Determinants of Real Exchange Rate in Papua New Guinea

Boniface Aipi*

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* Boniface Aipi is the Manager for Research Projects of the Research Department at the Bank of Papua New Guinea.

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Abstract

Small developing open economies typically are faced with large swings in price of goods they import and export. Given the openness of the economies, they are further confronted with volatile prices of financial assets. Volatilities in the financial and goods market are unwelcome in developing countries as it has adverse effects on output growth (GDP). It is imperative therefore to critically examine the impact volatility on traded commodities (price of exports relative to price of imports, referred to as terms of trade) and the price of financial assets (interest rate differentials) have on macroeconomic variables.

This paper attempts to identify the determinants of Real Exchange Rate (RER) in Papua New Guinea using Commodity Terms of Trade (TOT) as indicator for the goods market and Real Interest Rate Differentials as indicator for the financial market.

The paper concludes that real exchange rate developments in the country depend more on terms of trade movements than on real interest rate differentials. The impact trade shocks have on the real exchange rate is stronger than real interest rate differentials. These findings confirm structural underpinnings of the country, whereby, Papua New Guinea is a commodity exporter, more dependent on imported manufactured items, with a shallow financial market.

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I. Introduction

Small developing open economies typically are faced with large swings in price of goods they import and export. Given the openness of the economies, they are further confronted with volatile prices of financial assets. Volatilities in the financial and goods market are unwelcome in developing countries as it has adverse effects on output growth (GDP). It is imperative therefore to critically examine the impact volatility on traded commodities (price of exports relative to price of imports, referred to as terms of trade) and the price of financial assets (interest rate differentials) have on macroeconomic variables. Both theory and empirical underpinnings divulge the impact of terms of trade and interest rate differentials on real exchange rate.

Empirical work done at the Bank of Papua New Guinea authenticates exchange rate as the fundamental component in the monetary policy transmission mechanism in Papua New Guinea. David and Nants, 2006, in their analysis, found that, interest rate, credit, asset price and expectations channel of monetary policy transmission mechanism does not work for Papua New Guinea. They however, established that, exchange rate channel was uniquely significant as the monetary policy transmission channel. They found 3 to 4 quarter lag in the flow-on effect exchange rate have on inflation and the influence was significant. In another paper by Sampson, Nindim, Yabom and Marabini, 2006, they found that the pass through to underlying inflation from exchange rate movements is 50-60 percent. They concluded that, pass through since the float of the exchange rate in 1994 has doubled.

Given these significant findings, establishing the determinants of exchange rate is crucial. In published paper by Kauzi and Sampson, 2009, they established, Kina as a commodity currency, that is, international commodity prices of Papua New Guinea’s major export commodities play a fundamental role in determining the nominal exchange rate in Papua New Guinea. This paper deviates from the paper by Kauzi and Sampson, 2009. Rather than looking at the nominal exchange rate, this paper follows conceptual methods to establish the determinants of real exchange rate in Papua New Guinea, by empirically analyzing the impact of terms of trade which represents the goods market and interest rate differentials which represents the financial markets.

The diversion from Kauzi and Sampson’s, 2009, paper was to look at the determinants holistically, incorporating both imports and exports in the commodities market. Since Papua New Guinea is a small open economy, exchange rate developments would be determined by import and export prices of internationally traded commodities and financial assets. It is therefore imperative that both goods and financial market prices be analyzed to ascertain the determinants of real exchange rate in Papua New Guinea, using the same methodology as Bagchi, Chortareas and Miller, 2003.

Using error correction (ECM) model, this paper confines its investigation of the determinants of real exchange rate to two fundamental factors, terms of trade and interest rate differentials. Several papers also consider other factors such as domestic and foreign productivity proxies (Edwards 1989, Messe 1990, Huizinga 1987, Coughlin and Koedijk 1990, Faruqee 1995, Stein 1994, Strauss 1996, Williamson 1994, and Zhou 1995), capital accumulation (Edwards 1989, Stein 1994, and Williamson 1994), cumulated current account balances (Edison and Pauls 1993, and Coughlin and Koedijk 1990), the level and composition of government spending (Edwards 1989, Melzer 1993, and Zhou 1995), savings (Stein 1994) and the terms of trade (Faruqee 1995, Greun and Wilkinson 1994, Edwards 1989, and Amano and van Norden 1995).

The paper is structured as follows, the second section covers the literature review, the third briefly looks at terms of trade, interest rate differentials and real exchange rate movements in Papua New Guinea, the fourth section outlines the data, research methodology and its findings and the final section concludes the findings of the paper and outlines future research topics.

II. Literature Review

While much work has been done to establish the determinants of real exchange rate; the results have been idiosyncratic and not general as fundamental factors differ in explaining real exchange rate across countries (e.g., Baxter 1994, Chinn 1991, Coughlin and Koedijk 1990, MacDonald 1998, and Mussa 1990). Studies done by various researchers's using different fundamental factors to explain real exchange rate differ across countries, while at the same time it has been found that empirical results differ considerably from theoretical underpinning. For instance, in theory terms of trade plays a fundamental role in determining real exchange rate, however, many studies especially those that were done for developed countries have omitted this variable because it was insignificant in determining real exchange rate.

Both expected real interest rate differential and terms of trade alone failed to explain movements in real exchange rate, which prompted researchers to expand the set of explanatory variables. Empirical literature considers capital accumulation (Edward 1989, Stein 1994, Strauss 1996, Williamson 1994), domestic and foreign productivity proxies (Edward 1989, Messe 1990, Huizinga 1987, Coughlin and Koedijk 1990, Faruqee 1995, Stein 1994, Strauss 1996, Williamson 1994, and Zhou 1995), cumulated current account balances (Edison and Pauls 1993, and Coughlin and Koedijk 1990), the level and composition of government spending (Edwards 1989, Meltzer 1993 and Zhou 1995), and saving (Stein 1994).

On the contrary studies have ascertained that, changes in terms of trade – the prices of exports relative to the price of imports - can account for half of the output volatility in developing countries[i]. Empirical analysis shows that, Canadian – US real exchange rate depends on the movements of terms of trade and the influence of monetary factors, as reflected in expected real interest rates. Using cointegration methods Gruen and Wilkinson (1994) found the Australia's trade-weighted real exchange rate move together with both the terms of trade and the real interest rate differentials during the period of floating exchange rate regime. They further established that, real interest rate differentials are quantitatively more important than the terms of trade in explaining the real exchange rate movements.

Various studies done for developing countries have ascertained terms of trade as one of the factors among a set of structural determinants of the (equilibrium) real exchange rate in the medium-term for Tarzania and the Philippines (Krumm, 1993). Odedokun (1997) uses the terms of trade alone in the determination of real exchange rate equation for developing Africa. Edwards (1989) using a pooled data for 12 developing countries concluded that the external terms of trade as the real fundamental factor in influencing the equilibrium real exchange rate.

Chowdhury 1999, used terms of trade, government expenditure as percentage of GDP, net capital inflow, trade openness, flow of foreign aid and grant, excess supply of domestic money supply, nominal devaluation and a dummy variable for years with open trade regime to study the real exchange rate for Papua New Guinea. He used data between the years 1970 and 1994, during which the kina exchange rate regime was fixed against a basket of currency. He found that, nominal devaluation plays a major role in determining real exchange rate behavior, while an improvement in external terms of trade seems to have no long run effect on the trade-weighted real exchange rate. Net capital inflow, foreign aid,

[i] The studies include Mendoza (1995), Kose (2002), and Broda (2003).

trade restrictions and expansionary macroeconomic policies tend to cause the real exchange rate of Papua New Guinea to appreciate.

Structural changes ensued after Chowdury's work. In 1995, the exchange rate regime changed from fixed to a flexible exchange rate regime. Subsequently, the trade account was fully liberalized, followed by full liberalization of the capital and financial accounts. Foreign aid inflows shifted from direct budgetary grants to project grants, with most of the funds spend offshore. The structural composition of economy changed from an agricultural dominant economy to that of mineral, oil and gas driven economy. These structural changes have much bearing on the determination of real exchange rate in Papua New Guinea.

Contrary to the study by Chowdury, the exchange rate regime change and subsequent liberalization of the trade and financial and capital account would have a major bearing on the real exchange rate. Determination of real exchange rate as a result of trade account openness is assumed to be captured by the terms of trade of Papua New Guinea. Volatilities in the terms of trade in Papua New Guinea is expected to effect the real exchange rate. Similarly, liberalization of the capital and financial accounts is expected to effect the movement of the real exchange rate. These movements can be captured by expected interest rate differentials between Papua New Guinea and its major trading partners.

III. Papua New Guinea Data

a. Real Exchange Rate

Real exchange rate (RER) is a summary measure of the prices of one country's goods and services relative to those of another country or group of countries, thus an important consideration when analyzing macroeconomic conditions in an open economy.

RER depends upon the nominal exchange rate and relative price levels of both the home and foreign countries. Consumer price index (CPI) is most commonly used for the calculation of relative price level.

The RER between two countries is calculated as the product of the nominal exchange rate and relative price levels of the home and foreign country. The RER between foreign country 'i' and the home country at time 't' is thus

$$Rer_{i,t} = e_{i,t} \times \frac{p_{,t}}{P^*_{i,t}} \qquad (1)$$

Where:

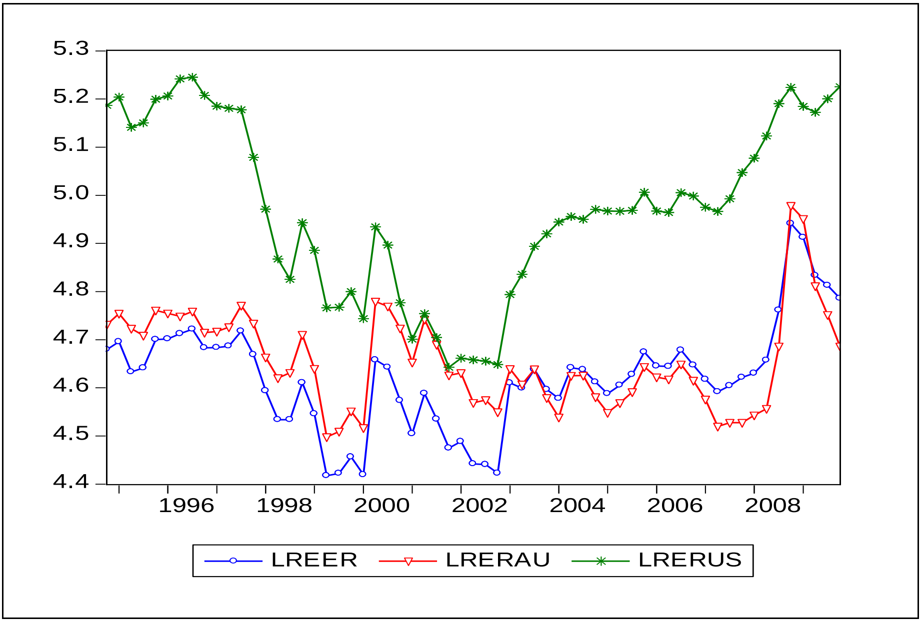
$Rer_{i,t}$ is the Real Exchange Rate between foreign country 'i', and home country at time 't'

$p^*_{i,t}$ is the price level, CPI of the foreign country i

p_t is the price level, CPI in home country, and

e_i is the nominal exchange rate between the currencies of foreign country i and the home country, expressed as the number of home currency units per foreign currency unit so that e_i rises with a depreciation of the home-country currency.

Figure 1: Real Effective Exchange Rate, Real Exchange Rate (USD) and Real Exchange Rate (AUD)



Source: Authors calculation

Australia being the closest neighbor to Papua New Guinea dominates almost 50 percent of Papua New Guinea's share of trade. Consequently, the kina real exchange rate against the Australian dollar trends well with the real effective exchange rate for Papua New Guinea. This can be seen in figure 1.

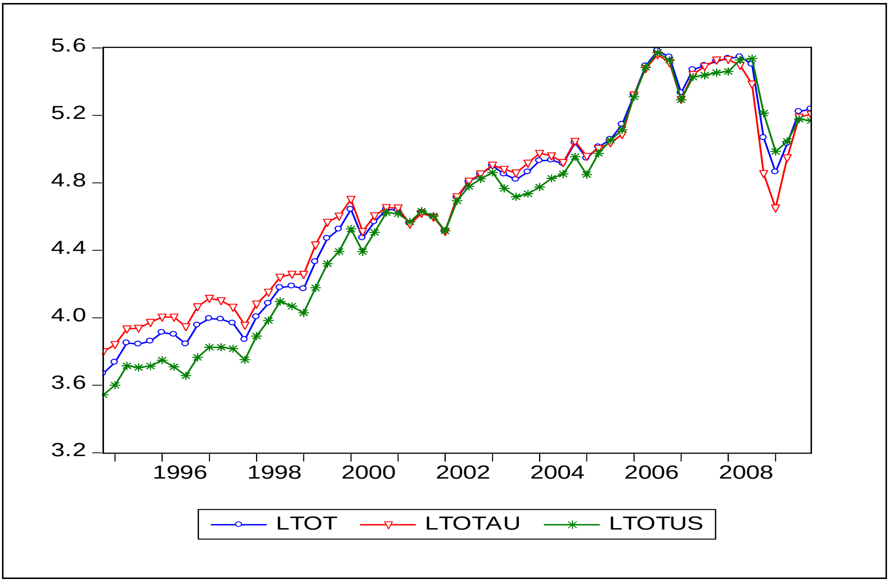
The US dollar being the major currency of trade for PNG tends to waddle on its own, diverging from the REER. Although US dollar dominants as the currency of transaction, PNG's trade share with the United States is trivial in affecting REER.

Research proves that the exchange rate of a country aligns itself to an equilibrium path when it is allowed to freely float, that is, price of domestic currency is set by supply and demand in the foreign exchange market. On the other hand a pegged or fixed exchange rate regime would experience significant misalignments in real exchange rate as a result of authorities fixing the domestic currency rate against foreign currency distorting market mechanisms to set the price in the foreign exchange market.

b. Terms of Trade

Commodity Terms of Trade (TOT) are the ratio of relative price of exports to the price of imports of a particular country. An improvement in the TOT would imply that, either export prices of the home country have increased or import prices of trading partners have declined or combination of both. On the other hand, a deterioration of the TOT would imply that, either export prices have declined or import prices have increased or the combination of both.

Figure 3: Papua New Guineas Terms of Trade, Terms of trade with US and Australia



Source: Authors calculation

Papua New Guinea's TOT against the rest of the world and against Australia and the United States has been always positive due to higher composition of mineral exports. Mineral exports comprise of more than 70 percent of Papua New Guineas total export; as a result movements in the TOT tend to lean towards price developments in oil and mineral products of Papua New Guinea.

Figure 2 shows that, both the TOT against Australia and united States trend along well with the total TOT, reflecting the high proportion of trade between Papua New Guinea and Australia.

c. Real Interest Rate Differentials

Real interest rate is approximately, nominal interest rate minus the inflation rate. The exact calculation is given by the Fisher equation as,

$$r_{rt} = (1 + r_{nt}) / (1 + \pi_t) - 1.$$

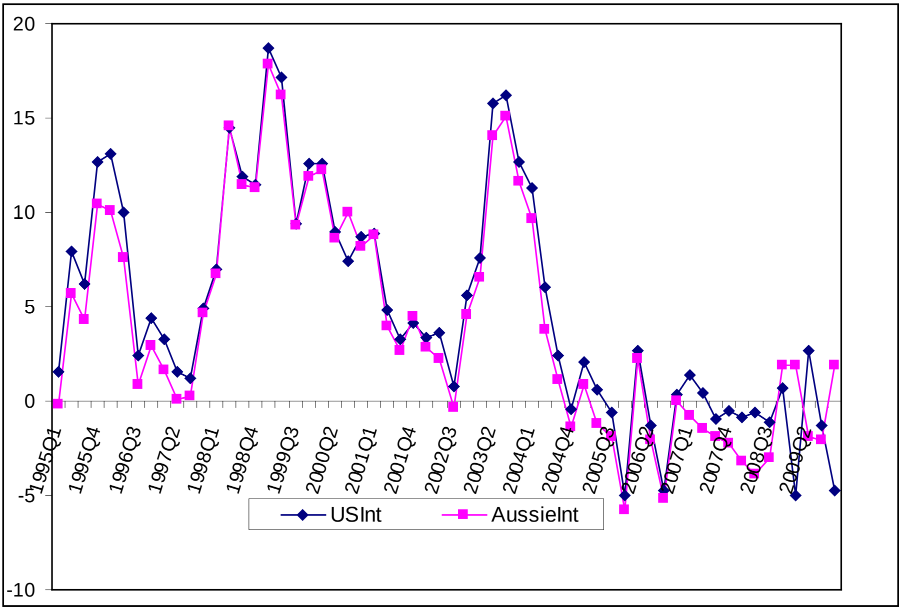
Where r_{rt} is the real interest rate at time'‘t’, r_{nt} is the nominal interest rate at time ‘t’ and π_t is the inflation rate at time ‘t’.

A positive real interest rate would imply that nominal interest rate is higher than the inflation rate. According to Purchasing Power Parity (PPP) theory, the investor is better off investing in financial markets. Negative interest real interest rates on the other hand indicate that, the inflation rate is higher than the interest rate. In PPP theory, the investor has a negative return on the investment.

What are more relevant to this paper are the interest rate differentials, which according to conventional theory determines the flow of capital between financial markets. Capital has become more mobile recently, as financial markets liberalized to lure and mobilize capital for development projects. The price of capital has become one of the major determinants of direction of flows. Another way to look at the price of capital is the interest rate that can be gained from shifting of capital from one financial market to another. Comparative interest rates across financial products, maturities and markets can be gauged by the interest rate differentials. When a positive interest rate can be gained from shifting of capital from one financial market to another, then the capital can shift quiet swiftly, assuming liberalized financial markets.

Interest rate differentials play a vital role in the transfer of capital from one financial market or product to another. Apparently one of the main drivers of cross border capital flows has been interest rate differentials. Movement of cross border capital has an immediate effect on the exchange rate and other macroeconomic variables for liberalized financial markets.

Papua New Guinea, being an open economy with a liberalized foreign exchange market has seen its share of capital flows. In 2006 the Central bank liberalized the capital account to allow free flow of capital. With a liberalized financial market, PNG has to compete with rest of the world by providing conducive environment for capital inflow. One of the major factors that determined the inflow of capital into PNG would be the rate of return, interest on the investment.



Source: Authors calculations

IV. The Model

The model uses a non-structural time-series approach replicating the same methodology applied by Bagchi, Chortareas and Miller, 2003, by defining the determinants of the long-run real exchange rate initially, which is established by the cointegration relationships of the variables.

There are also structural models that can be used to specify the relationship between real exchange rate and its determinants, mostly; purchasing power parity (PPP) and uncovered interest parity (UIP) are used to establish the determinants of exchange rate. In this case, however the non-structural time series approach seems sensible because both PPP and UIP don't seem to be significant in identifying real exchange rate because they seem more theoretical than empirical. That is, when empirically tested, both PPP and UIP don't seem to hold in many studies.

b. Data and Methodology

i. Augmented Dicker-Fuller (ADF) Test

To establish the cointegrating relationship of the different variables under investigation, the stationarity of the variables were tested using the ADF test on the variables, real effective exchange rate, real exchange rate, real interest rate differentials, and terms of trade. The Akaike information criterion (AIC) and Schwartz information criterion (SIC) were used to select the optimal lag length (k). Usually these two criterions identify the same lag length. Both AIC and SIC's show the same lag lengths, however, those that do not have the same lag length, SIC has been used for the lag length selection

The following equation specification carries out the ADF test for real effective exchange rate, real exchange rate, real interest rate differentials and the terms of trade.

$$\Delta x_t = \delta_0 + \delta_1 x_{t-1} + \sum_{j=1}^{k} \psi_j \Delta x_{t-j} + \epsilon_{it}, \qquad (1)$$

where:

x_t represents REER, RER, real interest rate differentials and terms of trade. q_t, tt_t and id_t in turn,

Results of equation 1 are given in table 1.

Table 1: ADF tests for Unit Roots in the Real Effective Exchange Rate, Terms of Trade and Interest Rate Differentials

		Levels	**1st Difference**	**Sample**
Real Effective Exchange Rate	δ_1	-0.151	-0.976	95:1 – 09:4
	$t(\delta_1)$	-2.061	-7.359***	
	SIC/AIC	1/1	1/1	
Terms of Trade	δ_1	-0.037	-0.832	
	$t(\delta_1)$	-1.486	-6.376***	

	SIC/AIC	1/1	1/1	
Real Interest Rate Differential (AU)	***δ_1***	-0.184	-1.079	
	$t(\delta_1)$	-2.425**	-8.205***	
	SIC/AIC	1/1	1/1	
Real Exchange Rate (AUD)	***Δ_1***	-0.337	-0.903	
	$t(\delta_1)$	-3.646***	-6.806***	
	SIC/AIC	1/1	1/1	
Terms of Trade (Australia)	***Δ_1***	-0.046	-1.004	
	$t(\delta_1)$	-1.493	-6.127***	
	SIC/AIC	1/1	1/1	
Real Exchange Rate (USD)	***Δ_1***	-0.046	-0.854	
	$t(\delta_1)$	-1.115	-6.512***	
	SIC/AIC	1/1	1/1	
Terms of Trade (US)	***δ_1***	-0.031	-0.844	
	$t(\delta_1)$	-1.484	-6.448***	
	SIC/AIC	1/1	1/1	
Real Interest Rate Differential (US)	***δ_1***	-0.187	-1.134	
	$t(\delta_1)$	-2.489***	-8.733***	
	SIC	*1/1*	*1/1*	

*** *means significantly different from zero at the 1-percent level.*
** *means significantly different from zero at the 5-percent level.*
* *means significantly different from zero at the 10-percent level.*

Source: Authors calculation

Results in table 1 shows that, real interest rate differentials between PNG and both Australia and United States and the real exchange rate (AU) are stationary at levels, i.e. I(0), while real effective exchange rate, real exchange rate (USD), terms of trade (Total), terms of trade (AU) and terms of trade (US) are stationary at their first differences, i.e. I(1).

ii. Cointegration Tests

After establishing the stationarity of the variables, we then proceed to test if there are any long term relationships between the variables by using Johansen's (1988) maximum likelihood technique to conduct cointegration analysis. We found that, there is no long-run relationship between RER(US), TOT(US) and Id (US), consequently, we then tested to see if RER(US) is determined by TOT(AU) and Id(AU), apparently there is cointegrating relationship between RER(US), TOT(AU) and ID(AU).

Johansen cointegration test results are presented in table 2.

Table 2: Model with intercept in the Cointegrating Vector and Trend in the Data

95%			λ-max Test		
H_0	H_A	n-r	REER	RER (AU)	RER (US)
r=0	r=1	3	38.68**	21.25**	39.14***
r=1	r=2	2	9.50	11.33	6.78
r=2	r=3	2	2.24	1.99	0.58

95%			λ-Trace Test		
H_0	H_A	n-r	REER	RER (AU)	RER(US)
r=0	r>1	3	29.18**	34.57**	46.49***
r=1	r>2	2	7.26	13.32	7.36
r=2	r>3	2	2.24	1.99	0.58

Note: H_o is null hypothesis and H_A is the alternative hypothesis. The number of variables and cointegrating vectors are n and r, respectively. The critical values for the λ-max and λ-trace tests from Johanson and Nielson (1993), as displayed by E-views. Total includes real effective exchange rate, terms of trade and interest rate differentials.

**** means significant at 1-percent level, i.e. rejection of null hypothesis at 1-percent level.*
*** means significant at 5-percent level, i.e. rejection of null hypothesis at 5-percent level.*
** means significant at 10-percent level, i.e. rejection of null hypothesis at 10-percent level*

Source: Authors calculation

Results from table 2, shows that both trace and maximum Eigenvalue test establishes at least 1 cointegrating equation in the three sets. As for the RER of the US dollar, both TOT and Interest rate differentials between PNG and the United States do not have a long run equilibrium relationship, consequently, the US dollar RER was tested using TOT and Interest rate differentials between PNG and the Australia. As it was established, there is cointegrating relationship between the 3 variables. This can be interpreted as, US dollar being the main currency of trade between Australia and PNG. It is therefore apparent that, Australia's trade relationship between PNG tends to play a pivotal role in the determination of the USD and the AUD RER.

According to table 2, both maximum eigenvalue and trace test validates cointegration between the variables, REER, total terms of trade and expected interest rate differentials between Australia and Papua New Guinea. It also shows that, RERAU, TOTAU and expected real interest rate differentials between Australia and Papua New Guinea are also cointegrated.

As an alternative way to confirm cointegration, Engle and Granger 2 step approach was used to test for cointegration in REER, RER(AU) and RER(US). Since we established that all variables are either I(0) or I(1), however, I(0) variables were converted to I(1) variables to assess the short-rundynamics of the model. According to Engel and Granger, the variable 'e_t' in the long run equation $Y_t = X_t + e_t$, whereby $e_t = Y_t - X_t$ has to be I(0) to qualify cointegration.

The long-run specification of the real exchange rate model is given by equation 2;

$$q_t = b_0 + b_1 id_t + b_2 tt_t + e_t \qquad (2)$$

priori expectations of estimates; b_1 & $b_2 < 0$

where:

q_t is the log real exchange rate (RER AU), RER(US) and log real effective exchange rate (REER) at time t,
id_t is the expected real interest rate differentials at time t and,
tt_t is the log terms of trade at time t.

Priori expectations of the estimates of coefficients b_1 and b_2 indicate that real exchange rate has an inverse relationship between both expected real interest rate differentials and the terms of trade. An appreciation in the real exchange rate would be either caused by an improvement in the terms of trade or a favorable expected interest rate differential for the home country.

Results of equation 2 are given in table 3.

Table 3: Long-Run Model			
Dependent Variables	**Coefficient of Variables**		
	tt	**Id**	**constant**
REER	-0.031 (-1.098)	-0.009 (3.413)***	4.803 (35.003)***
RER(AU)	-0.121 (-4.735)***	-0.006 (-2.655)**	5.248 (41.859)***
RER(US)	-0.146 (-3.137)***	-0.017 (-4.303)***	5.730 (25.078)***

****** means, significant at 1-percent level***
***** means, significant at 5-percent level***
**** means significant at 10-percent level***

Source: Authors calculation

As a second step to Engle Grangers 2 step approach of cointegration we generate the residuals for equation 2 and test for stationary. The results are provided in table 4.

Table 4:			
	REER(e_t)	RERAU(e_t)	RERUS(e_t)
t-value	-3.14	-4.06	-1.82
Mackinnon Critical Values			
	1%	-2.61	
	5%	-1.96	
	10%	-1.62	

Source: Authors calculation

From table 4, null hypothesis of non-stationarity of the error terms was rejected at 1 percent significant levels for REER and RERAU, while the null hypothesis of non-stationarity of the error term for RERUS was rejected at 10 percent significance level.

The variables real exchange rate, terms of trade and expected interest rate differentials are cointegrated variables for Papua New Guinea, as established by the Johansen's maximum likelihood approach and Engle and Granger two step approaches. This means that the spurious nature of the long run estimates in table 3 are longer become spurious since it is corrected by dynamic short-run error correction model.

iii. Error-Correction Model (ECM)

According to Granger (1983) and Engle and Granger (1987) the existence of at least one cointegrating vector validates error-correction representation of the data. This implies that, we can establish the short and long-run relationship for REER, RER(AU) and RER(US). The long run models were specified and variables and its associated coefficients were calculated in table 3. The shot run model is specified as follows:

The short-run adjustment also follows an error-correction specification is as follows:

$$\Delta q_t = c_0 + \lambda(\beta_0 q_{t-1} - c - \beta_1 id_{t-1} - \beta_2 tt_{t-1}) + \sum_{j=1}^{k} a_j \Delta id_{t-j} + \sum_{j=1}^{k} b_j \Delta tt_{t-j} + e_{jt} \qquad (3)$$

where

$(\beta_0 q_{t-1} - c - \beta_1 id_{t-1} - \beta_2 tt_{t-1})$ represents the lagged residual of the cointegrating relationships

λ represents the speed of adjustment parameters.
k the lag length

From equation 3, 3 different short-run dynamic models were estimated and presented below.

$$\Delta reer_t = 0.009 - 0.319\Delta tot_t - 0.004\Delta id_t - 0.227e_{t-1}$$
$$(1.34) \quad (-5.10)^{***} \quad (-2.17)^{**} \quad (-3.33)^{***} \qquad (4)$$

R^2 0.39

DW 1.65

Diagnostic Tests

Jarque-Berra F-statistics 6.631[0.036]
B-G LM test Chi-Square 4.188[0.123]
Arch tests Chi-Square 1.452[0.228]

$$\Delta rerau_t = 0.004 + 0.319\Delta rerau_{t-1} + 0.279\Delta rerau_{t-2} + 0.269\Delta rerau_{t-3}$$
$$(0.533) \quad (2.581)^{**} \quad (1.916)^{*} \quad (2.017)^{*}$$

$$+ 0.314\Delta rerau_{t-4} - 0.390\Delta totau_t - 0.005\Delta idau_t - 0.704e_{t-1}$$
$$(2.33)^{**} \quad (-7.112)^{***} \quad (-2.418)^{**} \quad (-4.148)^{***} \qquad (5)$$

R^2 0.63

DW 1.69

Diagnostic Tests

Jarque-Berra F-statistics 8.366[0.015]
B-G LM test Chi-Square 1.251[0.535]
Arch tests Chi-Square 0.155[0.694]

$$\Delta rerus_t = 0.005 + 0.327\Delta rerus_{t-1} - 0.162\Delta totau_t - 0.135\Delta totau_{t-4}$$
$$(0.736) \quad (2.524)^{**} \quad (-2.883)^{***} \quad (-2.209)^{**}$$

$$- 0.006\Delta idau_t + 0.005\Delta idau_{t-2} - 0.098e_{t-1}$$
$$(-2.974)^{***} \quad (2.519)^{***} \quad (-2.076)^{**} \qquad (6)$$

R^2 0.33

DW 1.83

Diagnostic Tests

Jarque-Berra F-statistics 6.389[0.041]
B-G LM test Chi-Square 2.878[0.237]
Arch tests Chi-Square 0.473[0.492]

*** *represents, 1 percent significant level*
** *represents, 5 percent significant level*
* *represents, 10 percent significant level*

Short-run dynamic models were generated using general to specific model specification. Using equation 3, models 4, 5, and 6 were generated from the 4th lag. Those lags that were not significant were dropped from the equations and parsimonious models were generated.

From equations 4, 5 and 6 the speed of adjustment and the model generated equilibrium real exchange rates were calculated.

Table 6: Speed of Adjustment and Equilibrium Values

	Speed of Adjustment (λ)	t-statistics	Equilibrium Value
REER	-0.227	-3.33***	0.9611
RERAU	-0.704	-4.148***	0.9943
RERUS	-0.098	-2.076**	0.9503

Source: Authors calculations

Several diagnostic tests were applied to the error correction models in order to validate the estimates.

Jarque-Berra test done on equations 4, 5 and 6 shows that the null hypotheses of normality in the errors were not rejected at the 5 percent significance levels.

Even though the Durbin Watson statistics for equations 4, 5 and 6 rejects problems of serial correlation of the variables, a higher order test was carried out to verify the results. Bruesch-Godfrey serial correlation Lagrange Multiplier (LM) tests for higher order serial correlation reveal that the Chi-Square statistics of the 3 equations could not reject the null hypothesis of absence of series correlation in the residuals.

Finally, the Autoregressive Conditional Heteroskedasticity (ARCH) tests were done on equations 4, 5 and 6 to test for heteroskedasticity in the error process in the models. Results of the calculated Chi-Square statistics indicate the absence of heteroskedasticity in the error process of the 3 models.

From the array of diagnostics tests the models are asserted to be well estimated and the observed data's fits the models specification adequately, thus we expect that the residuals to be distributed as white noise and the coefficients valid for policy discussions.

b. Interpretation of results

In the long-run the real effective exchange rate is determined by the expected real interest rate differentials between Papua New Guinea and Australia while the long-run real exchange rates for the US and the Australian dollars are determined by both the expected real interest rate differentials and the terms of trade. This means that an improvement in the terms of trade or a favorable real interest rate differential between home country and foreign country would result in an appreciation of the domestic currency against the US and Australian dollars. The and vice versa is true when there is deterioration in the terms of trade or an unfavorable real interest rate differential between home and foreign country.

The magnitude of the impact terms of trade movements play on the real exchange rate far outweigh the negligible impact real interest rate differentials have. In the long-run, a 10 percent improvement in the terms of trade of Papua New Guinea would result in a 1.4 and 1.5 percent appreciation of the RER against the Australian and US dollars', respectively. On the other hand, a 10 percent improvement in the real interest rate differentials would result in a 0.9, 0.6 and 0.2 percent appreciation of the REER, RER against the Australian dollar and RER against the US dollar, respectively. The vice versa is true for both cases when there is a deterioration in the terms of trade and an unfavorable real interest rate differential between the home and the foreign country.

While in the long-run terms of trade is not significant in determining the REER, in the short-run term of trade impact on the REER outweighs the impact of real interest rate differentials. A 10 percent improvement/deterioration in the terms of trade would result in 3.19 percent improvement/deterioration in the REER. On the other hand, a 10 percent favorable/unfavorable movement in the real interest rate differentials of home and foreign country would result in a 0.04 percent improvement/deterioration in the REER. Likewise, both the real exchange against the Australian and US dollar's had terms of trade having a significant impact while real interest rate differentials have mild impact.

According to this estimates, the implied long-run equilibrium REER, RER against the Australian and the US dollars' are 96.1, 99.4 and 95.0 percent of current terms of trade and the expected real interest rate differentials between Papua New Guinea, rest of the world, Australia and the USA, respectively. If current REER, RER against Australian and the US dollars' diverges from this equilibrium relationship with terms of trade and expected real interest rate differentials, then, due to the negative error-correction coefficients, there will be a tendency for both variables to adjust towards equilibrium REER, RER against Australian and US dollars' by 22.7, 70.4 and 9.8 percents, respectively from previous quarter's disequilibrium.

V. Conclusion

Estimates of both the long and short-run models confirm the findings of Kauzi and Sampson, 2009, establishing kina as a commodity currency. Real exchange rate developments in the country depend more on terms of trade movements than on real interest rate differentials. The impact trade shocks have on the real exchange rate is stronger than real interest rate differentials. These findings confirm structural underpinnings in the country.

Papua New Guinea is a small open economy, exporter of raw agricultural commodities and importer of processed items. Consequently PNG is exposed to foreign price movements, both export and import prices. The model results indicate that, terms of trade plays a significant role in determining the real exchange rate of the country. Evidences presented both for the long and short-runs show that both export and import price movements significantly impact on the real exchange rate for PNG. For instance, when international commodity prices declined significantly in 1997, PNG's real exchange rate deteriorated. In the recent past, when international export commodity prices of PNG increased, the real exchange rate appreciated.

The empirical results also confirm the status of the financial market developments. Papua New Guinea's financial market is shallow and most foreign capital inflows are long-term equity capital targeted towards highly capitalized resource projects. Short-term rent seeking capital inflows is rare or non-existent as there is no market. Real interest rate differentials particularly set the pricing difference for foreign and domestic short term capital to flow in both directions. When the short term capital market is not deep, bi-directional flows of short term capital is minimal. Empirical results from the models have indicated, that, though there remains a channel of short-term capital flows, as a result of foreign exchange control liberalization in PNG, less or minimal transactions are effected via real interest rate differentials to impact strongly on the real exchange rate.

Since both import and export price shocks play pivotal role in determining the real exchange rate of PNG, external shock buffers are an important ingredient for the PNG economy. Exchange rate pass through is an important element in the inflation model, Sampson, Nindim, Yabom & Marabini, 2006. Therefore external shock buffers are crucial for PNG to resist external price shocks, both import and export prices.

This paper has confined its discussions on real interest rate differentials and the terms of trade of PNG as the two variables responsible for real exchange rate movements in PNG. There are other notable variables such as, government expenditures, net capital inflow, trade openness, flow of foreign aid or grant, excess supply of domestic money supply, nominal devaluation, etc, can be used in the model to see its effect on the real exchange rate. Future researches can try to use these variables to model the real exchange rate developments in PNG.

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Notes