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Relationship between Oil Prices and Real Exchange Rates: the case of Angola

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Abstract

This paper examines the long-run synergies between oil prices and real exchange rates in Angola, between January 2002 and July 2017. Our study considers both the official and the parallel market exchange rate. To achieve this, standard integration/co-integration techniques were conducted, and an error correction model was estimated. Our results reject the purchasing power parity hypothesis and present evidence of long-run co-movements between oil prices and real exchange rates. Moreover, examination of the short-run dynamics displays evidence of unilateral Granger causality from oil prices to real exchange rates.

Keywords: Real Exchange Rates, Oil Prices, Co-integration, Error-Correction Model

1. Introduction

This article proposes to analyze the tie between real exchange rates and oil prices in Angola, a small open economy with a recent painful experience of how plunging oil prices can lead to an economic crisis.

For oil-exporting countries, changes in the terms-of-trade are fundamentally determined by fluctuations in oil prices (Amano & van Norden, 1998a, 1998b; Dauvin, 2014). In particular, an increase in the price of oil can lead to improvements in the terms-of-trade in an oil-exporting country in the long-run if the country’s exports rise by a more considerable amount than that of its imports. Increasing terms-of-trade display higher demand for the country’s exports, which results in growing revenues from exports. This, in turn, puts upward pressure on the country’s real exchange rates, and consequently, appreciation of the long-run equilibrium real exchange rate. This can weaken the home country's international competitiveness and result in a current account deficit. Conversely, a fall in the world price of oil can lead to deterioration in the terms of trade and consequently, depreciation of the long-run equilibrium real exchange rate. This should heighten international competitiveness as domestic goods become more competitive, leading to a rise in net exports.

Hence, fluctuations in the price of oil may cause macroeconomic imbalances, particularly in small developing countries that heavily rely on the export of such a commodity. An increase in oil prices can exert innovations in the long-run equilibrium real exchange rates, leading to persistent misalignments. Ngoma, Ismail, and Yusop (2016) state that "such an effect on the real exchange rates can undermine competitiveness, especially in the other sectors, create distortions in resource allocations, and trigger current account imbalances that could hinder growth possibilities". This phenomenon, commonly known as Dutch Disease, limits the country's ability to diversify its export bases.

Oil prices are a crucial driver of economic activities. According to OPEP, Angola is among the world's highest net oil-exporters. Hence, variations in the world price of oil may have a significant impact on Angola's business activity and lead to policy implications. Consequently, the following research paper aims at investigating the 'Dutch disease' hypothesis, by exploring the existence of a stable long-run relationship between real exchange rates and oil prices – both using the official and the parallel market exchange rate.

We study both the official and the parallel market exchange rate. As Gelbard and Nagayasu (2003) point out, "in mid-1999, the official exchange rate was allowed to float, leading to the virtual unification of the foreign exchange market". With oil prices plummeting in 2015, the National Bank of Angola tightened foreign currency controls and regulated the official exchange rate. Meanwhile, there has been no direct central bank intervention in the informal market, and therefore, according to Gelbard and Nagayasu (2003), "the parallel market rate has reflected supply and demand conditions in the foreign exchange market more accurately". As a result, starting in 2015, there has been a significant and volatile discrepancy between the parallel and the official real exchange rates (Figure 1).

The remainder of the paper is organized as follow: Section II presents empirical research on the subject. Section III provides relevant features of the Angolan economy since 2002. Section IV discusses the theoretical approach and describes the data. Section V interprets the estimated results. Finally, Section VI contains concluding remarks.

2. Literature Review

At the outset, mainly two distinct sources are used to justify real exchange rate fluctuations: one originating from financial forces and the other from macroeconomic forces. The financial market's view is a direct implication of Dornbusch (1976)'s "overshooting model", in which monetary shocks cause the exchange rate to depreciate when we are in the presence of sticky prices. On the other hand, Stockman (1980) argues that 'real' disturbances cause changes in relative prices of different goods in international trade, which in turn, explains exchange rate behavior. In this paper, we test the 'Dutch disease' hypothesis, by considering the ability of changes in oil prices to explain long-term fluctuations in real exchange rates. The sudden decrease in oil prices over the recent years has restored curiosity in the 'Dutch disease' hypothesis.

Paul Krugman was among the first macroeconomists to investigate the potential importance of oil prices for exchange rate movements. Krugman (1983a, 1983b) stated that the direction of the exchange rate effects of oil price shocks depends on real and financial asymmetries between countries and that oil shocks affect all nations. Recently, a number of studies have been conducted on oil-exporting developing countries with the intent of better understanding the long-run relationship between oil price shocks and fluctuations in real exchange rates. Existing literature on this topic can be split into two segments. The first one explores the long-run impact of oil prices on real exchange rates using panel data. Early literature on the subject includes Amano and van Norden (1998b). Using data from three different countries, Japan, Germany and the U.S., the authors tested for cointegration and Granger causality between terms of trade and real effective exchange rates. They were able to find evidence of a long-run relationship between the two variables, for Germany and Japan, and failed to find evidence of cointegration for the U.S. Amano and van Norden (1998b) were among the first, introduced the terms of trade as a direct transmission channel of oil prices to exchange rates. Similarly, a recent panel study by Dauvin (2014) examined the relationship between energy prices and the real effective exchange rates in ten energy-exporting countries from 1980 to 2011 and found that, when oil prices are highly volatile, terms-of-trade become an essential driver of the real exchange rate. Jahan-Parvar & Mohammadi (2008), using evidence from fourteen oil-producing countries, found evidence that supports the existence of a stable relationship between oil prices and real exchange rates, thus displaying ‘Dutch disease’. Similarly, Korhonen and Juurikkla (2009) examined the long-run determinants of equilibrium real exchange rates in nine members of the Organization of the Petroleum Exporting Countries (OPEC) from 1975 to 2005. The study showed that oil prices have significant effects on the long-run real exchange rates. Similarly, Ngoma, Ismail, and Yusop (2016) examined the long-run interactions between oil prices and real exchange rates in five oil-exporting African countries – Egypt, Ghana, Nigeria, South Africa and Tunisia. The study produced evidence of real exchange appreciations in Nigeria, South Africa and Tunisia, and real exchange rate fluctuations in Egypt and Ghana.

The second segment explores the relationship between oil prices and real exchange rates using single country data. Amano and van Norden (1998a) highlighted the tie between oil prices and U.S. macroeconomic aggregates. The authors found a stable link between oil price shocks and the US real effective exchange rate over the long horizon. A study by Huang and Guo (2007) assessed the degree at which oil price shocks influence the movements of China's real exchange rates over the period of 1990-2005. The results revealed that an increase in the real price of oil exerts immediate depreciation of the real exchange rates, which is accompanied by long-term appreciation. More recently, Ozturk, Feridun, and Kalyoncu (2008) analyzed, using Granger causality tests and Johansen cointegration, and found that oil prices "Granger cause the USD/YTL real exchange rate". Similarly, Rautava (2004), discussed the role of oil prices and the real exchange rate in Russia's economy and found a long-run relationship between oil prices and real exchange rates. The author also found that the long-run relationships have a significant impact on short-run dynamics through an error correction model (ECM). Finally, Gelbard and Nagayasu (1999, 2003) found that two exogenous variables, the price of oil and the foreign interest rate, were able to explain most of the variation in Angola's parallel market exchange rate during the 1992-2002 period.

All of the reviewed studies have confirmed the role of oil price variations in influencing the long-run evolution of real exchange rates. Moreover, despite being the "second largest oil producer in Africa", according to OPEC, very little work has carefully examined the impact on Angola's real exchange rate of changes in oil prices. Consequently, this study attempts to fill these gaps in the literature. The purpose of this is to understand the nature of the adjustment of real exchange rates to changes in oil prices. Such understanding can facilitate better policy decisions on what policy measures to adapt to manage exchange rate uncertainties resulting from oil price shocks and cushion their effects.

3. Angola Overview

According to the World Bank, "Angola has made substantial economic progress since the end of the civil war in 2002". The country abandoned its fixed exchange rate system and adopted an exchange rate based stabilization. However, much of Angola's experienced rapid growth was driven by the exploitation of its vast natural resources. According to the World Bank, in the years after the war, Angola doubled its daily oil production and turned its economy into one of the world's fastest growing. According to the Catholic University, from 2002 to 2015, "Angola's exports totaled almost $600 billion, nearly all of it oil". Today, oil accounts for over 95% of the country's exports and makes up most of the country's earnings. But with this came a problem: investments in Angola's oil industry grew steadily over the past decade, dwarfing other sectors of the economy, a phenomenon commonly known as Dutch Disease.

Angola has been suffering following the continued decline in international oil prices. According to a recent article by 'africanews', "revenues have gone down by at least a third over the past two years alone due to falling prices". A recent report by the World Bank points out that "the government has reacted by cutting expenditure and increasing non-oil revenue", while the threat of running out of foreign reserves provides direct pressure for devaluation. With the sharp decrease in oil prices, dollar inflows have decreased, prompting a severe reduction in foreign reserves. The central bank – National Bank of Angola – was forced to restrict dollar sales as foreign exchange supplies dried up. A decrease in oil prices, and hence in export prices, has caused downward pressure in the Kwanza[1]and the Angolan central bank has tried to curb these depreciations pressures by tightening monetary conditions. Furthermore, Franco, Delgado, Camacho and, Castro e Silva (2015) observed that the "critical role of the dollar as a medium of exchange and store of value in Angola creates a significant source of trade in dollars against Kwanzas that impact on the exchange rate".

Today, fifteen years after the end of the war, the country continues to face massive developmental challenges, which include reducing its dependency on oil and diversifying the economy.

[1] Official denomination of Angola's currency as of May 1999.

4. Data Collection and Theoretical Approach

4.1 The Model

The relationship between real exchange rates and oil prices can be displayed as the following:

(1) $\boldsymbol{q_t = \beta_0 + \beta_1 oil_t + \upsilon_t}$, using the official real exchange rate,

(2) $\boldsymbol{pq_t = \beta_0 + \beta_1 oil_t + u_t}$, using the parallel real exchange rate,

where q_t and pq_t represent the official and parallel real exchange rates respectively, oil_t is the international price of oil; and υ_t and u_t are error terms. Like previously mentioned, all variables were made more linear by taking the natural logarithm.

It's common practice to start by examining the time series properties of each variable. The empirical analysis involves unit root and cointegration tests. By testing for non-stationarity, the order of integration of the data can be determined, and if the variables are integrated of the same order, then it could be the case that they are co-integrated.

4.1.1 Augmented Dickey-Fuller (ADF) and Phillips Perron (PP) tests

As mentioned above, the first step is to test the time series for the presence of unit roots and establish the order of their integration. Dickey and Fuller (1979) proposed the following three alternative equations that can be used for testing for non-stationarity:

(3) $\Delta Y_t = \delta Y_{t-1} + \sum_{i=1}^{p} \beta_i \Delta Y_{t-i} + \upsilon_t$

(4) $\Delta Y_t = \alpha + \delta Y_{t-1} + \sum_{i=1}^{p} \beta_i \Delta Y_{t-i} + \upsilon_t$

(5) $\Delta \boldsymbol{Y_t} = \boldsymbol{\alpha} + \boldsymbol{\gamma T} + \boldsymbol{\delta Y_{t-1}} + \sum_{i=1}^{p} \boldsymbol{\beta}_i \Delta \boldsymbol{Y_{t-i}} + \boldsymbol{\upsilon_t}$

Equation **(3)** is a simple autoregressive (AR) process with no constant nor time trend; equation **(4)** contains a constant in the model; while equation **(5)** contains a constant and a non-stochastic time trend in the model. In all three cases, we test whether $\delta = 0$. In the ADF test, the rejection of null hypothesis implies stationarity. If the ADF statistical value is higher than Mackinnon (1994)' critical value, then we cannot reject the null hypothesis of a unit root and conclude that the considered variable is not a stationary process. We repeated this procedure after transforming the series into first differences. Alternatively, Phillips and Perron (1988) developed a generalization of the ADF test procedure that allows for fairly mild assumptions concerning the distribution of errors. The regression for the PP test is the following:

$$\textbf{(6)}\ \Delta \boldsymbol{Y_t = \alpha + \delta Y_{t-1} + e_t}$$

The distribution of the PP "t" statistic is the same as the ADF "t" statistic and thus the MacKinnon (1994) critical values are still appropriate.

4.1.2 Engle-Granger two-step approach

Next, we examine whether oil prices and real exchange rates are cointegrated. The concept of cointegration was introduced by Engle and Granger (1987). Two variables will be cointegrated if there exists a common trend that links them together. We should expect them to move together and it should be possible to find a combination of them that eliminates non-stationarity. Hence, to have a cointegrating relationship, we require a linear combination of Y_t and X_t that is a stationary variable. For single equation, the simple test for co-integration is the ADF tests on the residuals estimated from the co-integration regression. This approach is the Engle-Granger two-step approach and involves the following steps: firstly, using the ADF test, we check the variables for their order of integration. If both variables happen to be integrated of the same order, we proceed with step two, where we estimate the following long-run (possible cointegrating) relationship:

$$\textbf{(7)}\ \boldsymbol{Y_t = \widehat{\alpha} + \widehat{\beta} X_t + \widehat{\upsilon}_t}$$

and obtain the residuals of equation **(7)**:

$$\textbf{(8)}\ \boldsymbol{\widehat{\upsilon}_t = Y_t - \widehat{\alpha} - \widehat{\beta} X_t}$$

Thus, $\widehat{\upsilon}_t$ is the series of the estimated residuals of the long-run relationship. If these deviations from long-run equilibrium are found to be stationary, then the two variables are said to be cointegrated. If that's the case, then OLS regression yields consistent estimators for the co-integrating parameter $\hat{\beta}$.

4.1.3 Estimation of Error-Correction Model

If oil prices are real exchange rates are cointegrated, we can use the residuals from the equilibrium regression to estimate the error correction model (henceforth ECM). Estimating an ECM allows us to discriminate between short-run and long-run effects of both series, as well as to discern the adjustment coefficient, which is the coefficient of the lagged residual terms of the long-run relationship previously identified in step two.

As Asteriou and Hall (2007) point out, "ECM and ARDL are basically the same if the series Y_t and X_t are integrated of the same order, often I(1) and cointegrated". Consider the straightforward dynamic ARDL model describing the behavior of Y_t in terms of X_t:

(9) $Y_t = \mu Y_{t-1} + \delta_1 X_t + \delta_2 X_{t-1} + v_t$

where v_t ~ iid $(0,\sigma^2)$.

In this model, the specification δ_1 expresses the short-term reaction of Y_t after a shift in X_t. The long-run effect is given when the model is in equilibrium, as in the following equation:

(10) $\boldsymbol{Y^E = \alpha + \beta X^E}$

The ECM is shown below:

$$Y_t - Y_{t-1} = -(1-\mu)Y_{t-1} + \delta_1 X_t + \delta_2 X_{t-1} + v_t$$

$$\Delta Y_t = -(1-\mu)Y_{t-1} + \delta_1 X_t - \delta_1 X_{t-1} + \delta_1 X_{t-1} + \delta_2 X_{t-1} + v_t$$

$$\Delta Y_t = \delta_1 \Delta X_t - \lambda(Y_{t-1} - \alpha - \beta X_{t-1}) + v_t$$

(11) $\boldsymbol{\Delta Y_t = \delta_1 \Delta X_t - \lambda(ECT_{t-1}) + v_t}$

where $\lambda = 1 - \mu$ and $\beta = \frac{\delta_1 + \delta_2}{1-\mu}$. The part in parenthesis is the error-correction term. Equation (11) is known as the error correction model.

Using an ECM has several important advantages. Firstly, and according to Asteriou and Hall (2007), "when the two variables Y_t and X_t are co-integrated, the ECM incorporates not only short-run but also long-run effects. This is because the long-run equilibrium $[Y_{t-1} - \alpha - \beta X_{t-1}]$ is included in the model together with the short-run dynamics captured by the differenced term". A second significant advantage of using an ECM is that all the variables in the ECM model are stationary and therefore standard OLS estimation is valid. This is because if Y_t and X_t are I(1), then ΔY_t and ΔX_t are I(0), and by definition if Y_t and X_t co-integrated, then their linear combination $[Y_{t-1} - \alpha - \beta X_{t-1}]$ ~ I(0). Also, because the disequilibrium error-term is a stationary variable, this implies there is some automatic adjustment process which, according to Asteriou and Hall (2007), "prevents the errors in the long-term relationship becoming larger and larger".

Next, the coefficient $\lambda\ (= 1 - \mu)$, gives us information about the speed of adjustment in cases of disequilibrium. It tells us how much of the adjustment to equilibrium takes place in each period. Consider the long-run condition. When equilibrium holds, $[Y_{t-1} - \alpha - \beta X_{t-1}] = 0$. However, according to Asteriou and Hall (2007), "during periods of disequilibrium, this term is no longer zero and measures the distance the system is away from equilibrium".

Finally, the ECM has economic implications, as it measures the correction from disequilibrium of the previous period.

4.1.4 Causality Tests

One of the useful features in the VAR model is that it allows us to test the direction of causality. Causality in econometrics refers more to the ability of one variable to predict (and therefore cause) the other. Granger (1969) developed a test that defined causality as follows: "a variable Y_t is said to Granger-cause X_t, if X_t can be predicted with higher accuracy by using past values of the Y_t variable, rather than not using such past values, all other terms remaining unchanged".

The Granger causality test of the two stationary variables, say, ΔY_t and ΔX_t, involves as a first step, the estimation of the following VAR model:

(12) $\Delta Y_t = A_1 + \sum_{j=1}^{p} C_j \, \Delta Y_{t-j} + \sum_{j=1}^{p} D_j \, \Delta X_{t-j} + v_{1t}$

(13) $\Delta X_t = A_2 + \sum_{j=1}^{p} E_j \, \Delta Y_{t-j} + \sum_{j=1}^{p} F_j \, \Delta X_{t-j} + v_{2t}$

where we assume that both v_{1t} and v_{2t} are uncorrelated white-noise error terms, and Y_t and X_t are integrated of order 1.

The Granger causality test, then, involves the following procedures: firstly, we estimate the VAR given by equations (12) and (13). Then, according to Asteriou and Hall (2007) "we check the significance of the coefficients and apply variable deletion tests first in the lagged X terms for the equation (12), and then in the lagged Y terms in equation (13). According to the result of the variable deletion tests, we may conclude about the direction of causality".

4.2 Variable Definitions and Data Source

The data we use are monthly observations ranging from January 2002 to July 2017. The official real exchange rate ($\boldsymbol{q}$) is calculated as the bilateral official market exchange rate of the kwanza (vis-à-vis the U.S. dollar) times the U.S. consumer price index and divided by Angola's consumer price index. Similarly, the parallel market real exchange rate ($\boldsymbol{pq}$) is calculated as the bilateral informal market exchange rate (vis-à-vis the U.S. dollar) times the U.S. consumer price index and divided by the domestic consumer price index. Thus, an increase (decrease) in both ($\boldsymbol{q}$) and ($\boldsymbol{pq}$) represents a real depreciation (appreciation) of the kwanza. The world price of oil ($\boldsymbol{oil}$) is a composite of the Texas intermediate, Brent, and Dubai which, according to the World Bank, "is roughly equivalent to the Angolan mix". Oil is treated as an exogenous variable because international oil prices are believed to be determined outside the system. The data for the U.S. CPI was obtained from the Economic Research Database: The Federal Reserve Bank of St. Louis, while data for Angola's CPI and the parallel exchange rate was obtained from Banco Atlántico's monthly reports. Finally, data for the oil price and the official bilateral exchange rate was collected from the World Bank. All the data were transformed into logarithms before the estimations were carried out.

5. Estimated Results

The results of the non-stationarity tests on the series of real exchange rates and oil prices were based on the ADF (Table 1) and PP (Table 2) tests. Statistics to examine the null hypothesis that the variables are integrated of order one, I(1), against the alternative of stationarity, are provided beside the respective variables in levels; and statistics examining the null of I(2) against I(1) are displayed next to the differenced variables. Our study considers two cases involving different combinations of the deterministic – the time trend and/or the constant. According to the results, displayed in Table 1, the variables became stationary at the conventional significance level after taking the first difference, and thus we conclude that all the time-series are I(1). This holds for both the official and the parallel real exchange rate. Since the long-run or equilibrium concept of the PPP requires that the real exchange rate be stationary, our finding that the real exchange rate has a unit root over the 2002:1-2017:7 period implies that PPP is not a useful benchmark to assess the level of the real exchange rate in Angola. The PP test validates the results of the ADF test. Looking at the results, summarized in Table 2, we accept the null hypothesis of no stationarity when the variables are in levels. Similarly, we then proceed testing the variables in first differences and, according to the results, the variables became stationary, meaning, once again, all series are I(1). The results from the ADF and PP test were consistent. This implies that all series are integrated of order one or I(1).

Given that the variables have a unit root and are integrated of the same order, I(1), we employ the residual-based test of Engle and Granger (1987) to uncover whether the variables share a long-run relationship. Using the Engle-Granger test allows us to gauge the adequacy of specifying the real exchange rate only as a function of the price of oil. We regress $q_t = \beta_0 +$

$\beta_1 oil_t + v_t$, and predict the residuals v_t. We do the same for $pq_t = \beta_0 + \beta_1 oil_t + u_t$, and predict u_t. The results presented in Table 3 yield evidence of co-integration between the price of oil and the parallel exchange rate, at 5% significance level. We reject the null hypothesis of non-stationarity for pq and On the other hand, evidence of cointegration is found between oil prices and the official real exchange rate at 5% significance level when using a time trend component.

Having found evidence consistent with a long-run relationship, we turn to estimate the long-run response of real exchange rates to changes in oil prices. In this section, we determine how well the dynamic process generating the Angolan real exchange rate - both the official and the informal market rates - can be captured by a single-equation error-correction model (ECM). According to Engle and Granger (1987), the presence of co-integration in a system of variables implies that a valid error-correction representation exists. According to Table 4 and Table 5:

$$\Delta q_t = \delta_1 \Delta oil_t - \lambda(q_{t-1} - \alpha - \beta oil_{t-1}) + v_t,$$

$$\Delta pq_t = \delta_1 \Delta oil_t - \lambda(pq_{t-1} - \alpha - \beta oil_{t-1}) + u_t$$

According to our estimations (reported in table 1), we have the following:

$$\Delta q_t = 0.0229548 \Delta oil_t - 0.0267706(q_{t-1} - 6.270673 - 0.4136668 oil_{t-1}) + v_t$$

$$\Delta pq_t = 0.006546 \Delta oil_t - 0.0568454(pq_{t-1} - 7.899312 - 0.7130655 oil_{t-1}) + u_t$$

Relating to the official rate, the speed of the adjustment term (λ) is -0.0267706, indicating that about 2.7% of adjustment toward the long-run equilibrium is completed within one month. This is consistent with a low speed of adjustment towards equilibrium. A one percent increase in the price of oil will lead to a 0.414 percent appreciation of the official real exchange rate of Angola. We note that this result is consistent with a variety of economic models. Looking at the ECM estimated using the parallel market rate, the speed of the adjustment term (λ) is -0.0568454, indicating that about 5.7% of adjustment toward the long-run equilibrium is completed within one year. This is also consistent with a low speed of adjustment towards equilibrium. A one percent increase in the price of oil will lead to a 0.713 percent appreciation of the parallel real exchange rate of Angola. The adjustment parameters, in general, are small, but significant implying a slow correction to equilibrium in both cases. When the price of oil is high, the official and informal market rates slowly adjust downwards to match the oil prices. As noted by Jahan-Parvar & Mohammadi (2008), "one implication of these findings is that the probability of Dutch Disease problem has not diminished over time and monetary authorities in developing oil-exporting countries should be vigilant to counter the negative impact of oil windfalls". We also conclude that looking at the coefficients of adjustment, the parallel market rate adjusts more rapidly to shocks in oil prices than the official rate. In fact, as we mentioned earlier, nowadays, the official exchange rate of Angola is fixed by the National Bank of Angola, while the "parallel market rate reflects supply and demand conditions in the foreign exchange market more accurately."

From Engle and Granger (1987) we know that co-integration in a two-variable system implies that at least one of the variables must Granger-cause the other. The results are displayed in Table 6 and Table 7. Our results suggest that the price of oil is weakly exogenous, while the real exchange rate is not. Meaning, in the long-run, exchange rates Granger-cause oil prices; they adjust to the price of oil and not vice versa. This is true for both the official and the parallel market exchange rates. We see that although both exchange rates Granger-cause oil prices, the parallel market exchange rate does so at a higher coefficient. For the official market rate (Table 6), the probability value is 4,02%, which is less than 5%, so we reject the null hypothesis, meaning that lagged oil does cause q. For the parallel market rate (Table 7), the probability value is 1,06%, which is less than 5%, so we reject the null hypothesis, meaning that lagged oil does cause pq.

Jahan-Parvar & Mohammadi (2008), state that “causality might also shed light on the economic mechanism creating the long-run link between oil prices and real exchange rates. However, even if oil prices are not affected by exchange rate movements, we might still expect to find that exchange rates Granger-cause oil prices. For example, if forward-looking agents treat exchange rates as financial assets, then according to the Efficient Market Hypothesis, exchange rates should reflect all publicly available information, including future expected changes in oil prices. However, if oil prices have predictive power for subsequent exchange rate movements, this raises the question of whether exchange rates properly incorporate public information. Our first step in testing for causality is to test for “long-run causality” using standard tests on the vector auto-regression level representation of our system. Standard inference procedures are valid in this case under the maintained hypothesis of one cointegrating vector, provided that we test the exclusion restrictions of one variable at a time.

The results of this section show that consideration of the effects of oil price changes can lead to a simple, stable model of exchange rate changes.

6. Conclusion

Existing empirical studies have established evidence about the long-run co-movement of oil prices and real exchange rates in developing countries. While Angola is Africa' second highest net oil exporter, little attention has been paid regarding relationships between real exchange rates and oil prices. In this article, using monthly data from Angola, we explored whether a link exists between the price of oil and real exchange rates - using both the official and the parallel market rates.

The study found evidence of adjustment of real exchange rates (for the official and parallel market rate) to the long-run equilibrium values. The results presented above show that the both the official and the parallel market rates appear to be co-integrated with the price of oil, although the relationship seems to be weak when it comes to the official rate. The adjustment of the real exchange rates in Angola is more rapid using the parallel market rate than it is using the official rate. In fact, the speed of adjustment twice as high when using the informal market rate. Although the coefficients are significant for both ECMs, the estimated parameters are low, suggesting that disequilibrium in real exchange rates brought about by changes in oil prices is adjusted slowly in the latter period. Furthermore, examination of short-run dynamics between oil prices and real exchange rates determined that causality runs from oil prices to exchange rates and not vice versa. Finally, we estimated an error-correction model, that allowed us to develop/establish a single equation representation of the relationship between oil prices and real exchange rates. Hence, the results indicate strong support for the Dutch disease hypothesis.

These findings have significant policy implications. First of all, they suggest that Angola and other oil-exporting countries may be vulnerable to fluctuations in world oil prices. Therefore, appropriate policies to manage the effects of oil price shocks on real exchange rates are essential, especially during oil booms and slumps. This is to retain the competitiveness in other sectors of the economy and maintain sustainable current account balances, thereby "curing"

Dutch disease. Next, because positive and negative deviations of the real exchange rate from the equilibrium values represent depreciation and appreciation, respectively, which are prompted by changes in oil prices. Policy measures to prop up the country's currency against declining oil prices are likely to produce the desired outcome.

Our results make several useful contributions. They show that oil prices can account for innovations in real exchange rates and thereby add to the very limited literature that documents the influence oil price shocks on the Angolan economy.

While useful, the results of this analysis must be viewed with caution because of several limitations in this study. One limitation concerns data gathering. Gathering data from countries such as Angola is challenging, and only recently the country has started to open its traditionally closed financial accounts and economic indicators. Related to the previous limitation, is a second limitation, the time span of the analysis. Our data sample only encompasses a total, reduced number of 187 observations, from January 2002 to July 2017, roughly fifteen and half years. Meaning the results might be different to those when analyzing the same variables but for a longer time span.

As mentioned, existing studies have confirmed the presence of a long-run relationship between oil prices and real exchange rates and include, among others, Amano and van Norden (1998a,1998b), Krugman (1983a, 1983b), Korhonen and Juurikkala (2009), and Huang and Guo (2007). But these studies have rarely examined the ability of an error-correction model to forecast out-of-sample exchange rate movements. While the results for the ECM are suggestive, it would be useful to determine whether the model forecast significantly better than a random walk.

Appendix

1. Unit Root Tests

- **Table 1 - Augmented Dickey-Fuller (ADF) Test – Sample: 2002:01 – 2017:07 1/**

Variable	Constant	Constant with Trend
q	-3.368 (1)	-0.723 (1)
pq	-1.349 (1)	-0.519 (1)
oil	-2.248 (2)	-1.870 (2)
Δq	-8.446 (1)	-9.400 (1)
Δpq	-14.863 (0)	-15.449 (0)
Δoil	-8.017 (1)	-8.120 (1)
90 percent CV	-2.574	-3.139
95 percent CV	-2.884	-3.439
99 percent CV	-3.482	-4.012

- **Table 2 - Phillips-Perron (PP) Test – Sample: 2002:01 – 2017:07**

Variable	Constant	Constant with Trend
q	-3.525 (1)	-0.536 (1)
pq	-1.531 (1)	-0.706 (1)
oil	-2.433 (2)	-1.831 (2)
Δq	-11.147 (1)	-11.988 (1)
Δpq	-14.863 (0)	-15.449 (0)
Δoil	-10.297 (1)	-10.439 (1)
90 percent CV	-2.574	-3.139
95 percent CV	-2.884	-3.439
99 percent CV	-3.482	-4.012

1/ The critical values are obtained from MacKinnon (1994). Lag length used in the test is determined by Schwarz Bayesian Information Criterion (SBIC) and is indicated in parentheses.

- **Table 3 – ADF Test on Residuals – Sample: 2002:01 – 2017:07 2/**

Variable	Constant	Constant with Trend
v_t	-2.074 (2)	-3.770 (2)
u_t	-3.189 (1)	-3.326 (1)
90 percent CV	-2.574	-3.139
95 percent CV	-2.884	-3.439
99 percent CV	-3.482	-4.012

2/ The critical values are obtained from MacKinnon (1994). Lag length used in the test is determined by Schwarz Bayesian Information Criterion (SBIC) and is indicated in parentheses.

2. Error Correction Model Results

- **Table 4 - Using the Official Real Exchange Rate - Sample: 2002:01 – 2017:07**

	Parameter Estimate	Standard Deviation	t-statistic
λ	0.0267706	0.0060095	4.45
α	6.270673	0.4958009	12.65
β	0.4136668	0.1126604	-3.67
δ_1	0.0229548	0.0153488	1.50

- **Table 5 - Using the Parallel Real Exchange Rate - Sample: 2002:01 – 2017:07**

	Parameter Estimate	Standard Deviation	t-statistic
λ	0.0568454	0.0193089	-2.94
α	7.899312	0.6219773	12.70
β	0.7130655	0.1462192	-4.88
δ_1	0.006546	0.0440417	0.15

3. Granger – Causality Tests

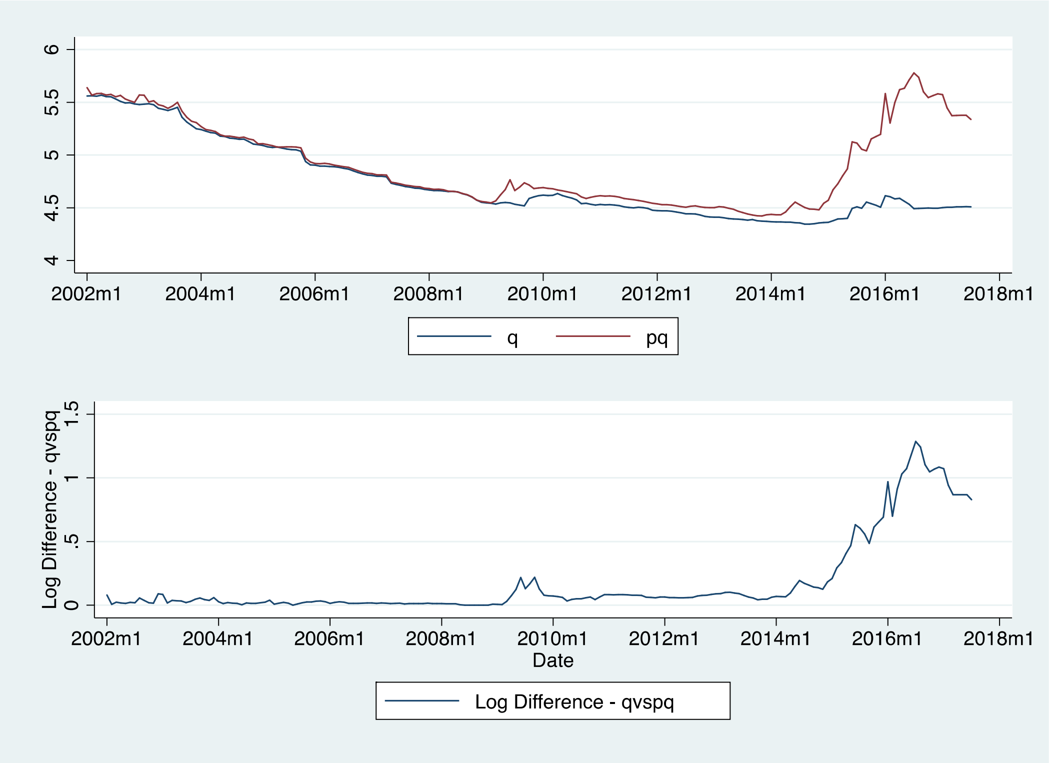
- **Table 6 - Using the Official Real Exchange Rate - Sample: 2002:01 – 2017:07**

Dependent Variable	Number of Lags	Independent Variable	Prob>F
Official Exchange Rate	2	Price of Oil	0.0402
Price of Oil	2	Official Exchange Rate	0.5056

- **Table 7 - Using the Official Real Exchange Rate - Sample: 2002:01 – 2017:07**

Dependent Variable	Number of Lags	Independent Variable	Prob>F
Informal Exchange Rate	2	Price of Oil	0.0106
Price of Oil	2	Informal Exchange Rate	0.0921

- Figure 1 – Official Real Exchange Rate and Parallel Market Real Exchange Rate in Angola: 2002:1 – 2017:07



Source: Author's estimation

Note: The official (parallel) real exchange rate is defined as the official (parallel) nominal rate adjusted for changes in the ratio of the foreign to the home's consumer price index (CPI). The two variables are expressed in logs.

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