Long-run and Short-run Determinants of the Real Exchange Rate in Zambia

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1 Introduction

Zambia is a mineral-exporting country, which has heavily depended on copper earnings for its foreign exchange revenues. Since independence, the contribution of copper to export revenues has been substantial, at times over 90 percent. The dependence on copper to provide foreign exchange resources has meant that during times when copper prices have plummeted, the country has faced severe foreign exchange shortages, which in turn put pressure on the exchange rate, and on resources available to the economy. This necessitated external financing from the *IMF* and the World Bank, whose financing was conditioned on some structural adjustment measures that the government had to implement. The measures included among others, price decontrols, elimination of subsidies, and trade liberalisation. However, the centrepiece of the adjustment measures was the adjustment of the nominal exchange rate in order to correct for the real exchange rate misalignment.

Adjustment in the nominal exchange rate is often emphasised in economic reforms as a way to correct for misalignment in the real exchange rate. Misalignment in the real exchange rate occurs when the actual or observed real exchange rate deviates from the equilibrium real exchange rate (Edwards, 1988). Misalignment in the real exchange rate is caused by inappropriate macroeconomic policies or by structural factors, such as permanent shocks in the terms of trade (Edwards, 1988; Nilsson, 1998). When the real exchange rate is misaligned, it can lead to a distortion in price signals, in turn affecting the allocation of resources in the economy. In developing countries, misalignment in the real exchange rate has often taken the form of overvaluation, which adversely affects the tradables sector by lowering producers' real prices. In turn, incentives and profits are lowered, leading to declining investment and export volume. Some studies have attributed the sluggish performance of developing countries to misaligned real exchange rates (Cottani *et* *al*, 1990; Ghura and Grennes, 1993; Nilsson, 1998). Indeed, a number of researchers have also pointed out the importance of the real exchange rate and why it is important to understand its main determinants (see for example, Edwards, 1988 and 1989; Elbadawi and Soto, 1997; Cottani *et al*, 1990; Elbadawi, 1994; Baffes *et al*, 1999; Ghura and Grennes, 1993; Khan and Montiel, 1996; and Aron *et al*, 1997).

This paper attempts to find the main determinants of the real exchange rate in Zambia, and once these are found, to estimate the degree of misalignment in the real exchange rate. The determinants are analysed both in terms of their impact on the long-run equilibrium real exchange rate and on their short-term effect on the real exchange rate. The empirical strategy will thus involve cointegration analysis and error-correction modelling.

This study takes into account the fact that it is difficult to obtain a unique and comprehensive index for the real exchange rate. Following Hinkle and Nsengiyumva (1999*c*), three indices for the real exchange rate are calculated and used in the analysis. These are; a real exchange rate for imports, a real exchange rate for exports, and a comprehensive internal real exchange rate calculated from national accounts data. In this sense therefore, this study is an improvement over other studies on African countries (see Edwards, 1988 and 1989; Elbadawi and Soto, 1997; Elbadawi, 1994; Baffes *et al*, 1997; Kadenge, 1998; and Aron *et al*, 1997).

Our study thus makes important contributions in several respects. To our knowledge, this is not only the first study of this type on Zambia, but also, it is the first study to have estimated the three versions of the real exchange rates. Such an attempt has been avoided for being too daunting (Hinkle and Nsengiyumva, 1999*b*). Our study also employs cointegration econometrics in the analysis of long-run determinants of the real exchange rates. In general, the application of cointegration econometrics on real exchange rates is still in its infancy in Africa.

The paper is structured as follows; the next section gives a brief overview of the Zambian economy, including a summary of the exchange rate regimes that the country has had since independence. The third section reviews literature pertaining to real exchange rate determination. The fourth section presents an illustrative model for analysing the determinants of the real exchange rate, based on Baffes *et al* (1999). The fifth section gives the empirical findings, and the last section summarises the paper and draws some conclusions.

2 A Brief Overview of the Zambian Economy

This section gives a brief overview of the Zambian economy. It first discusses some selected macroeconomic indicators. The aim is to familiarise the reader with the key features of the economy. Secondly, it reviews the exchange rate systems that the economy has had since independence to date. Nominal exchange rate policy can be both a cause of, and a tool for correcting misalignment in the real exchange rate (Edwards 1988). For example, excess domestic credit in a fixed nominal exchange rate regime can lead to the appreciation of the actual real exchange rate (thus departing from the equilibrium real exchange rate). One way of correcting this misalignment is to devalue the currency. The importance of nominal exchange rate regimes in the analysis of real exchange rates cannot therefore be over emphasised. Lastly, it discusses how the real exchange rates have evolved over the period under study.

2.1 Selected Macroeconomic Indicators

The Zambian economy has been dominated by the production and exporting of a single primary product, copper. Although other minerals are mined, copper has remained the major source of export earnings. The importance of copper is evident in Table 1.

Table 1: Importance of Copper Mining to the Zambian Economy

	1970	1975	1980	1985	1990	1996
Mining and Quarrying as % of *GDP*	36	14	16	16	7.4	5.9
Mineral Tax as % of Government Revenue	58	13	5	8	0.1	2.3
Copper Exports as % of Total Exports	95	91	85	83	84	52
Mining Employment as % of Total Employment	17	17	17	16	15	10

Source: IMF (1997); Kalinda (1992); IFS CD-ROM.

Soon after independence, the earnings from copper exports helped to develop infrastructure, public services and import-substituting industries, and copper has continued to play a key role in the economy. However, in the 1970s, the copper prices fell, and Zambia's growth, which was founded on the high world prices of copper, also slumped. Real *GDP* per capita declined, and copper's contribution to government revenues fell (see Table 1).

The dependence on copper has had a profound influence on all sectors of the economy. First of all, since copper earnings supported the development of import-substituting industries, these industries virtually came to a stand still after the fall in copper prices. The plants exhibited excess capacity because the raw materials, equipment and spare parts could not be imported due to shortages of foreign exchange. Secondly, the government reduced its expenditure on economic and social infrastructure since the fall in copper earnings affected tax revenues. The reduction in public expenditure on social services meant a deterioration in the quality of life. Table 2 presents some economic indicators of the Zambian economy between 1970 and 1996. As a result of this, the government resorted to the international financial institutions (*IMF* and World Bank).

Table 2: Selected Macroeconomic Indicators, 1970-96

	1970	*1975*	*1980*	*1985*	*1990*	*1996*
Urban population (% of total)	30.2	34.8	39.8	40.9	42	43.3
Total debt service (% of *GNP*)	na	7.5	11.4	6.9	6.7	8.2
Resource balance (% of *GDP*)	16.8	-19.7	-4.0	-0.8	-0.7	-6.2
Public spending on education, total (% of *GNP*)	4.5	6.7	4.5	4.7	2.2	na
Overall budget deficit, including grants (% of *GDP*)	na	-21.7	-18.5	-15.2	-8.6	0.7
Inflation, GDP deflator (annual %)	-11.4	-14.2	11.8	41.1	106.4	24.3
LME Real Copper Prices ($/lb)[1]	2.2	1.4	1.6	0.8	1.2	0.9
Gross domestic investment (% of *GDP*)	28.2	40.9	23.3	14.9	17.3	14.9
Current account balance (% of *GDP*)	na	na	-13.3	-17.6	-18.1	na
GDP growth (annual %)	4.8	-2.3	3.0	1.6	-0.5	6.5
GDP per capita (constant 1995 US$)	664.2	646.1	555.1	487.0	453.8	404.3

Notes: na – not available; LME – London Metal Exchange. [1]Deflated by the consumer price index for US.
Source: World Bank (1999), World Development Indicators CD-ROM, Kalinda (1992).

The government first resorted to the use of *IMF* funds in 1971 to help rehabilitate the copper mine in Mufulira, which got flooded. The compensatory financing facility was for *SDR*19 million. Between 1972 and 1982, a number of programmes were negotiated with the *IMF*. The programmes were meant to ease budgetary constraints, improve the balance of payments position, and diversify the economy. However, these programmes were not successful in stemming the economic downturn. In the 1983/1985 Structural Adjustment Programme (*SAP*), more wide-ranging reforms were instituted. The centrepiece of the reforms was the auctioning of foreign exchange. The exchange rate was thus emphasised as important in inducing structural adjustment (Elbadawi and Aron, 1992). In effect, adjustment in the exchange rate was meant to correct for the misalignment in the real exchange rate. In May 1987, the government abandoned the reform programme, and replaced it with a home grown programme, the New Economic Recovery

Programme (*NERP*), under the theme "Growth from Own Resources". However, the decision to go it alone only lasted for two years. In June 1989, the government returned to the *IMF*/World Bank programme due to mounting donor and domestic pressure (Mwanza *et al*, 1992).

With the return to the *IMF*/World Bank programme, a number of liberalisation measures were reintroduced, such as decontrolling the prices of all goods except that of maize, trade reforms, parastatal and civil service reforms, and also tight monetary and fiscal policies. In the initial period, the programme registered some progress. However, in 1991, the government backtracked on its reform measures as it was determined to win support in the upcoming presidential and parliamentary elections. The government put on hold the removal of subsidies on maize and fertiliser, and it also over-run its expenditure targets due to salary increments to civil servants. Besides the budget, it also relaxed on its monetary policy, and its privatisation progress was very slow. As a result of the slow progress in its liberalisation programme and general laxity in its economic management, the donors froze their support to the programme just before the 1991 elections (Bigsten and Kayizzi-Mugerwa, 2000).

The Movement for Multiparty Democracy (*MMD*) won the 1991 elections, and upon assuming power, it introduced its Economic Reform Programme (*ERP*). The main goal of the *ERP* was to arrest the economic decline, with a strong commitment to economic liberalisation (see Bigsten and Kayizzi-Mugerwa, 2000; White, 2000). The *MMD* government attracted tremendous support from the donors. It is reported that aid to the government reached its all time peak in 1992 (Bigsten and Kayizzi-Mugerwa, 2000). The considerable support that the new government attracted was due to its strong programme for economic reforms. During its first two years in power, the new government instituted reforms at a fast pace. It removed all price controls, it devalued the currency, and it rapidly liberalised external trade and payments system. In its effort to restrain government expenditure, the government introduced a cash budget in January 1993. A cash budget system meant that the government could only spend the money it had collected in revenue, so that there can be no deficit financing. On the revenue side, the government instituted some means of increasing the flow of revenue. It set up a revenue board, the Zambia Revenue Authority (*ZRA*), to effectively collect taxes, and it later introduced *VAT* and some user fees for social services.

In its privatisation programme, the initial progress was slow. Although the Zambia Privatisation Agency (*ZPA*) was launched in 1992, it had achieved very little in its first two years. As such, the donors were pressing for more to be done. The main conflict areas were the privatisation of the national airlines, which was taking up huge subsidies, and the privatisation of the copper mines (White, 2000). The airline was finally closed, and after a number of postponed deadlines for selling off the mines, a deal was finally reached in 1999 with the Anglo-American Corporation (The Economist, 1999).

Besides the slow privatisation process, which picked up momentum in mid 1995, the donors were also concerned at the slow reforms in the public sector, and the poor governance record (White, 2000). In the public sector, the reforms were to cut the civil service by 25 percent over a three-year period so that the remunerations could be increased. However, although some retrenchments took place in 1992, the number of civil service employees actually increased between 1991 and 1996 (Bigsten and Kayizzi-Mugerwa, 2000). The huge and inefficient civil service has thus remained a serious constraint on growth.

2.2 The Nominal Exchange Rate Regimes

The main thrust in studying real exchange rates is to determine the extent of real exchange rate misalignment. Misalignment that is due to the inconsistency between macroeconomic policy and the nominal exchange rate is of particular policy interest. Countries that pursue administratively fixed exchange rate regimes are more prone to this type of misalignment. In this sub-section, we briefly document different exchange rate regimes that Zambia has gone through since independence. Table 3 summarises these systems. We can identify seven distinct exchange rate systems, ranging from fixed ones to the current market-determined exchange rate system.

From Table 3, we can see that from independence in 1964 to 1985, Zambia had a fixed exchange rate regime. During this period, the kwacha was pegged to different convertible currencies, namely the British pound, the American dollar, the Special Drawing Right (*SDR*), and to a trade weighted average of a basket of currencies of Zambia's main trading partners. When the kwacha was pegged to Zambia's trading partners, it was allowed to adjust within a narrow range, unlike in the earlier cases when no adjustment was made except for occasional devaluations. The fixed exchange rate was not maintained by an active intervention in the foreign exchange market as is the standard in market economies. Rather, the exchange rate was fixed more or less by decree, and a series of administrative controls were instituted to deal with any possible excess demand for foreign currency. Issuing of import licenses was one such administrative control.

In 1985, the government adopted the auctioning system, in order to determine the market exchange rate, to improve the allocation of foreign exchange, and to eliminate the parallel market for foreign exchange (Mailafia, 1997; Reinikka-Soininen, 1990). The auctioning of foreign exchange was part of the reforms negotiated with the *IMF* under a wider adjustment programme. The auctioning system was a dual one in that there was an auction-determined rate, and a below-auction rate which was used for allocating foreign exchange to special needs such as debt-servicing, medical and educational supplies, oil imports, and needs for the mining company and national airline. [1]

Table 3: Exchange Rate Policy Episodes in Zambia, 1965-96

Period	*Policy*
1964-1971	Fixed to the British Pound.
1971-1976	Fixed to the American Dollar.
1976-1983	Pegged to the Special Drawing Right. The kwacha was devalued occasionally.
1983-1985	Pegged to a weighted average of a basket of currencies of Zambia's five trading partners. The kwacha was allowed to adjust within a narrow range.
1985(Oct)-1987(Jan.)	Dual exchange rate system – auction determined and below auction rate; two-tier auction.
1987(Jan)-1987(Mar.)	Fixed rate to the Dollar; then to a basket of currencies of Zambia's major trading partners; Rate allowed to float within a band of K9-K12.50/US$.
1987(Mar)-1987(May)	Dual exchange rate system – official rate and auction-determined rate; Foreign Exchange Management Committee (*FEMAC*) was to allocate foreign exchange.
1987(May)-1990(Feb.)	Fixed rate, with occasional devaluations.
1990(Feb)-1991(Apr.)	Dual exchange rate system – retail and official windows managed by *FEMAC*.
1991 to date:	The liberalised regime. The following events led up to the market-determined exchange rate:
Oct 1991	A new government, the Movement for Multiparty Democracy (*MMD*) assumed office, with a promise to accelerate the pace of liberalisation. It instituted a number of policy reforms.
Early 1992	Weekly devaluations of the kwacha were announced. A 100% retention for non-traditional exporters was announced.
September 1992	Legislation was passed to license bureaux. The bureaux became operational in October. The *OGL* list was expanded.
December 1992	*BOZ* announced that the bureau rates were to be used in its transactions. The *OGL* retail window and official foreign exchange windows were unified, although allocations to the government, *ZCCM*, and *ZIMOIL* were done outside the unified window.
June 1993	Further modifications were introduced to the *OGL*, one of which was that *BOZ* was to determine the exchange rate for *OGL* funds on the basis of the bureau rates.
January 1994	The Exchange Control Act was repealed. All capital controls were abolished, making the kwacha fully convertible.
December 1994	The *OGL* system was abolished.
1996	The *ZCCM* revenue retention scheme was abolished. The company could trade freely in the inter-bank market. The *BOZ* selling and buying rates were now determined by the average daily retail rates of commercial banks.

Source: Bank of Zambia; World Currency Yearbook (1996); Mwenda, 1996; IMF.

[1]The auctioning was done by a Dutch system in which sealed bids were submitted to commercial banks. Those who were successful bought their currency at their bid prices, while the exchange rate was determined by the marginal market-clearing bid that exhausted the supply of foreign exchange. The auctioning was conducted by the Bank of Zambia (*BOZ*) on a weekly basis.

The auctioning system's life was short. This was due to a number of factors (see Bates and Collier, 1995 for a detailed discussion of these factors). First, the auctioning of foreign exchange was seen as having caused not only the depreciation of the kwacha, but also, it was blamed for having caused inflation. As a result, it became extremely unpopular especially among urban dwellers. The second factor that contributed to the loss of support for the auctioning system among the people was that it was perceived as having benefited the rich at the expense of the poor. The third factor was that the auctioning system was mismanaged. At the time, the Bank of Zambia saw inflation as being driven by rising costs. As a result, they sought to appreciate the exchange rate by selling foreign exchange in amounts that were in excess of the amount of foreign exchange available. The intervention in the foreign exchange market by *BOZ* resulted in the following; firstly, private traders lost confidence in government commitments, which they found not to be credible, hence creating a huge demand for foreign exchange. Secondly, as a result of the huge demand created by the unfulfilled promises for foreign exchange, the exchange rate depreciated instead of appreciating as was initially intended. Thirdly, *BOZ* incurred huge losses by intervening. By agreeing to sales of foreign exchange that it did not have, it set up a forward market. However, given the depreciating kwacha, *BOZ* had to buy foreign exchange at a higher price than it sold it at. The losses that the Bank incurred were monetised, and according to Bates and Collier (1995), primary liquidity increased by 142 percent in a period of nine months from the beginning of the auctioning. Of course, such an increase in primary liquidity was inflationary. The intervention by *BOZ* in the foreign exchange market contributed to the misalignment in the real exchange rate. We shall see later that this was the case.

The auctioning system began to be dismantled in January 1987, and was replaced by a fixed exchange rate regime, in which the kwacha was first of all fixed to the dollar, and then to a basket of currencies of Zambia's major trading partners. The rate was allowed to float within a band of K9-K12.50/US$. This system lasted until March, when a new dual exchange rate system was ushered in. In the dual system, an official rate and an auction-determined rate existed. A new structure, the Foreign Exchange Management Committee (*FEMAC*), was also introduced to allocate foreign exchange and to process import license applications. In this system, the official rate was determined on a daily basis with reference to a basket of currencies of Zambia's leading trading partners, while the auction rate was the marginal bid at which the foreign exchange offered for sale was exhausted. The requirements for oil, the mining company, the national airline, and for fertiliser were given outside the *FEMAC* system. By May 1987, *FEMAC* was abolished due to administrative inefficiencies, and the exchange rate system reverted to a fixed one.

The fixed system lasted until February 1990. During the fixed system, a number of devaluations were effected. In the meantime, *FEMAC* was being restructured to take up operations of yet another regime. In February 1990, another dual system was put in place, and was once again, managed by *FEMAC*. The new dual system involved two windows, a retail and an official one. In the retail window, importers applied for foreign exchange through their banks, while the official window, which operated with a lower rate, catered for remittances and payments for the mining company. The dual system lasted until 1991, when a number of reforms were made to liberalise the foreign exchange market. Among the reforms done was the unification of the two windows, and legislation was passed to authorise the setting up of bureaux de change. By 1994, all capital controls were removed. Thus, as a result of the unification of the rates and the liberalisation of the foreign exchange system, the exchange rate became market-determined.

The exchange rate regimes in Table 3 reflect how the government's exchange rate policy evolved over time. Due to the existence of exchange controls from the time of independence, coupled by external macroeconomic imbalance, a black market for foreign exchange existed alongside the official market. The existence of a black market for foreign exchange is an indication of real exchange rate misalignment. In the black market, the exchange rate was freely floating. The parallel market was by and large illegal in Zambia, except prior to the auctioning when it was quasi-legalised with the introduction of the export retention schemes and “own funds” import licenses (Elbadawi and Aron, 1992). Kiguel and O’Connell (1995) observe that the parallel market was made legal between 1987 and 1988. Due to the illegal nature of the parallel market for most of the time that it existed, information on size and volume of transactions is not available. In spite of the lack of information, the importance of the parallel market is illustrated by the size of the premium. Between 1971 and 1993 for which data on the parallel market is available, the average premium was 193 percent. Figure 1 in Appendix 3 shows the evolution of the parallel market premium between 1971 and 1993.[2] The figure shows that the premium rose after the two copper price shocks of 1971 and 1974. Between 1976 and 1983, there was a slight downward trend in the premium. However, from 1984, an upward trend ensued, which coincided with the period just before the auctioning system. This period was also characterised by a further decline in the real price of copper. There was a sharp rise in 1988, a year after the break with the *IMF*. Thereafter, the premium took a steady downturn. It is notable that the government resumed its *IMF*/World Bank supported programme in 1989. The downward trend in the premium continued until it finally disappeared after the unification.

[2]The black market premium was calculated as follows; $\frac{BMR}{OR}-1$, where *BMR* refers to the black market rate, and *OR* to the official rate.

2.3 Definition and Evolution of the Real Exchange Rate

There are two approaches commonly used to define the real exchange rate. The first one defines the real exchange rate as the ratio of the price of foreign to that of domestic goods, expressed in domestic currency (Black, 1994). This is expressed as follows;

$$\langle 1 \rangle \quad RER \equiv e \equiv E\frac{P*}{P}$$

where, e is the real exchange rate, E is the nominal exchange rate expressed as the local currency price of a foreign currency, $P*$ is the foreign price level, and P is the local price level. This definition is *PPP*-based, and it is widely used in empirical studies on developed countries.

The other way of defining the real exchange rate derives from the "well known Salter-Swan non-traded goods model" (Black, 1994:285). The real exchange rate in this sense is defined as the ratio of the price of traded goods to non-traded goods (or its inverse);

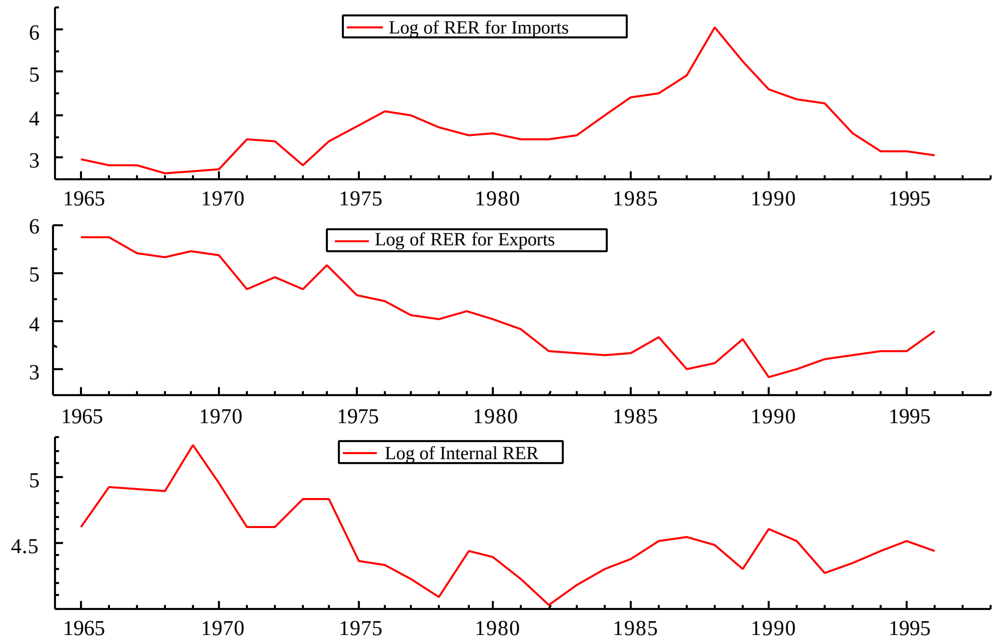
$$\langle 2 \rangle \quad RER \equiv e \equiv E\frac{P_T^*}{P_N}$$

where, P_T^* is the world price for traded goods, P_N is the (domestic) price of non-traded goods,[3] and E is the nominal exchange rate.

[3]In some cases, the real exchange rate is defined as $RER \equiv e \equiv \frac{P_N}{EP_T}$ (Edwards, 1988). If defined in this manner, an increase in e means an appreciation, while a decrease means a depreciation.

In our empirical analysis, we calculate three indices of the real exchange rate (see sub-section 5.1 for details). The first one is a multilateral real exchange rate for imports. We use the parallel market rate to calculate the multilateral real exchange rate for imports between 1971 and 1993, a period when the parallel market was widespread, while for the rest of the period, the official exchange rate is used. The second index we calculate is a multilateral real exchange rate for exports, in which we use the official market rate. The third index is calculated from national accounts data (see also Appendix 1 for details on the computation of the three indices). The evolution of the three indices is shown in Figure 1.

Figure 1: Evolution of the Real Exchange Rate Indices



A number of important features can be highlighted in Figure 1. The real exchange rate for imports was fairly stable between 1965 and 1970. It then depreciated after 1970 before appreciating between 1972 and 1973. There was a steady depreciation after 1973 up to 1976 when it appreciated until 1983. Thereafter, it started a fast depreciation, reaching an all time high in 1988, and then it appreciated thereafter. The real exchange rate for exports has shown a steady downward trend from 1965 to 1990. Thereafter, it started depreciating. The internal real exchange rate exhibits more fluctuations than the first two indices. Notable periods are in 1969 when the real exchange rate depreciated sharply, and also in 1974 and 1981 when it appreciated. In general, the trend between 1969 and 1981 was that of appreciation, and then depreciation thereafter.

In this study, we shall model the long-run fundamentals that have been behind the evolution of all the three real exchange rates, and also the short-run factors.

3 A Brief Literature Review

A recent book edited by Hinkle and Montiel (1999) offers an outstanding review on issues of real exchange rates. The book deals with measurement issues, determinants of the real exchange rate and empirical studies on real exchange rates. There are also other good reviews and analyses of the real exchange rate,[4] such as Williamson (1994) and Edwards (1988, 1989). Williamson (1994) provides a simple and excellent account of the way the concept of real exchange rate evolved through the desire by economists to determine what the equilibrium exchange rate is. Williamson himself has been central in the development and evolution of the real exchange rate concept.[5] In brief, Williamson (1994:178) pointed out that the motivation behind the preoccupation with issues of the real exchange rate has been the desire to “identify an appropriate concept of equilibrium exchange rate and estimating its value”. Once an appropriate nominal exchange rate is determined, then necessary adjustments can be made to achieve it. The accepted practice now is to consider a nominal exchange rate as appropriate if it is such that the actual real exchange rate coincides with the long-run equilibrium real exchange rate.

[4]The real exchange rate is also called fundamental equilibrium exchange rate or desired equilibrium exchange rate (Williamson, 1994).

[5]See for example Feyzioglu (1997).

Whichever definition of the real exchange rate is used, the equilibrium real exchange rate is considered to be the one that is consistent with both the external and internal balance of the economy. Misalignment occurs when the real exchange rate deviates from its equilibrium path.

Studies on the determinants of the real exchange rate and the effects of real exchange rate misalignment have assumed an important part in research over the past decades. For example, Edwards (1989) developed a theoretical model of real exchange rate behaviour and devised an empirical equation of how to estimate the real exchange rate dynamics. According to him, the long-run equilibrium real exchange rate is affected by real variables only, that can be classified as internal and external fundamentals. In the short-run however, the real exchange rate may be affected by both real and nominal factors. The important fundamentals that determine the real exchange rate are the terms of trade, level and composition of government consumption, controls on capital flows, exchange and trade controls, technological progress, and capital accumulation. Edwards (1989) empirically tested his model and its main implications using pooled data for a group of twelve developing countries by analysing the relative importance of real and nominal variables in the process of real exchange rate determination in the short-run and long-run. The study found that in the short-run, real exchange rate movements are affected by both real and nominal factors. In the long-run however, only real factors affect the sustainable equilibrium real exchange rate. Edwards (1989) further investigated whether there was any link between real exchange rate misalignment and economic performance. His conclusion was that the countries whose real exchange rates were closer to equilibrium out-performed those with misaligned real exchange rates.

Edwards' (1989) work inspired a number of studies on not only the determinants of the real exchange rate, but also on issues of misalignment of the real exchange rate. It led to increasing consensus to the effect that one of the crucial conditions for improving economic performance in less developed countries (*LDCs*) is a stable real exchange rate and one that is correctly aligned. Cottani *et al* (1990) also argued that in parts of Latin America, unstable real exchange rates inhibited export growth, while in Asia, export expansion was fostered by stable real exchange rates. On the other, in Africa, the widespread poor performance of the agriculture sector and economic growth in general could be attributed to persistently misaligned real exchange rates.

Empirical findings by other researchers have also concurred that a chronic misalignment in the real exchange rate is a major factor responsible for the poor economic performance of most developing countries[6]. For example, Ghura and Grennes (1993) used a panel of Sub-Saharan countries to investigate the impact of real exchange rate misalignment on economic performance. They too found that real exchange rate misalignment negatively affected income growth, exports and imports, and investment and savings.

The importance of the real exchange rate has led to several studies to investigate its determinants. Such studies include Ghura and Grennes (1993) for a panel of Sub-Saharan countries, Cottani *et al* (1990) and Elbadawi and Soto (1997), each on a group of developing countries, and Aron *et al* (1997) for South Africa. In these studies, the most common determinants of the real exchange rate were found to be terms of trade, openness, capital inflows and nominal devaluations.

While earlier research on the determinants of the real exchange rate used classical regression analysis,[7] of late, researchers have employed cointegration analysis.

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[6]See also Sekkat and Varoudakis (1998).

[7]See for example Edwards (1989), Sekkat and Varoudakis (1998), Ghura and Grennes (1993), and Cottani *et al* (1990).

Cointegration analysis provides statistical tests for determining the existence of a long-run equilibrium in a model. It further enables the estimation of long-run steady state parameters, once equilibrium is found to exist. Cointegration analysis is thus handy in the empirical investigation of the determinants of the long-run equilibrium real exchange rate. Studies employing cointegration analysis in the empirical analysis of real exchange rates are numerous. These include, Baffes *et al* (1999) for Côte d'Ivoire and Burkina Faso, Elbadawi and Soto (1997) for seven developing countries, Feyzioglu (1997) for Finland, Kadenge (1998) for Zimbabwe, Gelband and Nagayasu (1999) for Angola, and Faruquee (1995) for *US* and Japan.

4 Theoretical Framework

Two distinct approaches to analysing the equilibrium real exchange rate have been used in the literature, and they follow each other chronologically. The first approach is based on the Casselian form of strict Purchasing Power Parity, which holds that the equilibrium real exchange rate for a given country remains constant over time. This is because nominal exchange rates were considered to adjust rapidly to any price differential between the country and its trading partners (Elbadawi and Soto, 1997). This approach is hardly used. One of the reasons for discarding it is that the strict Casselian *PPP* fails empirical tests. It is now widely accepted that absolute *PPP* does not hold, and thus the equilibrium real exchange rate defined as such, cannot be constant over time.[8]

The second approach considers the equilibrium real exchange rate as a path upon which an economy maintains both internal and external balance. The equilibrium real exchange rate is not an immutable number; it is rather influenced by some real variables.

[8]For other variants of Casselian *PPP*, see Paper I in this thesis.

4.1 The Model

We will use a model developed by Montiel (1996, cited by Baffes *et al,* 1999; and Feyzioglu, 1997) to illustrate the theoretical derivation of the real exchange rate fundamentals. We will adopt the definition of the real exchange rate that has been widely accepted and used in developing countries (Baffes *et al*, 1999; Elbadawi and Soto, 1997; and Edwards, 1989). The real exchange rate is defined as the domestic relative price of traded to non-traded goods. That is;

$$\langle 3 \rangle \quad RER \equiv e \equiv E \frac{P_T^*}{P_N}$$

where, P_T^* is the world price for traded goods (we assume a small open economy), P_N is the (domestic) price of non-traded goods, and E is the nominal exchange rate. An increase in e implies a depreciation of the real exchange rate, while a decrease implies an appreciation.

The equilibrium real exchange rate is defined as the one that occurs when the economy enjoys both internal and external balance, and these balances are sustainable with respect to all the relevant factors. Internal equilibrium is attained when the supply and demand for non-traded goods are equal;

$$\langle 4 \rangle \quad Y_N(e) = (1-a)eC + G_N, \qquad \partial Y_N / \partial e < 0$$

where,

Y_N is the production of non-traded goods,

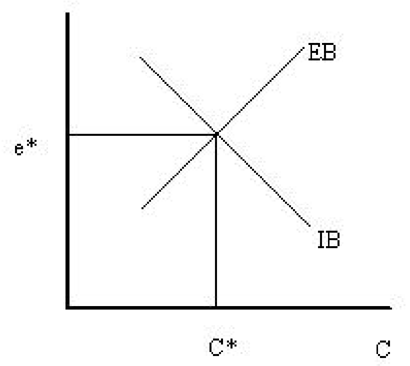
G_N is government consumption of non-traded goods,

a is the share of traded goods in total consumption, and

C is total private consumption measured in traded goods.

Equation 4 thus characterises the internal balance (*IB*) in Figure 2, where the real exchange rate is inversely related to consumption. This is because if we start from a position of internal balance, a rise in private spending creates an excess demand for non-tradable goods at the original real exchange rate. In order to restore equilibrium, a real appreciation is required, which would switch supply toward non-tradable goods, and demand toward tradable goods.

Figure 2: Internal and External Balance



Again, following Baffes *et al* (1999), external balance is defined by the following equation of the current account balance;

$$\langle 5 \rangle \quad \dot{f} = Y_T(e) - G_T - aC + z - rf$$

where,

f is net foreign assets, and $\dot{f}$ is change in net foreign assets over time,

$Y_T(e)$ is the domestic supply of traded goods,

G_T is government spending on traded goods,

z is net aid inflows and $r\,f$ is external debt service.

Equation 5 therefore states that the external balance equals the trade balance (that is, domestic output of traded goods net of local consumption of these goods), net aid inflows and less costs on foreign debt.

At equilibrium, $\dot{f} = 0$, along which we can obtain a relationship between private consumption and the real exchange rate depicted as *EB* in Figure 2. The *EB* line slopes upwards because if we started from a position of external balance, a rise in private spending would generate a current account deficit at the original real exchange rate. In order to restore equilibrium, the real exchange rate must depreciate. The depreciation would switch demand toward non-tradable goods, and supply toward tradable goods.

The intersection of *EB* and *IB* produces the equilibrium real exchange rate. At such an intersection, both the internal and external balance are achieved. This is also achieved by setting the right hand side of equation 5 to zero, and combining this with equation 4. This gives,

$$\langle 6 \rangle \quad e^* = e^*(G_N, G_T, r^* f^* + z)$$

where, a star on the variables refers to steady-state values of endogenous variables. The steady-state values of *r*f** are solved by assuming that the country faces an upward-sloping supply curve of net external funds and that households optimise over an infinite horizon. The final expression for the equilibrium real exchange rate becomes,

$$\langle 7 \rangle \quad e^* = e^*(G_N, G_T, z, r_W)$$

where, r_W is the world interest rate.

The derivation above is for illustrative purpose. It serves to show how the fundamentals (for example, government consumption, terms of trade, investment share, and technical progress) influence the movement of the real exchange rate. For practical application, extensions to the model above can be made in many ways. For example, Baffes *et al* (1999) discuss extensions to the model involving rationing of foreign credit, changes in the domestic relative price of traded goods, and short-run rigidities in domestic wages and prices. An interesting extension in the case of Zambia relates to changes in the terms of trade and trade policy. Changes over time in the terms of trade or trade policy require the real exchange rate to be disaggregated into two; the real exchange rate for imports, and the real exchange rate for exports (see Hinkle and Nsengiyumva, 1999*c*). The equilibrium real exchange rates for imports and exports would then be a function of the fundamentals in equation 7, along with terms of trade (x) and trade policy (h), as in equation in 8.

$$\langle 8 \rangle \quad e^* = e^*(G_N, G_T, z, r_W, x, h).$$

In the empirical literature, researchers focus on fundamentals that are relevant for their particular situations. For example, Edwards (1988:6) identified the following class of fundamental determinants that are domestic and susceptible to policy impact; the composition of government expenditure, import tariffs, import quotas, export taxes, exchange and capital controls and other taxes and subsidies. Other fundamentals may include terms of trade, change in technology, world real interest rates and so on. Below we discuss some of these determinants and try to identify their impact on the real exchange rate.

Terms of trade and Trade Policy

Terms of trade are defined as the relative price of exports to imports. The impact of a change in the terms of trade on the real exchange rate is theoretically ambiguous (see Elbadawi and Soto, 1997, Aron *et al,* 1997, Baffes *et al,* 1999, and Edwards. 1989). This is because the direct income effect operating through the demand for non-tradables may dominate the indirect substitution effect that operates through the supply of non-tradables. For example, to illustrate the impact of the direct income effect, let the price of exports increase, and the price of imports stay constant. This will increase the income of a country whose price of exports has increased (an improvement in the terms of trade). In turn, the increased income raises the demand for all goods, imports and non-tradables. Since the price of imports is given, the higher demand would not affect the price of imports. However, the price of non-tradable goods would increase due to the high demand, and hence a real exchange rate appreciation will occur. If a deterioration in the terms of trade occurred, it may lead to the opposite effect; reducing income and demand for all goods and hence resulting in a depreciation in the real exchange rate.

Sometimes, the indirect substitution effect may dominate the direct income effect, leading to opposite results of any terms of trade effects analysed above. For example, an improvement in terms of trade may provide sufficient foreign exchange resources to producers of non-tradable goods in the economy. Being one of the factors influencing production, the increased resources may then enable the producers to increase their production of non-tradable goods, hence lowering its price. The improvement in the terms of trade may thus lead to a depreciation in the real exchange rate. If terms of trade deteriorated, the producers would face foreign exchange constraints and hence their procurement of inputs for producing non-tradables would be constrained. The constraints in the procurement of inputs would then reduce production and increase the price of non-tradables, leading to an appreciation in the real exchange rate. In Elbadawi and Soto's (1997) study of seven developing countries, in three cases, an improvement in the terms of trade appreciated the real exchange rate, while in four cases, an improvement in the terms of trade depreciated the real exchange rate. Feyzioglu (1997) also found that an improvement in the terms of trade appreciated the real exchange rate for Finland.

Trade policy is another variable which affects the real exchange rate. A reduction, for example, in an import tariff can decrease the domestic price of imports, which are a part of tradables. This can in turn decrease the local currency price of tradables, leading to an appreciation in the real exchange rate. An increase in import tariffs can have the opposite effect. That is, it can raise the domestic price of imports, thereby depreciating the real exchange rate. However, the demand for imports and consequently for foreign exchange will increase, leading to a depreciation in the real exchange rate. In their study of Côte d'Ivoire and Burkina Faso, Baffes *et al* (1999) found results consistent with the theory; that reforms that are aimed at liberalising trade are consistent with a depreciated real exchange rate.

Government consumption spending also affects the real exchange rate. The impact of government consumption depends on whether such consumption is predominantly on traded goods or non-traded goods. Following Edwards (1989), we will illustrate this by assuming two periods, 1 and 2. We can further simplify the illustration by assuming away distortionary taxes. Let us assume an increase in government consumption of non-tradables in period 1. Assume further that borrowing from the public or international sources finances this. The equilibrium real exchange rate will be affected in two possible ways. Period 1 may witness an increase in demand for goods and services, which will lead to an increase in the price of non-tradables. This will lead to an appreciation in the equilibrium real exchange rate. However, in period 2, the government may have to hike taxes to pay the debt. This may reduce disposable income, and hence reduce aggregate demand. Such a movement will reduce the price of non-tradables, and thus lead to a depreciation in the equilibrium real exchange rate. From this, it may be noted that it is not possible to tell *a priori* the effect of changes in government consumption of non-tradables on the equilibrium real exchange rate. The same situation obtains in analysing the impact of changes in government consumption of tradables on the equilibrium real exchange rate (Edwards, 1989). Edwards (1989) found that an increase in government consumption appreciated the real exchange rate in four of the equations he estimated for a group of twelve developing countries, while in the other two equations, an increase in government consumption depreciated the real exchange rate.

Capital inflows affect the relative price of tradables to non-tradables, and hence the real exchange rate. For example, if there is an exogenous capital inflow, it can increase the demand for non-tradable commodities, hence raising its price in the process. This would in turn appreciate the real exchange rate. In his study of twelve developing countries, Edwards (1989) found that an increase in capital inflows appreciated the real exchange rate, as expected.

Central bank reserves indicate the capacity of the bank to defend the currency (Aron *et al*, 1997). As such, an increase in reserves has the effect of appreciating the real exchange rate, while a decrease in reserves depreciates the real exchange rate. In their study of the determinants of the real exchange rate for South Africa, Aron *et al* (1997) found results consistent with theory; an increase in reserves appreciated the real exchange rate.

Investment share's effect on the real exchange rate depends on whether an increase in investment changes the composition of spending on traded and non-traded goods. If an increase in the share of investment in *GDP* changes the composition of spending towards traded goods, it would lead to a depreciation in the real exchange rate (Baffes *et al*, 1999; Edwards, 1989). On the other hand, a change towards non-traded goods appreciates the real exchange rate. For example, Baffes *et al* (1999) found that an increase in the share of investment in *GDP* depreciated the real exchange rate in Côte d'Ivoire. Edwards (1989) also found that increases in the share of investment in *GDP* resulted in a depreciation in the real exchange rate in his study of twelve developing countries.

The growth rate of real Gross Domestic Product is normally used in empirical studies to proxy technological progress (Edwards, 1989). Ricardo is said to have been the first one to postulate a negative relationship between economic growth and the relative price of tradable to non-tradable goods. Other authors also pointed out the tendency for the relative price of tradables to non-tradables to decline over time. For example, Balassa indicated that the rate of productivity growth is higher in countries with higher rates of growth, and that within these countries, the productivity gains are higher in the tradable sector (Edwards, 1989).

Edwards (1989) formally incorporated the effect of technological progress in his model. According to his model, the effect of technological progress on the real exchange rate depended on two things; how technological progress affected different sectors, and the type of progress considered, whether product augmenting or factor augmenting (Edwards, 1989:48). If any productivity shock occurred, it would have a positive income effect, which would in turn generate a positive demand pressure on non-tradable goods. The increased demand would increase the price of non-tradables, and hence lead to an appreciation in the real exchange rate. However, technological progress could also depreciate the real exchange rate. This could happen if technological progress resulted in supply effects and if these more than offset the demand effects. The implication is that technological progress could appreciate or depreciate the real exchange rate. Edwards (1989) found that an increase in technological progress depreciated the real exchange rate in all his regressions. Aron *et al* (1997), on the other hand, found that an increase in technological progress appreciated South Africa's real exchange rate.

5 Empirical Analysis

This section discusses the data, estimation and empirical results.

5.1 The Data

The data in this study was obtained from the *IFS CD-ROM*, *OECD CD-ROM*, publications from the Bank of Zambia, the Ministry of Finance and the United Nations. The description of the variables used is given in Appendix 1. All the variables are in logs, except for the growth rate of real Gross Domestic Product, which proxies technological progress. The data used is annual, covering the period 1965 to 1996.

In most theoretical studies, the real exchange rate is defined as the ratio of the prices of tradable to non-tradable goods. In practice, however, the prices of tradable and non-tradable goods are difficult to get. Instead, proxies are used, and often, foreign wholesale price indices are used to proxy the prices of tradables, and consumer price indices are used to proxy prices of non-tradable goods. Hinkle and Nsengiyumva (1999*c*) have noted that this measure of the real exchange rate may be appropriate to use in situations where the terms of trade facing a particular country under study are stable. It therefore makes its use for developing countries inappropriate, since most of them export primary products whose prices fluctuate substantially. They recommend that if it is used in developing countries, it should be used to proxy the real exchange rate for imports, and a separate real exchange rate should be calculated for exports.[9] In our study, we calculate the real exchange rates for imports and exports, and an overall internal real exchange rate using national accounts data. We use the methods suggested by Hinkle and Nsengiyumva (1999*b*,*c*).

We used the parallel market exchange rate between the *US* dollar and the kwacha in our computation of the multilateral real exchange rate for imports for the period 1971 to 1993 during which the parallel market was pervasive. Before 1971, the data for the parallel market is not available, and as such, we use the official rate. After 1993, the parallel market disappeared with the liberalisation of the foreign exchange market. For calculating the real exchange rate after 1993, we used the market-determined rate.

The parallel market was pervasive, as indicated by the parallel market premium. Hence the parallel market exchange rate must have been relevant to economic agents in trade decisions. Edwards (1989) notes that in cases where the parallel market for foreign exchange is widespread, the official exchange rate is irrelevant in constructing real exchange rate indices (see also Hinkle and Nsengiyumva, 1999*a*). Edwards (1989) recommends the use of parallel market exchange rates in such cases. However, for calculating the multilateral real exchange rate for exports, we used the official exchange rate. This is because unlike the importers who could easily use the parallel market for their foreign currency needs, the main exporters, such as *ZCCM*, had to convert their foreign exchange earnings into local currency at the official exchange rate.

We could not find data for the price of tradable and non-tradable goods, and thus we follow the convention and use the wholesale price index for the trading partners

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[9] Hinkle and Nsengiyumva (1999*b*) provide a method for calculating the real exchange rate for exports, which we adopt in this study. Given their observation that they do not know of any study that has employed this method empirically, our study is probably the first to implement it.

as a proxy for the price of tradable goods, and the consumer price index for Zambia as a proxy for non-tradable goods. See Appendix 1 for details on how we calculated the real exchange rates for imports (*lrerm*) and exports (*lrerx*), and the internal real exchange rate (*lrera*).

The variables used for fundamentals were determined by three considerations; theory, availability of data, and whether the variable fits well in the model in statistical terms. The long-run fundamentals that we attempted in our estimation are; terms of trade, investment share, government consumption, the growth rate of real *GDP*, openness, trade taxes as a percentage of *GDP*, central bank reserves, government deficit as a percentage of *GDP*, world real interest rates, foreign price level, resource balance, and aid. The fundamentals that performed well in our estimation of the real exchange rate for imports are; terms of trade, investment share, and government consumption, while in the estimation of the real exchange rate for exports, the following variables performed well; terms of trade, central bank reserves, and trade taxes as a percentage of *GDP*. For the internal real exchange rate, the following variables performed well; terms of trade, investment share, and the growth rate of real *GDP*. We could not obtain data on government consumption disaggregated into tradables and non-tradables. We therefore follow a common practice of using aggregate government consumption (see Elbadawi, 1994).

The order of integration of the variables is reported in Table 4. We used the Augmented Dickey Fuller (*ADF*) test for the purpose, with sufficient lags to whiten the residuals. The results show that all the variables, except the nominal exchange rate (which is integrated to order two), are integrated to order one, denoted as *I(1)*.

Table 4: Unit Root Test of the Variables; Annual Data, 1965-1996

Variable	*Trend*	*Lags*	*ADF/DF*	*LM Test for Serial Correlation*	*Order of Integration*
Lrerm	No	0	-1.494	$F(1,28) = 2.198$ [0.149]	I(1)
ΔLrerm	No	0	-4.355**	$F(1,27) = 0.844$ [0.366]	I(0)
Lrerx	No	1	-2.036	$F(1,25) = 1.459$ [0.238]	I(1)
ΔLrerx	Yes	0	-8.128**	$F(1,26) = 2.329$ [0.139]	I(0)
Lrera	No	0	-2.028	$F(2,27) = 1.638$ [0.213]	I(1)
ΔLrera	No	1	-5.764**	$F(2,24) = 0.567$ [0.575]	I(0)
Ltot	No	2	-1.387	$F(2,23) = 1.241$ [0.308]	I(1)
ΔLtot	No	1	-5.343**	$F(2,24) = 1.327$ [0.284]	I(0)
Lgcons	Yes	0	-1.319	$F(2,26) = 0.362$ [0.699]	I(1)
ΔLgcons	Yes	0	-6.257**	$F(2,25) = 0.716$ [0.498]	I(0)
Lishare	Yes	0	-2.517	$F(2,26) = 0.216$ [0.807]	I(1)
ΔLishare	No	0	-7.049**	$F(2,26) = 1.092$ [0.351]	I(0)
Gry	Yes	0	-3.358	$F(2,25) = 2.273$ [0.124]	I(1)
ΔGry	No	1	-5.353**	$F(2,24) = 1.448$ [0.255]	I(0)
Loexr	Yes	4	0.872	$F(2,18) = 0.036$ [0.965]	I(2)
ΔLoexr	Yes	4	-2.664	$F(2,17) = 0.816$ [0.459]	I(1)
ΔΔLoexr	No	3	-4.237**	$F(2,19) = 2.013$ [0.161]	I(0)
Lcbresy	No	0	-1.709	$F(2,27) = 0.343$ [0.713]	I(1)
ΔLcbresy	Yes	0	-7.914**	$F(2,25) = 0.364$ [0.699]	I(0)
Lttaxy	No	0	-2.229	$F(2,27) = 0.418$ [0.663]	I(1)
ΔLttaxy	No	2	-4.004**	$F(2,22) = 2.959$ [0.073]	I(0)
Lopen	No	0	-3.253	$F(2,26) = 0.219$ [0.804]	I(1)
ΔLopen	No	3	-3.749**	$F(2,20) = 0.041$ [0.962]	I(0)
Lrms	Yes	0	-1.410	$F(2,26) = 0.298$ [0.745]	I(1)
ΔLrms	Yes	0	-5.354**	$F(2,25) = 0.726$ [0.494]	I(0)
Laid	Yes	3	-3.189	$F(2,20) = 1.120$ [0.346]	I(1)
ΔLaid	No	3	-4.792**	$F(2,20) = 2.839$ [0.076]	I(0)

Notes: *ADF – Augmented Dickey Fuller; DF – Dickey Fuller; **Significant at 1%; *Significant at 5%.*

5.2 Estimation

We first conducted cointegration analysis using the Johansen procedure to determine whether there is a long-run equilibrium relationship between the variables. Due to limited observations, we could not perform cointegration analysis for all the variables at a go. Instead, we carried out the analysis for four variables (real exchange rate included) at a time. After a series of attempts, we chose a combination whose Vector Autoregressive (*VAR*) analysis produced good diagnostic test results.[10] The combination we chose is; terms of trade (*ltot*), investment share (*lishare*), and government consumption (*lgcons*) for the real exchange rate for imports (*lrerm*); terms of trade, central bank reserves as a percentage of *GDP* (*lcbresy*), and trade taxes as a percentage of *GDP* (*lttaxy*) for the real exchange rate for exports (*lrerx).* For the internal real exchange rate (*lrera*), we chose terms of trade (*ltot*), the rate of growth of real *GDP* (*gry*), and investment share (*lishare*).

In employing the Johansen procedure to determine the number of cointegrating vectors, we first estimated an unrestricted *VAR* with sufficient lags. In the *VAR* estimation, due to concerns about the degrees of freedom, we started with a lag length of two. All the second lags were then pared down after checking their significance. After reducing the lag length to one, we checked whether the model reduction was accepted before proceeding (see Table 5). In Table 5, the *F-test* for reducing the number of lags from two to one is accepted for all the three real exchange rates. The information criteria, except the *AIC* for the case of the real exchange rate for imports, accept the reduction. The log-likelihood value also supports the reduction for all the three real exchange rates.

Furthermore, after testing for the inclusion of deterministic terms (see Table 1 in Appendix 3), we included the constant as a restricted variable. The dummies entered unrestricted in the *VAR*.[11] We did not include the trend.

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[10]We tried other variables in combination but could not get any set of cointegrated variables. Some of the variables we tried are; world real interest rate, deficit as a percentage of *GDP*, trade taxes as a percentage of *GDP* and several proxies of trade policy, aid flows, central bank reserves as a percentage of *GDP* and resource balance. We were particularly surprised by not finding any cointegration that includes aid flows in the model. White and Edstrand (1994) in a different study also failed to establish a cointegration relationship between aid flows and the real exchange rate in Zambia.

[11]See Doornik *et al* (1998) on the role of deterministic terms in cointegration analysis, in which they strongly recommend that impulse dummies should be entered unrestrictedly. The dummy used for *lrerm* was for the period 1988 when it depreciated sharply, while for the *lrerx*, the dummy was for 1990 when it appreciated. The inclusion of the dummies improved the diagnostic test results of the real exchange rate equations and the *VAR* in general.

Table 5: Model Reduction

RER	*Lags*	*T*	*P*	*Log-likelihood*	*SC*	*HQ*	*AIC*	*Test of model reduction*[1]
RER for Imports	1	30	24 OLS	213.84	-11.54	-12.30	-12.66	F(16,52) = 1.59 [0.11]
	2	30	40 OLS	231.91	-10.93	-12.20	-12.79	
RER for Exports	1	30	24 OLS	194.19	-10.23	-10.99	-11.35	F(16,52) = 1.07 [0.41]
	2	30	40 OLS	207.08	-9.27	-10.54	-11.13	
Internal RER	1	30	20 OLS	227.09	-12.87	-13.51	-13.81	F(16,55) = 1.14 [0.34]
	2	30	36 OLS	240.11	-11.93	-13.07	-13.61	

Notes: [1]From two lags to one lag; T- sample size; p – number of coefficients; SC - Schwarz Information Criteria; HQ - Hannan-Quinn Information Criteria; AIC - Akaike Information Criteria.

We also checked for the properties of the residuals, that is, for normality, serial correlation and heteroscedasticity in the preferred *VAR* model. The diagnostic tests are given in Table 6. The table only reports the diagnostic tests for the overall *VAR*, and it shows that the tests are all insignificant. The diagnostic tests for the other equations were all clear, although they are not reported here.

Table 6: Diagnostic Tests

RER	*Equation*	*Test*	*Test Distribution and Statistic*
RER for Imports	VAR	Normality	$\chi^2(8)$ = 4.7575 [0.7831]
		Serial Correlation	F(32,53) = 1.2695 [0.2171]
		Heteroscedasticity[1]	F(80,52) = 0.7821 [0.8406]
		Heteroscedasticity[2]	F(140,25) = 0.3798 [0.9998]
RER for Exports	VAR	Normality	$\chi^2(8)$ = 9.9392 [0.2693]
		Serial Correlation	F(32,49) = 1.1557 [0.3146]
		Heteroscedasticity[1]	F(80,52) = 0.9095 [0.6532]
		Heteroscedasticity[2]	F(140,17) = 0.5905 [0.9702]
Internal RER	VAR	Normality	$\chi^2(8)$ = 10.8870 [0.2082]
		Serial Correlation	F(32,56) = 1.1517 [0.3158]
		Heteroscedasticity[1]	F(80,56) = 0.8533 [0.7473]
		Heteroscedasticity[2]	F(140,33) = 0.5768 [0.9850]

Notes: [1]Using squares; [2]Using squares and cross products.

5.3 Cointegration Results

Table 7 gives the results of the cointegration analysis. For the real exchange rate for imports, both statistics, that is, the l_{trace} and l_{max} statistics show that the null hypothesis for no cointegration is rejected in favour of the alternative that there is one cointegrating vector. However, when adjusted for degrees of freedom, the l_{trace} statistic is exactly equal to the critical value at 5 percent. Thus, at 10 percent, the l_{trace} statistic would show that there is one cointegrating vector. The l_{max} statistic reports no cointegration for the real exchange rate for imports when adjusted for degrees of freedom. Such conflicting results are not uncommon in cointegration analysis. By using both the adjusted and unadjusted l_{trace} statistic at 10 percent, we proceeded with an assumption of one cointegrating vector. Our conclusion is supported by the plot showing the first vector in the cointegration space that appeared close to being stationary (see Figure 2a in Appendix 3).

Table 7: Cointegration Results

RER	*Ho:rank=p*	l_i	l_{max}	*Adj. for df*	*95% CV*	l_{trace}	*Adj. for df*	*95% CV*
RER for Imports	p == 0	-	28.69*	24.98	28.1	60.97**	53.1	53.1
	p <= 1	0.60	22.02*	19.18	22.0	32.29	28.12	34.9
	p <= 2	0.51	7.501	6.533	15.7	10.26	8.938	20.0
	p <= 3	0.22	2.76	2.404	9.2	2.76	2.404	9.2
RER for Exports	p == 0	-	33.28**	29.99*	28.1	51.84	45.15	53.1
	p <= 1	0.66	12.69	11.05	22.0	18.56	16.16	34.9
	p <= 2	0.34	3.872	3.373	15.7	5.866	5.109	20.0
	p <= 3	0.12	1.994	1.737	9.2	1.994	1.737	9.2
Internal RER	p == 0	-	32.35*	28.17*	28.1	69.32**	60.37**	53.1
	p <= 1	0.65	16.92	14.73	22.0	36.97*	32.2	34.9
	p <= 2	0.42	14.93	13	15.7	20.05*	17.46	20.0
	p <= 3	0.38	5.127	4.465	9.2	5.127	4.465	9.2

*Notes: **Significant at 1 percent; *Significant at 5 percent; The column denoted by l_i reports the eigenvalues.*

For the real exchange rate for exports, the l_{max} statistics shows that the null hypothesis of no cointegration is rejected in support of the alternative of one cointegrating vector, even when adjusted for degrees of freedom. However, the l_{trace} statistic shows no cointegration at all. We once again proceeded with the assumption that there is one cointegrating vector using the l_{max} statistic. The plot of the first cointegrating vector is given in Figure 2b in Appendix 3.

For the internal real exchange rate, the l_{trace} and l_{max} statistics show that the null of no cointegration is rejected. However, the l_{trace} also shows that there may be three cointegrating vectors, although when adjusted for degrees of freedom, it shows that there is only one cointegrating vector. We also proceeded with the assumption that there is one cointegrating vector. Figure 2c in Appendix 3 plots the first cointegrating vector.

Assuming we have one cointegrating vector for all three real exchange rate indices, we then investigated whether we could use a single equation rather than a multivariate procedure for estimating an error-correction model for each of the three real exchange rates. The use of a single equation would be appropriate for preserving the degrees of freedom. Two conditions need to be fulfilled; having a single cointegrating vector, and establishing that the variables are weakly exogenous (Harris, 1995).

To test for weak exogeneity, we imposed restrictions on the a vector that the relevant variables were equal to zero, together with a general restriction of a single cointegrating vector. Initially, we tested for each variable individually, and the restriction was accepted for all variables except investment share in the models for the real exchange rate for imports and the internal real exchange rate. However, at the 1 percent level of significance, the restriction was also accepted for investment share (see Table 8). We then imposed a joint restriction that all variables are weakly exogenous. This restriction was tested within the framework of a single cointegrating vector. The joint restriction could not be rejected for the real exchange rates for imports and exports, while for the internal real exchange rate, it was rejected at 5 percent. However, the restriction could not be rejected at 1 percent (see Table 8).

Table 8: Multivariate Test for Weak Exogeneity

Variable	*RER for Imports*	*RER for Exports*	*Internal RER*
Ltot	$\chi^2(1) = 0.0033$ [0.9539]	$\chi^2(1) = 1.3871$ [0.2389]	$\chi^2(1) = 0.0053$ [0.9421]
Lishare	$\chi^2(1) = 2.3387$ [0.1262]*	--	$\chi^2(1) = 5.6052$ [0.0179]*
Lgcons	$\chi^2(1) = 0.0109$ [0.9168]	--	--
Lcbresy	--	$\chi^2(1) = 0.1420$ [0.7063]	--
Lttaxy	--	$\chi^2(1) = 3.2083$ [0.0733]	--
Gry	--	--	$\chi^2(1) = 2.4752$ [0.1157]
All	$\chi^2(3) = 2.4606$ [0.4825]	$\chi^2(3) = 6.5475$ [0.0878]	$\chi^2(3) = 8.3611$ [0.0391]*

*Notes: *Significant at 5 percent.*

The cointegration results where the joint restrictions of one cointegrating vector and weak exogeneity are imposed are reported in Table 9. The variables are all significant, and the results show that the real exchange rate for imports depreciates if terms of trade improve, or if government consumption increases. However, the real exchange rate for imports appreciates if investment share increases. The real exchange rate for exports also depreciates if terms of trade improve, but it appreciates if central bank reserves and trade taxes increase. The internal real exchange rate depreciates if terms of trade improve, while it appreciates if investment share and the rate of growth of real *GDP* increase.

Table 9: Cointegration Analysis with Restrictions

RER for Imports				
β'				
Lrer	Ltot	Lishare	Lgcons	Constant
1.0000	-0.32059	1.6647	-1.8994	-3.4373
(0.00000)	(0.18576)	(0.37606)	(0.41534)	(0.69094)
α				
Lrer				
-0.39410				
(0.06286)				
RER for Exports				
β'				
Lrer	Ltot	Lcbresy	Lttaxy	Constant
1.0000	-0.70045	0.57004	0.31376	-1.2053
(0.0000)	(0.073806)	(0.17149)	(0.10608)	(0.64649)
α				
Lrer				
-0.78046				
(0.11882)				
Internal RER				
β'				
Lrer	Ltot	Lishare	Gry	Constant
1.0000	-0.46724	0.30948	0.48165	-3.6667
(0.0000)	(0.048825)	(0.085971)	(0.14849)	(0.16898)
α				
Lrer				
-0.77907				
(0.12385)				

Notes: The figures in parentheses are standard errors.

The positive and significant effect of the terms of trade on the real exchange rate indices that we found implies that the substitution effect dominates the income effect. The substitution effect may have been on the supply side, in which case an improvement in the terms of trade may have relaxed the foreign exchange constraints on intermediate inputs in the production of non-tradables. This in turn helped the producers to increase the supply of non-tradable goods, and hence lowering the price of non-tradables. This resulted in the depreciation in the real exchange rate indices (see also, Elbadawi and Soto, 1997).

Aron (1999) also observed the same positive effect of the terms of trade on the real exchange rate. In Aron's study, evidence is presented to illustrate that the relative prices of two non-tradable sectors, namely services and construction, increased sharply after the first copper price boom, then fell over time after 1974. Furthermore, it may be noted that there were price controls[12] in Zambia, which mainly affected food items. The price controls helped to keep the prices of non-tradables lower than the level they would have been at in a free market. The dominance of the substitution effect over the income effect that we found is not unusual. Elbadawi and Soto (1997) also found that the substitution effect dominated the income effect in Côte d'Ivoire, Ghana and India.

The coefficient on government consumption for the real exchange rate for imports is also positive and significant. In a way, this result comes as a bit of a surprise to us. This is because the result suggests that in the case of Zambia, government consumption has largely been in tradable commodities. Even though we could not obtain detailed data on the composition of government consumption, a general review of some statistics reveals that a large percentage of government consumption consists of wages and salaries, followed by recurrent departmental charges.[13] We consider labour as a non-tradable good in Zambia. However, in the empirical literature, we found that the same results have been obtained from studies on developing countries (see for example, Elbadawi and Soto, 1997; and Edwards, 1989).

[12]From independence, price controls were applied to producer prices of agricultural goods, prices of "essential commodities", and prices of some goods of parastatal companies (Aron, 1999). Some prices were liberalised in 1989, although maize was not liberalised until 1992.

[13]A further disaggregation done by Aron (1999) indicates that of the recurrent expenditure by the government, a significant proportion has been in "constitutional and statutory expenditure", of which defence has been increasing, apart from government debt. The other category of recurrent expenditure, which comprises of mainly salaries, has virtually been sustained at the same percentage.

The coefficient on investment share found for the real exchange rate for imports and the internal real exchange rate is negative and significant. It suggests that gross fixed capital formation has affected more the relative price of non-tradable commodities. It was not possible to get a detailed disaggregation of the data on gross fixed capital formation except that between 40 and 20 percent of it has been in residential and non-residential buildings, and land improvements. The other percentage has been in a category classified as "other". Since most of the investment is in buildings that are constructed using locally produced cement and materials, this might have contributed in increasing the price of non-tradables, and hence appreciating the real exchange rate. Combined with this result that investment share has had the effect of increasing the price of non-tradables, the implication is that the demand side effect of investment has been stronger than the supply side effect of investment.

The coefficient on central bank reserves is negative and significant. It indicates that an increase in central bank reserves appreciates the real exchange rate for exports. This is consistent with theory. Aron *et al* (1997) also found that in the case of South Africa, an increase in reserves appreciates the real exchange rate. The coefficient on trade taxes is negative. It implies that when trade taxes increase, they appreciate the real exchange rate for exports. This is because when trade taxes increase, they increase the domestic prices of imported goods. The increase in prices makes consumers to shift their demand to locally produced substitutes, and hence increasing their prices, leading to an appreciation in the real exchange rate for exports (see Hinkle and Nsengiyumva, 1999*c*).

Lastly, the rate of growth of real *GDP* appreciates the internal real exchange rate. The coefficient is negative and significant. This implies that the rate of technical progress has increased the prices of non-tradable goods over time, and hence appreciating the real exchange rate.

We then conducted further tests on the cointegration results. We tested whether each of the explanatory variables could be excluded from the equation individually and jointly. The results of the exclusion tests are given in Table 10. They show that all explanatory variables, except the growth rate of real *GDP* in the internal real exchange rate model, cannot be excluded from the cointegrating vectors. Although the multivariate test for exclusion of variables shows that the growth rate of real *GDP* could be excluded from the cointegration vector, we could not drop it given its significance, as indicated by its standard error in Table 9.

Table 10: Multivariate Test for Exclusion of variables

Variable	*RER for Imports*	*RER for Exports*	*Internal RER*
Ltot	$\chi^2(1)$ = 4.4335 [0.0352]*	χ^2 (1) = 18.018 [0.000]**	$\chi^2(1)$ = 13.542 [0.0002] **
Lishare	$\chi^2(1)$ = 5.9931 [0.0144]*	--	$\chi^2(1)$ = 12.897 [0.0003] **
Lgcons	$\chi^2(1)$ = 3.9071 [0.0481]*	--	--
Lcbresy		χ^2 (1) = 9.6793 [0.002]**	
Lttaxy		χ^2 (1) = 9.8285 [0.002]**	
Gry	--	--	$\chi^2(1)$ = 1.3814 [0.2399]
Lrer	$\chi^2(1)$ = 5.6321 [0.0176]*	$\chi^2(1)$ = 19.587 [0.0000]**	
All	$\chi^2(4)$ = 18.844 [0.0008]**	$\chi^2(4)$ = 28.093 [0.0000]**	$\chi^2(4)$ = 9.7307 [0.0018] **

*Notes: **Significant at 1 percent. *Significant at 5 percent.*

5.4 Error-correction Model: Estimation and Results

We then estimated error-correction models by using single equations. We did this in order to capture short-run determinants of the real exchange rates. The error-correction terms were obtained from the solved static long-run equations reported in Table 11. As expected, the long-run parameter estimates are the same as the ones calculated by the multivariate Johansen technique in Table 9. The output in Table

11 includes the *Wald test*,[14] which rejects the null that all long-run coefficients are zero at the 95 percent level of significance. The *Wald test* supports the multivariate tests we did on exclusion of variables (see Table 10).

Table 11: Solved Static Long-run Equations

RER for Imports					
Lrerm =	+3.438	+0.3206 Ltot	-1.665 Lishare	+1.899 Lgcons	+3.907 d1988
(SE)	(1.171)	(0.2561)	(0.5621)	(0.5588)	(1.179)
ECM = Lrerm - 3.4376 - 0.3206*Ltot3 + 1.6646*Lishare - 1.8995*Lgcons - 3.9075*d1988;					
WALD Test $\chi^2(4)$ = 38.374 [0.0000]**					
RER for Exports					
Lrerx =	+1.2053	+0.7005 Ltot	-0.57 Lcbresy	-0.3138 Lttaxy	-0.966 d1990
(SE)	(0.8794)	(0.09214)	(0.2168)	(0.1487)	(0.3327)
ECM = Lrerx - 1.205 - 0.7005*Ltot + 0.5700*Lcbresy + 0.31376*Lttaxy + 0.9664*d1990;					
WALD test $\chi^2(4)$ = 289.7 [0.0000]**					
Internal RER					
Lrera =	+3.667	+0.4672 Ltot	-0.309 Lishare	-0.4817 Gry	
(SE)	(0.2764)	(0.2197)	(0.1383)	(0.0727)	
ECM = Lrera – 3.66675 - 0.467233*Ltot + 0.309472*Lishare + 0.481655*Gry;					
WALD Test $\chi^2(3)$ = 62.096 [0.0000]**					

*Notes: lrerm – RER for Imports; Lrerx – RER for Exports; lrera – Internal RER; The figures in Parentheses are standard errors. **Significant at 1 percent.*

In the error-correction models, several stationary variables were included to capture the short-run dynamics. These include all the variables in the cointegration vector differenced once. Other stationary variables included are real money supply, openness, and aid flows, also differenced once, and the official nominal exchange rate differenced twice. General unrestricted models were estimated. In order to develop parsimonious models, we progressively eliminated variables that were insignificant, and we also re-parameterised some variables. In the progressive

[14] The *Wald test* is a test of the null that all long-run coefficients, except the constant, are zero (Harris, 1995).

elimination and re-parameterisation, we were guided by the information criteria and the *t*-statistic (Hendry, 1995; Adam, 1992). The steps we took to arrive at the parsimonious models are given in Table 2 in Appendix 2. The parsimonious models are given in Table 12.

Table 12: Parsimonious Error-correction Models

Dependent Variable: Dlrer[1]	*RER for Imports*	*RER for Exports*	*Internal RER*
Constant	-0.0534 (0.0489)	0.0244 (0.0400)	0.0012 (0.0215)
*ECT*_1	-0.3811 (0.2554)	-0.7891 (0.2420)	-0.7971 (0.1370)
ΔLrer_2		0.2184 (0.1225)	
ΔΔLrer_1	0.2272 (0.1003)		
ΔLgcons	1.1081 (0.3786)		
ΔLgcons_1	0.9042 (0.3557)		
ΔLishare	-0.8970 (0.2708)		
ΔLishare_1	-0.5743 (0.2756)		
ΔLtot		0.5307 (0.1852)	0.3557 (0.0958)
ΔΔLtot_1			0.1827 (0.0721)
ΔLaid_1			0.0874 (0.0374)
ΔGry_2			
ΔLcbresy		-0.4094 (0.1828)	
ΔLcbresy_1		-0.4699 (0.1800)	
ΔΔLoexr		0.4478 (0.1842)	
ΔLopen	0.8185 (0.3531)		
ΔLopen_1	1.0935 (0.3533)		
ΔLrms			0.2648 (0.1013)
Dummy	2.0397 (0.3321)	-0.9770 (0.2141)	
Diagnostics			
R-Squared	0.77	0.80	0.78
Serial Correlation	F(2,17) = 1.846 [0.188]	F(2,18) = 1.354 [0.283]	F(1,22) = 0.090 [0.767]
ARCH 1	F(1,17) = 0.995 [0.332]	F(1,18) = 1.691 [0.210]	F(1,21) = 0.000 [0.990]
Normality	$\chi^2(2)$ = 1.299 [0.522]	$\chi^2(2)$ = 0.102 [0.950]	$\chi^2(2)$ = 4.785 [0.091]
RESET	F(1,18) = 1.876 [0.188]	F(1,19) = 0.005 [0.944]	F(1,22) = 0.628 [0.437]

Notes: [1]*Refers to respective real exchanges; ECT – error correction term; The figures in parentheses are standard errors.*

The results in Table 12 show the short-run effects on the real exchange rate indices. All the variables, except for the constants, are significant. In the model for the real exchange rate for imports, a change in investment share appreciates the real exchange rate. This means that the long-run and short-run effects of investment share on the real exchange rate for imports is the same. The variables that depreciate the real exchange rate for imports are the second difference of the real exchange rate (lagged once), the first difference of government consumption (lagged once), and the first difference of openness (also lagged once). Although the openness variable did not enter in any of the real exchange rate models in the cointegration, it shows that in the short-run, an increase in the openness of the Zambian economy tends to depreciate the real exchange rate for imports.

In the model of the real exchange rate for exports, a change in the first difference in central bank reserves (and lagged once) leads to an appreciation in the real exchange rate. The effect of central bank reserves in both the long-run and short-run is the same. A depreciation in the real exchange rate for exports occurs due to a change in the following variables; the first difference of the real exchange rate lagged twice, the first difference of terms of trade, and the second difference of the nominal exchange rate. The substitution effect, once again, dominates the income effect in the terms of term effect, while a devaluation in the nominal exchange rate, as expected, leads to a depreciation in the real exchange rate for exports.

In the model for the internal real exchange rate, the following variables depreciate the real exchange rate in the short-run; the first difference of terms of trade, and the second difference of terms of trade lagged once, the first difference of aid, and the first difference of real money supply. This is as expected. In the short-run, once again, the substitution effect of a change in the terms of trade seems to dominate the income effect. The effect of aid flows has been to depreciate the internal real exchange rate. This can be explained by the fact that aid inflows may have eased the intermediate input constraints on producers, hence contributing to an increase in the supply of non-tradable goods, whose prices in turn fell. An increase in real money supply, as expected, depreciates the real exchange rate. This comes about due to an increase in aggregate demand, which increases the demand for all goods, including imports. The increase in demand for imports creates a higher demand for foreign exchange, hence depreciating the nominal and real exchange rates.

However, of significance to note in the error-correction models are the coefficients of adjustment, which are -0.38, -0.79, and -0.80 for the real exchange rates for imports and exports, and the internal real exchange rate, respectively. These coefficients indicate that the speeds of adjustment of the real exchange rates for imports and exports in Zambia are quite different, with the speed of adjustment for the real exchange rate for exports being almost twice the size of the one for the real exchange rate for imports. The reason for the difference could be that since imports are necessary to the economy, adjusting after a shock could be quite slow. The speed of adjustment for the internal real exchange rate is as high as the one for the real exchange rate for exports.

The speeds of adjustment for the real exchange rate for exports and the internal real exchange rate are higher than the ones for Chile and Mexico (see Table 13, which gives estimates of speeds of adjustment for seven countries as reported by Elbadawi and Soto, 1997). We may also point out that Feyzioglu (1997) obtained an estimate of -0.11 for the speed of adjustment for Finland. It is notable that a high disparity in the speeds of adjustment exists between countries.

Table 13: Coefficients of Speed of Adjustment

Country	*Estimate of Speed of Adjustment*
Chile	-0.70
Côte d'Ivoire	-0.30
Ghana	-0.91
India	-0.20
Kenya	-0.67
Mali	-0.45
Mexico	-0.70

Source: Elbadawi and Soto (1997).

A manipulation of the error-correction coefficient gives us the adjustment speed in terms of the number of years needed to eliminate a given exogenous shock.[15] According to our calculations, in order to eliminate 99 percent of a shock to the real exchange rate for imports, it would take about nine years, while for the real exchange rate for exports and the internal real exchange rate, it would take about three years.

Having arrived at our final models, we checked how stable the parameters of the models are in the sample period, and also to see whether there were any structural breaks in the model. For this, we plotted the one-step residuals and Chow test statistics. These are given, for each real exchange rate index, in Figures 3 to 5 in Appendix 3. The plots for the one-step residuals show that for all the real exchange rates, the values lie within the error band, indicating no structural break. The plots of the Chow test further support this, showing no statistically significant break.

5.5 Real Exchange Rate Misalignment

As we mentioned in our introductory remarks, one of the reasons for finding the determinants of the real exchange rate is to be able to estimate the degree of misalignment in the real exchange rate. In order to estimate the degree of misalignment in the three real exchange rate measures that we constructed, we used the long-run estimates of the fundamentals to obtain the fitted values of the equilibrium real exchange rates. We then used the Hodrick-Prescott filter to decompose the fitted values into their temporary and permanent movements. The

[15]The formula for the adjustment speed in terms of the number of years is given by; $(1-b_0)=(1-|a_0|)^t$, where, t is the number of years, a_0 is the error-correction coefficient, and b_0 is the percentage of a shock to be dissipated (see Aron *et al*, 1997; Elbadawi and Soto, 1997).

equilibrium real exchange rate is then taken to be the permanent movement in the filtered series of the real exchange rate. We calculated the misalignment in the real exchange rate as,

$$\langle 7 \rangle \quad e_{mis} = \frac{RER - ERER}{ERER}$$

where, RER is the actual real exchange rate, and $ERER$ is the equilibrium real exchange rate. The calculated percentages of misalignment for the three real exchange rate measures are given in Table 14, and Figure 6 in Appendix 3 plots the misalignment.

The computed indices of misalignment indicate that the real exchange rates were overvalued and undervalued in a number of episodes. The most notable period is the overvaluation between 1978 and 1984 in the real exchange rate for imports, and between 1982 and 1985 in the real exchange rate for exports. This overvaluation preceded the introduction of the auctioning system for foreign exchange. The auctioning system itself was an effort to deal with the external imbalance that characterised the period. The auctioning was abandoned in 1987. This may have been the cause for the severe depreciation in the parallel market exchange rate between 1987 and 1990. It is very likely that the parallel market premium then was largely dominated by a risk element due to the loss in government credibility in managing the economic crisis. It is likely therefore that the parallel market rate substantially overshot what would have been the market rate. This probably explains the undervaluation in the real exchange rate for imports between 1987 and 1990.

Table 14: Computed Real Exchange Rate Misalignment (Percentage)

	RER for Imports	*RER for Exports*	*Internal RER*
1966	19.13	2.47	11.08
1967	10.04	-15.81	7.09
1968	-14.01	-9.75	4.45
1969	-18.38	14.72	-44.00
1970	-20.58	20.62	-14.02
1971	41.47	-32.43	12.51
1972	24.65	-2.32	8.02
1973	-35.65	-6.83	-21.50
1974	-1.18	70.64	-29.49
1975	32.57	1.49	13.10
1976	63.03	8.77	10.99
1977	39.89	-7.11	16.31
1978	-4.99	-4.23	23.72
1979	-26.01	24.83	-12.74
1980	-28.60	22.65	-10.64
1981	-43.47	6.66	5.23
1982	-48.24	-21.40	21.98
1983	-48.12	-17.19	9.76
1984	-25.57	-17.21	0.41
1985	2.06	-1.40	-5.46
1986	3.29	40.52	-16.38
1987	45.07	-21.72	-16.28
1988	349.34	-12.44	-7.26
1989	108.50	47.27	12.16
1990	21.53	-33.29	-17.83
1991	8.06	-20.25	-6.24
1992	20.40	-8.51	16.38
1993	-26.87	-0.63	8.46
1994	-39.16	7.64	-1.00
1995	-21.70	2.37	-10.05
1996	-9.81	37.31	-3.96

The misalignment in the real exchange rate for exports during the auctioning has been well captured. The sale of foreign exchange that the Bank of Zambia did not have caused frantic bidding, resulting in a fall in the value of the kwacha. The rapid depreciation in the exchange rate is captured by the undervaluation in the real exchange rate after 1985. However, when the Bank of Zambia incurred some losses due to buying foreign exchange at a higher price than they had agreed to sell it at, they resorted to printing more money. The increase in liquidity was inflationary, that is, it increased the prices of non-tradables, hence appreciating the real exchange rate. This again, is captured by the period of overvaluation from 1987.

In general, and as one would expect, the episodes of overvaluation are predominant. Whether these episodes trace adequately the actual overvaluation in Zambia will of course depend on the reliability of the data used. It is well known that there were substantial price controls for commodities particularly in the period prior to 1989. This may make the official consumer price index suspect. It is also true that tracking the long-run equilibrium is quite tricky, and the method employed here can at best only provide a crude estimate.

6 Summary and Conclusions

This paper set out to find the main determinants of the real exchange rate in Zambia, and to estimate the degree of misalignment in the real exchange rate. The importance of the real exchange rate is well documented in the literature, and was very briefly reviewed in this paper.

First, a brief synopsis of the Zambian economy was provided, followed by a brief review of literature pertaining to the real exchange rate. Then an illustrative model of real exchange rate determination was presented.

Cointegration analysis was employed in identifying and estimating the long-run determinants (the fundamentals) of the three real exchange rates in Zambia, namely the real exchange rates for imports and exports, and the internal real exchange rate. In the long-run, the following fundamentals were found to influence the real exchange rate for imports; terms of trade, investment share, and government consumption, while terms of trade, central bank reserves, and trade taxes were found to be the long-run determinants of the real exchange rate for exports. For the internal real exchange rate, we found the following long-run determinants; terms of trade, investment share, and the rate of growth of real *GDP*. The next step involved estimation of error-correction models, in order to identify short-run determinants of the real exchange rates. Since one cointegrating vector was found for all real exchange rates, and all explanatory variables were weakly exogenous, we employed a single-equation method in the error-correction models. Apart from the difference of the fundamentals mentioned above, the flow of aid and real money supply were found to impart short-run effects on the internal real exchange rate. The nominal exchange rate and openness were also found to have short-run effects on the real exchange rates for exports and imports, respectively. The coefficients of adjustment were found to be -0.38, -0.79, and -0.80 respectively for the real exchange rates for imports and exports, and for the internal real exchange rate.

The degree of misalignment in the three real exchange rates was then calculated as the difference between the actual real exchange rate and the long-run equilibrium real exchange rate. The latter was obtained from the permanent component of the fitted values of the real exchange rate in the cointegration analysis. The real exchange rates were found to be overvalued in several periods.

A note of caution is needed with regards to the results in this paper. Whereas the method employed has been well refined and can reasonably invite confidence, the data used may not necessarily be good enough. The first obvious weakness in the study is the paucity of the sample. The small sample is a problem common to annual time-series data on African countries. Even smaller samples have been used in other studies on African countries (see for example, Baffes *et al*, 1999; Kadenge, 1998; and Elbadawi and Soto, 1997). The second weakness with regards to the data is on the domestic price level and the nominal exchange rate. With regards to the former, Zambia had price controls, which were particularly widespread prior to

1989. It is not possible to determine the extent to which the controlled prices were relevant to households compared to the parallel market prices. Unfortunately, data on the parallel market for goods is not available.

With regards to the nominal exchange rate, a fixed and non-convertible exchange rate regime prevailed prior to 1993. A parallel market for foreign exchange inevitably developed alongside the official "market". One can thus either use the official nominal exchange rate, or the parallel market rate, or, when possible, a weighted average of the two rates (Hinkle and Nsengiyumva, 1999*a*).[16] The analysis here followed the recommendation by Edwards (1991) and employed the parallel market rate between 1971 and 1993, when the parallel market was pervasive, to calculate the real exchange rate for imports. The assumption is that, at the margin, the parallel market rate counts in decisions on trade. We however used the official exchange rate to calculate the real exchange rate for exports. This is because the main exporter in Zambia, the mining company, was controlled by the government, and therefore naturally put up with the official exchange rate.

One interesting implication emerges from the calculated misalignment. In a situation of a controlled economy like Zambia was, it may be tempting to use the parallel market exchange rate as a rough guide to what would be a market-determined exchange rate. However, as noted above, even the parallel market rate can overshoot, particularly if the behaviour of the government increases the risk of holding the local currency. Such seems to have been the case in Zambia during the period after the botched auctioning system.

The other policy implication can be derived from adjustments to equilibrium from disequilibrium due to short-run changes. The error-correction models show that the rates of change in government consumption, investment share, central bank

[16] The weights can be the percentage of transactions at the official and parallel rates. However, no data exists on the volume of transactions at the parallel market exchange rate.

reserves, the nominal exchange rate, and openness all have a significant effect on the rate of change in the actual real exchange rate. This suggests possibilities for policy actions to correct for misalignment.

Despite the weaknesses pointed out above, this study makes important contributions in several respects. It seems to be the first study of this type on Zambia, and in general, the application of cointegration econometrics on real exchange rate studies is still in its infancy in Africa. Moreover, this is the first study to have estimated the three versions of the real exchange rate. Such an attempt has been avoided for being too daunting (Hinkle and Nsengiyumva, 1999*b*).

Lastly, the findings here concur with the view that the equilibrium real exchange rate is not constant over time, but responds to changes in a range of fundamentals and shocks to the economy (Aron *et al*, 1997). The determinants of the real exchange rate examined here may help in addressing issues of misalignment.

Appendix 1

Definition of variables

Lrerm - the log of the multilateral real exchange rate for imports.[17] It is calculated as follows;

$$\langle i \rangle \quad e = \frac{\sum_{i=1}^{k} a_i E_{it} P_{it}^{*}}{P_j}$$

where, e is the multilateral real exchange rate index, E_{it} is the index of the parallel market exchange rate between country i and Zambia in period t; $i = 1,\ldots,k$ denotes the k partner countries that are used in the construction of the index. The five largest trading partners were considered in constructing the index. The weight corresponding to partner i in the construction of the index is denoted by a_i. P_{it}^{*} is the price index of partner i in period t, and it denotes the price of tradables, which is proxied by the wholesale price index of the trading partners. P_j gives the price index for the home country, and it denotes the price of non-tradables. It is proxied by Zambia's consumer price index. According to Hinkle and Nsengiyumva (1999*a*,*b*), although this measure is called the *external* real exchange rate, for developing countries, it measure can be used to proxy the real exchange rate for imports.

Lrerx - the log of the multilateral real exchange rate for exports, calculated as;

$$\langle ii \rangle \quad e = \frac{\sum_{i=1}^{k} a_i E_{it} (1-b) P_{it}^{*} + P_x b}{P_j}$$

where, e is the bilateral real exchange rate, E_{it} is the index of the nominal exchange rate between country i and Zambia in period t; $i = 1,\ldots,k$ denotes the k partner countries that are used in the construction of the index. The five largest trading partners were considered in constructing the index. The weight corresponding to partner i in the construction of the index is the total trade share, and is denoted by a_i. P_{it}^{*} is the price index of partner i in period t. It denotes the price of tradables,

[17] The multilateral indices were constructed using the trade weights for three years of trade data, that is, for 1975, 1985 and 1995.

and it is proxied by the wholesale price index for the trading partners. P_j gives the price index for the home country, and it denotes the price of non-tradable goods, which is proxied by the consumer price index for Zambia. P_x is the price index of copper prices, b is the weight of copper exports in total exports, and (1-b) is the weight of other exports in total exports (see Hinkle and Nsengiyumva, 1999*b*).

Lrera - the log of the internal real exchange rate, which is calculated as follows;

$$\langle iii \rangle \quad e = RERM_N^{a} . RERX_N^{1-a}$$

where, e is the internal real exchange rate, a is the weight of the share of imports in total trade, (1-a) is the weight of the share of exports in total trade, $RERM_N$ is the internal real exchange rate for imports calculated as the ratio of the import deflator to the domestic absorption deflator, $RERX_N$ is the internal real exchange rate for exports calculated as the ratio of the export deflator to the domestic absorption deflator. This measure of the real exchange rate is calculated from national accounts data (see Hinkle and Nsengiyumva, 1999*b* for details on how to calculate the internal real exchange rate using national accounts data).

Ltot – log of the terms of trade. Due to the fact that published data for terms of trade data is not complete, we computed our own index for terms of trade. In doing this, we took into account the following; (i) Copper constitutes the major export from Zambia, (ii) Manufactured goods and oil constitute the major imports to Zambia. Thus, the index of the terms of trade was computed as follows;

$$\langle iv \rangle \quad tot = \frac{p_x}{P_m}$$

where,
P_x is the index of the real dollar price of copper
$P_m = a_i muv_{USA} + a_j po$; where, P_m is the index of the real price of imports; a_i is the weight of manufactured imports to Zambia, calculated as the ratio of the value of manufactured imports to total imports, muv_{USA} is the index of the unit value of exports of manufactured goods of the USA; a_j is the weight of oil imports to Zambia, calculated as the ratio of the value of oil imports to total imports; and Po is index of the real dollar price of oil.

Lgcons – the log of the ratio of real government consumption to real GDP.

Lishare – the log of the ratio of real gross fixed capital formation to real *GDP*.

Lcbresy – the log of the ratio of real central bank reserves to real *GDP*.

Gry **–** the growth rate of real *GDP*, as a proxy for technological progress.

Lopen – the log of openness. This is a proxy for the stance of trade policy, defined as the ratio of imports at constant prices to domestic absorption at constant prices.

Lttaxy – the log of the ratio of trade taxes to *GDP*.

Lrms – the log of real money supply.

Loexr – the log of the period average of the official nominal exchange rate.

Laid – the log of the ratio of aid flows to *GDP*. Aid flows include total net receipts of Official Development Assistance (*ODA*), Other Official Flows (*OOF*), and private sector flows (*OECD CD-ROM*, 1999).

Appendix 2

Table 1: Test for Inclusion of Deterministic Terms

Model	Deterministic Terms[1,]	Unrestricted log-likelihood		
		RER for Imports	*RER for Exports*	*Internal RER*
1**	Constant (R), Dummy (U), No trend	203.66493	191.32018	216.55876
2	Constant (U), Dummy (U), No trend	206.78156	193.26206	219.37903
3	Constant (R), Dummy (U), Trend (R)	nc	nc	nc
4	Constant (R), Dummy (U), Trend (U)	nc	nc	nc
5	Constant (U), Dummy (U), Trend (U)	211.16318	196.14174	220.42135
6	Constant (U), Dummy (U), Trend (R)	nc	193.90729	219.73666
7*	No Constant, No trend, Dummy (U)	203.5187	190.76453	213.66416

Notes: [1]*For the Internal RER, there is no dummy; U – unrestricted; R – restricted; nc– no cointegrating vector found.*
**This is the model that gave the lowest value of the log-likelihood. However, we did not choose this model because the constant takes care of the units of measurement in the estimation (Hansen and Juselius, 1995). The constant should not be included in a model only if there is a strong reason for not including it.*
***Our preferred model. It gave the second lowest value of the unrestricted log-likelihood test statistic.*

Table 2: Steps Taken to Arrive at Models in Table 12

RER	*Steps*	*F-Test for Model Reduction*	*SIC*[1]
RER for Imports			
	1. General error-correction model		-1.35404
	2 Excluded Δltot, Δltot_1, Δltot_2, Δlaid, Δlaid_1, Δlaid_2, Δlopen_2	F(7,9) = 0.6569 [0.7035]	-1.75412
	3. Excluded Δlgcons_2, Δlishare_2	F(2,16) = 0.7199 [0.5025]	-1.90033
	4. Repalced Δlrer_1 and Δlrer_2 with ΔΔlrer_1	F(1,18) = 0.0261 [0.8735	-2.015
RER for Exports			
	1. General error-correction model		-2.09985
	2. Excluded Δltot_1, Δltot_2, Δloexr_1, Δloexr_2	F(4,11) = 0.2469 [0.9056]	-2.48989
	3. Excluded Δlrer_1, Δlcbresy_2, Δlttaxy, Δlttaxy_2	F(4,15) = 0.7613 [0.5665]	-2.7811
	4. Excluded Δlttaxy_1	F(1,19) = 1.3606 [0.2579]	-2.83095
Internal RER			
	1. General error-correction model		-2.93317
	2. Excluded Δlrms_1, Δlrms_2, Δlrer_1, and Δlrer_2	F(4,10) = 0.1722 [0.9477]	-3.33102
	3. Excluded Δlishare and Δlishare_2	F(2,14) = 0.0262 [0.9741]	-3.5595
	4. Excluded Δgry, Δgry_1, and Δgry_2	F(3,16) = 0.6364 [0.6024]	3.79511
	5. Excluded Δlaid, Δlaid_2	F(2,19) = 0.7066 [0.5058]	-3.95559
	6. Excluded Δlishare_1	F(1,21) = 1.5087 [0.2329]	-4.00233
	7. Replaced Δltot_1 and Δltot_2 with ΔΔltot_1	F(1,22) = 0.3198 [0.5774]	-4.10401

Note: [1]Schwarz Information Criteria.

Appendix 3

Figure 1: Evolution of the Black Market Premium

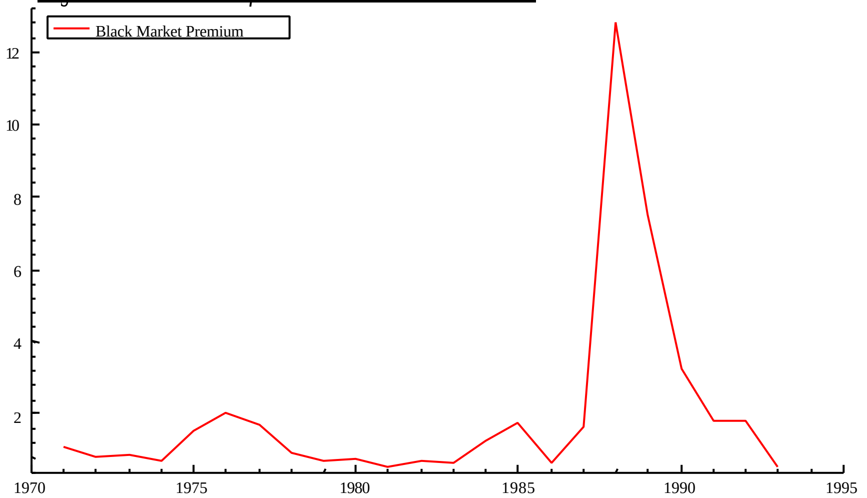


Figure 2a: First Cointegrating Vector – RER for Imports

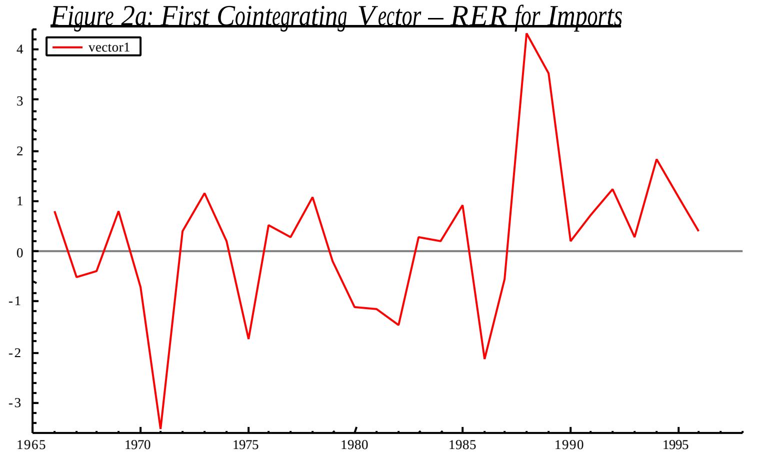


Figure 2b: First Cointegrating Vector – RER for Exports

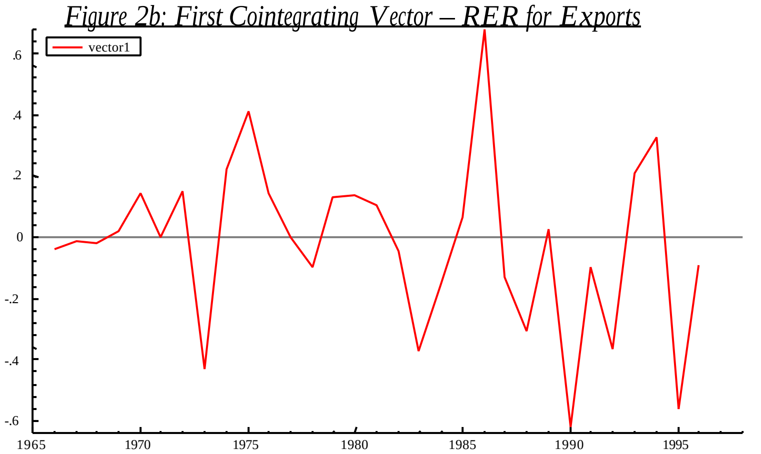


Figure 2c: First Cointegrating Vector – Internal RER

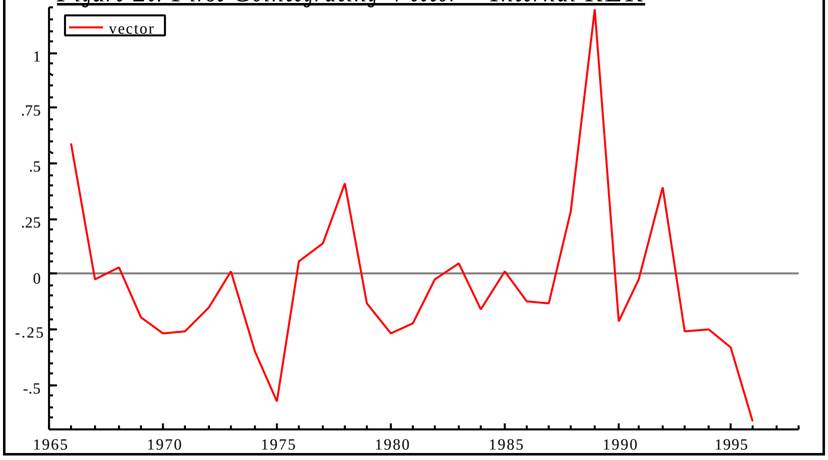


Figure 3: 1-Step Residuals, 1-Step Chow Tests, and Break-point Chow Test – RER for Imports

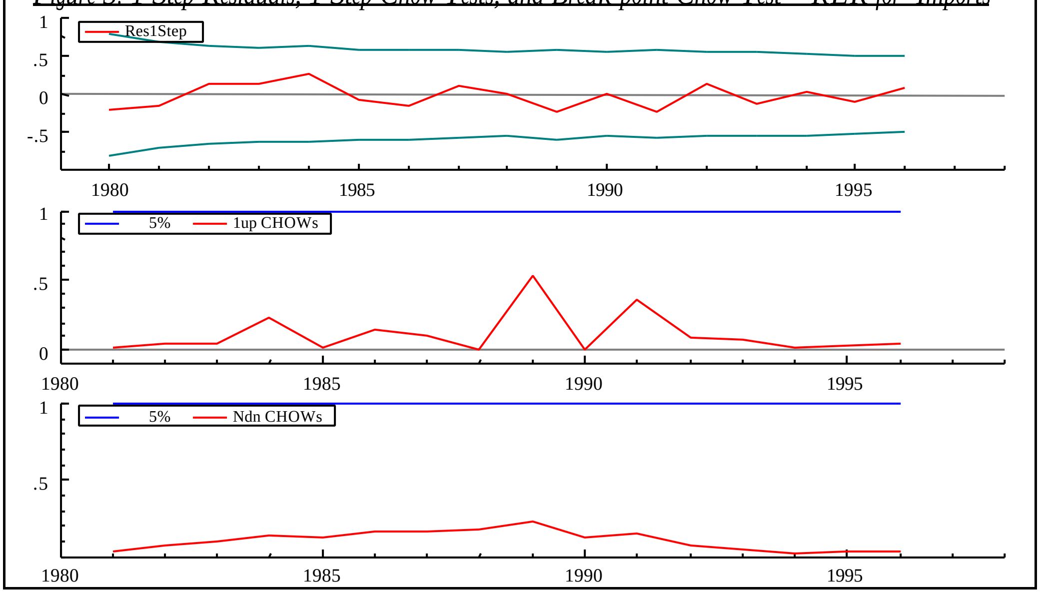


Figure 4: 1-Step Residuals, 1-Step Chow Tests, and Break-point Chow Test – RER for Exports

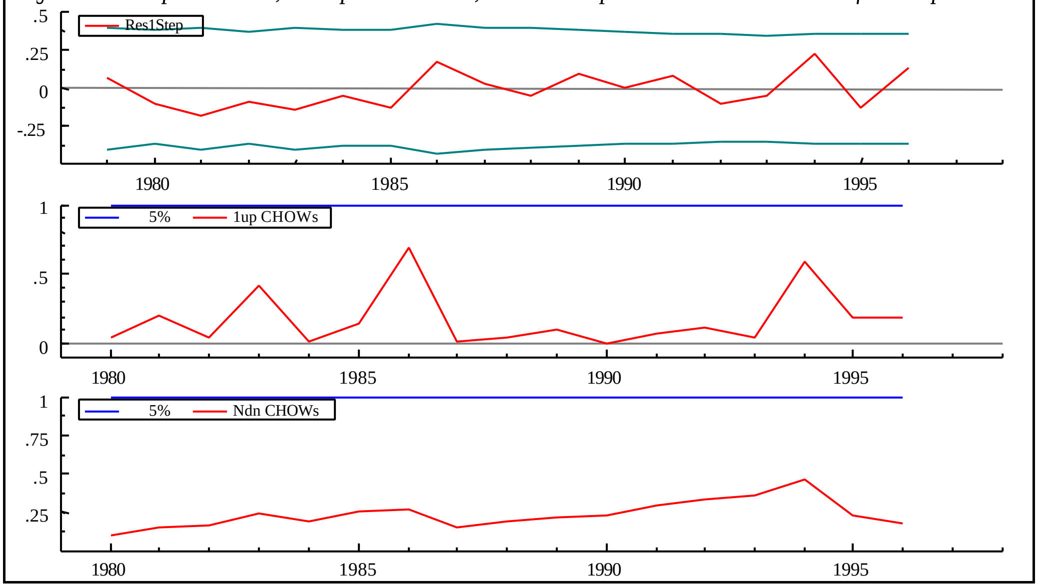


Figure 5: 1-Step Residuals, 1-Step Chow Tests, and Break-point Chow Test – Internal RER

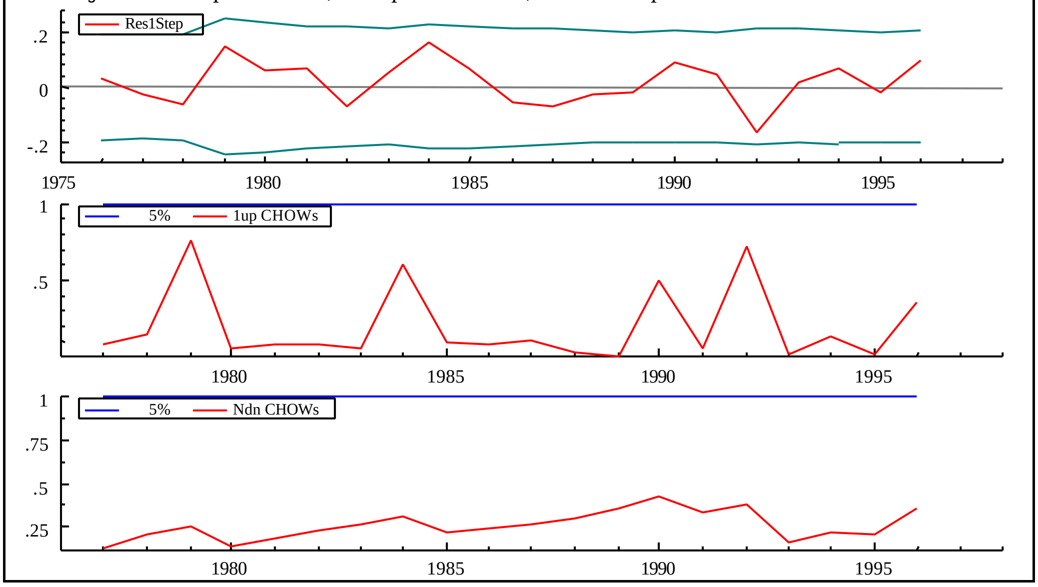
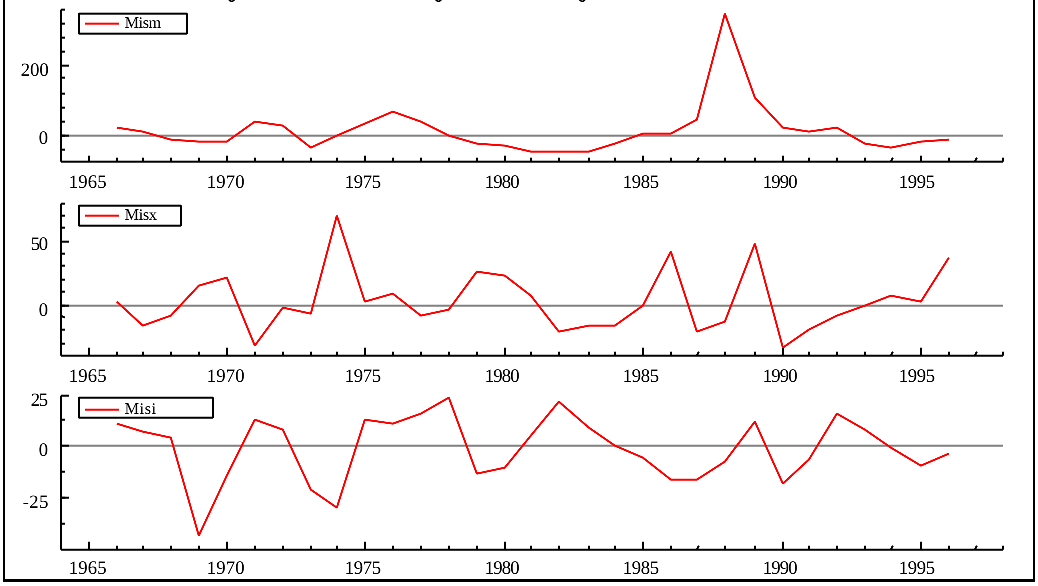


Figure 6: Real Exchange Rate Misalignment



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