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A RE-EXAMINATION OF LONG-RUN PURCHASING POWER PARITY (PPP) HYPOTHESIS: THE CASE OF TWO SOUTHERN AFRICAN COUNTRIES

Bernard Njindan Iyke¹ and Nicholas M. Odhiambo

Abstract

In this paper, we have examined the validity of the PPP hypothesis for two Southern African countries, namely: Lesotho and Zambia. We have utilized four econometric tests to examine the existence of the PPP hypothesis in Lesotho and Zambia. These tests include two unit root tests without structural breaks—the DF-GLS test and the Ng-Perron test; and two unit root tests with structural breaks—the Perron test and the Zivot-Andrews test. We extracted the data on the real exchange rate for Lesotho, and for Zambia, from the Penn World Tables, version 7.1, which is compiled by Heston et al. (2012). We found that the PPP hypothesis was supported in the case of Lesotho, but rejected in the case of Zambia. The implication of this finding is that Lesotho is unlikely to profit immensely from trade and investment arbitrages, whereas Zambia is more likely to profit immensely from trade and investment arbitrages, by trading with the US.

Keywords: *Exchange Rates, Purchasing Power Parity, Lesotho and Zambia*

JEL Classification Code: *F31*

1. Introduction

The exchange rate is at the core of most scholarly research in international economics. This variable has also dominated policy discussions for centuries. It is generally believed that a mismanaged exchange rate could have extensive ramifications on an economic set-up. One of the most important and frequently asked questions on the exchange rate is how it adjusts, and whether its adjustment depends on the exchange rate policy pursued (see Taylor and Taylor,

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2004). According to Taylor and Taylor, the exchange rate adjustment mechanism is crucial in those countries which pursue fixed exchange rate regimes. Such countries would need to understand what the long-run exchange rate should be. Similarly, those countries which pursue relatively flexible exchange rate regimes would need to understand the level and variation in the nominal and the real exchange rates they could expect (see Taylor and Taylor, 2004). According to these authors, the exchange rates adjust towards a level set by purchasing power parity (PPP). This aids policy makers and economists to determine the extent to which the international macro-economy is self-equilibrating (Taylor and Taylor, 2004).

On this account, whether or not the exchange rate adjust towards a certain equilibrium implied by certain purchasing power parity (PPP) hypothesis is undoubtedly very essential in empirical research. The PPP concept was originally developed by Gustav Cassel (1918) on the basis that the *law of one price* (LOOP) holds, at least in the long run. The central idea of the PPP hypothesis is that, in the absence of transaction costs and trade barriers, identical baskets of goods or services should trade at the same or identically similar prices. So, the real exchange rate between two countries is nothing more than their relative price levels (see Cassel, 1918). Since the proposition of the PPP hypothesis, various economists have applied different tests to verify its validity. The findings from various studies are remarkably divergent. It is widely held these days that the PPP hypothesis is rather a long-term phenomenon than a short-term one. Rogoff (1996), for example, iterates that: “While few empirically literate economists take the PPP seriously as a short-term proposition, most instinctively believe in some variant of purchasing power parity as an anchor for long-run real exchange rates.”

The PPP hypothesis has been subjected to various tests for several distinct or similar economies. In the cases of Lesotho and Zambia, the empirical literature is scant. Representative studies that have included Lesotho and Zambia in their samples are those of Holmes (2000), and Kargbo (2003a, 2003b, and 2004). This is why a fresh study on these countries is essential. In an effort to enhance better policy-making and better living standards around the world, research on these kinds of countries would be a step in the right direction. Our aim, in this paper, is therefore to investigate whether the PPP hypothesis holds in Lesotho and Zambia. Our measure of the real

exchange rate for these two Southern African countries is based on price comparisons. Essentially, we compared the prices in Lesotho and Zambia, with the prices in the US. The idea of the PPP has strong implications for international trade gains, and on trade relations and agreements. If the PPP hypothesis holds for Lesotho and Zambia, the implication is that they may not potentially gain from arbitrage in traded goods with the US, given that their real exchange rates are measured with respect to the US dollar. However, the presence of transaction costs and trade frictions implies that the PPP may not necessarily hold for Lesotho and Zambia. Before testing the PPP hypothesis for Lesotho and Zambia, we undertook a succinct review of the exchange rate regimes and policies pursued by these two countries – from independence to the present. We analyzed the trends of their nominal exchange rates, in response to the regimes and policies they (i.e. Lesotho and Zambia) have pursued.

The remaining sections of this paper are organized as follows. In the next section, we review the exchange rate history of these two countries. Section 3 contains a brief literature on the PPP hypothesis. Section 4 outlines the simple methodology which we have employed to test the PPP hypothesis. The results and discussion are presented in Section 5. In Section 6, we provide a conclusion to the paper.

2. A Review of the Exchange Rate History

2.1 Exchange Rate Regimes, Policies, and Trends in Lesotho

Lesotho has pursued relatively simple foreign exchange rate regimes, since independence. For a very long period (i.e. between 1910 and 1980), Lesotho pursued an exchange arrangement without a separate legal tender. The official legal tender was then the South African Rand. In January 1980, following Lesotho's decision to join the Common Monetary Area (CMA), (see Retselisitsoe and Malebese 2014), the country switched to a peg system (CBL, 2006). The official currency of Lesotho, the loti, was introduced and pegged to the South African Rand. The Rand was also allowed to float freely in the economy of Lesotho, as a legal tender.

This system was maintained until February 1983. However, in February 7, 1983, the peg system with adjustment (or the dual market system) was changed into a peg system without adjustment. The reference currency was still the South African Rand. The peg system, with no adjustment, was in place until September 2, 1985 – when the authorities switched back to the peg system with adjustment, as had been previously pursued (IMF, 2004). Again, the reference currency was the South African Rand. The dual market system was abolished on March 13, 1995. From March 13, 1995 to the present, the Lesotho economy has been under a peg system without any adjustment, with the loti being pegged to the South African Rand (see IMF, 2012).

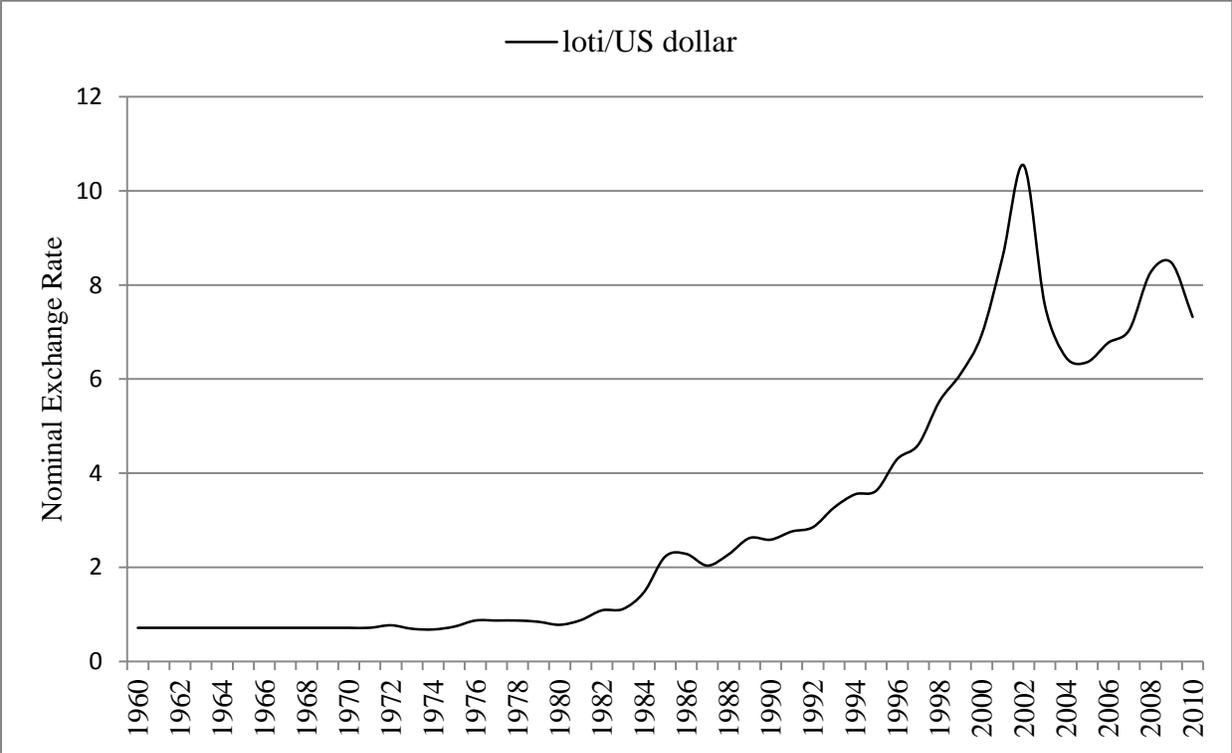
According to the Central Bank of Lesotho (CBL), the Common Monetary Area (CMA) peg system, which has been adopted by Lesotho, has had a positive impact on the Lesotho economy. It has provided macroeconomic stability and a robust anchor to inflationary expectations, in spite of the volatility that has characterised the South African Rand (CBL, 2006). Various policy interventions have also been carried out in the foreign exchange market of Lesotho, since the 1980s. For instance, three commercial banks were authorised to deal in the foreign exchange market. The current and capital accounts were also liberalized in 1998. In addition, the CBL was charged with the power to directly approve foreign exchange requirements for all capital account transactions (IMF, 2004).

The exchange rate of Lesotho (loti per US dollar) has been fairly fixed for a considerable number of years, since 1960 (see Figure 1). From 1960 to 1970, the exchange rate was fixed at 0.714. The loti depreciated by 7.62 per cent from 0.714 in 1970 to 0.769 in 1972. The loti experienced a mild appreciation of 11.61% between 1972 and 1974. The exchange rate then increased gradually from 0.679 in 1974, to 0.842 in 1979. The exchange rate dropped slightly to 0.779 in 1980, from 0.842 in 1979. The loti depreciated between 1980 and 1986; the loti per US dollar increased from 0.779 in 1980 to 2.285 in 1986.

The rate then dropped momentarily from 2.285 in 1986 to 2.036 in 1987. From 1987 to 2002, the loti has been depreciating. In fact, the loti depreciated by 417.71 per cent during this period – the largest exchange rate misalignment in the country’s history. A temporary appreciation of the loti

occurred between 2002 and 2006, as the loti per US dollar declined from 10.541 in 2002 to 6.772 in 2006. The exchange rate increased from 6.772 in 2006 to 8.474 in 2009. An appreciation ensued thereafter, as the loti increased in value by 14.31 per cent between 2009 and 2010. Figure 1 shows the trend of the exchange rate in Lesotho from 1960 to 2010.

Figure 1: Trend of the Exchange Rate in Lesotho during the Period 1960-2010



Source: Constructed from Heston *et al.* (2012)

2.2 Exchange Rate Regimes, Policies, and Trends in Zambia

The exchange policies of Zambia have been very erratic. Basically, Zambia operated a fixed exchange rate regime in two periods: (i) Between 1964 and 1982; and (ii) between 1987 and 1991. A crawling regime was adopted between 1983 and 1986. From 1992 to the present, Zambia has been under a flexible exchange rate regime. The regime choice was purely motivated by administrative factors.

The fixed exchange rates adopted between 1964 and 1982, and between 1987 and 1991, were largely maintained by administrative controls, such as import licences (see Aron and Elbadawi, 1992; Mkenda, 2001). For instance, such decrees ensured the occasional adjustments of the exchange rate, which was in stark contrast to the conventional market interventions being employed in other countries (see Aron and Elbadawi, 1992; Mkenda, 2001). The Zambian pound was created shortly after independence in 1964. This new currency was immediately pegged to the British pound. Debates over the colonial implications for adopting the Zambian pound as a legal tender led to the renaming of the currency to the Zambian kwacha in 1968. The kwacha was soon pegged to the British pound at a rate of 1.7 kwacha per pound in the same year. In December 1971, the authorities decided to link the kwacha to the US dollar (see Mkenda, 2001; Mungule, 2004; Mbululu *et al.*, 2013).

The first significant intervention in the Zambian foreign exchange market was a revaluation of the kwacha by 11.1 per cent in February 1973 (i.e. from 0.714 kwacha per dollar in 1971 to 0.643 kwacha per dollar in 1973). The new rate was maintained for about three years. The authorities undertook the first devaluation exercise in July 1976, devaluing the kwacha by 20 per cent against the US dollar. After the devaluation exercise, the kwacha was then officially linked to the Special Drawing Rights (SDR)² at SDR 1.085, amid the crisis in the external balance, the deteriorating terms of trade and oil price hikes (Mungule, 2004).

The first devaluation seems to have been inadequate; so a series of devaluation exercises ensued during this crisis period. The kwacha was devalued by a further 10 per cent in March 1978 to SDR 0.9763. It was again devalued by 20 per cent in January 1983 to SDR 0.7819. In July of the same year, the kwacha was delinked from the SDR, and pegged to a weighted average basket of currencies of its five major trading partners. At this point, the rate was allowed to adjust at a rate of 1 per cent monthly (see Mungule, 2004).

² “The SDR is an international reserve asset, created by the IMF in 1969 to supplement its member countries’ official reserves. Its value is based on a basket of four key international currencies, and SDRs can be exchanged for freely usable currencies. With a general SDR allocation that took effect on August 28 and a special allocation on September 9, 2009, the amount of SDRs increased from SDR 21.4 billion to around SDR 204 billion (equivalent to about \$316 billion, converted using the rate of March 12, 2014)” —International Monetary Fund

Under the fixed exchange regime, however, the economic conditions of Zambia shifted from bad to worse. The external position rapidly declined, following a free-fall of copper revenues and increasing external debts (see Mkenda, 2001). The viable option was to float the kwacha. Thus, in October 1985, the kwacha was officially floated against the currencies of its major trading partners (see Mwenda, 1996; Mkenda, 2001; and Mungule, 2004; Mbululu *et al.*, 2013; Chipili, 2014). After the adoption of a more flexible exchange rate regime, the Dutch Auction System (DAS) was introduced – with the objective of unifying the black market with the official exchange market, and thereby improving the allocation of foreign exchange, and allowing market forces to determine the external value of the kwacha (Mkenda, 2001).

In January 1987, however, the DAS was replaced by a peg system, with the kwacha pegged at 9.00 per US dollar (see Chipili, 2014). Following another desperate move by the authorities, the peg system was replaced by a two-tier system after just three months of its existence (see Mungule, 2004). This dual system operated in such a way that a specific rate was applied to all official transactions; and a floating rate was applied to all other transactions. Nonetheless, like all previous exchange policies, the two-tier system was soon abolished. The float rate under the two-tier system is reported to have experienced drastic depreciation; this alongside the rise in inflation, which had been mainly associated with the exchange rate, convinced the authorities to abandon the two-tier system in May 1987.

Following the abolishment of the two-tier system, another fixed exchange rate regime was adopted. The exchange rate system at this point was regulated by the Foreign Exchange Management Committee (FEMAC). The rate was fixed at 9.00 kwacha per dollar. The rate was later devalued by 20 per cent in November 1988, and relinked to the SDR. The kwacha was again devalued by 49 per cent in July 1989. After the devaluation exercise, the exchange rate was allowed to crawl monthly. In December 1989, the exchange rate was devalued by 50 per cent (see Mwenda, 1996; Chipili, 2014).

The FEMAC gradually shifted Zambia from the fixed exchange rate regime by introducing a dual exchange rate regime in 1990. The dual system consisted of an official retail window for importers, an open general licence system (OGL), and an open window with a lower rate. However, the official retail window for importers and the OGL were unified under the economic liberalization policies in 1991 (Mwenda, 1996; Chipili, 2014). The unified OGL list was widened, so that Forex bureaux were permitted to trade; non-traditional exporters were permitted to retain 100 per cent of their foreign earnings; and the Zambia Consolidated Copper Mines (ZCCM) were allowed to sell their foreign earnings at the prevailing market rate (see Mwenda, 1996). The official exchange rate was devalued by 30 per cent; and the rate was allowed by FEMAC to crawl monthly at a rate of 8 per cent. Commercial banks were given major controls over the exchange rate by 1993. After a few months of deliberations, the dealing system was implemented in December 1993.

In addition, the Exchange Control Act of 1965 was formally repealed in January 1994. Import restrictions were, subsequently, removed – permitting importers to fully convert the kwacha. For the first time, the public was allowed to hold foreign currency accounts in domestic banks. Furthermore, the current and capital accounts were fully liberalized. Additional reforms followed in April 1995; commercial banks were allowed to trade daily with the central banks instead of weekly. The retention scheme, which prevented the ZCCM from trading directly in the foreign exchange market, was also abolished in 1996 (see Mkenda, 2001; and Mungule, 2004).

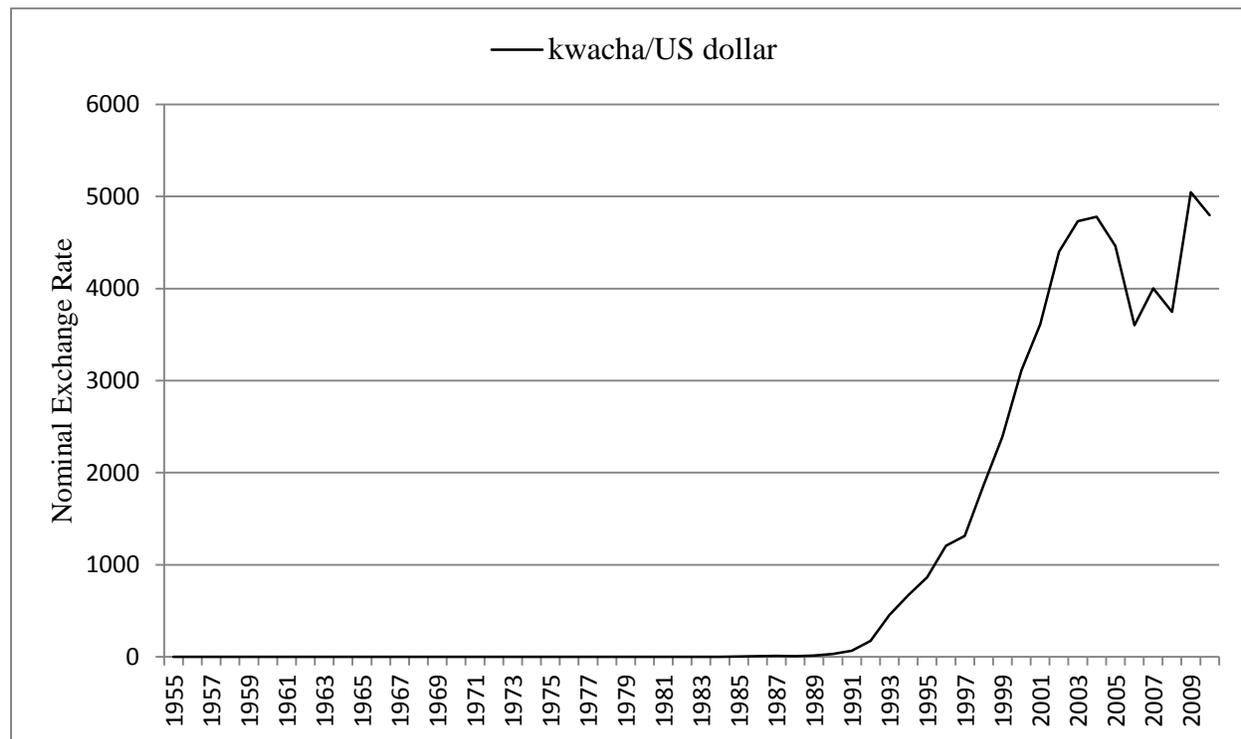
A sharp depreciation of the kwacha in 2001 prompted the authorities to announce new restrictive measures to stabilize the exchange rate. The dealing system, which had been abandoned in 1996, was reintroduced in January 2001. Besides, a law was passed by the parliament of Zambia prohibiting the use of foreign currency in the country. In the wake of such severe volatility of the exchange rate, and a sprout of multiple rates in the foreign market, the authorities launched the Interbank Foreign Exchange Market in July 2003 (see Mungule, 2004). In a recent move to strengthen the kwacha, the legislation – introduced in 2002 banning the use of foreign currency in Zambia – was revoked. Clearly, the exchange regime of Zambia has been relatively flexible in

the 2000s. The exchange rate has floated freely in some years during the 2000s; but the authorities intervened in other years (see Chipili, 2013).

Even though a fixed exchange regime was used before Zambia's independence, it was still pursued until 1982. From 1955 until 1972, the exchange rate was stable at 0.714 kwacha per US dollar (see Figure 2). After that, the exchange rate was revalued three times – in 1973, 1974 and in 1975. From the 1975 rate of 0.643, the rate increased to 0.801 in 1978. The rate declined from 0.801 in 1978 to 0.789 in 1980. During the crawling regime (i.e. 1983-1986), the kwacha per US dollar rate increased from 0.870 in 1981 to 7.788 in 1986, representing an increment of about 795.653 per cent.

The rate was increased on a year-on-year basis (except in 1988), when the fixed exchange rate regime was adopted for the second time between 1987 and 1992. For instance, the exchange rate was increased from 8.266 in 1988 to 13.814 in 1989, and again from 30.289 in 1990 to 64.640 in 1991. Even between 1991 and 1992, the rate was almost tripled (see Figure 2). The exchange rate depreciated massively, after it was liberalized in 1992. For instance, between 1993 and 2005, the kwacha per US dollar increased from 452.763 to 4463.503. This represents a depreciation of approximately 885.837 per cent. Since 2005 and thereafter, the pattern has been irregular. For example, the kwacha per US dollar appreciated from 4463.503 in 2005 to 3603.072 in 2006; and it then depreciated to 4002.523 in 2007. Figure 2 depicts the trend of the exchange rate in Zambia during the period 1955-2010.

Figure 2: Trend of the Exchange Rate in Zambia during the Period 1955-2010



Source: Constructed from Heston *et al.* (2012)

3. A Brief Literature Review

The purchasing power parity (PPP) hypothesis is a well-known hypothesis in the international economics literature. The PPP is directly traces its roots to the *law of one price* (LOOP), which suggests that identical goods and services should trade at equal prices, if transaction costs and trade barriers are negligible. Most economists believe that Gustav Cassel (1918) developed the PPP theory. The PPP has been extensively discussed in the literature, making it impossible for us to cover its nuances in this paper. Rogoff (1996); Sarno and Taylor (2002); and Taylor and Taylor (2004) provide excellent reviews of the PPP theory. For this reason, we only consider a précis of the key empirical test of the PPP hypothesis here.

The early tests of the PPP hypothesis (i.e. prior to the unit root and cointegration tests) were unsurprisingly based on regression analysis and other traditional methods. Isard (1977), for

example, tested the LOOP by using export transaction prices for 2 to 5 digit SITC groups between the US and Germany, and export unit values in 7 digit A and B classifications between the US and Canada, Japan and Germany. He finds large and persistent deviations of the LOOP for all these price comparisons, using regression analysis. He also finds a positive association between contemporaneous dollar exchange rates and relative dollar prices. Subsequent studies, such as those of Kravis and Lipsey (1978); Krugman (1978); Hakkio (1986), and Giovannini (1988) also found similar evidence against the LOOP and the PPP.

In quite recent studies, the LOOP and the PPP hypothesis have also been rejected. Engel (1993) compared the conditional variances of relative prices within and across countries for countries of the G7. Out of the 2400 variance comparisons, Engel finds 2250 to have a variance of the relative price within the country smaller than the variance across countries for the same type of good, thus invalidating the LOOP and the PPP hypothesis. In an advance analysis of Engel's approach, Rogers and Jenkins (1995) found the PPP hypothesis to be unsupported in 11 OECD countries, in their study.

Ever since unit roots, variance ratio tests, and cointegration tests became available, the approach to testing the LOOP and the PPP hypothesis has changed completely. For example, Frenkel and Mussa (1986), Grilli and Kaminsky (1991), Diebold *et al.* (1991), Lothian and Taylor (1995) all found evidence in support of the PPP hypothesis, using the unit root test. Also, Cheung and Lai (1993), Kugler and Lenz (1993), MacDonald (1993), MacDonald and Marsh (1994), and Pedroni (2001) all found strong evidence of cointegration in the studies, thereby supporting some form of PPP hypothesis. However, Baillie and Selover (1987), Enders (1988), Mark (1990), and Patel (1990) found little or no evidence of cointegration in their papers, rejecting the LOOP and the PPP hypothesis.

The most recent trend in the literature is the shift towards unit roots or cointegration tests, which incorporate nonlinearities. Yet, some recent papers have maintained the linear unit root or cointegration tests. Lopez *et al.* (2005) and Bahmani-Oskooee *et al.* (2007) found some evidence in favour of the PPP hypothesis in their studies, using conventional unit root tests. Within the

nonlinear context, Bahmani-Oskooee *et al.* (2006) and Wallace (2008) all found the PPP hypothesis to hold, utilizing the KSS unit root test.

In the context of Lesotho and Zambia, the empirical literature is very limited. The available studies of the PPP hypothesis on these two countries include the studies of Holmes (2000), and Kargbo (2003a; 2003b; 2004). Holmes (2000) tested the validity of the PPP theory for 27 high inflation African economies including Lesotho for the period 1974-1997, using quarterly data on the bilateral real exchange rate between these countries and the US. Holmes employed the augmented Dickey-Fuller (ADF) and the Im-Pesaran-Shin (IPS) tests. He found the ADF test to invalidate the PPP hypothesis for Lesotho, and the IPS test to firmly support the PPP hypothesis for the entire sample.

Kargbo (2003a) also examined the validity of the PPP hypothesis for 30 countries in Africa, including Zambia. Using the Johansen cointegration technique and a dataset consisting of black market exchange rates and the consumer price index (CPI) covering the period 1960-1997, Kargbo (2003a) found a strong support for the PPP hypothesis for Zambia. Kargbo (2003b) again utilized the Johansen cointegration technique to examine the validity of the PPP hypothesis in the long run for 25 countries in Africa, including Lesotho and Zambia. Using an annual dataset covering the period 1958-1997 on exchange rates and food price indices, Kargbo (2003b) found strong support for the PPP hypothesis in the long run. In another study, Kargbo (2004) investigated the validity of the PPP hypothesis for 35 countries in Africa, including Lesotho and Zambia. Using the annual data on bilateral official exchange rates and CPI for the period 1958-2002, and the Johansen cointegration technique, the author found strong evidence in favour of the PPP hypothesis, for both Lesotho and Zambia.

4. Methodology

4.1 Theoretical and Empirical Model Specification

In its absolute form³, the PPP theory suggests that identical baskets of goods and services should trade at identical prices, in the long run (see Cassel, 1918; Rogoff, 1996). Assuming that transaction costs and trade barriers are negligible, the PPP theory (or hypothesis) implies that the exchange rate between two countries is the same as the ratio of the price levels in the two countries. Thus, mathematically, we could state the PPP hypothesis in its absolute form as:

$$RER_t = P_t/P_t^f \quad (1)$$

where RER_t , P_t , and P_t^f are the real exchange rate, the domestic price level, and the foreign price level at time t , respectively. Stated in this way, the PPP hypothesis suggests that any price differential across countries would eventually be eliminated, because countries would take full advantage of the arbitrage from trade associated with the price differentials. Therefore, in the long run, the price levels must be equal (i.e. $RER_t = 1$).

To test the PPP hypothesis in its absolute form, most studies have examined the stationary properties of (1). If (1) is stationary, then the PPP hypothesis is said to hold for the country under consideration. Studies, such as those of Lopez *et al.* (2005), Bahmani-Oskooee *et al.* (2007), Bahmani-Oskooee *et al.* (2006) and Wallace (2008) have used the stationarity approach to verify the PPP theory in their respective studies. In this paper, we followed the stationarity approach. To maintain a link between the theory and the empirical test, we first constructed the real exchange rate in (1). Next, we examined the stationary properties of this exchange rate series. And finally, we concluded whether the PPP hypothesis is valid.

To execute these steps, we extracted the data on the real exchange rate for Lesotho and Zambia from the Penn World Tables, version 7.1, which are compiled by Heston *et al.* (2012). This database is the standard database extensively used in the literature, thus justifying our choice. For

³ To distinguish the definition from other definitions, such as the Relative PPP theory, the Efficient Market PPP theory, and the Generalized PPP theory.

each country, we extracted the *XRAT* and the *PPP* from this database. The *XRAT* denotes the nominal exchange rate of the country under consideration in terms of the US dollar. The *PPP* denotes the purchasing power parity conversion factors.

To arrive at the respective real exchange rates of Lesotho and Zambia, we divided *XRAT* by *PPP* (i.e. $RER = XRAT/PPP$). The standard procedure in the international economics literature is to take the natural logarithm of the real exchange rate indices and to remove outliers. Thus, our final real exchange rate series is:

$$\ln R\hat{E}R_t = \ln(XRAT_t/PPP_t) \quad (2)$$

where $R\hat{E}R_t$ is the calculated real exchange rate from the dataset. Equation (2) shows the links between the theory [stated in (1)] and the empirical model. In the remaining sections of this paper, the real exchange rate series is understood to mean the logarithm of $R\hat{E}R$ (i.e. $\ln R\hat{E}R_t$).

4.2 Econometric Techniques for Testing the PPP Hypothesis

4.2.1 Unit Root Tests without Structural Breaks

We proceeded to examine the purchasing power parity (PPP) hypothesis in Lesotho and Zambia by testing whether the real exchange rate in both countries is stationary at all levels. If the real exchange rate is stationary in both countries, it means that the PPP theory holds; otherwise, it does not. To do this, we utilized the Dickey-Fuller Generalized Least Squares (DF-GLS) and the Ng-Perron tests, proposed by Elliot *et al.* (1996), and Ng and Perron (2001), respectively.

We deployed these tests, rather than the conventional ADF and PP tests, because the latter are found to frequently reject the null hypothesis of unit roots, if the underlying series has a large and negative moving average (MA) component (see Schwert, 1987; Caner and Killian, 2001). In addition, various Monte Carlo studies have shown that the DF-GLS and the Ng-Perron tests have substantially higher power, even when the root of the time series is closer to unity (see Elliot *et al.*, 1996; Ng and Perron, 2001). The regressions and test statistics underlying these unit root techniques have been thoroughly discussed in various studies.

The DF-GLS and the Ng-Perron tests are based on the Dickey-Fuller test equation in the following form:

$$\Delta y_t = \alpha + \beta y_{t-1} + \delta t + \sum_{i=1}^k \rho_i \Delta y_{t-i} + \epsilon_t \quad (3)$$

Unlike the Dickey-Fuller test, the DF-GLS is performed on GLS-detrended data. The DF-GLS tests the null hypothesis that $H_0: \beta = 0$ (i.e. y_t is non-stationary) against two possible alternatives: (i) y_t is stationary about a linear trend; and (ii) y_t is stationary with no linear trend and a non-zero mean. The Ng-Perron test also uses GLS-detrended data and tests the same hypothesis; but it differs from the DF-GLS test in terms of the test statistics. Ng and Perron (2001) derived four test statistics, which are modifications of the Phillips-Perron statistics, the Bhargava (1986) statistic and the Point Optimal statistic of Elliot *et al.* (1996).

4.2.2 Unit Root Tests with Structural Breaks

It is possible that the real exchange rate series we considered here may contain structural breaks. In the presence of structural breaks, the standard unit root tests (briefly discussed above) often fail to reject the null hypothesis of unit roots in the series (see Perron, 1989). Following this revelation, some unit root tests have been developed to capture structural breaks in the underlying series. In this paper, we deployed the Perron test developed by Perron (1997), and the Zivot-Andrews test developed by Zivot and Andrews (1992). These tests are able to detect structural breaks in the transition parameter of the time series process.

The Perron test, which was originally derived by Perron (1989) and later modified by Perron (1997), proceeds by fitting the following Augmented Dickey-Fuller (ADF) regression with shifts in the mean and the trend:

$$\Delta y_t = \alpha + \beta y_{t-1} + \sum_{i=1}^k \rho_i \Delta y_{t-i} + \mu_t + \epsilon_t \quad (4)$$

where $\mu_t = \mu_0 + \mu_0^S d_{tTB} + \mu_1 t + \mu_1^S (t - T_B) d_{tTB}$ are potential deterministic terms, and T_B is the break date. The test has three null hypotheses: (i) y_t is non-stationary, with a structural break in the intercept; (ii) y_t is non-stationary with a structural break in the trend; and (iii) y_t is non-stationary with a structural break in both the intercept and the trend.

The Perron test suffers because the break date is exogenously determined (see Zivot and Andrews, 1992). Zivot and Andrews (1992) argued that the identification of a break date may not necessarily be associated with the data. Thus, if the critical values computed under the null hypothesis are computed on the basis that the break date is determined *ex ante*, then there could be substantial size distortions. In this kind of situation, the Perron test would frequently reject the null hypothesis of unit root. The Zivot-Andrews test differs from the Perron test by explicitly modelling the break date endogenously. The Zivot-Andrews test also uses the ADF regression in equation (4). The test applies the Perron (1989) procedure for each break date in the dataset, and selects the break date for which the support for the null hypothesis is strongest (see Zivot and Andrews, 1992). The null hypotheses under the Zivot-Andrews test are the same as those under the Perron test.

5. Results and discussion

Next, we consider the results of the PPP tests for both countries. We present these results in terms of the unit root tests that we have discussed in the previous sections. Table 1 shows the results for the unit root tests, which do not incorporate structural breaks (i.e. the DF-GLS and the Ng-Perron unit root tests). For Lesotho, the null hypothesis of unit roots was rejected at the conventional levels of significance. Thus, the long-run stationary behaviour of the real exchange rate is well supported in Lesotho, using the unit root tests without structural breaks. For Zambia, all except the DF-GLS test with drift failed to reject the null hypothesis of unit roots in the real exchange rate series. So, contrary to the results obtained for Lesotho, the unit root tests without structural breaks appear to reject the PPP theory in Zambia (see Table 1).

Table 1: Test for Unit Roots in the Real Exchange Rate without Structural Breaks

Test	Lesotho	Zambia
DF-GLS (Drift)	-3.223***	-1.678*
DF-GLS (Trend)	-3.220**	-1.985
Ng-Perron (Drift)	-15.323***	-5.361
Ng-Perron (Trend)	-15.071*	-6.803

Note:

- (i) Optimal lag for both tests was decided by the Modified Akaike information criterion
- (ii) *, ** and *** denote significance at 10%, 5%, and 1%, respectively.

As outlined earlier, if there are structural breaks, the Ng-Perron and the DF-GLS unit root tests may fail to reject the null hypothesis of non-stationarity (see also Perron, 1989). Hence, the logical way to proceed with the analysis is to investigate the stationary behaviour of the real exchange rate series under structural breaks, using the Perron and the Zivot-Andrews tests. Table 2 shows the results for the unit root tests which capture structural breaks. Evidently, the null hypothesis of the unit root with a structural break in the drift or trend in the real exchange rate is rejected in the case of Lesotho. This further buttresses the previous results of a well-supported PPP hypothesis for Lesotho. In the case of Zambia, the story is just as convincing as ever; the null hypothesis of unit root with a structural break in the real exchange rate series is accepted. This implies that the PPP hypothesis is strongly rejected at the conventional levels of significance for Zambia (see Table 2).

Table 2: Test for Unit Roots in the Real Exchange Rate with Structural Breaks

Test	Lesotho	Zambia
Perron (Drift)	-4.799[1983]*	-3.286[1982]
Perron (Trend)	-5.307[2000]*	-3.492[1982]
Zivot-Andrews (Drift)	-4.574[1984]*	-3.505[1984]
Zivot-Andrews (Trend)	-5.279[2000]**	-4.166[1983]

Note: Break dates are in block parentheses; * and ** denote significance at 10% and 5% levels.

Our simple empirical analysis clearly shows that, irrespective of whether we use the unit root tests with or without breaks in the drift or the trend of the real exchange rate series, the long-run stationarity of the real exchange rate series (i.e. PPP hypothesis) is supported in Lesotho, but refuted in Zambia. The finding of a well-supported PPP hypothesis for Lesotho is broadly consistent with previous studies, such as those of Holmes (2000), and Kargbo (2003b and 2004). Aggarwal and Simmons (2002) have also documented similar findings for developing countries in their study. For Zambia, our findings strongly contradict the findings outlined in Kargbo (2003a, 2003b, and 2004). The findings also contradict those found in the work of Salehizadeh and Taylor (1999) and Liu (1992) for a number of developing countries in their study.

The main implication of this finding is that Lesotho is unlikely to profit immensely from trade and investment arbitrages, by trading with the US; on the other hand, Zambia is more likely to profit immensely from trade and investment arbitrages, by trading with the US, due to trade frictions and transaction costs (see Rogoff, 1996; and Taylor and Taylor, 2004). Also, the validity of the PPP hypothesis for Lesotho indicates that the PPP doctrine may be a useful guide for the exchange rate and other macroeconomic adjustment policies in the country. Since the PPP hypothesis is rejected for Zambia, the applicability of the PPP in exchange rate and other macroeconomic adjustment policies may be doubtful (see Kargbo, 2003a and 2003b).

6. Conclusion

The exchange rate has received an extensive amount of attention in international economics for several years. The variable has also been widely discussed in policy-making. The undoubted belief held by many economists is that a poorly-managed exchange rate could have unfavourable economic consequences. Thus, considerable efforts have been devoted to define, measure, and track the movements of exchange rates in virtually all countries. An interesting proposition in the exchange rate literature is that due to the *law of one price* (LOOP), real exchange rates should be measured as relative price levels of countries. This is the so-called purchasing power parity (PPP) hypothesis. The validity of the PPP hypothesis is generally agreed to have important international trade implications. Nevertheless, the empirical tests of such an important hypothesis have generated divergent findings. In this paper, we have examined the validity of the PPP hypothesis for two Southern African countries, namely: Lesotho and Zambia. To examine the PPP hypothesis for these two countries, we employed two categories of unit root tests: (i) Unit root tests without structural breaks (i.e. the DF-GLS and the Ng-Perron tests); and (ii) unit root tests with structural breaks (i.e. the Perron and the Zivot-Andrews tests). Our dataset consisted of annual real exchange rate series spanning the period 1960-2010 for Lesotho, and 1955-2010 for Zambia. The empirical evidence suggests that the PPP hypothesis is supported for Lesotho, but rejected for Zambia. The implication of this finding is that Lesotho is unlikely to profit immensely from trade and investment arbitrages, whereas Zambia is more likely to profit immensely from trade and investment arbitrages, by trading with the US.

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