	32-64
D6	64-128
D7	128-256
D8	>256

4.2. Main findings: what is new with GCC countries?

We evaluate our main results reported in Table 7 considering two ways, i.e. time domain and frequency bands.

4.2.1. Time domain

Time domain analysis reveals that the nul hypothesis of no causality from oil price returns to changes in real exchange rate is not rejected for Saudi Arabia. However, for Qatar and UAE, there is a significant relationship that runs from oil price returns to those of real exchange rate and not vice versa. We evaluate then the same link under different time scales to check whether the oil price-exchange rate nexus varies across frequency bands.

4.2.2. Frequency bands

As depicted in Table 7, we obtain various results in terms of the direction of the linkage between exchange rate movements and those of oil price when moving from one frequency to other.

At the first frequency (i.e. from 2 to 4 months), we notice that for Qatar and UAE, there is a causal link between the key variables that runs from oil price to real effective exchange rate and not vice versa. Differently, for Saudi Arabia and for the same scale, we support a neutrality hypothesis. In addition, under the second and third frequency bands, we support a feedback hypothesis in Qatar and UAE and an unidirectional hypothesis in Saudi Arabia that runs from oil price to changes in real exchange rate. Further, across D4, D5 and D6 bands, the oil price returns cause nonlinearly real exchange rate returns and vice versa in Qatar and UAE. However, in Saudi Arabia, we note again an unidirectional link running from oil price to real exchange rate under D4 and D5 that changes on insignificant relationship at D6. Finally, across the last two frequencies (i.e. D7 and D8), oil price returns do not cause those of real exchange rate and vice versa, there is a strong evidence in favour of neutrality hypothesis for all considered GCC countries.

Briefly, the feedback hypothesis is supported in Qatar and UAE on 55.55% of total time scales. However, we provide evidence in favour of neutrality hypothesis in Saudi Arabia on 66.66% of frequency cases.

Table 7. Nonlinear causality test

Tests	Time domain	Frequency bands (months)							
		D1	D2	D3	D4	D5	D6	D7	D8
					Qatar				
H_0 *:Δoil does not cause ΔREER*	0.010	0.001	0.001	0.0018	0.0000	0.0011	0.0700	0.0093	0.0035
H_0 *:ΔREER does not cause Δoil*	0.276	0.509	0.019	0.0300	0.1013	0.0121	0.0000	0.1000	0.0134
					Saudi Arabia				
H_0 *:Δoil does not cause ΔREER*	0.319	0.157	0.009	0.0008	0.0000	0.0092	0.0018	0.0000	0.0026
H_0 *:ΔREER does not cause Δoil*	0.209	0.221	0.188	0.0921	0.1299	0.2287	0.2067	0.1493	0.0197
					UAE				
H_0 *:Δoil does not cause ΔREER*	0.000	0.001	0.001	0.0089	0.0181	0.0000	0.0230	0.0000	0.0000
H_0 *:ΔREER does not cause Δoil*	0.200	0.615	0.365	0.1033	0.0921	0.1345	0.5273	0.0009	0.0000

4.2.3. Some economic implications

The above outcomes have important implications in GCC countries, particularly, in Qatar, Saudi Arabia and UAE:

Firstly, the significant nonlinear causal link between oil price and exchange rate in Qatar and UAE always observable under different scales create a need to implement policy reforms in order to accelerate products' diversification. The diversification counter to specialization reduces the vulnerability of these countries to oil price shocks. Arguably, Espinoza and Prasad (2012) show that investment diversification in developing competitive non-oil sectors can have a powerful influence on mitigating oil prices effects on real exchange rate.

Secondly, we attribute the neutrality hypothesis widely supported in Saudi Arabia to two main features: (i) Monetary policy, which has proved very good at keeping inflation down in the case of Saudi Arabia (Sester, 2007) to absorb several external shocks including those of oil and then to remedy an overvaluation of real exchange rate; (ii) The fact that Saudi Arabia is price maker for oil commodity in international market, i.e. this country plays an important role in setting oil prices that can improve its ability of maintaining a quick recovery after oil shocks (Melhem and Terraza, 2010).

5. Conclusion

We revisit the nexus between real oil price and real exchange rates by combining wavelet decomposition with nonlinear Granger causality test.

Our main results reveal that there is a nonlinear causal relationship between changes in oil price and changes in real exchange rate that differs from one GCC country to other and varies over several time scales. This implies that the observation outcomes depend closely to country-to-country and to frequency-to-frequency variations.

Importantly, a feedback hypothesis is considerably supported in both Qatar and UAE. However, a neutrality hypothesis is more supported in Saudi Arabia. The first finding implies that Qatar and UAE should reinforce the downward effect of oil price on real exchange rate by improving diversification policy. The last result means that the monetary policy and the setting prices'behavior of Saudi Arabia succeed to enhance the ability of this economy to maintain a quick recovery after oil crisis and to better cope with negative shocks.

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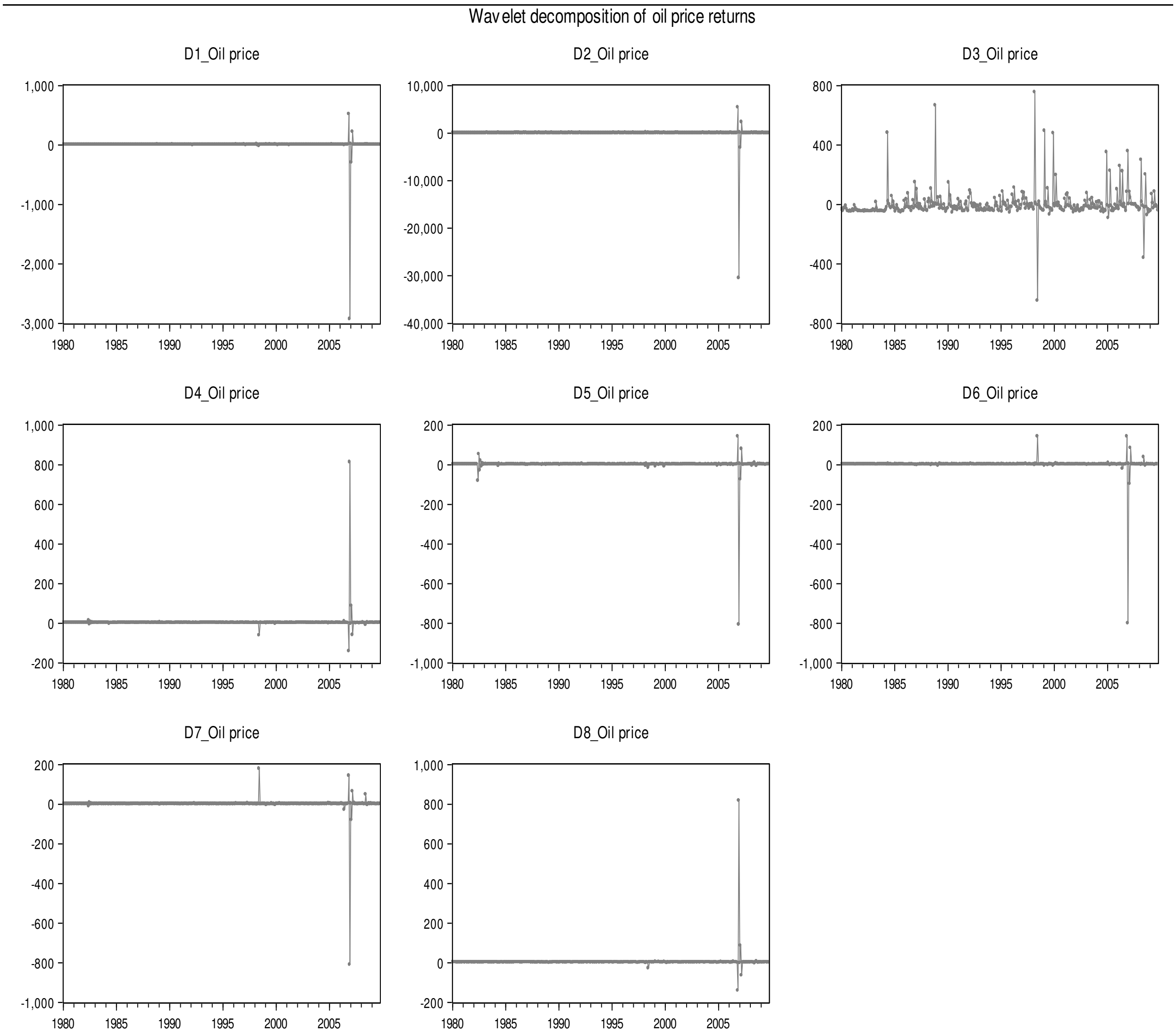
Appendix 1. Exchange Rate Regimes by country

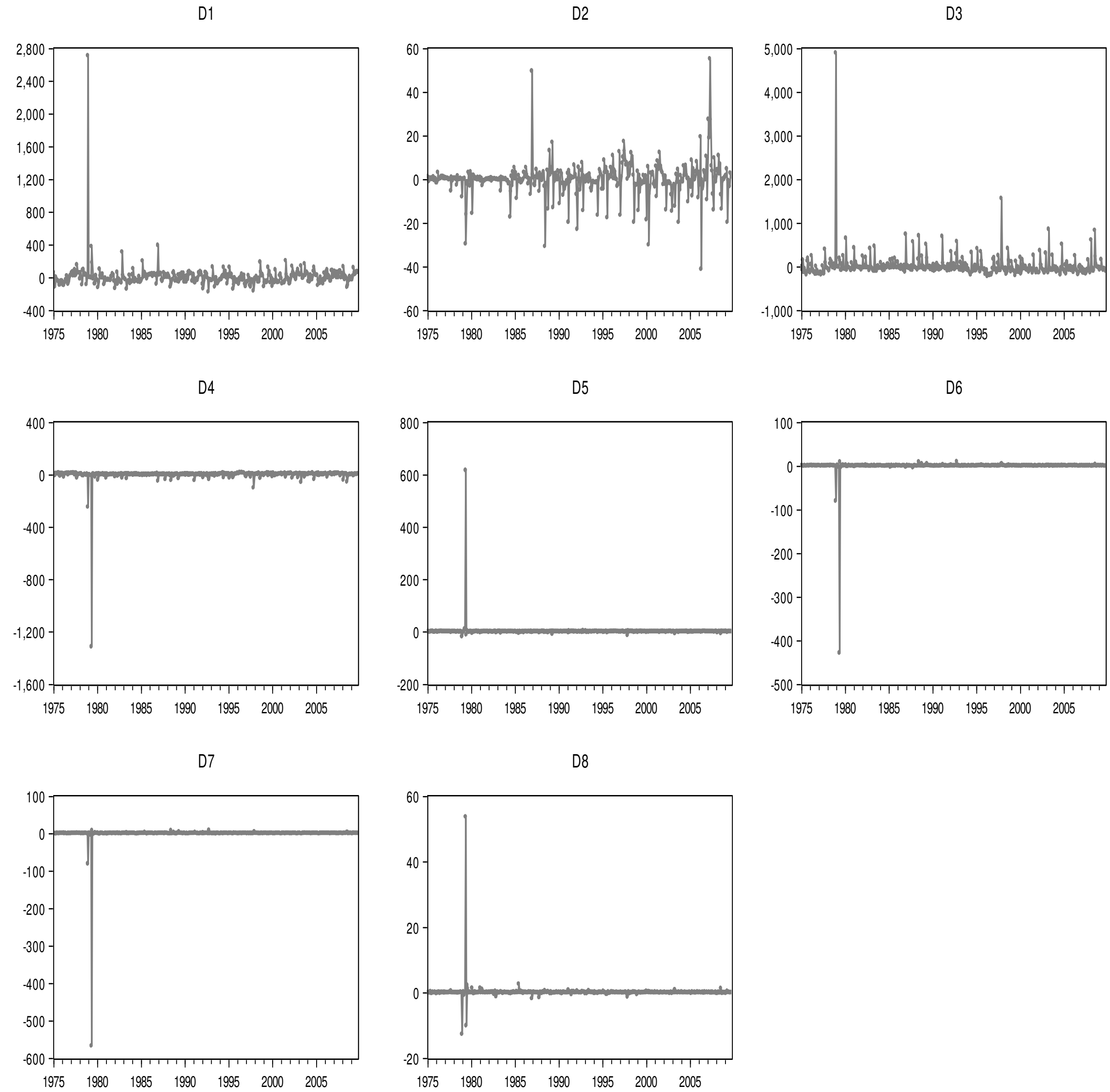
Country	Exchange regime
Qatar	Qatar's riyal is officially pegged to the SDR at QR 4.7619=SDR 1. The Qatar riyal has been effectively pegged to the dollar at the fixed rate of QR 3.6415=U.S. $1 since 1979.
Saudi Arabia	Saudi Arabia's riyal is officially pegged to the SDR at SRls 4.2826=SDR 1. The Saudi riyal has been effectively pegged to the dollar at the fixed rate of SRls 3.745=U.S. $1 since June 1, 1986.
UAE	UAE's dirham is officially pegged to the SDR at Dh 4.7619=SDR 1. The UAE dirham has been effectively pegged to the dollar at the fixed rate of Dh 3.6710=U.S. $1 since November 1980.

Source: Mohaddes K. and Williams O. (2011), International Monetary Fund.

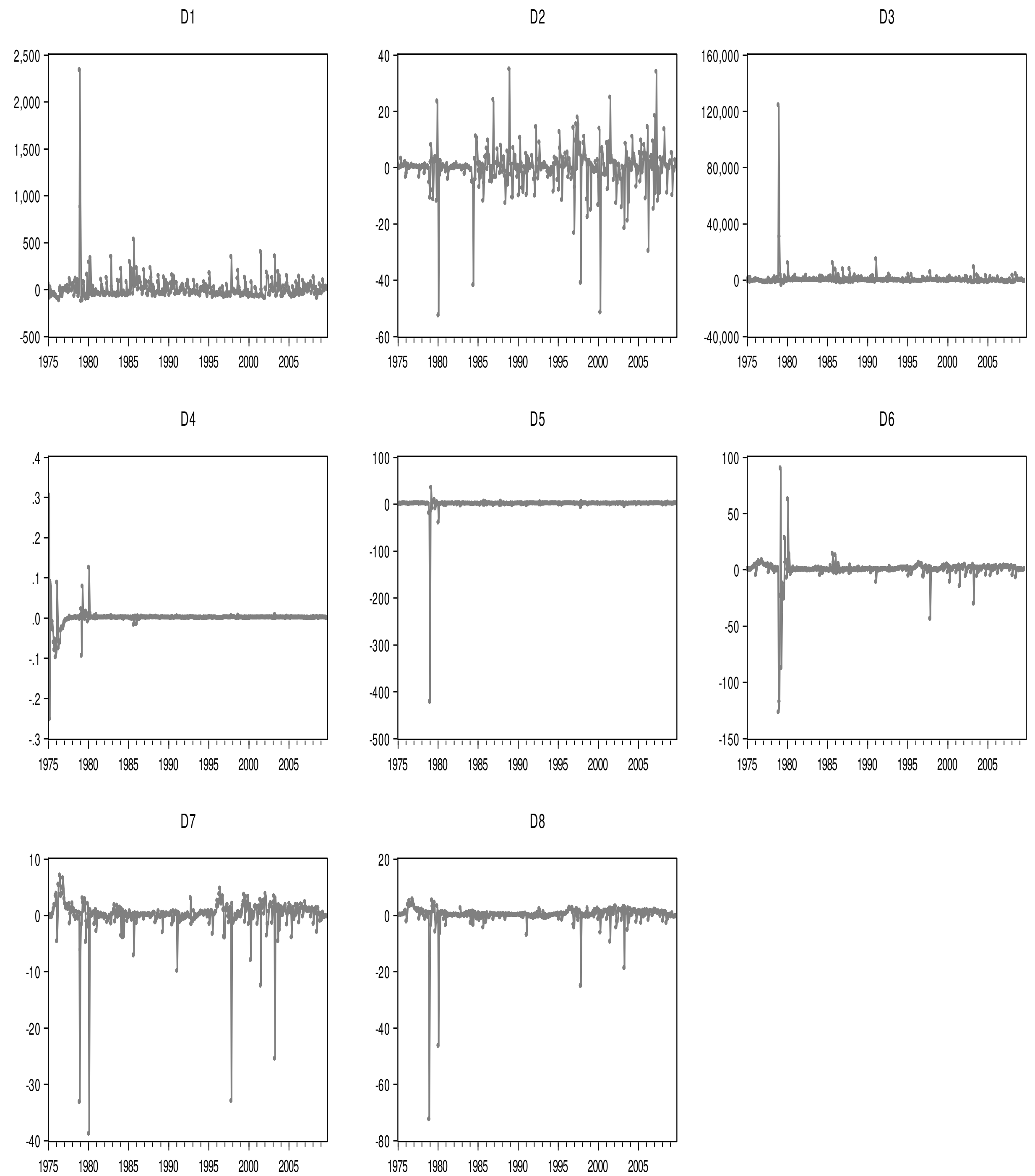
Appendix 2. Wavelet decomposition



Wav elet decomposition (REER_QATAR)



Wavelet decomposition (REER_SAUDI ARABIA)



Wavelet decomposition (REER_UAE)