

# **The determinants of the real exchange rate in Zambia**

By

Kombe Oswald Mungule  
*Department of Economics*  
*The University of Zambia*

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## **Abstract**

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This paper attempts to explain the movements of Zambia's real effective exchange rate using a vector error correction model and quarterly time series data between 1973 and 1997. The study results are similar to most studies about the nature of the determinants of the real exchange rate. Through the use of purchasing power parity tests, impulse response and variance decomposition functions, the study indicates that Zambia's real effective exchange rate depends significantly on the prevailing real fundamentals, price differentials and real shocks.

# 1. Introduction

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The real exchange rate (RER) is recognized as an important element in macroeconomic management and a key measure of the prices of tradeable goods relative to non-tradeable goods. Since the real exchange rate reveals the relative competitiveness of the exported goods from the domestic economy to the rest of the world, it is desirable to characterize its behaviour and test its fundamental determinants. Because of its importance, the RER has therefore been accorded a prominent role in the adjustment programmes supported by the International Monetary Fund (IMF). It has also been argued that the RER not only affects general economic performance and international competitiveness, but also different sectors of the economy, foreign trade flows, balance of payments, external debt crisis, employment, structure of production, consumption and allocation of resources in the economy. RER stability therefore works to stabilize all these sectors.

The RER affects foreign trade flows in the sense that an over-valued RER will tend to favour imports more than exports of goods and services. This leads to poor performance in the export sector. Consequently the trade deficit is reflected in the balance of payments account showing a net outflow of foreign exchange. The negative balance of payments implies that government has to borrow abroad to finance the deficit and this increases indebtedness. An over-valued RER also negatively affects domestic production and employment, whilst encouraging consumption of foreign goods.

The behaviour of the RER is intimately related to the behaviour of deviations from purchasing power parity (PPP). According to the PPP theory, nominal exchange rates adjust to offset changes in relative prices, so that the RER can remain at a constant value. However, there is now widespread agreement that there is no equilibrium value to which the RER tends to return. In empirical studies many authors cannot reject the null hypothesis that RERs follow a random walk process – see Frenkel, 1981; Hakkio, 1986; Mark, 1990). Thus, changes in the RER are considered permanent.

Froot and Rogoff (1996) have reviewed a large and growing literature that tests PPP and other models of long-run real exchange rate. They distinguish three different stages of PPP testing, but conclude that the real exchange rate appears stationary over sufficiently long horizons. In addition, they also reviewed the Balassa-Samuelson hypothesis.

The empirical purpose of this study is to investigate the factors that determine long-run movements of the equilibrium RER of the Zambian kwacha against the currencies of major trading partners (see Tables A1 and A2 in Appendix A). The multilateral real exchange rate was chosen because it takes into account the third country effects and is a very good measure of a country's competitiveness.

Recent developments in time series analyses have provided new ways of investigating the long-run relationships for this purpose. Particularly, the theory of cointegration provides a means of establishing whether long-run relationships exist between economic variables. Since testing for cointegration among economic variables seems to have become a standard method of assessing the empirical support for the equilibrium of economic behaviour, we wish to test the behaviour of the RER by applying the cointegration analysis. This paper will also test the PPP theory.

The organization of the study is as follows. Section 2 summarizes the evolution of exchange rate management policy in Zambia since independence in 1964, while Section 3 briefly discusses the movements of the real exchange rates, nominal exchange rates and relative price levels. Section 4 analyses the cointegration approach and Section 5 tests for the long-run properties of the real exchange rate movements. In Section 6, we evaluate the effects of changes in nominal exchange rates, and foreign and domestic price levels on the RER. The long-run determinants of the RER (i.e., the fundamentals) are presented in Section 7. Section 8 summarizes and gives policy implications of the study.

## 2. Evolution of Exchange Rate Management in Zambia

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Zambia has experimented with several exchange rate regimes that can be divided into distinct episodes from a fixed exchange rate regime to flexible exchange rate regime. The episodes are presented below following the format set by Aron and Elbadawi (1992). The first episode ran from October 1964 to the second quarter of 1976. This was a fixed exchange rate period, initially using the British pound (1964–1971) as an anchor and then shifting to the US dollar (1971.4–1976.2).

On 24 October 1964 the Zambian pound was fully convertible with the pound sterling. In January 1968, the kwacha (K) replaced the Zambian pound. In December 1971, the pound sterling link was substituted by the US dollar at K0.714/\$1, a de facto devaluation that led to the reduction of gold content on 18 December 1971. The reason for the move was purely economic – to maintain international competitiveness. The dollar was then the only international reserve asset under the modified Bretton Woods system of 1971 to 1973, called the “Dollar Standard”. In February 1973, the kwacha was realigned to K0.643/\$1 following the US devaluation of the dollar, and the regime lasted until 1976.2.

The second episode began in the third quarter of 1976 and continued to the third quarter of 1983. In July 1976, the exchange rate was de-linked from the dollar and pegged to the SDR (K1=SDR1.08479), a move that gave a de facto devaluation of 20%. This was followed by two devaluation enactments of 10% (K1=SDR 0.97631) in March 1978 and a maximum devaluation in January 1983 of 20% (K1=SDR 0.78105). In July 1983, the kwacha was de-linked from the SDR and pegged to a trade weighted basket of currencies, giving a de facto devaluation of 11%, and a crawl rate of 1% per month was adopted.

The third episode ran from the fourth quarter of 1983 to the third quarter of 1985. Following the July 1983 crawling rate of 1% per month, the rate of crawl was increased to 2.5% per month. Again this policy stance was meant to be in line with the liberalization measures put in place (Aron and Elbadawi, 1992).

The fourth episode, marked by foreign exchange auctions, began in the fourth quarter of 1985 and lasted until the second quarter of 1987. As a continuous policy towards achieving a more flexible exchange rate, unifying the official and unofficial rates and a commitment to liberalization programme in course, the auctioning started in October 1985 when the exchange rate was determined by marginal market clearing bids in a weekly auction administered by the central bank. In August 1986 a Dutch auction was introduced in which successful bidders exchanged at their bid price rather than the marginal rate and the excess accrued as tax revenue. In January 1987, the auction was temporarily suspended due to shortages of foreign exchange and in February 1987 the official parity rate was created and pegged to a basket of currencies with a range of K9.0 to 12.5 per US

dollar, for government, parastatal and central bank transactions. In March 1987, the weekly auction was reinstated for all other transactions, starting at K15/\$. This was a two-tier auction. In May 1987 the auction was suspended and the official and market rates were unified at K8/\$ for all transactions, due to a combination of both political and economic reasons.

The fifth episode lasted from the third quarter of 1987 to the fourth quarter of 1989. The system reverted to a fixed rate (kwacha was fixed to the US dollar) following the unification of the rates in May 1987. The shift was politically motivated, especially after the Copperbelt food riots. The kwacha was devalued to K10/\$1 in December 1988, K16/\$1 in June 1989 and K24/\$1 in December 1989.

The sixth episode occurred from the first quarter of 1990 to first quarter of 1991. This dual-exchange rate regime began in February 1990 with the establishment of a two-tier system: the official rate at K28/\$1 and managed float initially at K40/\$1. The dual exchange rate was unified in the first quarter of 1991, signifying the beginning of the current exchange rate regime.

The seventh and last episode starts from the second quarter of 1991 to date. This is the current system of freely floating exchange rate determined by market forces and achieved after the unification of the exchange rates in the first quarter of 1991. In October 1992 a system of bureaus of exchange was introduced to determine the market exchange rate. In March 1993 most foreign exchange controls on current account transactions were removed and an inter-bank foreign exchange system was introduced. In 1994 all controls on both capital and current accounts were removed. The exchange rate is now determined by the market conditions.

The seven episodes are closely linked to both the developments in the international payments system, which was regulated up to the second quarter of 1976 and thereafter became an unregulated international payments system, and to macroeconomic performance as observed by Aron and Elbadawi (1992).

Least to say, Zambia's macroeconomic performance over the episode periods has not been satisfactory as is shown by exchange rate policy reversals (see Table 1). Zambia's worst economic performance was during the first five years in the last episode after the exchange rate system became market determined, between 1991 and 1995. The transition in the exchange rate from controls to market determined rates dislocated the economy with an annual average real GDP growth rate of -0.6% for the same five-year period. The high speed and the policy sequencing process of the liberalization process were mainly to blame for the macroeconomic instability. During the same period, parastatal companies' collapsed productivity plummeted even further, with high rates of company closures and unemployment, while the international community experimentally watched the demise of the Zambian economy. As usual, the blame was placed on Zambian technocrats. The annual average gross domestic investment to GDP ratio declined to 12% in 1995 from 31% in 1974. In addition, other major macroeconomic indicators worsened, making the Zambian economy contract further. The performance of the kwacha exchange rates against major currencies was not spared from the economic slide. The next discussion sheds light on possible links between Zambia's macroeconomic policies and the exchange rate episodes.

**Table 1: Selected macroeconomic indicators: 1965–1995**

Variables	1965–74	1975–84	1985–90	1991–95	1965–95
Real GDP growth rate (annual percentage average)	2.4	0.3	1.6	-0.6	1.2
Gross domestic investment/GDP (annual percentage average)	31.1	22.3	15.1	12.0	22.1
Gross domestic savings/GDP (annual percentage average)	42.5	18.9	15.4	7.0	24.5
External debt stock – Period stock accumulation (US\$ million)	1191	3805	7242	6595	4079
External debt service/Exports of goods and services (annual percentage average)	—	21.3	64.4	57.1	42
Current account balance/GDP (annual percentage average)	1.4	-11.9	-12.5	-15.5	-9.0
Total government revenue/GDP (annual percentage average)	30.1	24.4	20.1	17.3	24.1
Overall fiscal deficit/GDP – (annual percentage average)	N/A	13.8	14.9	14.3	11.6

Note: The ratio of investment to GDP is in current prices.  
Source: World Bank (1996).

The first two ten-year periods – 1965–1974 and 1975–1984 – represent a pre-adjustment and fixed exchange rate period.

## The 1965–1974 Period

The first ten-year period (1965–1974) marked Zambia's best economic performance, presenting a well shock-proofed economy with good policies in line with economic take-off standards. The economy was shock-proof because despite the first oil crisis of 1973/74, the economy grew by 2.4 annual percentage average in real terms, with a robust average annual gross domestic saving to GDP ratio of 42.5 and only a \$1 billion accumulated external debt. Most importantly, Zambia experienced favourable copper export prices during the first ten years of independence. Additionally, the country was able to support a fixed exchange rate regime due to high foreign exchange reserves resulting from favourable terms of trade.

## The 1975–1984 Period

The economic numbers started getting worse in the second ten-year period (1975–1984), with more accumulation of external debt due to high government spending on non-tradeable goods and a nationalization programme that scared away private investment. The current account balance to GDP ratio on annual average was negative (-11.1%), with almost no positive real economic growth. The situation was worsened by the high costs of the liberation wars in the neighbouring countries and the apartheid economic sanctions, which meant no trade between Zambia and South Africa. Worse still, domestic savings declined on annual average, leading to outward looking borrowings and an increase in foreign debt. Because the lenders had influence in international payment systems, pressure started developing for Zambia to repay the money and foreign based policies started to be imposed on Zambians, thus bringing debt servicing related problems of capital flight, an ever shrinking domestic economy and rise in poverty levels. As if these negative performances were not enough, the kwacha was continuously losing value against major international currencies. Zambia's macroeconomic situation was worsened even further by falling copper prices and the increase in the price of imported crude oil during the 1978/79 world oil crisis and therefore further kwacha devaluations.

The fundamental external factors that adversely affected the Zambian economy during the fixed exchange rate regime of the first 20 years of independence were the two oil shocks and specifically the second oil shock of 1979; high public spending on liberation wars in South Africa and Zimbabwe; falling copper prices; rising crude oil prices; and the effects of economic sanctions on South Africa and Zimbabwe. The effect of these external factors was the misalignment of the real exchange rate through the maintenance of an over-valued currency. These factors created a lot of pressure on the currency in view of the dwindling foreign exchange reserves, which were being rationed by the central bank.

On the fundamental domestic factors front, the high domestic credit levels, high government spending on non-tradeable goods and services, and the maintenance of foreign exchange and price controls and a fixed exchange rate policy contributed to the depletion of the country's foreign exchange reserves and also led to further over-valuation of the kwacha.

The last two periods – 1985–1990 and 1991–1995 – represent the adjustment period with both fixed and flexible exchange rate regimes overlapping (i.e., fixed for the first six year period, 1985–1990).

## The 1985–1990 Period

During this period the country's macroeconomic scenario continued to deteriorate  
n  
average because no major investment, trade and migration policy realignments were in place. The major drain on foreign exchange was government's support for freedom

fighters in South Africa and around the region. These freedom fighters were perceived as terrorists by western countries and therefore any country that supported such groups did not receive foreign direct investments from industrialized countries and remained backward up to date. Trade between Zambia and industrialized countries was also restricted to export of raw materials only.

As a result, the period from 1985 to 1990 is well known in international circles for cold relationships with international financial institutions and for major policy reversals that cost the country in missed foreign direct investment and industrialization. For example, in 1987 Zambia suspended its relationship with the International Monetary fund. Zambia stopped debt servicing and all Fund supported programmes and developed its own “home grown” adjustment programme. This represented a major shift from the IMF supported structural adjustment programme. Paradoxically, the Zambian economy stabilized, productivity improved and the exchange rate was realigned downward to reflect a revaluation. Two things happened during the suspension of the programme; first, the economy grew by about 7% and second, the stock of external debt – which is a drain on both local and foreign reserves – increased, thereby having long lasting effects on the economy through, mainly, interest payments.

This period is mainly a Dutch auction system, with a two-tier exchange rate system as explained earlier. During this period the economy recovered with real GDP averaging 1.6% per annum. Real GDP performed better than that of the previous five-year period. Gross domestic investment to GDP and gross domestic saving to GDP ratios fell further to as low as 15.1 and 15.4%, respectively. The country accumulated a total debt stock of US\$7,242 million at the end of the period. Further, the external debt stock as a percentage of GDP increased to 231% and Zambia had an increase of the debt service obligation with the debt service ratio standing at 64.4%. The contribution of GDP to the current account balance and to government revenue averaged -12.5% and 20.1%, respectively. Nevertheless, the fiscal balance was in deficit; overall fiscal deficit to GDP ratio averaged about 14.9%.

## The 1991–1995 Period

This signified the beginning of the current period of flexible exchange rate regime. During this period the economy deteriorated with real GDP averaging at -0.6% per annum. This performance was worse than that of the previous five-year period. Gross domestic investment to GDP and gross domestic saving to GDP ratios continued declining to as low as 12% and 7%, respectively. The country accumulated a total debt stock of US\$6,595 million at the end of the period. Further, the external debt stock as a percentage of GDP stood at 190% and Zambia had a fall of her debt service obligation with the debt service ratio averaging at 57%. The contribution of GDP to current account balance and to government revenue averaged -15.5% and 17.3%, respectively. The fiscal balance was still in deficit, whose overall fiscal deficit to GDP ratio averaged about 14.3%.

## The Whole Period (1965–1995)

The economy grew marginally at an average of 1% per annum over the three decades, a real GDP growth performance that is well below the population growth of 3.2% per annum. The gross domestic investment to GDP and gross domestic saving to GDP ratios averaged at 22% and 24.5%, respectively. The country accumulated a total debt stock of US\$4.079 billion at the end of the period. Further, the external debt stock as a percentage of GDP stood at 120% and Zambia's debt service ratio averaged 42%. The contribution of GDP to current account balance and to government revenue averaged -9% and 24%, respectively. The fiscal balance has been in deficit, with an overall fiscal deficit to GDP ratio averaging about 11.6%. This scenario is on average an indication of poor macroeconomic performance.

The general economic performance and policy has been tied to the copper industry, with copper mining accounting for over 80% of foreign exchange earnings during the first decade after independence in 1964. In spite of the over 50% reduction in copper output in recent years, the copper industry still plays an important role, particularly in foreign exchange earnings.

Zambia's economic policy making centred around using copper surplus during the boom years and responding to the fallout from the collapse of the sector during the bust. This has driven the exchange rate policy in the country from a fixed regime during boom periods to flexible regime after the economic bust.

The macroeconomic conditions and the exchange rate episodes are linked in Zambia, and this is supported in World Bank (1996), which states that the performance of the Zambian economy has been worsened by declining copper production and the declining international price of copper in real terms. It can also be said that the apparent abundance of copper and reliance on it as a source of export earnings effectively impeded the development of non-copper related sources of growth. The Dutch disease, although it benefited related copper activities and provided the entire economy with larger purchasing power, actually disadvantaged other exporting activities and those that compete closely for labour and capital, negatively affecting the value of the kwacha in relation to other currencies. Further, the World Bank Report of 1996 states that in the absence of copper, Zambia's exchange rate would have been higher, and this would have benefited other exporters and import competing activities. This does not mean that growth would have been higher without copper, however, but that the growth of other exporting activities presumably would have been higher. The medium- to long-term effects depend heavily on how the income generated from copper has been used and the comparative dynamic effects of focusing heavily on copper rather than developing a more diversified economy. The Dutch disease effect of copper mining has been exacerbated by the relatively inefficient investments made with resulting savings.

### 3. Movements of the RER

---

Exchange rate changes can be measured in either nominal or real terms. A measure in real terms against one currency provides a better measure of relative competitiveness than do measures in nominal terms. Consider the real exchange rate (RER) defined in terms of nominal exchange rate (NER) adjusted for relative price levels ( $P^*/P$ ) at a particular period,  $t$ , that is:

$$RER_t = NER_t \leftrightarrow \frac{P_t^*}{P_t}$$

In our case, the nominal exchange rate is defined as the kwacha price per one US dollar (US\$1), so that an increase in NER indicates a depreciation/devaluation of the Kwacha; the star, \*, denotes the world economy. A rise in the real exchange rate corresponds to a fall in the purchasing power of domestic currency for foreign products. This change in relative purchasing power occurs because the kwacha prices of world products rise relative to those of Zambian products.

Hence, in the following sections we shall evaluate aspects of the RER behaviour by analysing:

1. The extent to which the RER reverts, in the long run, toward purchasing power parity.
2. The persistent effect of a nominal exchange rate and domestic and world price level adjustment on the real exchange rate.
3. The equilibrium relationship between the RER and the fundamentals.
4. The persistent effect of the fundamentals on the equilibrium RER.

The following paragraphs explain the exchange rate movements in Zambia over the study period. For comparative purposes this study uses two exchange rates, one based on copper prices and one on oil import prices. This is designed to identify the effects of both the reliance on copper exports and the impact of crude oil imports on the exchange rates.

First, the nominal exchange rate was controlled for most of the study period up to 1989, with some flexibility instituted from 1990. The exchange rates of the Zambian currency with respect to those of her trading partners are now floating and the nominal

exchange rate has been depreciating since the implementation of liberalization programmes in 1990.

Second, the real effective exchange rate based on copper prices has not been stable over the study period, but fluctuated close to the base year mark. The index fell below the base year mark in 1997, indicating an appreciating real effective exchange rate. Furthermore, the index shows high volatility between 1986 and 1993. This is the period of policy reversals in Zambia due to high macroeconomic instability. We shall try to model this type of behaviour in Section 7 of this report.

Third, Zambian data indicate that the foreign import price-based real effective exchange rate index has been appreciating on average. The index depreciated between 1973 and 1974 before appreciating in 1975 and thereafter. The period of 1985 to 1987 is the foreign exchange auction period in which volatility was the highest but the economy attained some competitiveness by making imports more expensive. The auction was discontinued in 1988 and we see an appreciating index further trying to make imports less attractive.

Finally, a comparative trend analysis indicates that the two types of real exchange rate indexes were highly volatile prior to the floating exchange rate system. Three things could be deduced from the movements of the two real exchange rate indexes:

- That falling copper prices contributed to an appreciating real copper based index.
- That rising import prices pushed the import based real index higher than the copper based index.
- That rapid growth in money supply and substantial changes in the income velocity of money suggest a change in money demand between 1973 and 1997.

Both types of real exchange rate indexes have been appreciating over the study period with rising inflation beginning 1991. The copper based real exchange rate index has been more fairly volatile than the foreign import price-based real exchange rate (see Appendix B, Figures B1–B3 for graphical details of changes in exchange rates).

## 4. VAR Modelling and the Cointegration Approach

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Vector autoregression (VAR) modelling and the cointegration approach provide not only an estimation methodology but also explicit procedures for testing the long-run relationship among variables suggested by economic theory.

According to the Granger Representation Theorem (Engle and Granger, 1987), if a  $P \times 1$  vector,  $X_t$ , generated by  $(1-L)X_t = d + c(L)e_t$ , is cointegrated, then there exists a vector autoregression (VAR), an error correction, as well as a moving average (MA) representation of  $X_t$ . A set of variables  $X_t$ , which is cointegrated, refers to the existence of long-run equilibrium relationships among economic variables. That is, though each series may be non-stationary, there may be stationary linear combinations of the variables. The basic idea is that individual economic time series variables wander considerably, but certain linear combinations of the series do not move too far apart from each other. In economic terms, there is a long-run relationship among variables.

The most common test for cointegration is the two-step procedure of Engle and Granger (1987) which performs well for univariate tests. The first step is to fit the cointegration regression, an ordinary least squares (OLS) estimation of the static model. The second step is to conduct a unit root test on the estimated residuals. To test for cointegration is just to test for the presence of a unit root in the residuals of the cointegrating regression. If the null of a unit root is rejected, then cointegration exists. However, the long-run parameter of the cointegrating vector estimated from this approach can be severely biased in finite samples. An improved procedure of cointegration test is that which allows for more than one cointegrating vector, as suggested in Johansen (1988) and Johansen and Juselius (1990).

Following Johansen and Juselius (1990), let the  $p$  variables under scrutiny follow a vector autoregression of order  $p$  (VAR( $p$ )) as below,

$$X_t = c + P_1 X_{t-1} + \dots + P_p X_{t-p} + e_t \quad (1)$$

where,  $X_t = nx1$  vector of economic variables in the model;  $c = nx1$  vector of constants or drift terms are innovations of this process and are assumed to be drawn from  $p$ -dimensional independently, identically distributed (i.i.d.) Gaussian distributions with covariance  $G$ ; and  $X_{p+1}, \dots, X_0$  are fixed.

Where;

- $P_i$  =  $nxn$  matrixes of time invariant coefficients,  $i = 1, \dots, p$ , and
- $e$  =  $nx1$  vector of i.i.d. errors with a positive covariance matrix.

Let  $\Delta$  represent the first difference filter. The equation can be reparameterized into the equivalent form presented below,

$$\Delta X_t = c + PX_{t-p} + \sum_{i=0}^{p-1} \tau_i \Delta X_{t-i} + \tau_t \tag{2}$$

where  $\tau_t = -\tau + \sum_{j=1}^i P_j$ , for,  $i = 1, \dots, p-1$ ,  $p = \tau + \sum_i^p P_j$

The coefficient matrix  $P$  contains information about the long-run relationships among variables. Since  $e_t$  is stationary, the number of ranks for matrix  $P$  determines how many linear combinations of  $X_t$  are stationary. If  $0 < \text{Rank}(P) = r < p$ , there exists  $r$  cointegrating vectors that make the linear combinations of  $X_t$  to become stationary. In that case,  $P$  can be factored as “a” and “b”, with “a” and “b” being matrixes. Here “b” is a cointegrating vector that has the property that  $bX_t$  is stationary even though  $X_t$  itself is non-stationary and “a” then contains the adjustment parameters.

Based on an unrestricted estimation that is parameterized in terms of levels and differences, Johansen (1988) proposed likelihood ratio statistics for testing the number of cointegrating vectors. First we must solve the eigenvalues of  $|\ddot{e}S_{pp} - S_{p0}S_{00}^{-1}S_{0p}| = 0$ , where  $S_{00}$  is the moment matrix of the residuals from the ordinary least squares (OLS) regression of  $\Delta X_t$  on  $\Delta X_{t-1}, \dots, \Delta X_{t-p+1}$ ;  $S_{pp}$  is the residual moment matrix from the OLS regression of  $\Delta X_{t-p}$  on  $\Delta X_{t-1}, \dots, \Delta X_{t-p+1}$ ; and  $S_{0p}$  is the cross-product moment matrix. The cointegrating vector,  $b$ , is solved out as the eigenvectors associated with the  $r$  largest statistically significant eigenvalues derived using two test statistics, “maximum eigenvalue statistics” and “trace statistics”. The first statistic tests the hypothesis that there are  $r=s$  cointegrating vectors against the alternative of  $r =s+1$  by calculating the maximum likelihood test statistics as  $-T \cdot \ln(1-l_{s+1})$ , where  $T$  is the sample size and  $l_{s+1}$  is an estimated eigenvalue. The second statistic tests the hypothesis that there exists at most,  $r$  cointegrating vectors. If the test is performed by calculating trace statistics:

$$-T \sum_{i=r+1}^p \ln\{(1 - \lambda i^*) / (1 - \lambda i)\}$$

where  $\ddot{e}i^*$  are eigenvalues obtained from cointegration analysis assuming there is no linear trend.

## 5. Purchasing Power Parity (PPP) Empirical Results on RER in the Long-Run

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This section investigates the behaviour of the real exchange rate with cointegration methods to see if its long-run movement is consistent with the implications of PPP theory. The Relative PPP theory asserts that the rate of change in the nominal exchange rate is equal to the domestic inflation minus the foreign inflation rate. This implies that when the nominal exchange rate goes up or down, the relative price levels will adjust continuously in order to maintain the real exchange rate close to its equilibrium value. The equation for the relative PPP theory may be rearranged to produce an expression for the change in the RER, so that the real exchange rate should equal zero.

To test for long-run deviations of the actual RER from its equilibrium RER, we used the Wu (1996) procedure by first checking the stochastic process of the RER series by unit root tests (see Table C1 of Appendix C) and then testing for cointegration relationships among changes in the nominal exchange rates and domestic and foreign price levels – i.e., either foreign copper prices or weighted foreign import prices – without imposing any proportionality and symmetry restrictions (see Table C2 Appendix C). According to Wu (1996), measurement errors in price variables could cause violations of the symmetry restrictions of the absolute PPP theory and thus cause us to erroneously accept the hypothesis of a non-stationary real effective exchange rate.

The results in Appendix C, Tables C2 and C3 test the absolute version of the PPP theory and were arrived at by using Johansen approach, performed on an unrestricted VAR framework. In order to avoid any bias of the regression results by measurement errors, the cointegrating regression was considered without imposing symmetry and proportionality restrictions. Results in both tables confirm the existence of cointegration between the nominal exchange rate and the domestic and foreign prices. The results appear to suggest that the simple notion of the PPP may hold, implying that both domestic and foreign prices adjust in such a way that the real exchange rate adjusts toward its equilibrium PPP value.

## 6. Impulse Response Analysis

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The existence of cointegration between the nominal effective exchange rate index (NEERI), domestic price index (CPI) and foreign copper price index (CuPI), on one hand, and the nominal effective exchange rate index (NEERI) and weighted foreign import price index (WFIPI), on the other hand, implies that shocks to the real effective exchange rates (REERs) are temporal and that the REERs return to their long-run value as PPP predicts.

Figure B4 (Appendix B) shows that Zambia had very low inflation levels (fixed) prior to 1992, but that inflation rose steeply between 1993 and 1997 owing to price decontrols. The other relevant prices, the copper price and the petroleum price, have a different pattern. The copper price index was fairly stable between 1975 and 1987. However, the country experienced favourable export commodity prices between 1989 and 1991 (for three years). On the other hand, the price index of the petroleum imports has been very unstable. The worst hit period in terms of high petroleum prices was 1980–1983, mainly a result of the 1979 oil shock, but 1989 and 1990 were equally bad periods for import prices, peaking in 1990.

Because the real effective exchange rates are constructed by trading partners' nominal exchange rates, the relative price levels for tradeables and non-tradeables and the trade weights of each trading partner, the variability in the real effective exchange rate can be dominated by either the nominal effective exchange rates or the relative price level changes. We therefore investigated the extent to which the nominal effective exchange rate and the domestic and foreign price level changes affect the real effective exchange rate through an analysis of impulse response functions.

The unrestricted VAR consisting of the first differences in logarithms of the nominal effective exchange rate and the domestic price and foreign price of tradeables:

$$A(L) X_t = m_t \quad (3)$$

where,

$$X_t = (\Delta \ln \text{NEERI}_t; \Delta \ln \text{CPI}_t; \Delta \ln \text{CuPI}_t; \Delta \ln \text{WFIPI}_t)$$

and denoting,

$$\Delta \ln P = \Delta \ln \text{CPI}; \Delta \ln E = \Delta \ln \text{NEERI}; \Delta \ln P_f = \Delta \ln \text{CuPI} \text{ and } \Delta \ln P^* = \Delta \ln \text{WFIPI}, \text{ then}$$

$X_t = (\Delta \ln P_t, \Delta \ln E_t, \Delta \ln P_t^*, \Delta \ln Pf_t)$ , respectively.

The price and exchange rate variables are put in log form because the change in the log of a variable approximates to the percentage change in the variable. This also necessitates testing of the relative PPP theory. Therefore,

$$A(L) = \sum_{j=0}^k A_j L^j ; \text{ and } A_0 = I \quad (4)$$

Akaike's information criterion was used to select the appropriate lag length of the VAR system. Inverting  $A(L)$ , we get the moving average representation  $X_t = A(L)^{-1} m_t$ . To evaluate the dynamic response of the variables in  $X_t$  to an innovation in,  $\Delta \ln E_t$ ,  $\Delta \ln P_t$ ,  $\Delta \ln P_t^*$ ,  $\Delta \ln Pf_t$  and  $m_t$ , it is orthogonalized by means of a Choleski factorization of  $W$ . Let  $e_t = B m_t$ , with  $B$  chosen to be a lower triangular matrix such that  $BWB' = I$ .  $I$  is a diagonal matrix. Thus, we can write  $X_t = c(L) e_t$ , where

$$C(L) = A(L)^{-1} B(L)^{-1} = \begin{matrix} C11(L) & C12(L) & C13(L) \\ C21(L) & C22(L) & C23(L) \\ C31(L) & C32(L) & C33(L) \end{matrix}$$

The change in  $\ln E$ ,  $\ln P$  and  $\ln Pf$  or  $\ln P^*$  responding to a unit shock to  $\ln E$  is given by  $C11(L)$ ,  $C21(L)$ , and  $C31(L)$ , respectively. Similarly, the change in  $\ln E$ ,  $\ln P$  and  $\ln Pf$  or  $\ln P^*$  responding to innovations in  $\ln P$  and  $\ln Pf$  or  $\ln P^*$  are presented by  $C12(L)$ ,  $C22(L)$  and  $C32(L)$  and  $C13(L)$ ,  $C23(L)$  and  $C33(L)$ . Therefore, the implied change in  $\ln REER$  following shocks to  $E$ ,  $P$ , and  $Pf$  or  $P^*$  is  $(-C11 + C21 + C31)$ ,  $(-C12 + C22 + C32)$  and  $(-C13 + C23 + C33)$ , respectively. Note that if PPP theory held,  $(-C12 + C22 + C32) + (-C13 + C23 + C33) - (-C11 + C21 + C31)$  would be identically equal to zero.

Table C5 (see Appendix C) gives results of the relative version of the PPP theory and shows the cumulative impulse response function of  $\Delta \ln E$ ,  $\Delta \ln P$  and  $\Delta \ln Pf$  for the first model and  $\Delta \ln E$ ,  $\Delta \ln P$  and  $\Delta \ln P^*$  for the second model, both models with the implied impulse response function of  $\Delta \ln REER_{cu}$  and  $\Delta \ln REER_{im}$ — for copper and foreign import-based real effective exchange rates, respectively, the two real effective exchange rates being used in the study.

The results of the first model from Table C5 show that first, a unit of innovation in the NEER generally leads to a 2% increase in the NEER itself and a 1% increase in domestic prices and nothing happens to the copper price. Second, a unit shock in the domestic price leads to no change in the nominal exchange rate, in itself and in copper prices. Third, a unit innovation in the copper price leads to 1% increase in itself.

The first model of Table C5 (Appendix C) also reports the implied change in the foreign copper export price-based real effective exchange rate following a unit innovation in  $\Delta \ln E$ ,  $\Delta \ln P$  and  $\Delta \ln Pf$ . The largest cumulative change comes from the foreign

copper price and the shock is positive. The second largest accumulated shock comes from the nominal exchange rate and the last from domestic prices.

Model 2 of Appendix C Table C5 also confirms the likely existence of the long-run relationship between nominal effective exchange rate, the domestic price and the foreign import price. Under this model, a unit shock to the nominal effective exchange rate causes the greatest change in the nominal effective exchange rate than do innovations in the domestic price and foreign import price. We also report the change in the foreign import price based real effective exchange rate following a unit innovation in  $\Delta \ln E$ ,  $\Delta \ln P$  and  $\Delta \ln P^*$ . This cumulative change is approximately minus 1% for a shock in the NEER, plus 1% for a shock to the domestic price level and zero for a shock in the foreign import price. The estimates show that a unit shock from the foreign import price leads to a small percentage change in the REERim. The cumulative change of innovations in the nominal effective exchange rate, the domestic price and the foreign import price leads to a very small change in the real exchange rate, implying that PPP theory holds. The same is the case for the first model.

Appendix C also shows some graphs of the cumulative impulse response functions, confirming that innovations in the nominal effective exchange rate are followed by changes in domestic and foreign prices for the first seven quarters and thereafter become constant (see Figure C1). Figures C2 through C4 indicate the nominal exchange rate adjustment in response to innovations in domestic and foreign prices. The results show negative sharp impulses of the exchange rate from innovations in domestic prices for the first nine quarters (see Figure C2). Figure C3 indicates the impulse response function of the nominal exchange rate to innovations in the foreign copper price. It is negative for the first four periods then positive afterwards. Figure C4 shows the nominal exchange rate's impulse response function to innovations in the foreign import prices. It tends to be positive for the first four periods, though very small. The implication of the results is that the shocks to the crude oil import prices have a quick impact on the movement in the real exchange rate. The effect of the copper exports on the exchange rate confirms the Dutch disease phenomenon in Zambia, although the impact is weaker than that coming from crude oil prices.

## 7. RER Movements and the Fundamentals

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Our earlier analysis suggests that there is no systematic tendency for the foreign copper price based REER to revert to a constant PPP equilibrium value after a shock. Therefore, permanent shifts in this type of REER can result from permanent changes in nominal effective exchange rate and domestic price level. However, the scenario is different for the crude oil price-based REER. In this scenario REER reverts to a constant PPP equilibrium.

The practical foundation of this paper is based on the determinants of the equilibrium RER as applied by Khan and Montiel (1987), Edwards (1989), Ghura and Grennes (1993), Elbadawi (1994), and Montiel (1999). All these authors' models can be said to have constituted three important components of a good equilibrium RER model for sub-Saharan African countries like Zambia. The models:

- Specified the equilibrium RER as a forward looking function of the fundamentals.
- Allowed for a flexible dynamic adjustment of the RER toward the equilibrium RER.
- Allowed for the influence of the short- to medium-term macroeconomic and exchange rate policy on the RER.

The theoretical basis for this study's method rests on models suggested by various authors, including Khan and Montiel (1987), Edwards (1989), Cottani et al. (1990), Ghura and Grennes (1993), Elbadawi (1994), and Montiel (1999). This study's approach seems to be the standard methodology for countries like Zambia because it has been found that in the short to medium term, macroeconomic and exchange rate policies influence the RER movements.

### Measurement of the RER

We compute the multilateral real exchange rate in order to capture third country effects on Zambia's real exchange rate. The multilateral real exchange rate is of two types. The first one is computed using the foreign copper price while the second is computed using the crude oil import prices. These two foreign prices of tradeables tend to have a significant influence on the Zambian economy and can therefore have a considerable impact on the country's real exchange rate. We present two types of RERs for Zambia using the export and import prices for tradeable goods. This procedure compares favourably with that in Aron and Elbadawi (1992) and was chosen to facilitate discussion on the Dutch disease in the Zambia economy. The following PPP theory condition was adopted in this study,

$$\text{RER} = \text{PT/PN} \tag{5}$$

where RER = real exchange rate and PT and PN are the domestic price indexes of tradeables and non-tradeables, respectively. Thus, three proxies will be used in an operational definition for RER, as is given by:

$$RER_i = (E_i \cdot FPT) / PN \quad (6)$$

where,

- RER<sub>i</sub> = BRERI = Bilateral real exchange rate index as reported in various issues of the International Financial Statistics Quarterly of the IMF.
- E<sub>it</sub> = nominal exchange rate measured as the Zambian kwacha per unit of country I's currency.
- FPT = foreign currency price of tradeables, proxied using the indexes for world copper price (CuPI) and weighted foreign import price index (WFIPI).
- PN = as defined earlier and proxied using Zambia consumer price index (CPI).

Note that a rise in the RER index indicates a real depreciation, while a fall indicates a real appreciation. The indexes are empirically calculated as,

$$BRERICu_t = (E_{it} \cdot CuPI_t) / CPI_t \quad (7a)$$

where BRERICu is the bilateral RER index calculated using foreign copper price index as a proxy for foreign price of tradeables, FP.

and

$$BRERIm_t = (E_{it} \cdot WFIPI_t) / CPI_t \quad (7b)$$

where BRERIm is the bilateral RER index calculated using Zambia's weighted foreign import price index as a proxy for FP.

The real effective exchange rate (REER) index is calculated using trade weights for six major trading partners (as shown in Appendix A) by multiplying the bilateral real exchange rates with the trade weights and summing the products:

$$REERcu_t = BRERICu1.W1 + BRERICu2.W2 + \dots + BRERICu6.W6 \quad (8a)$$

where,

- REERcu = foreign copper price based real effective exchange rate index.
- W = trade weights, 1,2...6 are Zambia's major trading partners as shown in the appendix.

and

$$REERim_t = BRERIm1.W1 + BRERIm2.W2 + \dots + BRERIm6.W6 \tag{8b}$$

where, REERim = weighted foreign import price based real effective exchange rate index.

## The Equilibrium RER

The standard approach to the equilibrium RER modelling is to express the theoretical relationship between the RER and its most important “fundamentals” or real variables that determine its movements. This has been derived by Edwards (1988a) and Elbadawi (1994) and the standard form has been used by many studies like Ghura and Grennes (1993). This study adopts the following relationship to suit the availability of data.

$$e^* = e \begin{matrix} (TOT, & CLOSE, & CAPFLOY, & EXCRE) \\ +/- & - & - & - \end{matrix} \tag{9}$$

with its linearized version as given below,

$$\log e^*_t = b_0 + b_1 \log (TOT)_t + b_2 (CAPFLOY)_t + b_3 \log (CLOSE)_t + b_4 (EXCRE)_t + b_5(Other)_t + u_t \tag{10}$$

where,

- e\* = equilibrium real effective exchange rate (REER).
- TOT = external terms of trade, defined as the ratio of foreign price of exportables (world copper price) to weighted foreign import price for Zambia.
- CAPFLOY = capital inflow, measured as the difference between net change in reserves and trade balance scaled by GDP, following the approach used by Ghura and Grennes (1993).
- CLOSE =  $[Y/X+M]$ , which is the ratio of GDP over the sum of Exports (X) and Imports (M). This is used as a proxy for policies affecting trade in general and follows the approach used by Ghura and Grennes (1993). An increase in the ratio indicates an increase in closeness of the economy.
- EXCRE = excess supply of domestic credit measured as the rate of growth of money supply minus the rate of growth of GDP. This assumes that the demand for domestic credit has a unitary elasticity with respect to real income. The effect of excess domestic credit, which captures the influence of over expansionary macro-policies, is to induce inflation in the economy and hence appreciate the RER.
- Other = other fundamentals that might be necessary determinants of the RER: dummy variables that capture regime shifts, the lagged real

exchange rate, and nominal devaluation (NOMDEV), which is the growth rate in nominal effective exchange rate.

U = error term.

### *The Terms of Trade Partial Effects Analysis*

The impact of the terms of trade (TOT) on the real exchange rate operates through variations in the import and export prices, which in our case are represented by petroleum and copper prices, respectively. If the foreign currency values of exports rises (i.e., TOT improves), the supply of foreign exchange reserves increases. In a free floating exchange rate system, the supply curve of foreign currency (e.g., US dollar) shifts rightwards leading to an appreciation of the real exchange rate. Under a fixed exchange rate regime, the increased supply of the foreign currency (e.g. dollar) leads to an expansion of money supply of the domestic currency (e.g., kwacha) and an increase in inflation (assuming no price controls). This causes the real exchange rate to appreciate. But a change in the foreign currency value of imports may cause the demand curve for foreign currency to either increase or decrease, depending on the elasticity of demand. As a result, the real exchange rate may depreciate or appreciate. However, a depreciation in the terms of trade resulting from the increase in import prices would increase inflation, if there are no price controls (Mungule, 1997).

In theory therefore, the ambiguity of the expected partial effect of the terms of trade on the real exchange rate gives rise to an alternative method for examining the terms of trade effects on the real exchange rate, through income and substitution effects that depend on the source of the terms of trade variations. According to Fosu (1992), and adopted in Mungule (1997), the income effect arises when the real exchange rate depreciates/appreciates in reaction to a decline/increase in the relative price of exports. A fall/rise in the relative price of exports precipitates a fall/rise in the real income of the economy. This exerts a downward/upward pressure on domestic demand for non-traded consumer goods. This leads to a decline /rise in the domestic prices on non-traded goods and a depreciation/appreciation of the real exchange rate. In general, the net effect of the change in the terms of trade on the real exchange rate depends on the magnitude of the income and substitution effects in relation to the price effect.

### *The Closeness of the Economy Partial Effects Analysis*

The closeness of the economy (CLOSE), as is generally abbreviated, is used as a proxy for the trade policy and its partial expected effect on the real exchange rate is negative. The general view is that trade liberalization characterized by reductions in tariffs and/or the elimination of quantitative restrictions will lead to increased trade. A fall in CLOSE (i.e., more open) therefore results in a real exchange rate depreciation. However, the demand for imports is expected to rise as the import prices fall in line with lowered tariffs or removed quantitative restrictions, thereby generating a trade deficit.

To restore the external balance, trade liberalization has to be accompanied by a rise in the relative price of tradeable goods or a real appreciation (Mungule, 1997).

Alternatively, a fall or elimination of import duties allows importers to buy more foreign exchange for the same level of total expenditures. The resulting increased foreign exchange demand under a free floating exchange rate regime leads to a depreciation of the real exchange rate. The real exchange rate will also be devalued under the fixed exchange rate regime, but this arises because the domestic monetary contraction causes inflation to fall. Under fixed exchange rate regimes, the conversion of more foreign currency into domestic currency leads to the expansion of money supply, a rise in domestic inflation (without price controls) and an appreciation of the real exchange rate (Obadan, 1994).

### *The Capital Flows Partial Effects Analysis.*

Capital flows (CAPFLOY), which is measured in ratio terms as the capital flows to gross domestic product ratio, has a negative expected partial effect. The explanation is that international capital inflows lead to the appreciation of the real exchange rate. Under a floating exchange rate regime, capital inflows produce an excess supply of foreign currency, which leads directly to an appreciation of the real exchange rate. Under a fixed exchange rate regime, however, capital inflow leads to a rise in money supply. This leads in turn to increases in prices (if no price controls) and real appreciation of the exchange rate. In general, when an economy makes a transfer to the rest of the world, current and future real income and expenditure decline, precipitating a slump in the relative price of non-traded goods. This depreciates the real exchange rate in both the current and the future periods (Fosu, 1992:15).

The sustainable capital inflows lead to the appreciation of the real exchange rate and results in further real resource transfer.

### *The Excess Supply of Domestic Credit Partial Effects Analysis*

The expected partial effect of the excess supply of domestic credit (EXCRE) on the real exchange rate is negative. The effect of monetary policy on the real exchange rate depends on whether monetary policy is expansionary or contractionary. An expansionary monetary policy, represented by an increase in money supply, exerts upward pressure on the domestic price, which causes the real exchange rate to appreciate. In the context of real money balances, an injection of money temporarily raises real balances. Under a floating rates regime, if inflation does not adjust instantly, the increase in money depreciates the exchange rate. However, under the fixed exchange rate regime, an increase in money will lead to a devaluation of the currency. The effect of money supply reduction or inflation increase is to appreciate the currency (for floating regimes) and revalue the currency (under fixed exchange rate regimes).

### *The Nominal Devaluation Partial Analysis*

The growth rate in nominal exchange rate (NOMDEV) has the expected positive partial sign. The implication of this is that an increase/decrease in the nominal exchange rate leads to a rise/fall in the real exchange rate. The ability of the nominal exchange rate variations to affect the real exchange rate will depend on the extent to which macroeconomic policies are consistent with the objective of the nominal exchange rate, such as inflation anchoring (i.e., domestic price stabilization).

### *The Lagged Real Exchange Rate Partial Analysis*

The lagged real exchange rate has the expected negative partial effect (Edwards, 1988b). This is true when one considers the time series properties of real exchange rates. The negative coefficient implies that in the absence of other interventions, the real exchange rate converges slowly towards its long-run equilibrium level.

## An Equation for the Dynamics of RER

This study uses a version of the dynamic model as in Edwards (1988a). Edwards' model was adopted because of the growing importance of RER in policy discussions and the lack of attempts to empirically analyse the forces behind real exchange rate behaviour in Zambia. The issue of RER determination in Zambia had remained in a 'murky' state with most of the studies being carried out at an informal level. Edwards (1988a) arrived at the following general model:

$$\Delta \log e_t = q [\log e_t^* - \log e_{t-1}] - 1 [Z_t - Z_{t-1}^*] + f [\log E_t - \log E_{t-1}] \quad (11)$$

where,

- $e$  = actual real exchange rate (RER).
- $e^*$  = equilibrium real exchange rate (ERER).
- $Z_t$  = index of macroeconomic policies (i.e. the rate of growth of domestic credit).
- $Z_{t-1}^*$  = the sustainable level of macroeconomic policies (i.e. the rate of increase of demand for domestic money).
- $E_t$  = nominal exchange rate (NER).

$q$ ,  $\bar{e}$ , and  $f$  are positive parameters that capture the dynamic aspects of the adjustment process.

This model captures the most important features of the theoretical analysis (see

Edwards, 1989), including: (a) that discrepancies between actual and equilibrium RERs will tend to disappear slowly if left on their own; (b) that nominal devaluations are neutral in the long run, but can be potentially helpful to speed up the restoration of RER equilibrium; (c) that macroeconomic disequilibrium affects the RER in the short run; and (c) that the long-run equilibrium RER responds to changes in fundamentals. The model specification indicates that the autonomous forces that move the RER back to equilibrium operate fairly slowly, keeping the country out of equilibrium for a long period of time. Therefore, if a country is indeed in disequilibrium, theoretically, nominal devaluations can greatly help to speed up the RER realignment, as is given by the partial adjustment term  $q [\log e_t^* - \log e_{t-1}]$ . The  $q$  captures the self-adjustment process. The smaller the  $q$ , the slower is the adjustment speed at which RER misalignment will be corrected. Theoretically, several variables will affect the size of the partial coefficient,  $q$ .

The second term in the model (11),  $-\delta [Z_t - Z_{t-1}^*]$  indicates that if the macroeconomic policies are unsustainable in the medium to long run there will be pressures towards a real appreciation – that is if  $(Z_t - Z^*) > 0$ , with other things given,  $\Delta \log e_t < 0$ .

The third determinant of the RER movements,  $+f [\log E_t - \log E_{t-1}]$ , closely captures the impact of changes in the nominal exchange rate. A nominal depreciation/devaluation will have a positive effect on the RER on impact, generating a short-run depreciation, with the actual depreciation magnitude represented by the value of  $f$ .

## Estimation

After replacing Equation 10 for  $\log e_t^*$  and the expressions for  $[Z_t - Z_{t-1}^*]$  in (11) we obtain an equation that could be estimated using conventional methods. The model (Equation 10) is to be estimated by using a forward-looking expression for the equilibrium RER:

$$i \log e_t = g_0 + g_1 \log (TOT)_t + g_2 \log (CLOSE)_t + g_3 \log (EXCRE)_t + g_4 \text{Trend}_t + U_t \tag{12}$$

where the  $g$ 's are combinations of  $b$ 's and  $q$ .

Defining the vector of coefficients and the corresponding vector of fundamentals:

$$d = (g_0, g_1, g_2, g_3, g_4), F = [1, \log (TOT), \log (CLOSE), \log (EXCRE), (\text{Trend})]$$

If the vector of fundamentals is integrated of order one  $I(1)$ , the following cointegrating relationship exists:

$$\text{Log } e_t = [1/(1-h)]d' F_{t+j} + m \tag{13}$$

where

$F$  = vector of sustainable fundamentals.  
 $[1/(1-h)]d$  = cointegrating vector.

Therefore, Equation 13 is the standard version of a cointegrating regression and is the one to be used. The presence of cointegration in Equation 13 will give way to the existence of an error correction specification (Engle and Granger, 1987). The following error correction specification will be consistent:

$$\hat{\log e}_{t+1} = b_0 [ \{ 1/(1-h) \} d' F_t - \log e_t ] + b \hat{F}_{t+1} + b_i \hat{x}_{it+1} + e_{t+1} \quad (14)$$

where,

$[ \{ 1/(1-h) \} d' F_t - \log e_t ]$  = error-correction term;  
 $\hat{F}_{t+1}$  = first difference of the fundamentals; and  
 $\hat{X}_{it+1}$  = non-fundamentals that are expected to influence the RER in the short run.

The vector error correction model represents both the short- and long-run dynamics of the RER around its equilibrium RER.

The impulse response functions (IRFs) and the variance decomposition functions (VDFs) used in the analysis of the fundamental determinants of the equilibrium real exchange rate follow Wu (1996) and Braun and Mitnik (1993) procedures.

## Limitation of the Study

The study had the following limitations:

- The study period is limited to between 1973.1 and 1997.3.
- The computation of the real effective exchange rate is different from the IMF's International Financial Statistical (IFS).
- This is a preliminary study of the determinants of the real exchange rate in Zambia.
- The issue of currency substitutes is not included in this study.
- The study does not differentiate between the official exchange rate and the parallel market rate, which existed on a smaller scale than currently. The study period ends in 1997, one to two years after the black market started to be prominent.

## Equilibrium RER Empirical Results

As in Section 4, the Johansen (1988) estimation methodology was used to specify and estimate the VAR model. This is consistent with a lot of studies. Quarterly data taken from secondary sources are used in the estimation. However, as before, the correct

specification of the VAR model depends on whether the variables involved are stationary or not. The augmented Dickey–Fuller test was first conducted for each individual series to investigate which of the  $I(2)$ ,  $I(1)$  or  $I(0)$  assumption is the most likely to hold.

Table C2 (see Appendix C) shows the univariate time series properties of our quarterly data. The test was successfully conducted against one alternative: without fluctuations around a constant mean, deterministic linear trend and seasonality. The test entertained a maximum lag length of five. The hypothesis of a unit root is not rejected for all the variables in levels. Most of the variables are stationary after differencing once, except for CAPFLOY, which is stationary in levels.

According to Engle and Granger (1987), even though individual time series are non-stationary, linear combinations of them can be stationary because equilibrium forces tend to keep such series together in the long run. When this happens, variables are cointegrated and error corrections exist to account for short-run deviations from the long-run equilibrium relationship.

The Johansen procedure (Johansen, 1998, and Johansen and Juselius, 1990) for cointegration analysis is used. To implement this procedure, the optimal order of the VAR model was determined. This was done because too often an insufficient lag length can lead to rejection of the null of no cointegration (see Monte Carlo experiment in Boswijk and Franses, 1992) and over parameterization of the dynamic structure leads to loss of power. However, the order selection criterion does not require stationarity of the system (Lutkepohl and Reimers, 1992). Therefore, the likelihood ratio (LR) test was used to determine the lag structure of the unrestricted VAR model. The procedure involved sequentially testing down a lower order VAR ( $p-1$ ) against the higher order VAR ( $p$ ) beginning with the value of  $p$  equal to eight and reducing the value of  $p$  by one each time. A two-order specification was adopted for the VAR model, since no presence of serial correlation was detected and the VAR residuals were orthogonalized for policy purposes.

The cointegration results are presented in Appendix D for the copper based RER and Appendix E for the foreign import based RER. The results were arrived at by using “E-Views” computer software. The Johansen procedure was adopted to test the hypothesis that the constant is restricted in the cointegration space. The results indicated that a model with a restricted constant was to be considered for the analysis.

The test assumption of the presence of a linear deterministic trend in the data was imposed. The exogenous series included impulse dummies (...0 1 0...) for the periods 1987 and 1992 to represent the discontinuity of the foreign exchange auction and the beginning of the flexible exchange rate regime, respectively.

## Results for the Foreign Export Price Based Equilibrium RER (REER<sub>cu</sub>)

The world copper price was used to determine the real exchange rate; its movement is illustrated in Appendix B. This form of real exchange rate is different from the conventional wisdom, such as models based on International Monetary Fund statistics.

The other form of real exchange rate was computed using world petroleum price. The two forms of exchange rates were different in value terms for the largest part of the study period, with the copper based measure giving a more over-valued currency. Whether this is the Dutch disease phenomenon is up to the reader to think through (see Appendix B, Figures B4 and B5).

The results in Appendix D (Table D1) were arrived at by using the foreign copper price based real exchange rate and the fundamentals. The cointegration test suggests that there are two long-run relationships among the four fundamentals – real effective exchange rate, terms of trade, general trade policies and growth rate in nominal exchange rate. The cointegrating equations were identified through the normalization of coefficients and tests on residual properties (see Appendix B, Figure B1). Impulse responses are summarized in Box 1.:

**Box 1: Results for Impulse Responses of the REERcu**

Source of innovations	Cumulative impulse response by REERcu
Lagged REERcu	Negative response
Terms of trade	Positive response
Trade policies	Negative response
Excess supply of domestic credit	Negative response
Capital flows	Negative response

Note: Results were computed using “E-Views” econometric software.

It can be deduced from the results in Box 1 that innovations are coming from the past values of the real exchange rate itself, the terms of trade, trade policies, capital flows and macroeconomics variables such as excess supply of domestic credit. The terms of trade leads to a positive response of the real exchange rate; this is likely to result from a fall in the relative price of copper exports that precipitated a fall in real national income for Zambia, which exerted a downward pressure on the domestic demand for non-tradeable consumer goods. Domestic prices for non-tradeable consumer goods were controlled at very low levels for the most part of the study period, precipitating depreciations. Alternatively, either a decline in copper export prices or an increase in the crude oil prices decreases disposable income, thereby generating positive excess supply of non-tradeable consumer goods. This puts a downward pressure on the price of non tradeable consumer goods or forces the authorities to reduce prices on non tradeable consumer goods and a real depreciation ensues. Therefore, there is a positive relationship between the copper determined real exchange rate and the terms of trade. These results on the reaction of the real exchange rate to the fundamentals are in line with all literature on the determinants of the real exchange rate.

Additionally, variance decomposition functions for the long-run RER over a 12-week period gave the following specific results:

- The percentage RER variation due to itself is negative/decreasing.

- The percentage RER variation due to the terms of trade is positive/rising.
- The percentage RER variance due to general trade policies is very small (fairly constant).
- The percentage RER variance due to the excess supply of domestic credit is negative/falling.

The vector error correction (VEC) model of Appendix D, Table D2 shows that short-run and long-run exchange rate determinants with their expected partial signs are in line with what theory predicts. The only significant variables in the model were the VEC terms, the growth rate in nominal exchange rate or nominal devaluation, the excess supply of domestic credit, and the 1992 impulse dummy representing the effects from the 1989 oil crisis. These results to some extent give us the presence of an error correction mechanism in the model. However, the terms of trade, general trade policies and capital flows seem to be long run factors in the determination of the real exchange rate. The only significant short run factors are the macroeconomic factors proxied by the excess supply of domestic credit and the changes in nominal exchange rate proxied by nominal devaluation.

Therefore, through the use of the VEC model we have empirically shown which variables affect the real exchange rate in the short run and what the long-run factors are. As confirmed by the results of a copper based measure of the real effective exchange rate, macroeconomic conditions have been the major factors in the exchange rate movements.

## Results for the Foreign Import Price Based Equilibrium RER (REERim)

The world petroleum price was used as a proxy for the import price based real exchange rate. This type of exchange rate is different from the conventional practice in real exchange rate measure, but it is also technically correct. The literature, both empirical and theoretical, on the real exchange rate is highlighted in the Appendix F.

Appendix G (Tables G1–G2) gives the cointegration model for the long-run determinants of the real exchange rate. The admissible variables for the model were the terms of trade, trade policies proxied by the closeness of the economy, nominal devaluation, and the 1987 and 1992 shocks. These are the regime shifts, being the home grown economic recovery programme of 1987 and the liberalization of the economy in 1992. The results indicate that there are two long-run equilibrium relationships for the RER.

The impulse response functions from the cointegrating regression yielded the results shown in Box 2.

**Box 2: Results for impulse responses of the REERim**

Source of innovations	Cumulative impulse response by REERim
Lagged REERim	Negative response
Terms of trade	Negative response
Trade policies	Negative response
Excess supply of domestic credit	Negative response
Capital flows	Negative response

Note: Results were computed using “E-Views” econometric software.

Box 2 reconfirms and strengthens the results on impulse responses by the real exchange rate given changes in the real fundamentals. The results also confirm that the terms of trade tends to have an ambiguous effect on the real exchange rate. The negative response by the real exchange rate indicates a negative partial effect in the model. This implies that in the absence of other interventions, the real exchange rate will tend to converge slowly towards the long run equilibrium level. This has been verified by Edwards (1988b: 339).

Both the impulse response functions and the variance decompositions functions gave similar results vis-à-vis the innovations in the fundamentals (see Appendix G, Table G2).

Box 3 shows larger variance impacts from the REERim itself and from the macroeconomic situation of the country. The study considered a 12-quarter period, which is three years of variance decomposition analysis.

**Box 3: Percent REERim variance due to fundamental changes**

Fundamentals	% REERim variance		
	Average % REERim variance (12 periods = 3 years)	Periods1–3	Periods 4–12
Lagged REERim-1	92.5	100%	90%
Terms of trade (TOT)	12.0	3%	3%
Trade policies (CLOSE)	3.92	10%	3%

Note: Computed using E-Views econometrics software, regressed in levels.

The specific narrations of Box 3 follow:

- The percentage REERim variance due to itself is 100% in period one then falls to 90% in period four and remains constant over that mark.
- The percentage REERim variance due to TOT is fairly constant at about 3% for the entire 12 periods.
- The percentage REERim variance due to general trade policies is zero in period one to about 10% in period three and remains fairly constant over the 3% mark.

The VEC results of the REERim indicate similar results to those of the REERcu above. Basically, the same variables were significant and the nature of the movement of the REERim was similar. The following are the specific results (see Appendix D, Table D2):

- First, the variables had the expected partial signs.
- Second, there exists a VEC mechanism, similar to the results on the REERcu presented above.
- Third, the significant variables include the error correction term two, the excess supply of domestic credit, nominal devaluation and the 1992 impulse dummy variable representing regime change of liberalization policies.

## 8. Conclusion and Policy Implications

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The Zambian economy over the study period has mixed results in terms of macroeconomic performance. Real GDP growth rate between 1965 and 1974 was the highest, estimated at an average annual growth rate of 2.4%. The worst period was between 1991 and 1995 when average real GDP growth was minus 0.6%.

The country experimented with both the fixed and nominal exchange rate systems. Price controls were in place over most of the study period up to 1991. A look at the two types of the real effective exchange rates indicate that the copper price computed REER was much lower than the petroleum price based REER. The country's terms of trade fell in 1974 and remained at very unfavourable low levels for the whole study period. This indicated a drop from 35 to 10 basis points. The excess supply of domestic credit was generally positive for most parts of the study period. However, there were price controls during the study period up to 1991/92. Therefore, price movements were the result of a policy move by government. Additionally, we see evidence of extreme growth in money supply in 1987 and 1992. The capital flows for the country are very unstable but are at low levels. These capital inflows drastically dropped beginning 1974 and the country has been experiencing a highly volatile situation. With the slump in the terms of trade since 1974 and towards the end of 1980s, the export performance has lagged the import performance, leading to deterioration in the current account position.

This paper has analysed the behaviour of the REER and found the following:

- The important long-run fundamental determinants are the terms of trade, closeness of the economy and nominal devaluation.
- The important short-run determinants are the excess supply of domestic credit and the growth in nominal exchange rate/nominal devaluation.
- The absolute version of the purchasing power parity relationship seems to hold in the long run with both the copper price based REER and the foreign import price based REER. The analysis of cumulative impulse response functions suggests that innovations in the nominal exchange rate and domestic and foreign price levels result in the real exchange rate moving back to the PPP equilibrium RER. However, the effect of copper exports tends to have a more permanent effect on the real exchange rate. The effect of the crude oil import price tends to have a temporal but volatile impact on the real exchange rate.
- The empirical tests of the relationship between the REERs and the fundamental determinants indicate the existence of the long-run equilibrium relationship. The terms of trade and the general trade policies are used in the regression equation. The other variables were impulse dummies (i1987 and i1992) and excess supply of domestic credit.

- Through the impulse response functions, the following were concluded;
- First, innovations in the real exchange rate and the terms of trade tend to lead to significant negative changes in the copper price based REER, causing the currency to appreciate and therefore giving rise to disequilibrium in the foreign exchange market and depreciating the exchange rate further.
- Second, there was a feedback effect because innovations in the REER tend to significant negative changes in itself/lagged value (i.e., the foreign import price based REER) and positive changes in the domestic price (inflation). The increase in foreign prices (crude oil prices) is less than the increase in domestic inflation, leading to real appreciation and thus putting pressure on the currency to depreciate.

Through the analysis of variance decomposition functions, it was established that, first, the instability in the copper based REER is most likely to come from itself and the terms of trade and second, the variations in the foreign import price based REER is most likely to come from itself and general trade policies, such as import duties.

The VEC regression results indicate convergence of the system towards the long-run equilibrium REER. This result is in line with most empirical studies findings as given in the literature review (Appendix E). However, the real exchange rate seems to take about a two-quarter lag period before adjusting to changes in the fundamentals. The fundamentals are likely to have more permanent effects on the real exchange rate in the long run than in the short run. The effects of the fundamentals in the long run have not led to loss of international competitiveness as variance decomposition functions indicate.

The cumulative impulse response functions of the VEC regression results show short-run changes in the REER. In the short run, the REERs respond most to changes in themselves with cumulative impulses of about 0.1% for 12 periods. However, both REERs tend to have the largest feedback on capital flows. The fundamentals were found to be causing appreciations of the two types of real exchange rate.

The interactions between the real exchange rates and the fundamentals have implications for the stabilization and growth policies being pursued. The fundamentals have the potential to destabilize the economy through their impact on the real exchange rate. That is, they can lead to improvements/deterioration in the country's competitiveness and this may positively/negatively affect productivity in the tradeable goods sector. This ultimately implies an increase/decrease in the exportable goods sector's output, with wide implications for the whole economy. For example, the effects on unemployment and poverty are real in Zambia.

However, the crucial link between causes and impact on the REER is the effect of the nominal exchange rate depreciation and foreign prices, as relative PPP theory results indicate, on one hand, and the effect of the trade regime and capital flows, on the other. Both nominal exchange rate and foreign price movements have potential effects on the domestic prices.

For one, the analysis implies that the trade-off between competitiveness and inflation is real. Large depreciations may produce a sharp and permanent rise in inflation and this may be sufficient to prevent some real exchange rate depreciation (Appendix C, Figure C1). Marginal devaluations/depreciations are likely to have less inflationary risk and

more real effect in the longer term.

Further, the analysis also implies that the trade-off between competitiveness and policy credibility is also real in Zambia. Large devaluations/depreciations may produce large short-run capital inflows, which may not be sustained in the long run. Therefore, in the long run, these short-term capital inflows may prove to be highly volatile. Monetary, fiscal and supply enhancing measures are also needed to reduce the risk of inflation and thus loss of credibility of the stabilization policies in the country.

To fully understand the determinants of the real exchange rate, several key research issues need to be addressed, including the following:

- There is need to understand the causes and effects of continued segmentation into official and bureau rates between 1992 and to date. The paper has limitations on this issue, which can be explored in another study.
- There is need to evaluate the tension between a stable exchange rate target and the unification of exchange rates.
- There is need to understand the structure and operations of the domestic foreign exchange market and the whole financial system in order to effectively implement monetary and fiscal policies.

These proposals are aimed at complementing constant micro analysis of the functioning of the domestic foreign exchange market and the domestic money and capital markets. They would provide policy makers with an early warning system about trends in the economic fundamentals and how they are likely to affect external competitiveness and the implied effect on credibility of the stabilization policies. This would likely enhance monitoring of short-term aims of the exchange rate policy.

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# Appendix A: Zambia's Major Trading Partners (1990–1996)

**Table A1: .Currency weights in Zambia's real exchange rate (1990–1996)**

	Export weights	Import weights	Trade weights
USA	9.735	9.536	9.605
UK	8.407	19.785	15.796
Japan	52.458	8.420	23.866
Germany	2.310	8.579	6.380
RSA	4.081	43.267	29.522
Saudi Arabia	23.009	10.412	14.831
Total	100.000	100.000	100.000

Source: IMF, Direction of Trade Statistics, various issues.

**Table A2: Zambia's direction of trade with major trading partners (1990–1996) (US dollars million)**

	Exports (US\$ mn)	Imports (US\$ mn)	Trade (US\$ mn)
USA	198	359	557
UK	171	745	916
Japan	1,067	317	1,384
Germany	47	323	370
RSA	83	1,629	1,712
Saudi Arabia	468	392	860
Total	2,034	3,765	5,799

Source: IMF, Direction of Trade Statistics, Various issues

## Appendix B: Graphical Representation of the Important Background Data

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Figure B1: Nominal effective exchange rate index (NEERI)

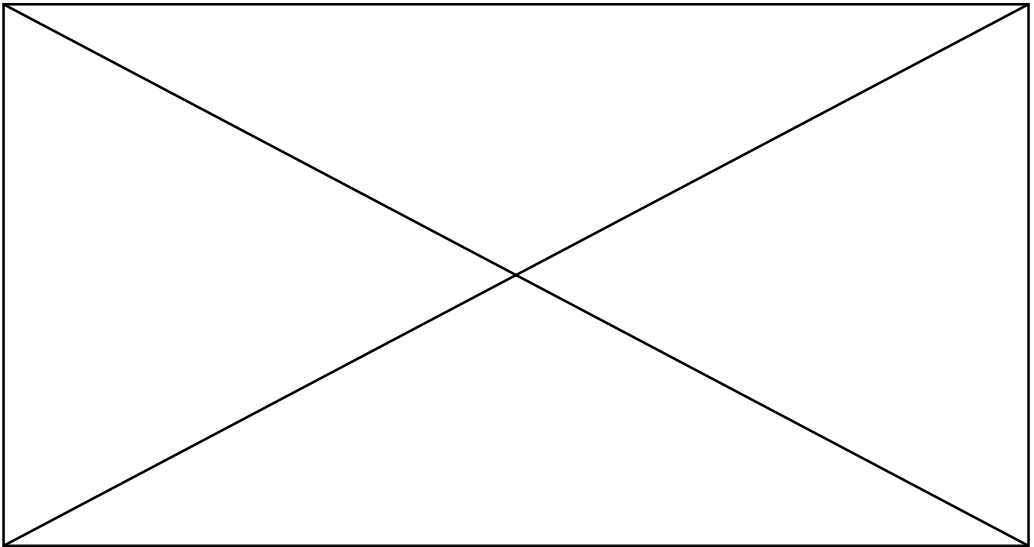
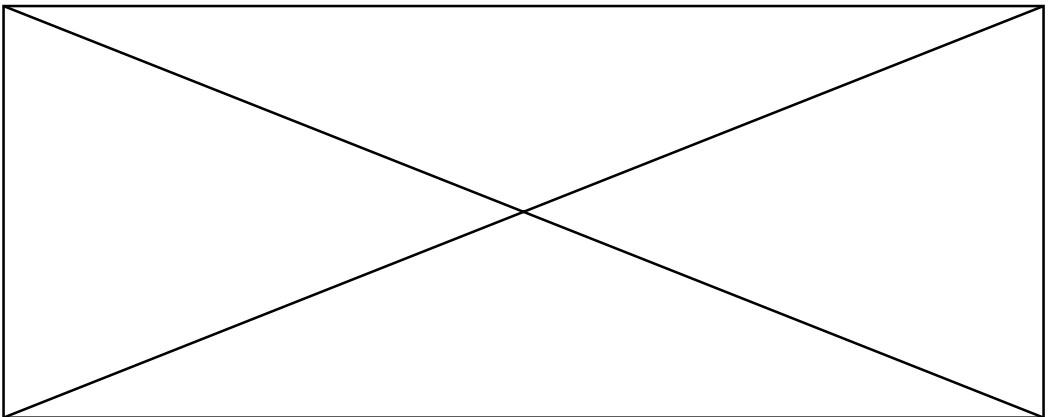
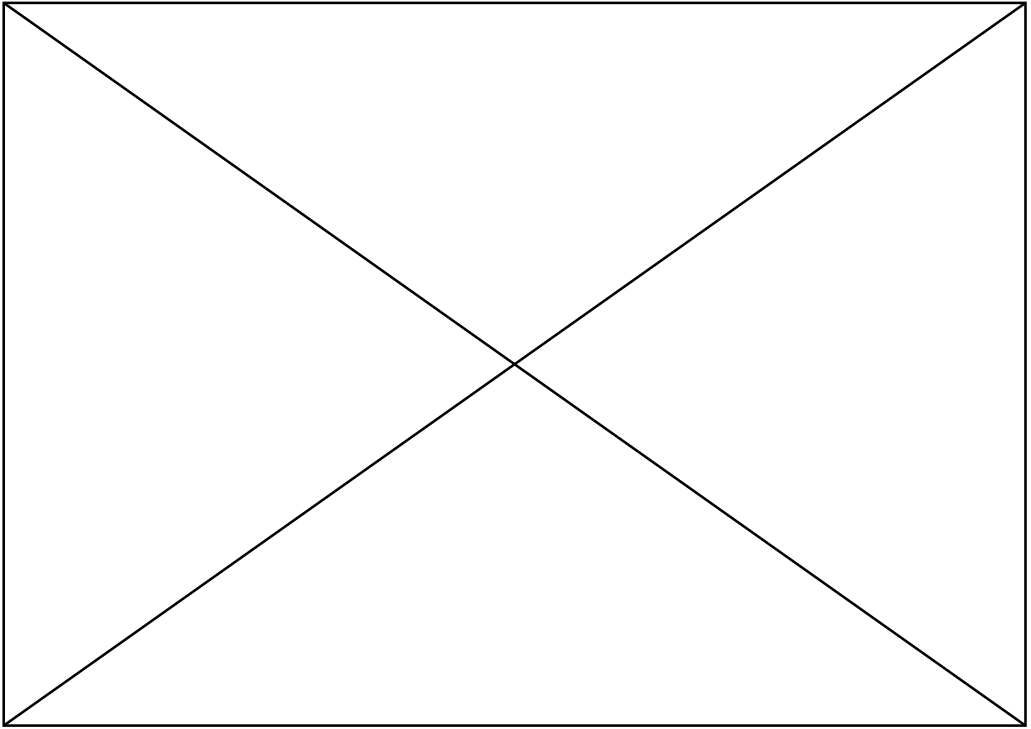


Figure B2: Real effective exchange rate index computed using Foreign copper price (REERcu)



**Figure B3: Real effective exchange rate index computed using crude oil prices (REERim)**



**Figure B4: Zambia's real effective exchange rates**

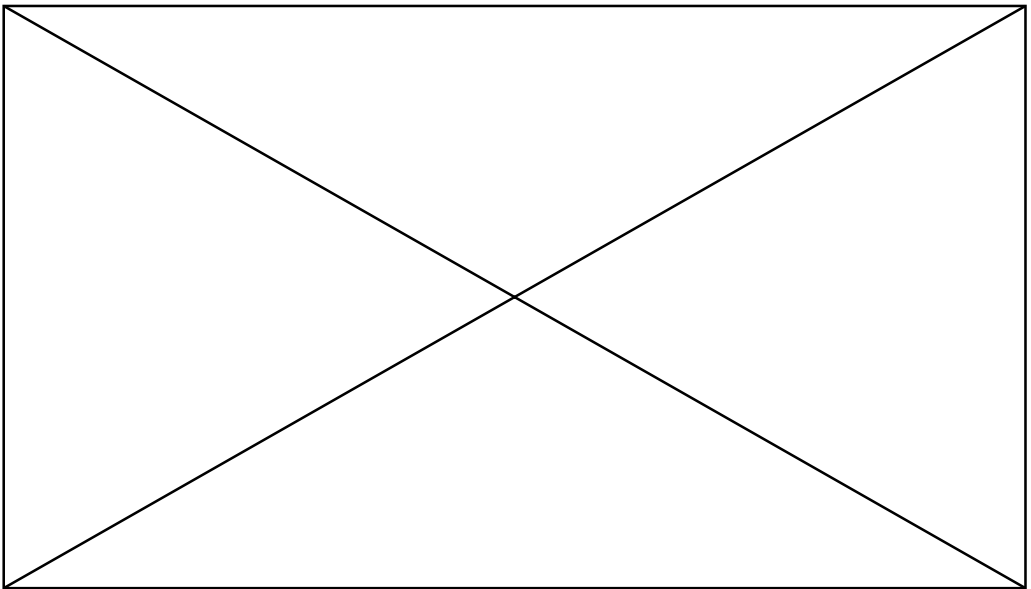
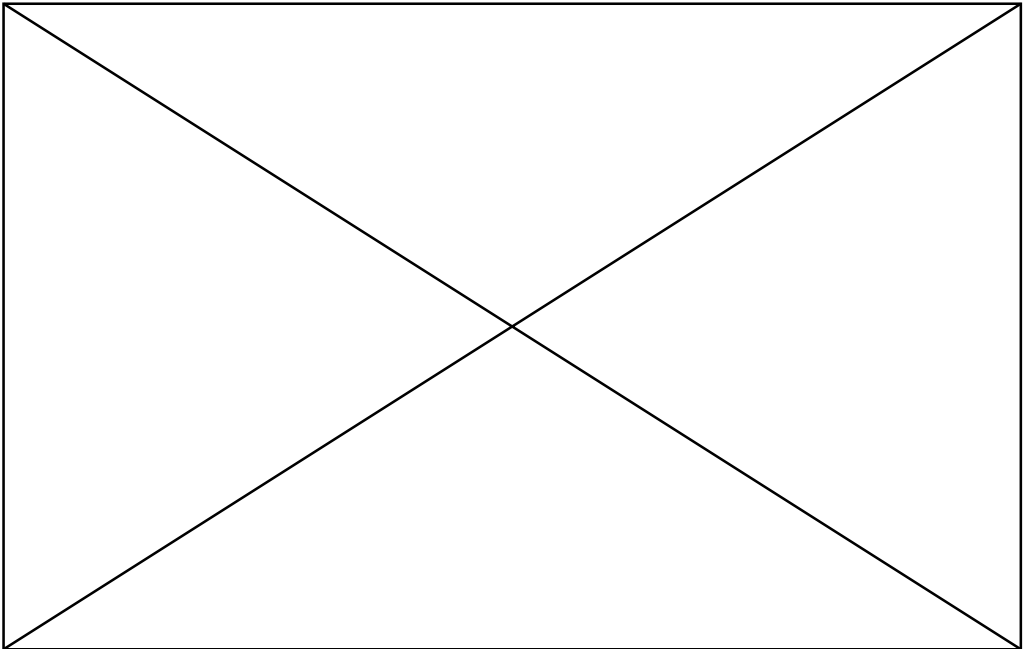


Figure B5 shows that Zambia had very low inflation levels (fixed) prior to 1992, but rose steeply between 1993 and 1997 due to price decontrols. The other relevant prices, the copper and petroleum prices, have a different pattern. For example, the copper price index was fairly stable between 1975 and 1987. However, the country experienced favourable export commodity prices between 1989 and 1991 (for three years). On the other hand, the price index of petroleum imports has been very unstable. The worst hit period in terms of high petroleum prices was between 1980 and 1983, mainly as a result of the 1979 oil shock. However, 1989 and 1990 were equally bad periods for the import prices, peaking in 1990.

**Figure B5: Consumer prices, copper and petroleum price indexes for Zambia, 1973–1997**



# Appendix C: Time Series Properties of Data, Cointegration, and Impulse Responses for the PPP Tests

**Table C1: Unit root tests**

Variables	t-ADF levels	t-ADF first difference	Significant lag length	Order of integration
With constant and trend				
Critical values: 5% = -3.47, 1% = -4.08				
LNOMDEV	-1.0	-4.1**	5	1
LCPI	-2.8	-10.6**	2	1
Without constant and trend				
Critical values: 5% = -1.94, 1% = -2.59				
LGDPF	-0.84	-8.98**	1	1
LCuPI	-0.12	-8.29**	0	1
LREERcu	-0.65	-3.91**	1	1
LREERim	-1.51	-8.8**	2	1
LTOT	-1.19	-8.53**	0	1
LCLOSE	-1.59	-7.47**	0	1
CAPFLOY	-12.11**	—	0	0
With constant only				
Critical values: 5% = -2.89, 1% = -3.50				
LWFIPI	-1.98	-7.43**	0	1
EXCRE	-6.512**		0	0

Note: \*\*, \* = indicates significance at 1% and 5% significance levels, respectively. Accept null hypothesis of a unit root, if computed t-ADF is less than critical values (i.e., Mackinnon critical values) and reject the Ho of a unit root (i.e., accept stationarity) if t-ADF computed is greater than Mackinnon critical values. L = natural logarithms.

**Table C2: Cointegration results for testing the PPP theory – lnNEERI, lnCPI and lnCuPI**

1. Null	Alternative	Test statistic	95% critical value
(i) Maximum eigenvalue test			
r = 0	r = 1	39.1**	25.5
r = 1	r = 2	17.7	19.0
r = 2	r = 3	11.2	12.3
(ii) Trace test			
r=0	r=1	68.0 **	42.4
r=1	r=2	28.9**	25.3
r=2	r=3	11.2	12.3

Sample: 1974 (q1) to 1997(q3).

**Table C3: Cointegration results for testing PPP theory – lnNEERI, lnCPI and lnWFIPI**

2. Null	Alternative	Test statistic	95% critical value
(iii) Maximum eigenvalue test			
r = 0	r = 1	38.1**	25.5
r = 1	r = 2	14.6	19.0
r = 2	r = 3	10.8	12.3
(iv) Trace test			
r = 0	r = 1	63.5**	42.4
r = 1	r = 2	25.4*	25.3
r = 2	r = 3	10.8	12.3

Sample: 1974 (q1) to 1997(q3).

**Table C4:. Cumulative impulse response changes (orthogonalized)**


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 Model 1: Period = First 12 quarters
 

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$$D \ln E_t = C_{11}(L) e^e_t + C_{12}(L) e^p_t + C_{13}(L) e^{pf}_t$$

$$D \ln P_t = C_{21}(L) e^e_t + C_{22}(L) e^p_t + C_{23}(L) e^{pf}_t$$

$$D \ln P_t^f = C_{31}(L) e^e_t + C_{32}(L) e^p_t + C_{33}(L) e^{pf}_t$$


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$$\begin{bmatrix} C_{11} & C_{12} & C_{13} \\ C_{21} & C_{22} & C_{23} \\ C_{31} & C_{32} & C_{33} \end{bmatrix} = \begin{bmatrix} 1.59 & 0.07 & 0.34 \\ 1.17 & 0.46 & 0.48 \\ -0.19 & 0.03 & 0.76 \end{bmatrix}$$

Implied change in the copper price based real exchange rate:

$$D \ln REER_{cu}_t = -0.61 e^E_t + 0.42 e^P_t + 0.9 e^{pf}_t$$


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 Model 2: Period = First 12 quarters
 

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$$D \ln E_t = C_{11}(L) e^e_t + C_{12}(L) e^p_t + C_{13}(L) e^{p^*}_t$$

$$D \ln P_t = C_{21}(L) e^e_t + C_{22}(L) e^p_t + C_{23}(L) e^{p^*}_t$$

$$D \ln P_t^* = C_{31}(L) e^e_t + C_{32}(L) e^p_t + C_{33}(L) e^{p^*}_t$$

$$\begin{bmatrix} C_{11} & C_{12} & C_{13} \\ C_{21} & C_{22} & C_{23} \\ C_{31} & C_{32} & C_{33} \end{bmatrix} = \begin{bmatrix} 1.55 & 0.14 & -0.30 \\ 1.16 & 0.55 & -0.25 \\ -0.13 & 0.07 & 0.23 \end{bmatrix}$$

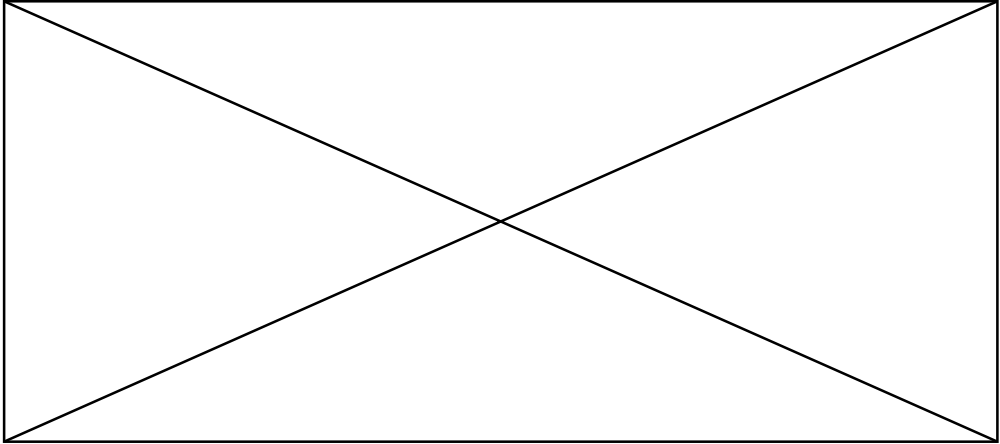
Implied change in the weighted foreign import price based real exchange rate:

$$D \ln REER_{im}_t = -0.52 e^E_t + 0.48 e^P_t + 0.28 e^{p^*}_t$$


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**Impulse Response Functions For PPP Theory Test Results (Orthogonalized)**

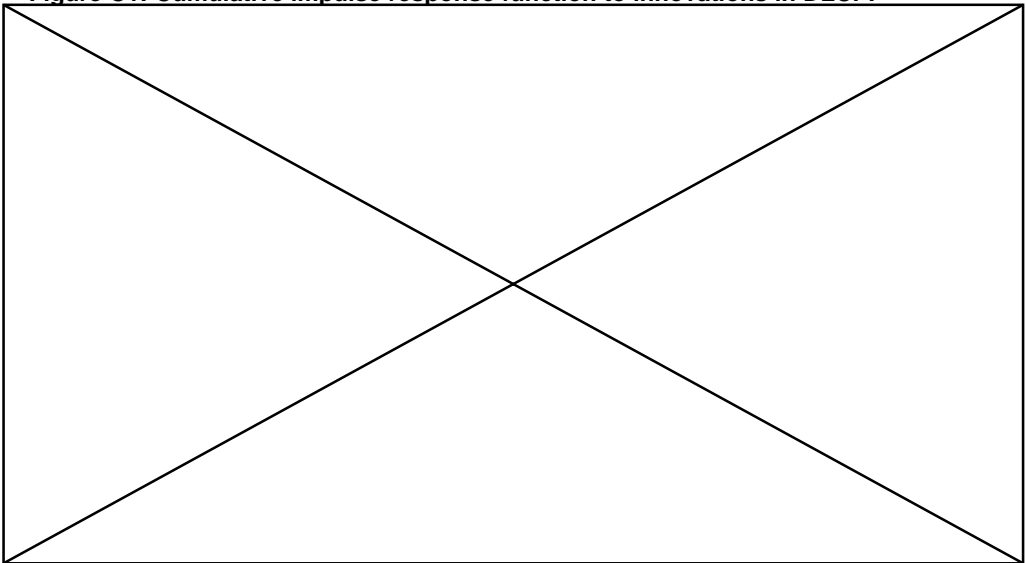
**Figure C1: Cumulative impulse response functions to innovations in DLNEERI**



Note: DLCPI = First difference of the log of consumer price index for Zambia.  
DLNEERI = First difference the log of nominal effective exchange rate index.  
DLWFIPI = First difference the log of the weighted foreign import price index for Zambia.  
DLCuPI = First difference the log of the foreign copper price index.

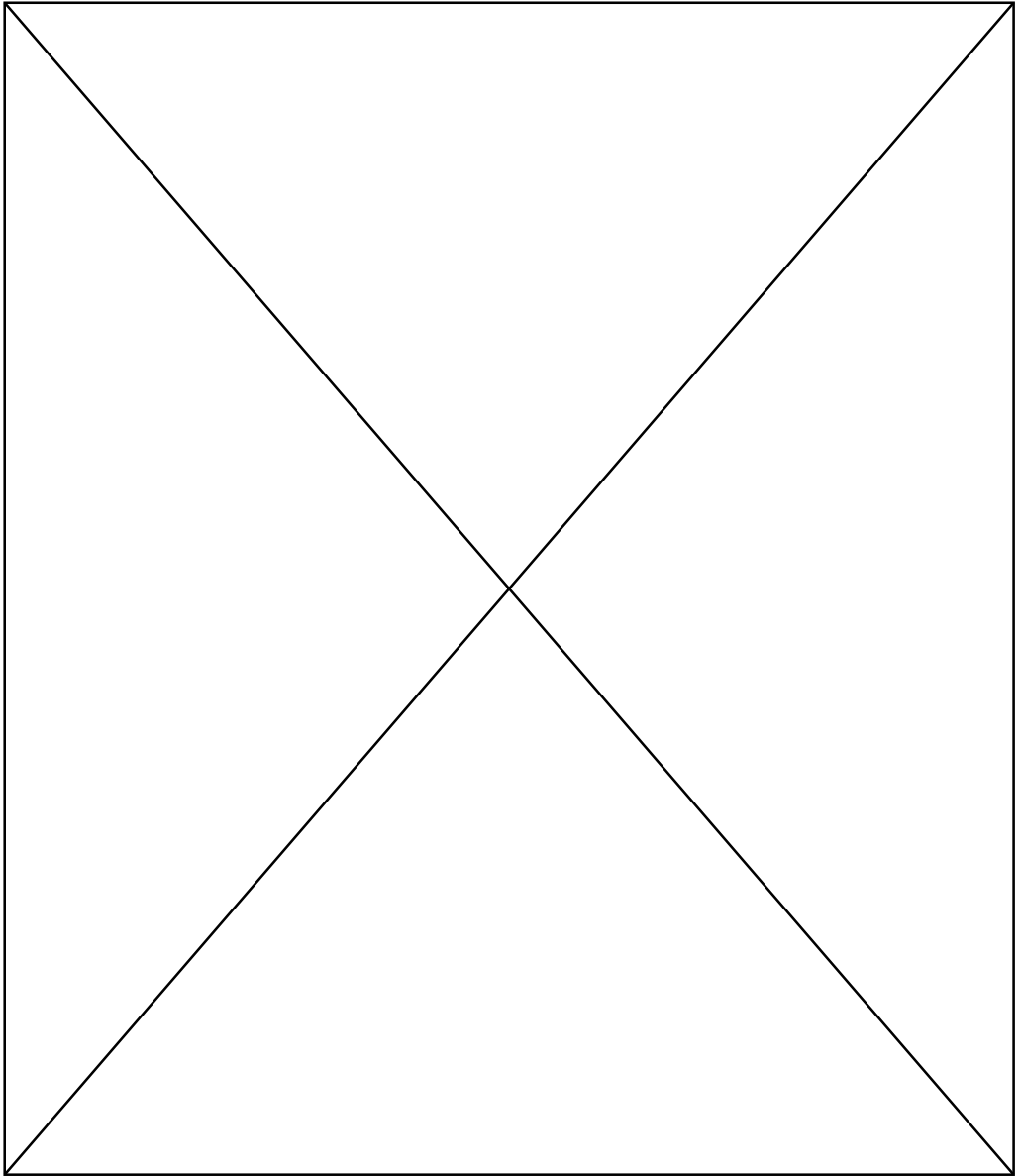
Source: Computed by the author from PC Fiml results.

**Figure C1: Cumulative impulse response function to innovations in DLCPI**

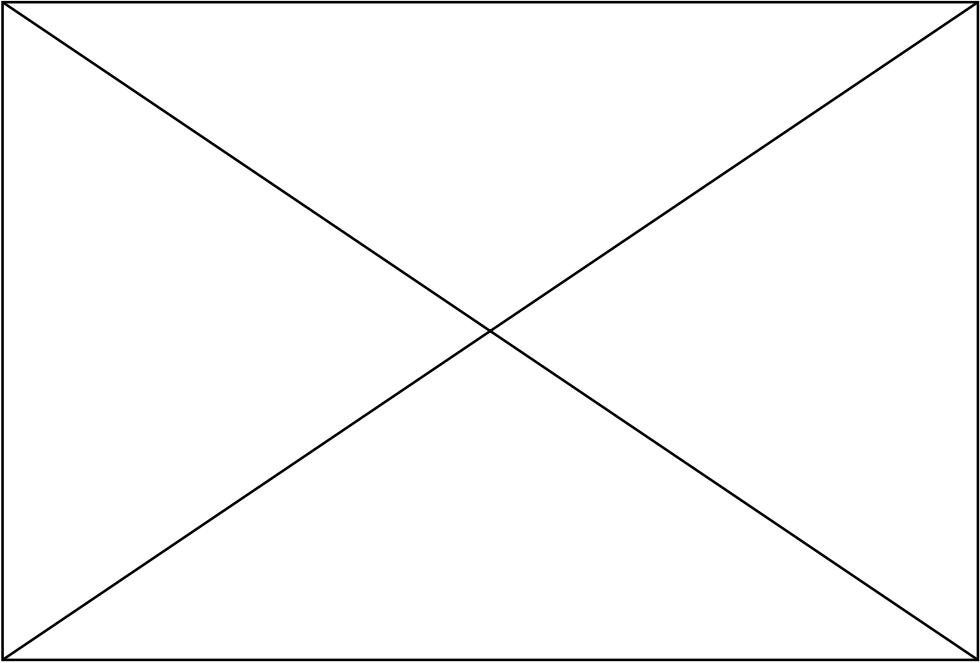


Source: Computed by the author from PC Fiml results.

**Figure C3: Cumulative impulse response function to innovations in DLCuPI**



**Figure C4: Cumulative impulse response function to innovation in DLWFIPI**



# Appendix D: Foreign Copper Price Based Equilibrium RER Model Results

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**Table D1: Cointegration test**

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Sample:	1974:1 1997:3
Included observations:	95
Test assumption:	Linear deterministic trend in the data
Series:	lnREERcu lnTOT lnCLOSE lnNOMDEV
Exogenous series:	i1987:1 i1992:1
Warning:	Critical values were derived assuming no exogenous series.
Lag interval:	1 to 2

---

Eigenvalue	Likelihood ratio	5% critical value	1% critical value	Hypothesized No. of CEs
0.70	164.41	47.21	54.46	None**
0.36	49.65	29.68	35.65	At Most 1**
0.07	7.97	15.41	20.04	At Most 2
0.01	1.05	3.76	6.65	At Most 3

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\*(\*\*) denotes rejection of the hypothesis at 5% (1%) significance level L.R. test indicates 2 cointegrating equations at 5% significance level.

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Notes: L = ln = Natural log operator.

Source: Computed by the author using "E-Views" computer software.

**Table D2: Vector error correction estimates**

1. VEC Results for Copper Based RER (DLREERCU)		2. EC Results for Petroleum based RER (DLREERim)	
Variables	Estimates	Estimates	Variables
Res1	-0.37* (-2.98)	-0.04 (-1.98)	Res1
Res2	-0.16 *(-2.69)	-0.06* (-2.7)	Res2
DREERCU <sub>t-1</sub>	-0.27 (-1.98)	-0.13 (-2.69)	DREERim <sub>t-1</sub>
DLREERCU <sub>t-2</sub>	0.05 (0.43)	-0.23 (-3.33)	DLREERim <sub>t-2</sub>
DLTOT <sub>t-1</sub>	0.30 (1.29)	-0.10 (-0.97)	DLTOT <sub>t-1</sub>
DLTOT <sub>t-2</sub>	0.12 (0.57)	0.18 (1.02)	DLTOT <sub>t-2</sub>
DLCLOSE <sub>t-1</sub>	-0.02 (-0.06)	0.42 (1.49)	DLCLOSE <sub>t-1</sub>
EXCRE <sub>t</sub>	-0.421* (-3.25)	-0.202* (-3.42)	EXCRE <sub>t</sub>
DLCLOSE <sub>t-2</sub>	0.41 (1.27)	0.63 (2.11)	DLCLOSE <sub>t-2</sub>
Constant	-0.008 (-0.38)	-0.02 (-1.22)	Constant
I1987 (impulse dummy)	0.04 (0.17)	-0.11 (-0.55)	I1987 (impulse dummy)
I1992 (impulse dummy)	-0.42 (-1.95)	-0.43 (-2.15)	I1992 (impulse dummy)
CAPFLOY <sub>t</sub>	0.01 (2.75)	0.003 (0.72)	CAPFLOY <sub>t</sub>
DLNOMDEV <sub>CU (t-1)</sub>	-1.116* (-4.98)	-0.897* (-3.98)	DLNOMDEV <sub>im (t-1)</sub>
R <sup>2</sup>	0.71	0.61	R <sup>2</sup>
Adjusted R <sup>2</sup>	.54	0.49	Adjusted R <sup>2</sup>
Likelihood Ratio	354.21	335.20	Likelihood ratio
AIC	-5.40	-4.93	AIC
SC-5.28	-4.11	SC	
SAMPLE	1973:4-1997:3	1973:4-1997:3	SAMPLE

Notes: t-values are in parentheses; Res1 and Res2 are vectors for the error term from each cointegration equation (see model for definitions of other variables); AIC = Akaike information criterion; SC = Schwartz information criterion.

Source: Computed by the author using "E-Views" computer software.

# Appendix E: Residual Test Results

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**Table E1: Foreign import price based equilibrium RER model results – Johansen cointegration test**

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Sample: 1974:1 1997:3  
 Included observations: 95  
 Test assumption: Linear deterministic trend in the data  
 Series: lnREERim, lnTOT, lnCLOSE, lnNOMDEV  
 Exogenous series: i1987:1 i1992:1  
 Warning: Critical values were derived assuming no exogenous series.  
 Lag interval: 1 to 2

---

Eigenvalue	Likelihood ratio	5% critical value	1% critical value	Hypothesized No. of CEs
0.66	253.49	48.61	55.12	None**
0.29	58.34	31.45	36.89	At Most 1**
0.09	13.64	14.17	21.96	At Most 2
0.07	5.46	4.62	7.25	At Most 3*

---

\*(\*\*) denotes rejection of the hypothesis at 5% (1%) significance level

L.R. test indicates 3 cointegrating equations at 5% significance level.

---

Notes: L = ln = Natural log operator.

Source: Computed by the author using “E-Views” computer software.

## Appendix F: Theoretical Literature Review

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A number of studies have assessed the fundamental determinants of the RER behaviour. The studies include those that concentrate on productivity differentials between the domestic and foreign countries and those that look at real, monetary and non-policy variables – called fundamentals.

First, those that used productivity differentials include Wu (1996), Balassa (1964), Hsieh (1998) and Marston (1987). In Wu (1996), differential productivity growth between the traded and non-traded goods and changes in the relative unit labour cost can lead to changes in the RER in the long run. A paper by Balassa (1964) establishes that if productivity in the domestic traded goods sector grows more rapidly than productivity in the non-traded goods sector, under the assumption of equalization in wages across sectors, the relative price between traded and non-traded goods has to fall. Since the prices of traded goods are equalized between countries through international arbitrage, the general price level will rise at home and the RER will appreciate.

Hsieh (1998) looks at the relationship between movements in the RER and productivity growth differentials in the traded and non-traded sectors. His study has supported the idea that productivity differentials are useful in explaining the movements in the RERs.

Marston (1987) also investigated the effects of productivity growth differentials between the United States and Japan and found the relationship between the RER and productivity differential to be highly significant with the latter determining the movements in the former. He measured the RER using different price indexes – unit labour costs at home and abroad.

Second, among those that used the fundamental determinants of the equilibrium RER are the following: Dornbusch (1982); Khan (1986); Khan and Montiel (1987); Edwards (1988a/b, 1989, 1990); Balassa (1990); Cottani et al. (1990); Dollar (1992); Devarajan et al. (1993); Mwegu (1993); Ghura and Grennes (1993); and Elbadawi (1994). In all these studies the equilibrium real exchange rate has been determined.

In his first study, Edwards (1988a), gave a preliminary analysis to the equilibrium RER (ERER) determination, and later developed a dynamic model of ERER determination in Edwards (1988b). The important reasons for developing such a model were because of (a) the growing importance of RER in policy discussions and (b) the lack of attempts to empirically analyse the forces behind real exchange rate behaviour in developing countries. The issue of RER determination in developing countries had remained in a “murky” state with most of the studies being carried out at an informal level. There were virtually no studies that formally attempted to explain the distinction between equilibrium and disequilibrium (i.e., misaligned) RERs. Edwards (1988b) used a dynamic model of

the long-run equilibrium real exchange rate. His model captures the most important features of the theoretical analysis in Edwards (1989) and includes: (a) that discrepancies between actual and equilibrium RERs will tend to disappear slowly if left on their own; (b) that nominal devaluations are neutral in the long run, but can be potentially helpful to speed up the restoration of RER equilibrium; (c) that macroeconomic disequilibria affect the RER in the short run; and (d) that the long-run equilibrium RER responds to changes in fundamentals. This type of model specification indicates that the autonomous forces that move the RER back to equilibrium operate fairly slowly, keeping the country out of equilibrium for a long period of time. Therefore, if a country is indeed in disequilibrium, theoretically, nominal devaluations can greatly help to speed up the RER realignment.

According to Edwards (1989), the RER has rich theoretical ground over its influence on macroeconomic performance. However, reviewing theoretical works on the RER, Edwards states that “macroeconomic policies determine whether the exchange rate chosen by the authorities can be sustained in the longer run, and under most circumstances, if macroeconomic policies become ‘inconsistent’, international reserves will be depleted (i.e. under fixed exchange rate regime), the real exchange rate will become misaligned and have an exchange rate crisis – that is, a devaluation – will eventually occur in the case of overvaluation and a revaluation in the case of an undervaluation. Therefore, a fundamental principle of open economy macroeconomics is that in order to have a sustained and stable macroeconomic equilibrium it is necessary for monetary and fiscal policies to be consistent with the chosen nominal exchange rate system. This means that the selection of an exchange rate regime imposes certain limitations on the extent of macro-policies. Therefore, violation of this consistency results into severe disequilibria characterized by misalignments of the real exchange rate.” NEED A PAGE NUMBER FOR THIS QUOTE

Elbadawi (1994), for example, used Edward’s style model to set three criteria for modelling the equilibrium RER. These criteria were selected because in the short to medium run it is the macroeconomic and exchange rate policies that influence movements in the RER.

Cottani et al. (1990) and Ghura and Grennes (1993) used the Edwards (1988b) model to measure RER misalignment and determined its impact on macroeconomic performance. However, Ghura and Grennes (1993), applied Edwards’ (1988b), on 33 countries of sub-Saharan Africa (SSA) using pooled time series (1972–1987) and cross-section data. Their results, from a simple regression method using instrumental variables, were used to construct the RER misalignment (RERMIS) index, which was then regressed against real per capita gross domestic product (GDP) and other measures of economic performance. Similarly, Mungule (1997) applied a similar model on Zambia using annual data (1965–1995). His results from the cointegrated equilibrium RER model were used to construct the RER misalignment, which was then regressed against measures of economic performance. The policy implications from the study were that inappropriate RER policy may lead to a vicious circle in which a decline in exports reduces the ability to pay for imports including capital goods, which then reduces export capability and income growth.

Dornbusch (1982) and Williamson (1985) have examined the role of real exchange rate behavior, Harberger (1986) and Dervis and Petri (1987) have also analysed the relationship between real exchange rate and economic performance. These studies concluded that the RER is determined by the real variables or fundamentals.

Medhora (1990), Ssemogerere and Ddamulira (1997), and Mwega (1993) determined the RER and analysed its behaviour in an economy. For instance, in Medhora (1982), a persistently overvalued real exchange rate would discourage all tradeable production, unless offset by tariffs, controls and subsidies. Typically, tariffs and controls are introduced when currencies are over-appreciated, but export subsidies are not. The effect is then to discourage exports, and some import-competing activities, and encourage black markets and smuggling of currency and goods. An over-depreciated exchange rate, too, results in allocative inefficiencies. Mwega (1997) concluded that under-valuation positively determined non-traditional exports and that RER levels do not explain non-traditional export performance.

# Appendix G: Impulse Responses for VEC Equation Results

**Table G1: Cumulative impulse response changes for the equilibrium real exchange rate:  $\hat{\ln}REER_{cu}$  (orthogonalized)**

Cumulative impulse response by	To innovations in				
	DLREER <sub>cu</sub>	DLTOT	EXCRE	DLCLOSE	CAPFLOY
DLREER <sub>cu</sub>	-0.243	0.670	-0.753	-0.796	-0.499
DLTOT	0.052	0.213	-0.485	-0.067	-0.060
EXCRE	-0.421	-0.117	0.238	0.078	-0.046
DLCLOSE	-0.021	-0.042	-0.372	0.106	0.039
CAPFLOY	8.932	6.453	4.461	-3.791	7.903

Source: Computed using Pc Fiml 9.0.

**Table G2: Cumulative impulse response changes for the equilibrium real exchange rate:  $\hat{\ln}REER_{im}$  (orthogonalized)**

Cumulative impulse response by	To innovations in				
	DLREER <sub>im</sub>	DLTOT	EXCRE	DLCLOSE	CAPFLOY
DLREER <sub>im</sub>	-0.014	-0.018	-0.696	-0.592	-0.313
DLTOT	-0.033	0.127	-0.039	-0.055	-0.024
EXCRE	-0.015	-0.324	0.085	0.964	-0.269
DLCLOSE	-0.042	-0.035	-0.246	0.096	0.011
CAPFLOY	4.011	5.573	2.455	-0.702	39.174

Source: Computed using Pc Fiml 9.0.

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