Determinants of the Real Exchange Rate in Oil-Producing Countries of the Middle East and North Africa: A Panel Data Investigation

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ABSTRACT: We develop and estimate a model of the real exchange rate for oil-producing countries in the Middle East and North Africa (MENA) for the period 1985–2009. We find that over the long run, money supply, domestic real gross domestic product (GDP), government expenditure, oil price, and the U.S. externally financed debt per GDP influence the real exchange rate. Over the short run, the changes in domestic real GDP, money supply, government expenditure, domestic and U.S. interest rates, as well as the U.S. debt per GDP, are the determinants of the real exchange rate in these countries.

KEY WORDS: crisis, debt, foreign financing, money supply, real exchange rate

It is very important to identify the determinants of the real exchange rate for net oil-producing emerging countries as one may argue that the success of these countries depends on their real exchange rate. This is especially important since the real exchange rate is a measure of price-cost competitiveness. If we assume determinants of nominal exchange rate affect relative domestic and foreign prices, but not in the same proportion, then these determinants will also affect the real exchange rate.

For example, under short-run sticky prices and high capital mobility, fluctuations of the nominal exchange rate will be translated one for one into the real exchange rate. In such models, the nominal exchange rate is more volatile than its underlying fundamentals over the short run, but as prices do adjust over the long run, the real exchange rate converges to its long-run equilibrium level in the same proportion. Furthermore, over the long run, the real exchange rate converges to purchasing power parity (PPP), implying that fundamental macrovariables do not have any effect on the real exchange rate (Devereux 1997). However, in this article, we show that the fundamental macrovariables, especially the oil price, affect the real exchange rate in oil-producing countries even over the long run.

There are different lines of research in the literature on exchange rate determination. The asset approach focuses on the importance of asset prices in exchange rate determination. With this approach, interest rate differential is the main driving force behind the exchange rate movement between countries. Hence, the covered and uncovered interest parity conditions are used to determine the exchange rate. Another line of research uses the PPP hypothesis to study exchange rate dynamics. In these models, the relative price level is the main determinant of the exchange rate movement. This line of research can be linked to money market to examine how money supply and demand can influence the exchange rate through changing the interest rates, price levels, and our expectations about future exchange rate movements. In short, many monetary models of exchange rate determination are derived from the PPP hypothesis, interest parity condition, and money demand and supply functions.¹

Numerous studies have used the monetary approach to study exchange rate determination. Many authors have found evidence in support of monetary models of the exchange rate determination. Among these authors, mentioning the most recent, are Bitzenis and Marangos (2007), Crespo-Cuaresma et al. (2005), Hsing (2008), Loria et al. (2010), Sarno et al. (2004), and Uz and Ketenci...
Most empirical studies have used time series models to determine the exchange rate between two countries. More recently, however, the focus has shifted to using panel data models. For example, Camarero and Tamarit (2002), Crespo-Cuaresma et al. (2005), and Uz and Ketenci (2008), among others, use panel cointegration models to examine the exchange rate movement.

More specifically, Camarero and Tamarit (2002) use a monetary approach in the determination of the bilateral real exchange rate of the peseta relative to nine EU members. They find out that both supply and demand variables were important in the evolution of the peseta during the study period. Their results verify the importance of the demand side of the economy for the determination of the real exchange rate.

Crespo-Cuaresma et al. (2005) use a panel data set for six Central and Eastern European countries (CEECs) to estimate the monetary exchange rate model with the panel cointegration method. They show that the monetary model can explain the long-run exchange rate relationships of a group of CEECs. Uz and Ketenci (2008) use different panel cointegration tests and show that there is a long-run relationship between nominal exchange rate and monetary variables such as monetary differential, output differential, interest rate differential, and price differential in the newly entered ten EU members and Turkey.

The economic research on nominal exchange rate determination using monetary approach is far more extensive than studies on real exchange rate determination. While the studies on real exchange rate determination in developing countries and transition economies are growing, the research on real exchange rate determination in oil-producing countries is rather rare. Indeed, very few authors have studied the role of oil prices in the real exchange rate determination. For example, Habib and Kalamova (2007) examine whether the real oil price has an effect on the real exchange rates of three main oil-exporting countries: Norway, Russia, and Saudi Arabia. They find a positive long-run relationship between the real oil price and the real exchange rate for Russia. However, the real oil price has no effect on the real exchange rates for Norway and Saudi Arabia.

Jahan-Parvar and Mohammadi (2011) use the autoregressive distributed lag (ARDL) bounds testing approach to study the validity of the Dutch disease hypothesis by examining the relationship between real oil prices and real exchange rates in a sample of fourteen oil-exporting countries. Their results support the existence of a relationship between real exchange rates and real oil prices in the countries under investigation. Finally, Tsen (2011) studies the effect of oil price, through the terms of trade, on the real exchange rate in Hong Kong, Japan, and Korea. The study finds the real oil price, along with productivity differential, terms of trade, and reserve differential, is an important determinant of the real exchange rate. The existing literature ignores the fact that external factors such as foreign countries’ debt and debt management (how governments finance their debt) as well as crisis can affect the degree of competitiveness (real exchange rate) of an oil-producing country. Furthermore, it is possible that a small deviation from a long-run equilibrium is ignored, but agents react substantially to a large deviation. To the best knowledge of the authors, this situation is also ignored in the existing literature.

This study extends the literature by focusing on the determinants of the real exchange rate of the oil-producing countries that rely heavily on revenue from the exports of their natural resources, mainly oil. More specifically, we narrow our focus to factors determining real exchange rate in oil-producing-and-exporting Middle East and North Africa (MENA) countries (Algeria, Bahrain, Egypt, Iran, Kuwait, Libya, Oman, Qatar, Saudi Arabia, Syria, and the United Arab Emirates). Our model is also capable of investigating the effect of what was ignored in the literature on the real exchange rate in these countries. It is found that, over the long run, besides money supply, domestic real GDP, and government expenditure, the oil price and the U.S. externally financed debt per GDP also influence the real exchange rate. Over the short run, the changes in the domestic and U.S. interest rates as well as the U.S. debt per GDP, the U.S. stock market crisis of 1987, and the economic crisis of 2008 are the determinants of the real exchange rate in these countries. We also find that economic agents in these countries ignore a small deviation from equilibrium but react drastically to a large deviation in such a way to depart more from the long-run equilibrium. However, over two periods, market forces and/or monetary or fiscal policy bring the real exchange rate back to equilibrium.
The Model

Let us consider an economy with a single consumer, representing a large number of identical consumers. The consumer maximizes the following utility function:

\[ E \left\{ \sum_{t=0}^{\infty} \beta^t U(c_t, c^*_t, g_t, m_t/k_t, m^*_t/k^*_t) \right\}, \tag{1} \]

where \( c_t \) and \( c^*_t \) are single, nonstorable, real domestic and foreign consumption goods, respectively; \( m_t \) and \( m^*_t \) are the holdings of domestic real \((M/p)\) and foreign real \((M^*/p^*)\) cash balances, respectively; \( E \) is the expectation operator, and the discount factor satisfies \( 0 < \beta < 1 \); \( g \) is the real government expenditure on goods and services and is assumed to be a "good." For the sake of simplicity, following Cox (1983), Drazen and Helpman (1990), Hueng (1999), and Kia (2006), among many others, we assume labor is supplied inelastically, and so total output is exogenously given. Note that none of the results will be affected if we relax this assumption.

Following, among many, Hueng (1999) and Kia (2006, 2013), it is assumed that purchases of domestic and foreign goods are made with domestic and foreign currencies, respectively, and following Sidrauski (1967), the services of both domestic and foreign currencies enter the utility function. Let us choose the units in such a way that the services of domestic money is equal to \( m \) and the services of foreign money is equal to \( m^* \). Variables \( k \) and \( k^* \) reflect risk associated with holding \( m \) and \( m^* \), respectively.

Let us assume that the services of domestic money change for oil-producing countries as the oil price changes. Specifically, we postulate that over the long run,

\[ \log(k_t) = k_0 + k_1 \log(oilprice_t), \tag{2} \]

where \( k_0 \) and \( k_1 \) are constant parameters.\(^4\) It is assumed that the short-run dynamics of the risk variable [\( \log (k) \)] include a set of interventional dummies that account for wars, sanctions, political changes, economic crisis, and innovations as well as policy regime changes that influence services of money. The variable oilprice is the world oil price. As we expect, as the price of oil goes up, the risk associated with holding the currency of an oil-producing country, everything else being constant, will fall, implying that \( k_1 < 0 \). Clearly, as the oil price goes up, the demand for money of net oil-exporting countries will go up, which results in a higher value of their currencies in terms of, for example, U.S. dollars.\(^5\)

We also follow Kia (2013) and assume \( k^* \), which summarizes the risk associated with holding foreign currency (e.g., U.S. dollars), has the following specification:

\[ \log(k^*_t) = k^*_0 + k^*_1 debtgdp^*_t + k^*_2 fdgdp^*_t, \tag{3} \]

where \( k^*_0, k^*_1, \) and \( k^*_2 \) are constant coefficients. Variables debtgdp* and fdgdp* are the outstanding foreign country debt per foreign GDP, and the internationally foreign-government financed debt per foreign GDP. A higher foreign debt is assumed to be associated with future monetization of debt and a lower value of foreign currency (i.e., a lower demand for foreign currency), and consequently, \( k^*_1 > 0 \). Furthermore, an increase in the amount of government debt held by international investors/governments may be considered a cause for future devaluation of the foreign currency, which implies \( k^*_2 > 0 \). Note that currency holders of net oil-importing countries consider that deficit and/or outstanding debt of these countries enhance the risk of holding the currency of these countries. However, the currency holders of net oil-exporting countries do not. The main reason is that investors expect the governments of net oil-exporting countries to finance their deficits and debt simply by exporting more oil. Therefore, the change in oil price is only relevant to the risk associated with the currency holding of these countries.
Equation (3) is held subject to the short-run dynamics of the system. Specifically, it is assumed that the short-run dynamics of the risk variable associated with holding foreign currency \([\log (k^*)]\) includes a set of interventional dummies that account for economic crisis, political changes, and policy regime changes that influence the value of money. The utility function is assumed to be increasing in all its arguments (except variables \(k\) and \(k^*\), which are decreasing), and is strictly concave and continuously differentiable. The demand for services of money (both domestic and foreign), \(S[=m]\) and \(S^*[=m^*]\), following Sidrauski (1967), will always be positive if we assume \(\lim_{s \to 0} U_s(c, c^*, g, m/k, m^*/k^*) = \infty\) and \(\lim_{e^* \to 0} U_e(c, c^*, g, m/k, m^*/k^*) = \infty\), for all \(c\) and \(c^*\), where, for example, \(U_s = \partial U(c, c^*, g, m/k, m^*/k^*)/\partial s\). Assume also that the U.S. dollar represents foreign currency. Given \(g\), the consumer maximizes (1) subject to the following budget constraint:

\[
\begin{align*}
\tau_t + y_t + (1 + \pi_t)^{-1}m_{t-1} + q_t(1 + \pi^*_t)^{-1}m^*_{t-1} + (1 + \pi_t)^{-1}(1 + R_{t-1})d_{t-1} \\
+ q_t(1 + \pi^*_t)^{-1}(1 + R^*_{t-1})d^*_{t-1} = c_t + q_t c^*_t + m_t + q_t m^*_t + d_t + q_t d^*_t,
\end{align*}
\]

where \(\tau_t\) is the real value of any lump-sum transfers/taxes received/paid by consumers; \(y_t\) is the current real endowment (income) received by the individual; \(\pi_t\) is the inflation rate; \(q_t\) is the real exchange rate, defined as \(E_t p_t^*/p_t^*\); \(E_t\) is the nominal market (nonofficial/black-market rate in some developing countries) exchange rate (domestic price of foreign currency); \(p_t^*\) and \(p_t\) are the foreign and domestic price levels of foreign and domestic goods, respectively; \(m^*_{t-1}\) is the foreign real money holdings at the beginning of the period; \(d_t\) is the one-period real domestically financed government debt, which pays \(R_t\) rate of return; and \(d^*_t\) is the real foreign issued one-period bond, which pays a risk-free interest rate \(R^*_t\). Assume further that \(d_t\) and \(d^*_t\) are the only two storable financial assets.

Define \(U_c = \partial U(c, c^*, g, m/k, m^*/k^*)/\partial c\), \(U_{c^*} = \partial U(c, c^*, g, m/k, m^*/k^*)/\partial c^*\); \(U_m = \partial U(c, c^*, g, m/k, m^*/k^*)/\partial m\); \(U_{m^*} = \partial U(c, c^*, g, m/k, m^*/k^*)/\partial m^*\); and \(\lambda_t = \text{the marginal utility of wealth at time } t\). Maximizing the preferences with respect to \(m, c, m^*, c^*, d, d^*\), and subject to budget constraint (4) for the given output and fiscal variables, will yield the first-order conditions:

\[
\begin{align*}
U_{ct} + \lambda_t c_t = 0 \\
U_{c^*t} + \lambda_t c^*_t = 0 \\
U_{mt} + \lambda_t m_t - \beta \lambda c_{t+1}(1 + \pi^e_{t+1})^{-1} = 0 \\
U_{m^*t} + \lambda_t m^*_t - \beta \lambda c^*_{t+1}q^e_{t+1}(1 + \pi^*e_{t+1})^{-1} = 0 \\
\lambda_t - \beta \lambda c_{t+1}(1 + R_t)(1 + \pi^e_{t+1})^{-1} = 0 \\
\lambda_t q_{t} - \beta \lambda c^*_{t+1}q^*_{t+1}(1 + R^*_t)(1 + \pi^*e_{t+1})^{-1} = 0
\end{align*}
\]

Note that \(x^e_{t+1} = E(x_{t+1} \mid I_t)\) is the conditional expectations of \(x_{t+1}\), given current information \(I_t\). From (5) and (6) we can write

\[
U_{ct}/U_{c^*t} = 1/q_t.
\]

Equation (11) indicates that the marginal rate of substitution between domestic and foreign goods is equal to their relative price. Solving (6), (8), and (10) yields

\[
U_{c^*t}(1 + R^*_t)^{-1} + U_{m^*t} = U_{c^*t}.
\]
Equation (12) implies that the expected marginal benefit of adding to foreign currency holdings at
time \( t \) must equal the marginal utility from consuming foreign goods at time \( t \). Note that the holding of
foreign currency directly yields utility through its services \((U_{m^*})\). Furthermore, from (10) and (6) we have
\(-U_{ct} = \beta \lambda^c_{t+1} q_t^{c_{t+1}} (1 + R^c_t) (1 + \pi_{t+1}^c)^{-1}\), which implies that the expected real foreign
currency invested in foreign bonds has a forgone value of \(-U_{ct}\). Consequently, the total marginal benefit
of holding money at time \( t \) is \( U_{ct} + U_{m^*} \).

Similarly, from (5), (7), and (9), we have
\[
U_{ct}(1 + R_t)^{-1} + U_{mt} = U_{ct},
\]
(13)

Equation (13) implies that the expected marginal benefit from adding to domestic currency holdings
at time \( t \) must equal the marginal utility of consuming domestic goods at time \( t \).

To construct a parametric demand for real balances, we assume the utility has an instantaneous function:
\[
U(c_t, c_t^*, g_t, k_t m_t, k_t^* m_t^*) = (1 - \alpha)^{-1} \left( c_t^{a_1} c_t^*^{a_2} g_t^{a_3} \right)^{1-a} \nonumber \\
+ \xi (1 - \eta)^{-1} \left[ (m_t/k_t)^{\eta_1} (m_t^*/k_t^*)^{\eta_2} \right]^{1-\eta},
\]
(14)

where \( a_1, a_2, a_3, \alpha, \eta_1, \eta_2, \xi, \) and \( \xi \) are positive parameters, and \( 0.5 < \alpha < 1 \) and \( 0.5 < \eta < 1 \). The latter
assumption \((0.5 < \alpha < 1 \) and \( 0.5 < \eta < 1\)) is needed to ensure a standard demand for money. Since none
of the following results is sensitive to the magnitudes of \( a_1, a_2, a_3, \eta_1, \) and \( \eta_2 \), for the sake of
simplicity, we assume these parameters are all equal to one. The utility function (14) is similar to what
Kia (2006) assumes; however, he ignores the fact that there is also risk associated with holding foreign
currency.

Using (11) and (14), we will have
\[
c_t^* = (\alpha_2/\alpha_1) c_t q_t^{-1}.
\]

Since we assume \( \alpha_2/\alpha_1 = 1 \), we will have
\[
\log(c_t^*) = \log(c_t) - \log(q_t).
\]
(15)

Using (12), (14), (15), and the assumption \( \alpha_1 = \alpha_2 = \alpha_3 = \eta_1 = \eta_2 = 1 \), we will have
\[
\xi/k_t^*(m_t/k_t)^{\eta_1(1-\eta)}(m_t^*/k_t^*)^{-\eta}/\left[ \alpha_2 c_t^{a_1(1-a)} c_t^{a_2(1-a)} g_t^{a_3(1-a)} \right] = (R^*_t/1 + R^*_t)
\]
(15–1)

Substitute (15) in (15–1) and solve the final equation for \( m^*_t \) to get
\[
m^*_t = k_t^{(\eta-1)/\eta}(R^*_t/1 + R^*_t)^{-1/\eta}(c_t^{1-2a} g_t^{1-a} q_t^{a})^{-1/\eta} \xi^{1/\eta} (k_t^{-1} m_t)^{(1-\eta)/\eta},
\]
or
\[
\log(m^*_t) = (\eta - 1)/\eta \log(k^*) - \eta^{-1} \log(R^*_t/1 + R^*_t) - \eta^{-1}(1 - 2a) \log(c_t) - \eta^{-1} a \log(g_t)
\]
\[
- \eta^{-1}(1 - a) \log(g_t) + \eta^{-1} \log(\xi) + (\eta^{-1} - 1) \log(m_t) - (\eta^{-1} - 1) \log(k_t).
\]
(16)

As we can see from Equation (16) for \( \eta < 1 \), an increase in the foreign risk results in a reduction in
demand for foreign currency while an increase in the domestic risk as well as in the domestic currency
results in an increase in the demand for foreign currency. Note that Equation (16) is not a final
equilibrium condition, and according to our assumption [utility function (14)], a representative consumer must have both currencies in his satisfaction function. The elimination of one leads to the elimination of the other. Using (13), (14), (15), and (16), and assuming the domestic real consumption \((c_i)\) is some constant proportion \((\omega)\) of the domestic real income \((y_i)\), where for simplicity we assume \(\omega = 1\), we will have

\[
\log(m_i) = m_0 + m_1 i + m_2 \log(y_i) + m_3 \log(g_i) + m_4 \log(k_i) + m_5 \log(q_i) + \\
+ m_6 \omega_i + m_7 \log(k^*),
\]

(17)

where \(i^*_t = \log(R^*_t/(1 + R^*_t))\); \(i_t = \log(R_t/(1 + R_t))\). Using \(0.5 < \alpha < 1\) and \(0.5 < \eta < 1\), we will have

\[
m_0 = -1/(1 - 2\eta) \log(\xi) > 0, m_1 = \eta(1 - 2\eta)^{-1} < 0, m_2 = (1 - 2\eta)^{-1}(1 - 2\alpha) > 0,
\]

\[
m_3 = -(1 - \alpha) < 0, m_4 = (1 - 2\eta)^{-1}(1 - \eta) < 0, m_5 = -(1 - 2\eta)^{-1}[(\eta - 1)\alpha - \eta(1 - \alpha)] < 0,
\]

\[
m_6 = -(\eta - 1)(1 - 2\eta)^{-1} < 0, \quad \text{and}
\]

\[
m_7 = (1 - 2\eta)^{-1}(1 - \eta) < 0.
\]

Note that the coefficients of both \(k\) and \(k^*\) are negative, implying that both domestic and foreign risks associated with holding domestic and foreign currencies reduce the demand for domestic currency. This is because, as we can see from Equation (16), the demand for domestic currency \((m)\) has a positive relationship with the demand for foreign currency \((m^*)\). Therefore, as \(k^*\) goes up, \(m^*\) will fall, which results in a fall of \(m\). We should also bear in mind that as risk associated with any of these currencies goes up, demand for bond, as well as goods and services, will go up.

At the equilibrium, we will have \(\log(m_i) = \log(m^*_i)\), where \(m^*_i\) is the supply of money. Substituting \(\log(m^*_i)\) for \(\log(m)\) in Equation (17) and Equations (2) and (3), for \(\log(k)\) and \(\log(k^*)\) in Equation (17), and solving for \(\log(q_i)\) results in

\[
\log(q_i) = \beta_0 + \beta_1 \log(m^*_i) + \beta_2 i + \beta_3 \log(y_i) + \beta_4 \log(g_i) + \beta_5 \log(oilprice_i) + \\
+ \beta_6 \omega_i + \beta_7 \text{debtgdp}_i^* + \beta_8 \text{fdgdp}_i^* + \beta_9 \text{trend} + u_i,
\]

(18)

where \(\beta_0 = -m_0/m_5 < m_4/m_5 k^*_0 > 0; \quad \beta_1 = 1/m_5 < 0; \quad \beta_2 = -m_1/m_5 < 0; \quad \beta_3 = -m_2/m_5 > 0; \quad \beta_4 = -m_3/m_5 < 0; \quad \beta_5 = -m_4/m_5 k^*_1 > 0; \quad \beta_6 = -m_6/m_5 < 0; \quad \beta_7 = -m_7/m_5 k^*_2 < 0; \quad \text{and} \quad \beta_8 = -m_7/m_5 k^*_2 < 0.
\]

Equation (18) is a long-run real exchange rate relationship. To capture technological improvements, we add a time trend (trend) to the equation. We also add an error term, which is assumed to be white noise. According to this equation, a higher supply of money and higher interest rate result in a lower real exchange rate over the long run. One possible explanation is that an increase in money supply or interest rate could cause an increase in price over the long run, which would result in a lower real exchange rate. This could confirm the view that “given the time path of fiscal policy and given that government interest-bearing debt can be sold only at a real interest rate exceeding the growth rate \(n\), the tighter is current monetary policy, the higher must the inflation rate be eventually” (Sargent and Wallace 1986, 160) (see also Kia 2006). A higher real income results in a higher real exchange rate over the long run. A higher real income could result in a higher real demand for money and a lower price level and so a higher exchange rate.

A higher government expenditure results in a lower demand for money and, therefore, a higher demand for goods and services and consequently a higher price level and a lower real exchange rate. A higher oil price leads to a higher demand for domestic currency and a lower demand for goods and
services and price. Consequently, a higher oil price results in a higher real exchange rate. Factors that affect the risk associated with holding foreign currency—that is, debt and foreign debt financing of the foreign debt—also result in a lower real exchange rate. This could be because these factors reduce demand for money [Equation (17)] and result in a higher demand for goods and services and price level (a lower real exchange rate). It should be emphasised that the long-run Equation (18) is also subject to a short-run dynamic system, which includes stationary variables that represent crisis as well as policy regime changes and other exogenous factors that affect the system in both domestic and foreign countries.

The long-run real exchange rate relationship, Equation (18), is very different from those in the literature of real exchange rate for commodity-resource-oriented countries. For example, Chen and Rogoff’s (2003) real exchange model is a function of terms of trade and commodity prices; Cashin et al.’s (2004) real exchange rate model is a function of the commodity terms of trade (or the price of the primary commodity with respect to the intermediate foreign good), the productivity differentials between the export and import (foreign) sectors, and the productivity differentials between the local and foreign nontraded sectors. Finally, Bodart et al. (2012) estimate a real exchange rate model that is only a function of the commodity price. However, none of these models incorporate debt, deficits, and debt management.

Our model, though very different, is close to Kia’s (2013) model. Kia’s (2013) model is for a country that has the highest degree of openness; that is, Canada. While the model incorporates both domestic and foreign (U.S.) fiscal variables, it includes commodity price rather than oil price. In fact, our model is for oil-producing countries in which the fiscal variables are financed mainly by exporting oil. That is the reason the risk associated with holding domestic money is only a function of the world oil price and has nothing to do with domestic fiscal variables. Oil price can determine how much the governments of these countries can spend and how they can finance their debt. This is the main difference between our model and Kia’s model.

Data, Methodology, and Results

The countries under investigation include eleven MENA oil-producing countries: Algeria, Bahrain, Egypt, Iran, Kuwait, Libya, Oman, Qatar, Saudi Arabia, Syria, and the United Arab Emirates (UAE). Iraq is dropped from our sample due to a lack of data. Hence, these countries were chosen according to the availability of data for the period 1985–2009. The data used in this article were obtained from the International Financial Statistics (IFS) and World Development Indicators (WDI) (CD-ROMs) published by the International Monetary Fund (IMF) and the World Bank, respectively, and from IMF online statistics (www.imfstatistics.org/imf). Data on inflation rate for the United Arab Emirates were obtained from the Ministry of Economy of the United Arab Emirates. In the case of Iran, the short-term expected profit rate reported by the Central Bank of Iran is used as a proxy for the interest rate. One should also note that the Treasury bill rate for most MENA countries is not available, so we use the deposit rate, as reported by IFS. For most MENA countries, no market exchange rate is reported by IFS or other sources. We also use the secondary market rate for Syria and the principal rate for Egypt, as are reported by IFS. We use the Consumer Price Index (CPI) to construct the real exchange rate, \( q \) (i.e., \( q = E \cdot CPI^* / CPI \), in which \( E \) is the nominal exchange rate). Since there are many missing data when working with MENA countries, we use an unbalanced panel model for our estimation purpose. The source of U.S. data is the St. Louis Federal Reserve website (http://research.stlouisfed.org/fred2/).

Equation (18) adjusted for panel data is

\[
Lq_{it} = \beta_0 + \beta_1 Lm_{it} + \beta_2 i_{it} + \beta_3 Ly_{it} + \beta_4 Lg_{it} + \beta_5 Loilprice_{it} + \beta_6 i^d_{it} + \beta_7 debtgdp_{it} \\
+ \beta_8 dgdgdp_{it} + \beta_9 trend + u_{it}, \text{ for } i = 1, \ldots, m \text{ and } t = 1, \ldots, T, \tag{19}
\]
where $L$ stands for the logarithm of a variable. As before $\beta_0 > 0$, $\beta_1 < 0$, $\beta_2 < 0$, $\beta_3 > 0$, $\beta_4 < 0$, $\beta_5 > 0$, $\beta_6 < 0$, $\beta_7 < 0$, $\beta_8 < 0$. 

According to the Granger representation theorem, if two variables $Y$ and $X$ are cointegrated, then the relationship between them can be expressed as error correction model (ECM) (Engle and Granger 1987). Hence, provided a long-run equilibrium relationship exists among the variables, we can estimate the following panel data ECM:

$$
\Delta Lq_{it} = \gamma_0 + \gamma_1 DUM87 + \gamma_2 DUM97 + \gamma_3 DUM2008 + \sum_{j=1}^{p} \theta_{1j} \Delta Lq_{it-j} + \sum_{j=1}^{p} \theta_{2j} \Delta Lm_{it-j} + \sum_{j=1}^{p} \theta_{3j} \Delta Ly_{it-j} + \sum_{j=1}^{p} \theta_{4j} \Delta Lg_{it-j} + \sum_{j=1}^{p} \theta_{5j} \Delta Loilprice_{it-j} + \sum_{j=1}^{p} \theta_{6j} \Delta oilprice_{it-j} + \sum_{j=0}^{p} \theta_{7j} \Delta Ly_{it-j} + \sum_{j=0}^{p} \theta_{8j} \Delta debtgdgdp_{it-j} + \sum_{j=1}^{p} \theta_{9j} \Delta fdlgdgdtp_{it-j} + \sum_{j=1}^{p} \lambda_{1j} ECT_{it-j} + \sum_{j=1}^{p} \lambda_{2j} ECT_{it-j}^2 + \sum_{j=1}^{p} \lambda_{3j} ECT_{it-j}^3 + \sum_{j=1}^{p} \lambda_{4j} ECT_{it-j} ECT_{it-j}^3 + \eta \text{trend} + \epsilon_{it}.
$$

(20)

In this equation, $\gamma$, $\theta$s, $\lambda$s, and $\eta$ are constant parameters; $\Delta$ denotes first difference; $L$, as before, stands for “log” of a variable; $ECT$ is the error correction term; $\text{trend}$ is a time trend; and $\epsilon_{it}$ is the disturbance term. We have also included dummy variables $DUM87$, $DUM97$, and $DUM2008$ in the model to capture the effect of the U.S. financial crisis of 1987, the East Asian financial crisis of 1997, and the U.S. economic crisis of 2008, respectively, on real exchange rate movement. Hence, $DUM87$, $DUM97$, and $DUM2008$ are equal to one for the years 1987, 1997, and 2008, respectively, and zero otherwise. Note that these dummy variables also affect the short-run dynamics of the system in the cointegration relationship.

Following Granger (1986), we should note that if small equilibrium errors can be ignored, while reacting substantially to large ones, the error correcting equation is nonlinear. All possible kinds of nonlinear specifications (i.e., squared and cube powered of the equilibrium errors, with statistically significant coefficients, as well as the products of those significant equilibrium errors) are included in Equation (20). Given the variables are cointegrated, in the first step, we will estimate the long-run model using Equation (19). The estimated residual from this model will be obtained, and then our panel error correction model will be estimated.

Prior to estimating the above equations, we should examine whether the variables are stationary. For this purpose, we conduct panel data unit root tests proposed by Im, Pesaran, and Shin (Im et al. 2003) (IPS) and Levin, Lin, and Chu (Levin et al. 2002) (LLC). The results of our unit root tests show that our variables are I(1). Hence, we should make sure that at least one long-run equilibrium relationship exists among the variables. We use Kao’s (1999) test to examine whether the variables are cointegrated. The result of this test shows there is a long-run equilibrium relationship among the variables. For the sake of robustness, we also use the Fisher Johansen–based cointegration test, which allows for more than one cointegration relationship in space. The test result confirms Kao’s test result.

Next, we have to choose a proper panel data estimation method. We do the Breusch-Pagan test of random effects against poolability (Baltagi 2005, 58). The result of this test is reported in the second column of Table 1. As the result shows, the null hypothesis of poolability is rejected. This means that there is within-unit correlation. Hence, the result suggests the use of a random effects model.
Next, we use the Chow test to choose between pooling and fixed effects models (Baltagi 2005, 57). The likelihood ratio (LR) test result reported in the third column of Table 1 shows that the null hypothesis of redundant fixed effects is rejected. This means we can use a fixed effects model.

Since one test suggests using a random effects model and the other test suggests using a fixed effects model, we conduct Hausman’s (1978) test to examine random versus fixed effects models (Baltagi 2005, 65). The result of this test is reported in the fourth column of Table 1. As the result shows, the null hypothesis of no correlation between explanatory variables and the error term is rejected. Hence, the use of a random effects model is not appropriate because it will result in an inconsistent estimation.

Given the results of the above tests, we use a cross-section fixed effects method with cross-section weights to estimate Equation (19). Table 2 reports the estimated long-run relationship. According to the estimation result, the coefficients of money supply, domestic real GDP, government expenditure, oil price (at the 10 percent level), the U.S. externally financed debt per GDP, and trend are statistically significant. However, the estimated coefficients of the domestic interest rate, the U.S. interest rate, and the U.S. debt per GDP are not statistically significant. This means that these three variables have no long-run effect on the real exchange rates of the oil-producing and exporting countries.

The negative estimated coefficient of real output may be because a higher income leads to a higher demand for goods and services and results in a higher domestic price level over the long run, which by itself causes a lower real exchange rate. A possible explanation for the positive estimated coefficient of the real government expenditure is that higher government expenditure could result in devaluation of the domestic currency by the government over the long run. This could generate more income for the government from the oil exports and, therefore, compensate for the increase in the government expenditure and vice versa.

### Table 1. Breusch-Pagan, Chow, and Hausman tests

<table>
<thead>
<tr>
<th>Period</th>
<th>Breusch-Pagan test: $\chi^2$</th>
<th>Chow test: $F$</th>
<th>Hausman test: $\chi^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1985–2009</td>
<td>2,212.46*</td>
<td>2.931120*</td>
<td>181.859905*</td>
</tr>
</tbody>
</table>

*Statistical significance at the 5 percent level or less.

### Table 2. The estimation result of the long-run model

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>t-statistic</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>$C$</td>
<td>-95.458120*</td>
<td>-3.282909</td>
<td>0.0012</td>
</tr>
<tr>
<td>$Lm$</td>
<td>-0.440469*</td>
<td>-2.845427</td>
<td>0.0049</td>
</tr>
<tr>
<td>$i$</td>
<td>-0.342953</td>
<td>-0.931387</td>
<td>0.3528</td>
</tr>
<tr>
<td>$Ly$</td>
<td>-0.307311**</td>
<td>-1.860024</td>
<td>0.0643</td>
</tr>
<tr>
<td>$Lg$</td>
<td>0.940171*</td>
<td>3.788850</td>
<td>0.0002</td>
</tr>
<tr>
<td>$Lt$/price</td>
<td>-0.114848**</td>
<td>-1.680011</td>
<td>0.0945</td>
</tr>
<tr>
<td>$i^*$</td>
<td>0.141900</td>
<td>0.602955</td>
<td>0.5472</td>
</tr>
<tr>
<td>deptgdp*</td>
<td>0.910410</td>
<td>0.897699</td>
<td>0.3704</td>
</tr>
<tr>
<td>fdgdp*</td>
<td>-3.169336*</td>
<td>-1.910011</td>
<td>0.0575</td>
</tr>
<tr>
<td>trend</td>
<td>0.045250*</td>
<td>2.954705</td>
<td>0.0035</td>
</tr>
</tbody>
</table>

| $R^2$        | 0.993312     | Adjusted $R^2$ | 0.992653 |
| F-statistic  | 1507.512     | Prob (F-statistic) | 0.000000 |

*Statistical significance at the 5 percent level or less; **statistical significance at the 10 percent level or less.
The sign of the estimated coefficient of oil price does not justify our theoretical model. However, it is only statistically significant at the 10 percent level. A higher oil price increases the relative demand for currency of oil producing and exporting countries. This in turn increases the value of the domestic currency relative to the U.S. dollar in foreign exchange markets and hence leads to a lower nominal exchange rate. Consequently, a higher oil price might result in a lower real exchange rate. We also deflate the oil prices by the Manufactures Unit Value Index (MUV) and assume the domestic real consumption \( (c_t) \) is a function of net foreign assets \( (NFA) \). That is, \( c_t = e^{\omega_1 NFA} \omega_2 y_t \). Using the revised consumption function, we will have NFA in Equations (17) and (18), where the coefficient of \( NFA \) in Equation (18) will be positive. We estimate the revised Equation (18). While none of the estimated coefficients change, the estimated coefficient of the oil price becomes statistically insignificant. Furthermore, while the estimated coefficient of \( NFA \) is positive, it is statistically insignificant. The latter result confirms most of Christopoulos et al.’s (2012) estimation result of the effect of NFA on the real exchange rate, although they have a different model for the determinants of the real exchange rate. For the sake of brevity, this estimation result is not reported, but is available upon request.

Furthermore, regarding the effect of oil price on real exchange rate, Habib and Kalamova (2007) find mixed results. They show that there is a positive long-run relationship between the real oil price and the real exchange rate for Russia. However, they show that the real oil price has not affected the real exchange rates for the cases of Norway and Saudi Arabia.

All other estimated coefficients justify our theoretical model. An increase in money supply leads to a lower real exchange rate in the long run. Furthermore, the estimated coefficient of U.S. externally financed debt per GDP is negative (justifying the theoretical model) and statistically significant. This means the debt management (externally financed debt) of a large country such as the United States has an effect on the real exchange rate of these oil-producing countries. Overall, the above result indirectly indicates that purchasing power parity does not hold for these oil-producing countries.

Having established that a long-run cointegration relationship between our variables [Equation (19)] exists, we need to estimate the short-run dynamic model (ECM), Equation (20), by using the residual obtained from the long-run model. We also include dummy variable \( DUM-ER \) in Equation (20) to capture the nominal exchange rate devaluation in Algeria (1991), Egypt (1989–91), Iran (1993 and 2002), Libya (2002), and Syria (1988). Note that “having too many coefficients can also lead to inefficient estimates. To guard against this problem and ensure parsimonious estimations, we select the final ECMs on the basis of Hendry’s General-to-Specific approach” (Kia and Darrat 2007, 114). The estimation result of our panel ECM is reported in Table 3.

As the result in Table 3 shows, the error correction term, \( ECT \), is negative and statistically significant. The \( ECT \) also enters in a nonlinear form, implying that while a small deviation from equilibrium in these countries may be ignored, the economic agents react drastically to a large deviation, though a further departure from equilibrium. This important fact so far has been ignored in the panel data literature. Furthermore, it takes two periods for the departure from equilibrium to be eliminated. The overall speed of adjustment is about \(-0.17153\) (the sum of the linear and nonlinear estimated coefficients).

The result shows all variables with the exception of \( \log(m) \), \( oilprice \), and \( fdgdp^* \) have a short-run effect on the real exchange rate. Contrary to the long-run estimation result, both domestic and U.S. interest rates have a statistically significant effect on the real exchange rate. However, the estimated sign of the domestic interest rate does not justify our theoretical model; that is, it is positive rather than negative. Over the long run, however, we find (see Table 2) the domestic interest rate has a correct sign, but not a statistically significant effect on the real exchange rate. These results imply that, for a given relative price of the United States to the domestic country, a higher domestic interest rate leads to a decrease in exchange rate (an appreciation of the domestic currency) over the short run and has no effect on the real exchange rate over the long run.

Moreover, the growth of real GDP, similar to its level over the long run, has a negative and statistically significant effect on the real exchange rate. This implies that when the economy in these countries, for
example, grows, the demand for goods and services increases more than the demand for money and, therefore, results in a higher domestic price level over the short run and causes a lower real exchange rate.

The growth of the real government expenditure has a correct sign. The coefficient of the change in \( \text{debtgdp}^* \) is statistically significant and has a correct sign, implying that an increase in the U.S. debt per GDP decreases the real exchange rate over the short run. According to our estimation result reported in Table 3, the coefficients of \( \text{DUM87} \) and \( \text{DUM2008} \) are negative and statistically significant. This means that the U.S. stock market crisis of 1987 and the economic crisis of 2008 had short-term negative effects on the real exchange rate for oil-producing-and-exporting countries. However, the Asian crisis of 1997 did not influence the real exchange rate. Moreover, the nominal exchange rate devaluations in Algeria (1991), Egypt (1989–91), Iran (1993 and 2002), Libya (2002), and Syria (1988) increased the real exchange rates in these countries.

### Concluding Remarks

We develop a model of real exchange rate for MENA countries. The model takes into account external crises, debt, and deficits. Using a panel data of eleven MENA oil-producing countries, (Algeria, Bahrain, Egypt, Iran, Kuwait, Libya, Oman, Qatar, Saudi Arabia, Syria, and United Arab Emirates), we test the model. The sample period is 1985–2009.

We find that the main determinants of the real exchange rate over the long run in these countries are money supply, domestic real GDP, government expenditure, oil price, and the U.S. externally financed debt per GDP. However, neither domestic and U.S. interest rates nor the U.S. debt per GDP have any effect on the real exchange rate over the long run in these countries. Over the short run, however, the changes of the domestic and U.S. interest rates as well as the U.S. debt per GDP influence the growth of the real exchange rate in these oil-producing countries.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>t-statistic</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>( C )</td>
<td>4.062874*</td>
<td>5.832978</td>
<td>0.0000</td>
</tr>
<tr>
<td>( \Delta L_y ) (-1)</td>
<td>-0.152991*</td>
<td>-4.001269</td>
<td>0.0001</td>
</tr>
<tr>
<td>( \Delta L_g ) (-2)</td>
<td>-0.008854*</td>
<td>-4.243676</td>
<td>0.0000</td>
</tr>
<tr>
<td>( \Delta L_q ) (-3)</td>
<td>0.070963*</td>
<td>1.903936</td>
<td>0.0586</td>
</tr>
<tr>
<td>( \Delta ) (-3)</td>
<td>0.305205*</td>
<td>2.187933</td>
<td>0.0300</td>
</tr>
<tr>
<td>( \Delta \text{debtgdp}^* ) (-1)</td>
<td>-0.726684*</td>
<td>-8.599802</td>
<td>0.0000</td>
</tr>
<tr>
<td>( \Delta ) (-2)</td>
<td>-0.187684*</td>
<td>-6.307755</td>
<td>0.0000</td>
</tr>
<tr>
<td>( \Delta ) (-3)</td>
<td>-0.162057*</td>
<td>-3.075540</td>
<td>0.0024</td>
</tr>
<tr>
<td>( DUM_{ER} )</td>
<td>0.610277*</td>
<td>7.431527</td>
<td>0.0000</td>
</tr>
<tr>
<td>( DUM87 )</td>
<td>-0.059406*</td>
<td>-6.571646</td>
<td>0.0000</td>
</tr>
<tr>
<td>( DUM2008 )</td>
<td>-0.039837*</td>
<td>-6.746540</td>
<td>0.0000</td>
</tr>
<tr>
<td>( Trend )</td>
<td>-0.002092*</td>
<td>-6.039228</td>
<td>0.0000</td>
</tr>
<tr>
<td>( \text{ECT}(-1) )</td>
<td>-0.110877*</td>
<td>-2.685983</td>
<td>0.0079</td>
</tr>
<tr>
<td>( \text{ECT}(-2) )</td>
<td>-0.123070*</td>
<td>-4.239255</td>
<td>0.0000</td>
</tr>
<tr>
<td>( \text{ECT}(-1)^2 )</td>
<td>0.039982*</td>
<td>5.972415</td>
<td>0.0000</td>
</tr>
<tr>
<td>( \text{ECT}(-2)^2 )</td>
<td>0.022435*</td>
<td>3.435390</td>
<td>0.0007</td>
</tr>
<tr>
<td>( R^2 )</td>
<td>0.663002</td>
<td>Adjusted ( R^2 )</td>
<td>0.613444</td>
</tr>
<tr>
<td>( F )-statistic</td>
<td>13.37819</td>
<td>Prob (( F )-statistic)</td>
<td>0.000000</td>
</tr>
</tbody>
</table>

*Statistical significance at the 5 percent level or less.
Interestingly, while a rise in the money supply, real GDP, oil price, and U.S. debt foreign financing per GDP reduce the real exchange rate over the long run, the increase in the government expenditure will increase the real exchange rate. Over the short run, an increase in the domestic interest rate will increase the growth of the real exchange rate while an increase in the growth of the real GDP and real government expenditure as well as an increase in the U.S. debt per GDP and U.S. interest rate will result in a fall of the real exchange rate.

Finally, we find that the U.S. stock market crisis of 1987 and the economic crisis of 2008 had short-term negative effects on the real exchange rate for oil-producing-and-exporting countries. However, the Asian crisis of 1997 did not influence the real exchange rates in these countries. Furthermore, the nominal exchange rate devaluations in Algeria, Egypt, Iran, Libya, and Syria positively influenced the real exchange rates in these countries. Overall, the above result indirectly indicates that purchasing power parity does not hold for these oil-producing countries as a block.

Notes
1. Some authors, such as Dornbusch (1976) and Frankel (1979), have developed different versions of monetary models of exchange rate determination depending on their assumptions about stickiness or flexibility of prices.
2. There are also studies (Atasoy and Saxena 2006; Dufrenot and Balázs 2005; MacDonald and Wójcik 2008) that find that productivity differentials and other factors such as current account, exchange and trade controls, as well as capital account control inflows, affect the real exchange rate.
3. Some lines of research combine real and nominal sectors and emphasize the role of trade balance, monetary factors, government policies, and real and nominal disturbances in exchange rate determination. Behavioral equilibrium exchange rate approaches are among these strands.
4. This equation is different from what Kia (2013) assumes. He assumes $k$ is a function of deficits, debt, and foreign financing, all per GDP, for Canada which is a resource-oriented country. Other studies on resource-oriented countries (e.g., Bodart et al. 2012; Cashin et al. 2004; Chen and Rogoff 2003; Coudert et al. 2008) ignore such a risk associated with holding domestic or foreign money. We owe this point to the referee who brought this to our attention.
5. For example, the panel correlation coefficient between eleven MENA oil-producing countries’ (see the Data, Methodology, and Results section for the name of these countries and the sample period) nominal exchange rate in terms of U.S. dollars and oil price is $-0.015063$ ($t$-statistic $= -2.84$), implying that as the oil price increases, the value of the currency of these countries will go up. Note that the exchange rate is defined as domestic currency value of one unit of the U.S. dollar. Furthermore, even though there have been sanctions against Iran from the United States since the second quarter of 1982, prices and Iranian currency are highly correlated with U.S. prices and currency. For example, Kia and Darrat (2007) show that the absolute purchasing power parity relationship between Iran and the United States exists.
6. If we relax the assumption that supply is labored inelastically (income is exogenous), then we need to add an extra term—for example, $-(1-\eta_3)^3(N_3)^{1-\eta_3}$ to (14), where $N$ is hours worked and $\eta_3 \geq 0$ represents Frisch labor supply elasticity. In such a case, one can easily verify that none of our results will be different.
7. Iran has been operating under an interest-free banking system since 1983.
8. Note that $q$ is the real exchange rate based on the U.S. dollar. This is because the United States dominates the trade relation with these countries. This is also true even for a country such as Iran, which has been under U.S. sanctions for most of the sample period. The main reason is that the prices in the countries (e.g., China) with which Iran has been trading during the sanction period are heavily influenced by the U.S. prices. Data on effective real exchange rate are not available, and since the dominant trading partner for these countries is the United States, the proportions of trade with other countries, if any, are not reported in any data base. Consequently, the construction of the effective real exchange rate is impossible.
9. According to IPS test results, all variables except $debtgdp*$ are I(1). However, according to LLC’s $t*$ test results, all variables including $debtgdp*$, are I(1). Since no rational investor will buy a debt with nonstationary changes, we assume $debtgdp*$ is I(1). Note that finding $Lq$ to be I(1) immediately rejects the existence of PPP between these oil-producing countries and the United States. For the sake of brevity, we do not report the results of these tests, but they are available upon request.
10. For the sake of brevity, the results of Kao’s test and the Fisher Johansen–based cointegration test are not reported, but are available upon request.
11. An AR(1) correction term is added to the model to take care of the autocorrelation problem.
12. One may argue that government expenditure is biased toward nontraded domestic goods, which would cause an appreciation of the domestic currency. But keeping in mind that the main source for the
governments of these oil-producing countries is oil exports, a higher government expenditure, therefore, requires a depreciation of the currency over the long run to generate a higher income in terms of domestic currency to compensate for the rise in the government expenditure.

13. We have used feasible generalized least squares (GLS) method with cross-section weights to estimate Equation (20) for different lag selections. Given our data limitations and using the diagnostic tests, the best lag length chosen is three; that is, \( p = 3 \) in this equation. However, in the first round of estimation when we included the nonlinear ECTs and their cross product with three lags, the matrix became singular. To obtain a nonsingular matrix, we had to start with a lag length of two for nonlinear ECTs.

Acknowledgments

The authors thank the anonymous referees for their helpful comments and suggestions.

References


