Is SADC an Optimal Currency Area? Evidence from the Generalized Purchasing Power Parity Test

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ABSTRACT

In this paper we investigate the likelihood of a proposed monetary union in the Southern African Development Community (SADC) from the viewpoint of the Generalized Purchasing Power Parity (GPPP) hypothesis and optimum currency area (OCA) theory. We apply Johansen's multivariate co-integration technique. The findings from this study confirm that GPPP holds among the 11 SADC countries included in this study on account of cointegration in real exchange rate series. The South African rand-normalized long run beta coefficients of all the real exchange rates are below one except in the case of the Mauritian rupee and all bear negative signs except in the case of the Angolan New Kwanza and Mauritian rupee. This provides some evidence to support monetary union in the region with the exclusion of Angola and Mauritius. However, the absolute magnitudes of the short run adjustment coefficients of SADC countries' real exchange rates are low and bear positive signs in some cases. This finding implies that the observed slow speed of adjustment for (log) real exchange rate of SADC member states might constrain the effectiveness of stabilization policies in the wake of external shocks, rendering SADC countries vulnerable to macroeconomic instability. This result has important policy implications for the proposed monetary union in SADC.

Key Words: SADC, OCA, GPPP, real exchange rate, cointegration, panel unit root
JEL Classification: C32, E31, F15, F41

1. Introduction

The Southern African Development Community (SADC) is the largest regional economic grouping in sub Saharan Africa (SSA) (Burgess, 2009). SADC's regional economic integration agenda is outlined in its Regional Indicative Strategic Development Plan (RISDP), adopted by member states in 2003. The RISDP plans for deepening regional integration over a 15-year period. The timeline for the plan include the creation of a free trade area by 2008, a customs union by 2010, a monetary union by 2016, and a single currency by 2018.

The formation of the European Union (EU) has inspired countless research papers on economic integration; specifically relating to monetary integration and (optimum currency area) OCA theory. There is a sense of urgency in getting research results to policy makers to avoid a repeat of the EU financial crises in other regions. Recent research results are mixed about the economic and political feasibility of monetary integration in the SADC region and other regional economic communities in Africa (Burgess, 2009; Zerihun, et al., 2014). The chief aim of this paper is to test generalised purchasing power parity (GPPP) in SADC as measure of real convergence - an OCA criterion - towards monetary union in the region. The most important macroeconomic variable behind GPPP is the real exchange rate and its determinant factors. Stability of exchange rates along with other macro variables in the economy of potential currency union members, relative to other members, is one of the requirements for a group of countries to constitute an OCA and hence of adopting a single currency. This paper sheds light on the long run relationship among SADC constituent[1] economies to answer the question of whether SADC economies constitute an OCA. However, due to data limitations, four member countries namely the Democratic Republic of Congo (DRC), Lesotho, Namibia, and Zimbabwe are not included in the analysis. The motivation behind this study is to contribute empirical evidence towards the AU's agenda of economic integration with reference to SADC. Assessing criteria in the context of SADC and considering the lessons and practices from other regional integration initiatives on the continent will contribute to this end.

[1]The fifteen countries forming SADC are Angola, Botswana, Democratic Republic of Congo, Lesotho, Malawi, Madagascar, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe.

Studies carried out to test the validity of the PPP theory in the sub Saharan Africa (SSA) context fail to reject the null hypothesis of a unit root (Krichene, 1998; Nagayasu, 2002; Mkenda, 2001; Mokoena et al., 2009, Changet et al., 2010, and Olayungbo, 2011). This means that the real exchange rate series do not display mean-reverting behaviour in the long run. In some cases the results are not conclusive. To the best of our knowledge this paper is the first to test the GPPP hypothesis in SADC with a view of identifying countries in the region that may qualify as an OCA and may safely enter into a monetary union.

The remainder of the paper is organised as follows: section 2 adds contextual background, section 3 presents data and methodology, and section 4 presents empirical results and economic implications. The last section concludes the paper.

2. The Relevance of GPPP in OCA Theory

OCA theory, from the classic contributions by Mundell (1961), McKinnon (1963), Kenen (1969) and Ingram (1973), to its modern applications and revisions stresses that asymmetric, country specific shocks represent a key element in the choice of an exchange rate regime. Traditional OCA theory states that the requirements for suitable monetary unions are the *symmetry of shocks, the mobility of factors, the diversification of factors of production, the similarity of inflation rates, the flexibility of wages and prices and the capacity of risk sharing* (Tapsoba, 2009). In this section we attempt to explore the relevance of GPPP in OCA theory. GPPP hypothesise that the real exchange rates between two countries comprising the domain of a currency area should be co-integrated. GPPP is also relevant in a multi-country setting. If GPPP holds among member countries, it implies that the fundamentals that drive real exchange rates will exhibit common stochastic trends. Thus, real exchange rates in the currency area will also share common stochastic movements. Within the currency area, therefore, there should at least be one, at most n-1, linear combination of various bilateral real exchange rates among member countries that is stationary (Beirne, 2008).

GPPP hypothesis is a variant of the PPP theory. PPP theory is commonly regarded as one of the major pillars of international trade and finance theory. It has attracted considerable interest in the literature in the past and recently (Lau et al., 2011). However, puzzles associated with PPP and exchange rate economics make the theory debatable and without universal consensus (Taylor and Taylor, 2004; Mokoena, et al., 2009). Many recent studies taking advantage of econometric techniques confirm the positive contribution the theory has had. Furthermore, methodological improvements in addressing the limitations in the PPP theory are well documented (see Christopoulos and Leon-Ledesma, 2010; Lau et al., 2011). Recently, Snaith (2012) in a panel of 15 OECD countries using new panel root tests, which account for cross sectional interdependence among countries, finds that these panels produce more support for PPP theory using PPI indexes that represent a higher proportion of tradable goods.

The failure of traditional PPP theory in explaining bilateral exchange rate behaviour does not rule out the possibility of the existence of a stationary relationship between real exchange rates in multi-country settings. When PPP fails, GPPP can be used to test whether a stationary relationship exists between the real exchange rates of a panel of countries. This alternative view of the GPPP hypothesis was developed by Enders and Hurn (1994). The idea is that traditional PPP can fail because the fundamental macroeconomic variables determining real exchange rates, including national income, terms of trade and government consumption, etc. are non-stationary, and thus real exchange rates themselves tend to be non-stationary. Although bilateral real exchange rates are generally non-stationary, GPPP hypothesizes that bilateral real exchange rates can exhibit common stochastic trends if the fundamental macroeconomic determinants that affect real exchange rates are sufficiently interrelated. Therefore, the importance of the innovation of GPPP lies in the fact that it establishes a linkage among macroeconomic variables, real exchange rates and the concept of PPP (Gao, 2007).

Enders and Hurn (1994) first used the GPPP approach to assess the suitability of forming a currency union. If two countries qualify for the creation of a currency union the fundamental macroeconomic variables in the two countries must move together. In the context of GPPP, the fundamentals that drive real exchange rates will exhibit common stochastic trends. Within the currency area, therefore, there should at least be one linear combination of various bilateral real exchange rates that is stationary. Bilateral exchange rates are affected through both market conditions and intervention. Therefore, OCA theory help explain the behaviour of bilateral exchange rates on the same grounds that decisions are taken whether or not to form a currency union. Such links arise because shocks to the foreign exchange market reflect OCA-related factors. Countries' bilateral exchange rates are stable relative to each other when the shocks they experience are similar. However, we should note that when potential members of a proposed monetary union belong to different exchange rate regimes; it might have an impact on the speed of real exchange rate adjustment by different exchange rate regime countries, when exposed to similar shocks. Table 1 below shows SADC currencies and exchange rate regimes since 2004.

Table 1: SADC Currencies and Exchange Rate Regimes since 2004

Country	Currency	Exchange Rate Regime
Angola	New Kwanza	Managed floating
Botswana	Pula	Conventional fixed peg to a basket
DRC	Franc Congolais	Independently floating.
Lesotho	Loti	Conventional fixed peg to ZAR
Malawi	Kwacha	Independently floating
Madagascar	Malagasy ariary	Independently floating
Mauritius	Mauritian rupee	Managed floating
Mozambique	Metical	Managed floating
Namibia	Namibian dollar	Conventional fixed peg to ZAR
Seychelles	Seychelles rupee	Conventional fixed peg to ZAR
South Africa	Rand	Independently floating
Swaziland	Lilangeni	Conventional fixed peg to ZAR
Tanzania	Tanzanian Shilling	Independently floating
Zambia	Kwacha	Managed floating
Zimbabwe	Zimbabwe dollar	Managed floating

Source: SADC Central Banks (various issues)

Pooling real exchange rates from countries with different exchange rate regimes may therefore underestimate GPPP. When we consider the exchange rate regimes in the SADC region most of the countries in the region either have an independently floating or managed floating exchange rate regime. The rest are pegged to the South African rand which is independently floating. In the case of SADC, however, we can assume that the exchange rate regimes are inherently uniform in the region.

3. Data and Methodology

3.1 Data

This study covers a sample of 11 SADC member countries. Four member states of SADC namely the DRC, Lesotho, Namibia, and Zimbabwe are not included in the sample given data limitations. Monthly data for the period January 1995 to August 2012 is used in this study. All data relating to consumer price indices (CPI) (based on 2005=100) and nominal exchange rates relative to the US dollar are taken from the IMF International Financial Statistics. Each of the consumer price index and nominal exchange rate series are transformed into natural logarithms before the econometric analysis. The PPP approach measures the real exchange rate as the price of foreign goods relative to that of domestic goods, where both prices are expressed in the same currencies. That is, it defines the real exchange rate as the nominal exchange rate adjusted for the relative price levels of the foreign and domestic economy. In its simplest form, under the assumption of purchasing power parity, the RER is the nominal exchange rate (NER) multiplied by the relative prices of trading countries i.e.

$$RER = NER\frac{P*}{P} \qquad (1)$$

where $P*$ & P are the foreign and domestic prices respectively.

Alternatively, we can express equation (1) in logarithmic form, such that the series of interest for country 'i' at time-'t', is given by the following equation:

$$r_{i,t} = s_{i,t} + p^{*}_{us,t} - p_{i,t} \qquad (2)$$

where $r_{i,t}$ is the logarithm of the RER against the US dollar, $s_{i,t}$ is the logarithm of the NER against the US dollar, $p^{*}_{us,t}$ and $p_{i,t}$, are the logarithms of consumer price indices in the US and country 'i respectively'. Using equation 2 we compute the RER series for the countries included in this study. Annex 1 presents the descriptive statistics of the SADC RER series. Annex 2 reports unit root test results, whereas Annex 3 depicts the graphical illustration of RER series with non-mean reverting features at level and stationary in second difference, in line with literature reviewed in this study.

3.2 Methodology

A time series of RER $\{r_t\}$ is stationary if the following relation holds true under the assumption of linearity:

$$r_t = \alpha + \beta \, r_{t-1} + \varepsilon_t \ , 0 < \beta < 1 \qquad (3)$$

When β=1, equation (1) becomes a unit root process. It means the process does not allow the system to come back to equilibrium which limits the usefulness of PPP as a tool to assess monetary integration. However, the GPPP hypothesis can be employed in such conditions for the reasons discussed in section two. Following Enders and Hurn (1994) and succeeding literature - for example Wilson and Choy (2007) and Beirne (2008) - GPPP can be described as follows: Assuming an *n*-country world, an *m*-country ($m \leq n$) currency area exists such that a long-run equilibrium relationship exists between the *m-1* bilateral exchange rates of the form

$$r_{12t} = \alpha + \beta_{13t} r_{13t} + \beta_{14t} r_{14t} + \ldots + \beta_{1mt} r_{1mt} + \varepsilon_t \qquad (4)$$

where r_{i1t} is the log of the bilateral RER in period *t* between country 1 and country *i* ; α is the intercept term; β_{i1t}'s are the parameters of the cointegrating vector, which represent the degree of comovement of the RERs; and is ε_t a stationary stochastic disturbance term. Beirne (2008) explains equation (4) as the spill-over effect due to real shocks in country *i* that are transmitted to other economies with high degrees of economic interdependence with country *i*. GPPP holds when at least one linear combination of bilateral RERs is observed. The existence of linear combinations implies that output shocks have a symmetrical effect on the RERs in a given area (Ogawa and Kawasaki, 2003; Beirne, 2008). Mathematically,

$$r_{i0t} = \sum \beta_j r_{j0,t} + \varepsilon_{GPPP,t} \qquad (5)$$

where the residual term '$\varepsilon_{GPPP,t}$' is stationary.

In this paper we adopt the Johansen (1996) Multivariate Maximum Likelihood Estimation (MMLE) procedure because it assumes all variables to be endogenous and does not require the choice of a dependent variable. The Johansen method tests the restrictions imposed by co-integration of the unrestricted Vector Auto Regression (VAR) involving the series. To test whether the $n-1$ set of countries form an OCA, following Beirne (2008) we set up the *VAR (k)* in the following matrix notations:

$$z_t = A_1 z_{t-1} + \ldots + A_k z_{t-k} + \varepsilon_t \qquad \varepsilon_t \sim IN(0,\Sigma) \qquad (6)$$

where z_t is the log of the RER in the form of $(n\times 1)$ and A_i represents a matrix of parameters $(n\times n)$. In line with the Vector Error Correction Model (VECM), we can rewrite equation (6) as follows (in first-difference form):

$$\Delta z_t = \Gamma_1 \Delta z_{t-1} + \ldots + \Gamma_k \Delta z_{t-k+1} + \Pi z_{t-k} + \varepsilon_t \qquad (7)$$

where short run information is given by Γ_i which represents $(I - A_1 - \ldots - A_i), (i = 1,\ldots,k-1)$, and long run information is provided by Π which represents $-(I - A_1 - \ldots - A_k)$. Thus the hypothesis to be tested is given by:

$$H_1(r): \Pi = \alpha.\beta' \qquad (8)$$

Where α is the loading matrix known as the adjustment parameter in VECM and the reduced rank where, r is the number of co-integrating relationships. Granger's representation theorem indicates that if the coefficient matrix Π has a reduced rank $r < n-1$, there exists $(n-1)\times r$ matrices α and β each with rank r such that:

$$\Pi = \alpha.\beta' \, and \, \beta'.z_t \sim I(0)$$

Finally, the Johansen method estimates the matrix from an unrestricted VAR and tests whether we can reject hypothesis 1 (in equation 8) on the reduced rank of Π. When the matrix is stable, there is a long-run relationship among $n-1$ real exchange rates whose countries can form an OCA (Sugimoto, 2008).

To test the hypothesis in equation (8) using the Johansen co-integration procedure we can have two specific test statistics; one relating to the trace[2] test and the other to the maximum Eigen-value test. Both tests yield the number of co-integrating vectors in the system. The null hypothesis is that there are at most 'r' co-integrating vectors, i.e. ($0 \leq r \leq n$). The trace test statistics is computed as follows:

$$\lambda_{trace} = -N\sum_{i=r+1}^{n} \ln(1-\lambda_i) \qquad (9)$$

where λ_i are the (n-r) smallest squared canonical correlations of z_{t-1} with respect to Δz_t, corrected for lagged differences and *N* is the sample size.

In the same way, the maximum Eigen-value test is computed as follows:

$$\lambda_{\max} = -N \ln(1-\lambda_{N+1}) \qquad (10)$$

With the maximum Eigen-value test, the null hypothesis is that there are 'r' co-integrating vectors against the alternative that r+1 exist. Thus, rejection of the hypothesis implies that a maximum of 'r' co-integrating vectors exist.

4. Empirical Results and Discussions

Prior to cointegration and panel unit root test analysis it is customary to carry out conventional unit root tests. In this study we performed the following four unit root tests; the Dickey–Fuller test with generalised least squares (DF-GLS), Augmented Dickey Fuller (ADF) test, Philipps−Perron (PP), the test proposed by Ng and Perron (NG-MZ_α) (2001), and the Kwiatkowski-Philips-Schmidt-Shin (KPSS) test. The test results confirm that the series are non-stationary at level. See the results of unit root tests in Annex 2.

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[2]Both trace and maximum eigenvalue tests are likelihood ratio type tests, however, both operate under different assumptions regarding the deterministic part of the data generation process. The trace test tends to have more distorted sizes whereas their power in some situations superior to that of the maximum eigenvalue tests (Lutvephol, 2000).

4.1 Johansen Cointegration Test Result

The co-integration rank is determined by assessing the Trace and Maximum Eigen-value test statistics. As shown in Table 2 the Trace statistics indicate three cointegrating relationships while the Maximum Eigen-value shows one cointegrating equation at the 1% level. The Eigen-values in Table 2 are less than unity which implies that the system as a whole is stable and the co-integration results are reliable (Chiemeke, 2010). Given these findings there are more than one co-integrating vector for SADC (log) real exchange rate in support of GPPP hypothesis in the SADC region for the sample period.

Table 2: GPPP Test using Johansen multivariate co-integration test on SADC (Log) RER (Base currency =US$)

Sample (adjusted): 1995M08 2012M10 Null hypothesis: no integration
Included observations: 207 after adjustments Trend assumption: Linear deterministic
Series: *RERSA RERA RERB RERMA RERMD RERMU RERMO RERSC RERSW RERTA RERZA*
Lags interval (in first differences): 1 to 4

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	1 % Critical Value	Max-Eigen Statistic	1 % Critical Value
None***	0.418328	**395.8688**	293.44	**112.1628**	75.95
r≤ 1***	0.268538	**283.7060**	247.18	64.73099	69.09
r≤ 2***	0.248888	**218.9750**	204.95	59.24356	62.80
r≤ 3	0.190979	159.7314	168.36	43.86950	57.69
r≤ 4	0.152646	115.8619	133.57	34.28672	51.57
r≤ 5	0.125896	81.57520	103.18	27.85303	45.10
r≤ 6	0.090721	53.72216	76.07	19.68641	38.77
r≤ 7	0.070556	34.03575	54.46	15.14602	32.24
r≤ 8	0.047670	18.88973	35.65	10.11057	25.52
r≤ 9	0.030071	8.779158	20.04	6.320142	18.63
r≤ 10	0.011809	2.459016	6.65	2.459016	6.65
Note: *** denotes rejection of the null hypothesis.		*Trace test indicates 3 cointegrating equation (s) at the 1% level.*		*Max-Eigen test indicates 1 cointegrating equation(s) at the 1% level.*	

Source: own estimation

4.2 Speed of short run adjustment and long run elasticity coefficients

The alpha (α) coefficients in Table 3 provide the estimates of the short run adjustment of each of the real exchange rates towards the long run equilibrium. The alpha coefficients of SADC countries in Table 5 are all below one and the standard errors of the estimation are very low. These are good indications of RER stability in the region. However, all the coefficients are positive except in the case of the Angolan new kwanza, Mauritian rupee, Seychelles rupee, and Zambian kwacha. The coefficients can be interpreted as a measure of how quickly each of the RERs converges to GPPP (Beirne, 2008). Considering the absolute magnitude of the alpha coefficient in Table 3 the Angolan new kwanza has highest value of -0.94 which implies that the (log) RER of the Angolan new kwanza expressed against the dollar adjusts at the rate of 94% per month towards the long run equilibrium whereas the Zambian kwacha adjusts at a rate of -0.0088 or only 0.88% per month towards the long run equilibrium. The rest of the coefficients can also be interpreted likewise.

Table 3: Short-run Adjustment Coefficients (α)

RER series	Adjustment coefficients (α)	Standard Error
D(South African rand)	0.016662	0.03318
D(Angolan new kwanza)	-0.941522	0.12886
D(Botswana pula)	0.037468	0.02376
D(Malawian kwacha)	0.086315	0.03880
D(Malagasy ariary (MGA))	0.107311	0.02685
D(Mauritian rupee)	-0.024887	0.01444
D(Mozambique metical)	0.042243	0.02391
D(Seychelles rupee)	-0.016641	0.05774
D(Swazi lilangeni)	0.016270	0.03557
D(Tanzanian shilling)	0.022810	0.01770
D(Zambian kwacha)	-0.008818	0.03676

Source: own computation from sample data (1995m1-2012m8)

The absolute magnitude of the adjustment coefficients of SADC countries' real exchange rate is low. The lower the absolute magnitude of the 'α' coefficient, the slower becomes the speed of adjustment towards long run equilibrium. This finding implies that the observed slow speed of adjustment for (log) real exchange rate of SADC member states might constrain the effectiveness of stabilization policies in the wake of external shocks, rendering SADC countries vulnerable to macroeconomic instability in the region. Though the magnitudes of the alpha coefficients are low, they are all significantly different from zero at 1 percent level of significance. Therefore, the problem of weak exogeneity[3] is not observed for the countries included in this study over the study period.

The beta (β) coefficient in Table 4 reflects the interrelationships among SADC real exchange rates in terms of the long run elasticities. The real exchange rates based on the South African rand expressed against the US dollar is used to obtain the normalized equations in Table 4. When using the South African RER to obtain the normalised cointegrating equations, the results of adjustment coefficients (α) and long run coefficients (β) are superior to other currencies in the region. The results are statistically significant at the 1 percent level of significance for the bilateral real exchange rates. The sign and the magnitude of the parameters of the co-integrating vectors of countries in the sample reflect common policy connections and coordination that exist among member countries (Beirne, 2008). The magnitude of the beta coefficients of all the real exchange rates are below one except in the case of Mauritius and they all bear negative sign except in the case of Angola and Mauritius. We can take this evidence as supportive of monetary union in the region, excluding Angola and Mauritius. These two countries may exhibit asymmetry in response to external shocks, disqualifying them from a SADC OCA. The interpretation goes with Table 4. Thus, a 1 percent increase in the real exchange rate of the South African rand per US dollar (i.e. a devaluation of rand) will induce a 0.818%, 0.137%, 0.558%, 0.387%, 0.083%, 0.779% , 0.445% and 0.156% decrease in the real exchange rates of the currencies of Botswana, Malawi, Madagascar, Mozambique, Seychelles, Swaziland, Tanzania, and Zambia per US dollar, respectively.

[3] An economic variable tends to be weakly exogenous if its speed of adjustment coefficient is not statistically different from zero (Harris, 1995). Such a variable has no explanatory power with respect to the long run coefficients.

Table 4: SADC Real Exchange Rate Normalised long run Cointegrating Equations (β-Coefficients)

RER series (1 Cointegrating Equation: Log likelihood 4852.518)	Normalised Long run Cointegrating Equations (β- Coefficients)	Standard Error
South African rand	1.000	
Angolan new kwanza	0.160	0.031
Botswana pula	-0.818	0.345
Malawian kwacha	-0.137	0.075
Malagasy ariary (MGA)	-0.558	0.154
Mauritian rupee	1.616	0.252
Mozambique metical	-0.387	0.131
Seychelles rupee	-0.083	0.135
Swazi lilangeni	-0.779	0.273
Tanzanian shilling	-0.445	0.177
Zambian kwacha	-0.156	0.087

Source: own computation from sample data (1995m1-2012m8)

5. Conclusion

In this paper we aimed to establish whether SADC countries form an OCA by using the GPPP framework. For the analysis the Johansen multivariate co-integration techniques were used. A panel of the logarithm of SADC real exchange rates, nominal exchange rates, CPI, and CPI of the US as a base country for the period of 1995 to 2012 are employed in the analysis.

Consistent with the previous studies in developing regions across the globe, all the conventional unit root tests confirm that the panel series in this study have unit roots. We also employed panel unit root tests for RER series which confirmed stationarity with a high level of significance with a time trend included in the estimation. Johansen's multivariate co-integration test has two specific test statistics: the trace and the maximum Eigen-value. In this paper the trace statistics indicate the existence of three co-integrating relationship among SADC real exchange rates while the maximum Eigen-value shows one cointegration relationship. The Eigen-values obtained in the analysis of these two statistics are less than unity which implies that the systems of equations are stable and hence the results from the estimations are reliable. Therefore, the conclusion from these findings implies that GPPP holds in the SADC region. However, the absolute magnitudes of the short run adjustment coefficients of SADC countries' real exchange rates are low. The lower the absolute magnitude of the alpha coefficient, the slower becomes the speed of adjustment towards long run equilibrium. This finding implies that the observed slow speed of adjustment for (log) real exchange rate of SADC member states might constrain the effectiveness of stabilization policies in the wake of external shocks, rendering SADC countries vulnerable to macroeconomic instability in the region. The magnitude of the long run beta coefficients of all the real exchange rates are below one except in the case of Mauritius and they all bear negative sign except in the case of Angola and Mauritius. We can take this evidence as supportive of monetary union in the region excluding Angola and Mauritius. These two countries may exhibit asymmetry in response to external shocks, disqualifying them from a SADC-OCA. Similar findings are reported by Zerihun et al. (2014) that states that not all countries in SADC conform to OCA criteria judged by both asymmetrical business cycles and weak co-movements in business cycles.

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Annexure

Annex 1: Descriptive Statistics and Normality Test of SADC (Log) Real Exchange Rate

Country	Mean	Median	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Jarque-Bera[4]
Angola	4.460	4.479	5.627	1.966	0.551	-0.867	5.800	95.768***
Botswana	1.714	1.696	2.129	1.493	0.143	0.743	2.945	19.527***
Madagascar	7.438	7.453	7.894	7.171	0.152	0.114	2.155	6.767**
Malawi	4.629	4.680	5.107	4.083	0.215	-0.910	3.432	30.886***
Mauritius	3.300	3.335	3.492	3.093	0.111	-0.262	1.833	14.453***
Mozambique	3.118	3.104	3.457	2.874	0.146	0.559	2.463	13.603***
South Africa	1.909	1.884	2.528	1.592	0.193	0.975	3.992	42.273***
Seychelles	1.798	1.733	2.263	1.558	0.158	1.054	3.212	39.619***
Swaziland	1.949	1.911	2.580	1.581	0.207	0.832	3.416	25.979***
Tanzania	6.911	6.937	7.161	6.635	0.118	-0.470	2.462	10.357***
Zambia	8.476	8.601	9.066	7.904	0.316	-0.284	1.481	23.240***

Source: own computation from sample data (1995m1-2012m8)
Note: ** and*** indicate significance at the 5% and 1% levels, respectively.

Annex 2: Univariate Unit Root Tests of SADC (Log) Real Exchange Rate Series

(Log) Real Exchange Rate Series	**DF**(GLSdetrended)	**ADF** (Level)	**PP** (GLSdetrended)	MZ_{α} **(**GLS detrended)	**KPSS** (Trend Stationary)
Angola	-0.770(8)	-1.477(8)	-0.523(8)	-0.298(8)	0.239(14)***
Botswana	-1.350(2)	-2.090(8)	-3.712(2)	-3.685(2)	0.236(10)***
Madagascar	-1.699(1)	-2.428(1)	-6.703(1)	-6.665(1)	0.233(11)***
Malawi	-1.699(5)	-1.510(5)	-5.085(5)	-5.051(5)	0.217(13)***
Mauritius	-1.166(7)	-1.5348(7)	-2.967(7)	-2.949(7)	0.316(14)***
Mozambique	-1.532(7)	-1.481(7)	-4.321(7)	-4.293(7)	0.223(14)***
South Africa	-0.995(2)	-2.404(8)	-2.184(2)	-2.158(2)	0.237(14)***
Seychelles	-0.653(1)	-1.235(5)	-1.2801(1)	-2.076(1)	0.254(14)**
Swaziland	-1.215(3)	-1.420(8)	-3.309(2)	-3.283(3)	0.233(14)***
Tanzania	-1.122(8)	-1.299(6)	-2.269(8)	-2.296(8)	0.229(12)***
Zambia	-0.578(1)	-0.441(8)	-1.280(1)	-1.272(1)	0.242(14)***

Source: own computation from sample data (1995m1-2012m8)

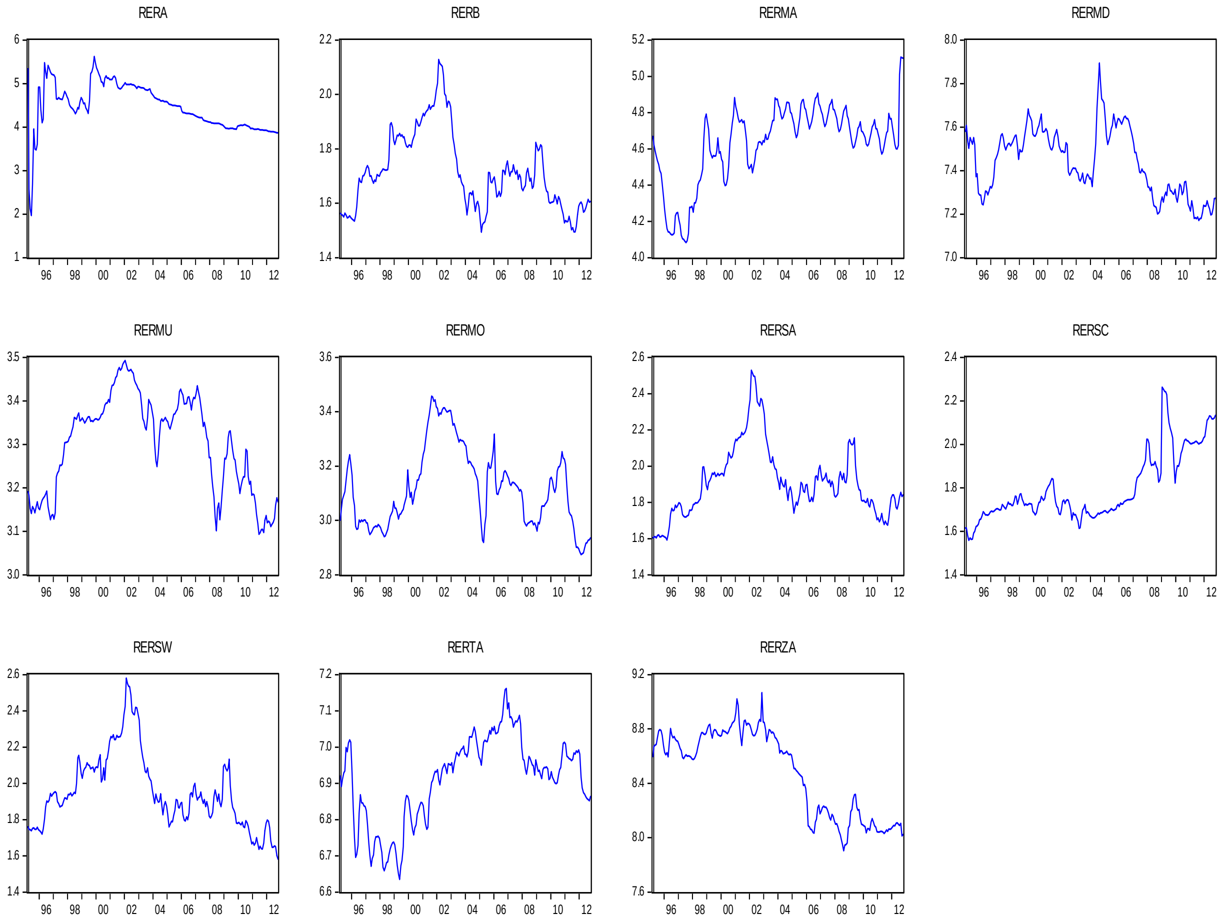
[4] This results present test statistics for the null hypothesis of a univariate normal distribution.

Note: For ADF we used one-sided (lower tail) test of H_0: Non-stationary vs. H_1: Stationary and 1%, 5%, 10% critical values (T=100) = -3.510 -2.890 -2.580, respectively.
5% Crtical Value for ADF, PP, MZ_{α} and DF-GLS test is -8.350.

Figures in parentheses are optimal lag lengths selected by appropriate lag criteria. For KPSS test maximum lag of 14 is chosen by Schwert criterion and the autocovariances weighted by Bartlett kernel. Critical values for Ho: real exchange rate is trend stationary are: 10%:**0.119**, 5%:**0.146**, and 1%:**0.216**.

Annex-3: (Log) Monthly Real Exchange Rates-SADC Countries in the sample, 1995:03-2012:10

a) RER-at Level



b) RER-Residuals