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DOES SADC CONSTITUTE AN OPTIMUM CURRENCY AREA? EVIDENCE FROM GENERALISED PURCHASING POWER PARITY

Abstract:

The Southern African Development Community (SADC) has ambitious plans of economic integration for the region. It is planning to introduce a common currency and a regional central bank by the year 2018. As advocated by the optimal currency area (OCA) theory, lower transaction costs, stable prices, efficient resource allocation and improved access to goods, labour and financial markets are some of the benefits accrued from monetary unions. Relinquishing monetary and exchange rate policies are cited as the main costs of joining such a union. It is argued that sufficient and sound economic bases should be in place for a monetary union to be effective and yield the desired result. The primary objective of this paper was to determine whether SADC constitute an OCA. The study employs the generalised purchasing power parity (GPPP) framework consistent with OCA theory on price (inflation rate) and exchange rate. The method included Johansen cointegration test, vector error correction model and Pedron`s panel cointegration test. The findings of the study suggest that GPPP holds in SADC. This can be interpreted as existence of similarities of fundamental macroeconomic factors that drive real exchange rates in the region. This evidence suggests that bilateral real exchange rates in the SADC region share a common stochastic trend in the long-run. However, the differences in the size of coefficients of normalised long-run cointegrating equation suggest that the aggregate demand patterns in the region are dissimilar and indicate asymmetries in exchange rate adjustment process to disequilibrium in the region. Other economic concerns such as business cycle synchronisation, and convergence of key macroeconomic variables including budget deficit, government debt and foreign reserves cover should be thoroughly investigated before the said economic union is implemented.

Keywords:

Optimum currency area, generalised purchasing power parity, monetary union, single currency, SADC

JEL Classification: F33, F40, C23

1. Introduction

The Association of African Central Bank Governors, in 2003, announced that it would work for a single currency and common central bank for Africa by 2021. Many regional trading blocs and economic communities are working towards this grand objective. The Southern African Development Community (SADC) has ambitious plans of economic integration for the region. It is planning to introduce a common SADC currency and a regional central bank by the year 2018 (Mboweni, 2003; Tavlas, 2007:2-3). Hartzenberg (2011:5) indicates that the Southern African Development Co-ordinating Conference (SADCC) was established in 1980, by the so-called front line states with the principal purpose of reducing economic independence on South Africa during the apartheid era. SADCs history and treaty records show that in 1992, the Governments of the region agreed to transform SADCC into the SADC, with the focus on integration of economic development (SADC, 2016a)**.** Khamfula and Huizinga (2004:700) also note that before the end of apartheid in South Africa, SADC was characterised by a high degree of economic disintegration, marked political divisions and hostility. However, with the end of apartheid in the early 1990s, the SADC region entered into a new era and was geared as platform to increased economic cooperation among member countries (Khamfula and Huizinga, 2004:700). South Africa joined SADC in 1994 (Rossouw, 2006a:156). Presently, SADC is the largest trading block in Africa and consists of 15 member countries, namely Angola, Botswana, Congo (DRC), Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe.

It is vital to mention the existence of a separate and long-standing common monetary area (CMA) within the SADC region. The CMA or rand area is composed of South Africa, Lesotho, Namibia and Swaziland. The CMA has its roots in the *de facto* currency area and it was established formally in December 1975 (Metzger, 2004; Wang, Masha, Shirono & Harris, 2007:8-9). In terms of the CMA agreement, member countries have their own currencies, which are at par with each other allowing free capital flows among member countries (Nielson, Uanguta & Ikhide, 2005:711). However, given the size and degree of development of the three smaller members, the Reserve Bank of South Africa set the monetary policy and the other smaller countries' central banks function as currency boards and issue their own currencies (Masson & Pattilo, 2001:38). These three countries (Lesotho, Namibia and Swaziland) were, therefore, excluded from the study to avoid multicollinearity.

The GPPP theory incorporates two important macroeconomic variables, namely exchange rate and inflation rate. As indicated earlier, the Vaubel theory focuses on real exchange rates and states that a group of countries should form a monetary union when they have no need to modify their real exchange rates through changes in nominal exchange rates (Zis, 1992; Marco, 2014:8). Similarity in inflation is crucial in maintaining stable trade among countries (Fleming, 1971:476). As elaborated earlier, flexible prices and wages are vital in restoring equilibrium according Mundell's OCA theory (Dellas & Tavlas, 2009:1123).

The study employs the generalised purchasing power parity (GPPP) framework consistent with the OCA theory on price (Mundell, 1963), inflation rates (Fleming, 1971) and exchange rates (Vaubel, 1976; Zis, 1992; Marco, 2014). Various studies have employed the GPPP in assessing the viability of monetary unions and single currencies (Aggawal & Mougoue, 1996; Enders & Hurn, 1997; Bernstein, 2000; Beirne, 2008; Kim, Kim & Oh, 2009; Mishra & Sharma, 2010).

To give perspective to GPPP, first reference is made to the purchasing power of parity. Purchasing power parity (PPP) is one of the key assumptions in open macroeconomics and international finance models (Su, Cheung & Roca, 2014:161). The PPP hypothesis has been a major topic for empirical research (Wu, Lee & Wang, 2011:572). The PPP hypothesis is based on a simple idea on the law of one price, which postulates that identical goods should sell at the same price in different countries and that the exchange rates between currencies will allow this to happen (Kreinin, 2002:379). Thus, the existence of PPP is based on the assumption of perfect inter-country goods arbitrage. As a result, PPP is expected to hold only in the long run. This is simply because in the short run, market conditions such as transaction costs, taxation, trade barriers and differences in price indices across countries tend to interfere in the price adjustment (Kim *et al*., 2009:96). This implies that the PPP has limitations in explaining the relationship between movement in prices and exchange rates as non-stationary series.

In light of the limitations and weaknesses of the PPP in explaining the movements in prices and exchange rates and its inability to adequately clarify the non-stationarity of real exchange rate caused by the fundamental determinants of exchange rate that are non-stationary themselves, Enders and Hurn (1997:437) proposed the GPPP to address such limitations and weaknesses. Enders and Hurn's (1997:437) theory (the GPPP) is a powerful tool in evaluating exchange rate behaviours across multiple countries (Bernstein**,** 2000:389). The GPPP theory postulates that even though bilateral real exchange rates are generally non-stationary, in the long-run they might be cointegrated, provided the forcing variables or long-run macroeconomic determinants that define real exchange rates are highly associated (Bernstein**,** 2000:389; Mishra & Sharma, 2010:207). The implication of this assumption is that if GPPP holds in proposed monitory areas, the fundamental forces that affect real exchange rates may share common stochastic trends and at least one linear combination of the various bilateral real exchange rates may exist that is stationary (Mishra & Sharma, 2010:207).

Dellas and Tavlas (2009:1118) assert that the theory of OCA has long been a subject of academic research and object of controversy since the 1950s initiated by Friedman on the issue of fixed versus floating exchange rates. Drummond, Aisen, Alper, Fuli and Walker (2015:5) opine that lower transaction costs, stable prices, efficient resource allocation and improved access to goods, labour and financial markets are some of the benefits accrued from monetary unions. Furthermore, Drummond *et al*. (2015:5) indicate that these benefits will in turn stimulate trade, investment and economic growth across members of the monetary union. Similarly, Bąk and Maciejewski (2015:8), argue that a currency union also supports integration and the development of financial markets, contributes to business cycle conformity among member countries and facilitates price and interest rate arbitrage, which imposes greater competition and is a guarantor of better capital allocation within the common currency area. Relinquishing monetary and exchange rate policies are cited as the main costs of joining a monetary union (Dellas & Tavlas, 2009:1118; Van Der Merwe & Mollentze, 2010:426). Forming a monetary union is a serious endeavour by any stretch of imagination that needs serious and deliberate consideration. It could have a devastating impact on the continent and may even worsen the socio-economic conditions of the people if it is not based on sound macroeconomic principals. Therefore, serious consideration ought to be given to such a decision. This is particularly important as we witness economic crises in the Euro zone, which is largely hailed for its successful launch of the Euro and the establishment of the European Central Bank (ECB). As the year of implementation of the monetary union in SADC draws closer; this study attempts to provide an economic analysis of the feasibility of the said monetary union so that informed economic decisions may be made by policy makers.Thus,

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primary objective of this paper was to determine whether SADC constitute an optimum currency area (OCA).

2. Research methodology

2.1 Data and selection of variables

Monthly nominal exchange rates (a market price of a domestic currency for US dollar) and CPI of all the sample countries in the two regions and United States' CPI were utilised in analysing the GPPP in the two regions. Data were downloaded from INET BFA. The data spans from 1995:02 to 2015:11 resulting in 250 country-specific observations, which is more than sufficient for econometrics analysis. For panel data analysis, a cross-sectional entry for the 10 countries resulted in a total of 2500 observations for each variable.

2.2 Econometric modelling of GPPP

In order to determine whether SADC constitutes an OCA, we employ various econometrics techniques. As indicated earlier, the study employs the generalised purchasing power parity (GPPP) framework consistent with the OCA theory. The purchasing power parity (PPP) hypothesis is based on the law of one price, which postulates that identical goods should sell at the same price in different countries and that the exchange rates between currencies allows this to happen. There are two versions of PPP, namely the absolute version and the relative version (Kreinin, 2002:379). The absolute version of PPP posits that if $1 buys the same quantity of goods and services in the United States as R12 in South Africa, then the long-run exchange rate would be $1 = R12 reflecting the relative power of the two currencies. On the other hand, the relative version of PPP posits that if prices in the United States double and in South Africa quadruple from a given base, then South African currency (R) should depreciate 50 percent relative to the United States currency ($). From this, it is evident that the role of price and nominal exchange rate adjustments is crucial in the reversion of PPP (Wu *et al.*, 2011:283). In terms of the absolute PPP hypothesis, Enders & Hurn (1997:437) express the relationship between domestic price, foreign price and the price foreign exchange as follows:

$$NER = \frac{P_d}{P_f} \quad \text{..........} \quad (1)$$

Where, *NER* is the nominal exchange rate (expressed as the domestic price of a foreign currency, P_d *and* P_f denote the logs of domestic and foreign price levels respectively. The real exchange rate is calculated as follows:

$$RER = NER \times P_f/P_d \quad \text{..........} \quad (2)$$

Where, *RER* is the real exchange rate, *NER* is the nominal exchange rate, P_d *and* P_f denote the logs of domestic and foreign price levels, respectively.

2.2.1 Testing for pure PPP

The long-run PPP expressed by the following equation implies that real exchange rate is stationary (Enders & Hurn, 1997:437). For countries *x* and *y*, we construct the bilateral real exchange rate in time period *t* as

$$RER_{xyt} = NER_{xyt} + Pxt - P_{yt} \quad \text{..........} \quad (3)$$

Where, *RER* is the real exchange rate, *NER* is the nominal exchange rate, *P* denotes the price levels.

Enders and Hurn (1997:437) argue that numerous studies have shown that real exchange rates are non-stationary and this has put the validity of PPP into question. Kim *et al.* (2009:96) suggest that the existence of PPP is based on the assumption of perfect inter-country goods arbitrage. As a result, PPP is expected to hold only in the long run. This is simply because, in the short-run, market conditions such as transaction costs, taxation, trade barriers and differences in price indices across countries tend to interfere in the price adjustment mechanism.

2.2.2 Testing for common stochastic trend using GPPP

In light of the limitations and weaknesses of the PPP in explaining the movements in prices and exchange rates and its inability to adequately clarify the non-stationarity of real exchange rate caused by the fundamental determinants of exchange rate that are non-stationary themselves, Enders and Hurn (1997:437) proposed the GPPP to address such limitations and weaknesses. The GPPP theory is a powerful tool in evaluating exchange rate behaviours across multiple countries (Bernstein, 2000:389). The GPPP theory postulates that even though bilateral real exchange rates are generally non-stationary, in the long run they might be cointegrated, provided the macroeconomic determinants that define real exchange rates are highly associated (Enders & Hurn 1997:437; Bernstein, 2000:389; Beirne, 2008:3). Examination of stationarity of a series is therefore the stating step in testing for the GPPP.

The Augmented Dickey-Fuller (1979) test statistic (ADF) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests were used to determine the order of integration of the variable (real exchange rate). The ADF statistic tests the null hypothesis of a unit root (i.e. a series is non-stationary) against the alternative hypothesis of a stationary series (Hsiao, 2003:301; Brooks, 2014:363). The KPSS null hypothesis is the opposite and it states that a time series is stationary (Kwiatkowski *et al*., 1992; Adom, Sharma & Morshed, 2010:248). After establishing that the exchange rate series is integrated of order one, I(1), the cointegration test was conducted.

The cointegration approach normally is employed in determining whether the GPPP holds in monetary area (Enders & Hurn, 1997:440). Following Enders and Hurn (1997:440), the cointegrating vector of *n* real exchange rate with the USA dollar as a base currency can be expressed as follows:

$$RER_{12} = \alpha_0 + \beta_{13}RER_{13} + \beta_{14}RER_{14} + \beta_{15}RER_{15} + \cdots + \beta_{1n}RER_{1n} + e_t \qquad (4)$$

Where NER_{1nt} is the log of bilateral real exchange rates at period *t* between country 1 and country n; α_0 is the intercept term; β_{1n} are the parameters of cointegrating vector (representing the degree of movement between the countries) and e_t is a stationary stochastic disturbance trend. This implies that if GPPP holds in proposed monitory area, the fundamental forces that affect real exchange rates may share common stochastic trends and at least one linear combination of the various bilateral real exchange rates may exist that is stationary (Enders & Hurn 1997:437; Beirne, 2008:5). The existence of GPPP suggests that although individual bilateral exchange rate may appear non-stationary relative to an outside currency, the variation between members of a union has a long-run stationary trend.

Johansen cointegration test is the econometric technique used in examining the GPPP (Enders & Hurn, 1997:440). The test assess whether or not real exchange rate of the countries are cointegrated. Following Beirne (2008:5), we consider the following VAR(k) model:

$$Z_t = A_1 Z_{t-1} + \ldots + A_k Z_{t-k} + e_t \qquad e_t \sim IN\ (0, \Sigma) \ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \ (5)$$

Where Zt is the logarithm of the log of real exchange rate in the form (n x 1) and A_i represents an matrix of parameters (n x n).

Equation 5 can be expressed as a VEC model as follows (in first differenced form):

$$\Delta Z_t = \Gamma_1 \Delta Z_{t-1} + \ldots + \Gamma_{k-1} \Delta Z_{t-k+1} + \Pi Z_{t-k} + e_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

Where Γ_i represents –(I – A_1 - …- A_i), (I = 1,….k-1) and Π = - (I – A_1 -….A_k).

By notating the system in this fashion, information is provided for the long-run and short-run relationships to changes in Z_t. The short-run information is given by the estimates of Γ_i, while the long-run information is provided by the estimates of Π (Beirne, 2008:5-6). Therefore, Johansen co-integration is based on the examination of the Π matrix.The Johansen test of cointegration was employed to assess whether real exchange rates in the respective economic regions countries are cointegrated. We employ two test statistics, namely trace statistic and max-Eigen statistic available in testing cointegration exchange rates in the region (Brooks, 2014:387). The two test statistics are formulated as follows respectively:

$$\lambda \text{trace} = -\text{T} \sum_{i=r+1}^{n} ln\,(1 - \lambda \text{i}) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (7)$$

and

$$\lambda \max\,(r, r+1) = -\text{T}\ln(1 - \lambda \text{r} + 1) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (8)$$

Where *r* is the number of cointegrating vectors under the null hypothesis and λ is the estimated value for the *i* th ordered eigenvalues of the matrix of canonical correlations (Enders & Hurn, 1997:441; Brooks, 2014:387). These two test statistics test the hypothesis that there are at most *r* cointegrating vectors (0 ≤ *r* ≤*n*) in a series.

λ_{trace} is a joint test where:

H_0: the number of co-integrating vectors ≤ r and

H_1: the number of co-integrating vectors > r.

λ_{max} conducts a separate test on each eigenvalue in sequence as follows:

H_0: r = 0 versus H_1: 0 < r ≤ n

H_0: r = 1 versus H_1: 1 < r ≤ n

H_0: r = 2 versus H_1: 2 < r ≤ n

… … ...

H_0: r = n-1 versus H_1: r = n

The first test involves a H_0 of non-co-integrating vectors. If the H_0 is not rejected, it would indicate that there are no co-integrating vectors and the cointegration test would be completed. Contrary, if the H_0 for r = 0 is rejected; the H_0 for r = 1 will be tested and so on. Hence, the value of r is increased repeatedly until the H_0 is no longer rejected. The Johansen cointegration test was conducted with intercept and no trend in model but with a linear deterministic trend in the data series. If variables are found to be co-integrated then the VECM is used to capture the error correction.

2.2.3 Panel cointegration approach

To supplement the results, a panel cointegration was also used. Before conducting the panel cointegration, the panel unit was first conducted. I Three tests, namely the ADF test (Fisher chi-square and Choi Z-stat), Im, Pesaran and Shin (IPS) and Hadri (Z-stat and heteroscedastic consistent Z-stat) were conducted to assess the stationarity of panel variables, namely real exchange rate, nominal exchange rate and consumer price index (CPI). The ADF and IPS test whether the null hypothesis of panel series has unit root, meaning it is non-stationary (Hsiao, 2003:301; Mishra & Sharma, 2010:208). The Hadri's (2000) null hypothesis is the opposite and it states that the panel series does not have unit root; meaning it is stationary (Mishra & Sharma, 2010:208; Brooks, 2014:550). Subsequent to panel root test and establishing the results, the next appropriate technique, Pedroni's panel cointegration test, was pursued to further examine the cointegration indicated by Johansen cointegration test.

2.2.4 Lag selection and diagnostic checks

Prior to undertaking the Johansen test of integration, an optimal lag length was selected using Logl statistic, LR test statistic, FPE, AIC, SIC and HQIC in the VAR (vector autoregression) system. This study adopted various tests including test for serial correlation and heteroskedasticity to validate the robustness of the results of VECM. Furthermore, the study also conducted a stability check using the inverse roots of AR characteristic polynomial to investigate whether the long-run relationships established are stable.

3. Results and discussion

3.1 Unit root test results of RER

An assessment of stationarity a series is crucial before undertaking any analysis to avoid to spurious regression (Brooks, 2014:353). Unit root tests are also useful in determining the order of integration of variables. Using unit root test, the stationarity of real exchange rates of member countries in the SADC was examined so appropriate techniques are selected. Two tests, namely the ADF test and KPSS tests, with AIC lag selection, were used. The tests were conducted with intercept and without trend. The critical values for both tests were set at 5 percent significance level. Table 1 presents the results of unit root tests of real exchange rates for the 10 countries in the SADC region. The result of unit root tests of all member countries in the SADC indicates that the bilateral real exchange rates are non-stationary at level and become stationary only when first differenced. This implies that the variable (in this case real exchange rate) is integrated of the same order, I(1). This suggests that there is a probability of cointegration of real exchange rate in the SADC region. Hence, the next step was to examine this probability using a cointegration test.

Table 1: Unit root test results of RER

Countries	ADF (Level)		ADF (1st diff)		KPSS (Level)	KPSS (1st diff)
	t-Statistic	Critical values	t-Statistic	Critical values	LM-Stat.	LM-Stat.
Angola	-0.037313	-2.873093	-4.685395	-2.873093	1.815388	0.147561
Botswana	0.220525	-2.872998	-12.30545	-2.872998	1.756280	0.156437
DRC	-0.653587	-2.873093	-13.66461	-2.873093	1.942389	0.085060
Madagascar	0.039336	-2.872998	-11.39547	-2.872998	1.840016	0.163388
Malawi	2.038374	-2.873543	-13.69901	-2.872998	1.599318	0.862031
Mauritius	-1.827764	-2.872998	-11.67031	-2.872998	1.470923	0.084555
Mozambique	0.735961	-2.873045	-6.171200	-2.873045	1.881592	0.170153
South Africa	-0.270432	-2.872998	-11.37252	-2.872998	1.122608	0.177741
Tanzania	1.400488	-2.872950	-13.43040	-2.872998	1.996645	0.211284
Zambia	1.547237	-2.872998	-11.53143	-2.872998	1.790224	0.353404

Note 1: Test critical values for ADF is at 5%.

Note 2: Asymptotic critical values for KPSS at 5% is 0.463000.

3.2 Johansen test of cointegration of RER

Prior to undertaking the Johansen test of integration, an optimal lag length should be selected in the VAR system. The criteria used for lag selection were Logl statistic, LR test statistic, FPE, AIC, SIC and HQIC. The VAR lag selection criteria indicaated optimum lag one based on SIC and HQIC; while AIC and FPE select two optimum lags. Both number of lags were considered and lag one produced better results.

Cointegration results were estimated with intercept with no trend for linear deterministic trend in the data series. The results for the two methods, namely trace statistic and max-Eigen statistic, are in Table 2. The trace statistic indicates there is at least one cointegrating equation at the 0.05 level of significance. The second method, the max-Eigen statistic similarly indicates that there is at least one cointegrating equation at the 0.05 significance level. These results indicate a long-run association of real exchange rates in the SADC region. The presence of cointegrating vector(s) is supportive of an OCA and can be interpreted as similarities of fundamental macroeconomic factors that derive the real exchange rate in the region (Beirne, 2008:8; Mishra and Sharma, 2010:206). Dellas and Tavlas (2009:1128) suggest that the degree of real convergence should be the main characteristic underpinning the choice of real exchange rate system. The results indicate the countries share similar real disturbance in as far as real exchange rate is concerned. This means bilateral real exchange rate in the SADC region share common stochastic trend in the long-run (Enders & Hurn, 1997). The overall assessments indicate that the GPPP holds in the SAD region. The implication of this is that a single exchange rate policy managed by a single central bank is possible.

Table 2: Johansen cointegration`s results of RER

	Trace cointegration test		maximum Eigenvalue test	
Hypothesised No. of CE(s)	**Trace statistic**	**Prob.****	**Test statistic**	**Prob.****
r = 0*	256.3734	0.0066	70.42674	0.0123
r < 1	185.9467	0.1589	50.25212	0.2532
r < 2	135.6946	0.4601	37.72306	0.6376
r < 3	97.97150	0.6647	28.59524	0.8527
r < 4	69.37626	0.7430	23.51501	0.8516
r < 5	45.86125	0.8023	17.10900	0.9175
r < 6	28.75226	0.7800	12.02392	0.9317
r < 7	16.72833	0.6601	7.396798	0.9366
r < 8	9.331537	0.3356	6.988035	0.4906
r < 9	2.343502	0.1258	2.343502	0.1258

To support and supplement the evidence suggested by the unit root test and Johansen cointegration test, panel root test and Pedroni's panel cointegration test of real exchange rate, nominal exchange rate and CPI were conducted

3.3 Panel root test results of RER

Table 3: Panel root test results of RER

Table 3 reports on the various unit root tests conducted in the study.

Series	Methods	ADF - chi-square	ADF - Z-stat	IPS	Hadri Z-stat	Heteroscedasti Z-stat	Series
RER	At level	Statistic	0.37155	3.38277	3.35071	22.1199	22.1199
		Prob.	1.0000	0.9996	0.9996	0.0000	0.0000
	1st difference	Statistic	60.6382	-6.56916	-6.44121	-0.25633	-0.25633
		Prob.	0.0000	0.0000	0.0000	0.6012	0.6012
NER	At level	Statistic	1.21997	5.33235	5.23927	36.5757	36.5757
		Prob.	1.0000	1.0000	1.0000	0.0000	0.0000
	1st difference	Statistic	134.396	-9.43468	-9.15771	-0.54379	-0.54379
		Prob.	0.0000	0.0000	0.0000	0.7067	0.7067
CPI	At level	Statistic	7.1E-06	16.5087	18.1691	40.4316	40.4316
		Prob.	1.0000	1.0000	1.000	0.0000	0.0000
	1st difference	Statistic	296.490	-15.5368	-15.8430	-2.54699	-2.54699
		Prob.	0.0000	0.0000	0.0000	0.9946	0.9946

Three tests, namely the ADF test (Fisher chi-square and Choi Z-stat), IPS and Hadri (Z-stat and heteroscedastic consistent Z-stat) were conducted to assess the stationarity of panel variables, namely real exchange rate, nominal exchange rate and CPI. AIC lag selection was used in panel units. The tests were conducted with intercept with no trend. The critical values of all the tests were set at 0.05 significance level. The ADF, IPS and the Hadri results of panel root test indicated that real exchange rate, nominal exchange rate and CPI in the SADC region are non-stationary at level but become stationary when estimated at 1st difference (see Table 3). Thus, they are integrated of the order one, I(1). These results suggest that it is appropriate to conduct cointegration analysis for further examination. The panel cointegration was conducted using Pedroni's cointegration technique.

The Pedroni's (Engle-Granger-Based) technique was applied to examine panel cointegration of real exchange rate, nominal exchange rate and inflation in the SADC region. As illustrated in Table 4, the no cointegration hypothesis is rejected because the probabilities of all seven statistics (both within-dimension and between-dimension) are less than 0.05; suggesting cointegration of the three variables, namely real exchange rate, nominal exchange rate and CPI in the SADC region. Thus, there is a long-run relationship between the real exchange rate, the nominal exchange rate and price levels within SADC.

Table 4: Pedroni's panel cointegration results (SADC)

Within-dimension	**Statistic**	**Prob.**	**Statistic**	**Prob.**
Panel v-Statistic	50.89519	0.0000	50.89519	0.0000
Panel rho-Statistic	-60.80992	0.0000	-60.80992	0.0000
Panel PP-Statistic	-24.78972	0.0000	-24.78972	0.0000
Panel ADF-Statistic	-14.04149	0.0000	-14.04149	0.0000
Between-dimension	**Statistic**	**Prob.**		
Group rho-Statistic	-62.73098	0.0000		
Group PP-Statistic	-29.79664	0.0000		
Group ADF-Statistic	-16.37267	0.0000		

The normalised long-run cointegrating equation is reported in Table 5. Given the dominant size of its economy in the SADC region, South Africa's rand expressed against US dollar was used to obtain the normalised equations in the model. The normalised vectors indicate the interaction of real exchange rates in the region, while the coefficients indicate the long-run elasticities between the exchange rates.

The long-run coefficient indicates that a 1 percent increase in the South African Rand (real depreciation) induces a 0.006082 percent, 0.001896 percent, 0.283531 percent and 2.514395 percent depreciation of the real value of the currencies of DRC, Madagascar, Mozambique and Zambia, respectively. However, a 1 percent increase in the South African rand (real depreciation) induces a 0.072175 percent, 1.16755 percent, 0.301054 percent, 0.009215 percent and 0.010342 percent appreciation of the real values of the currencies of Angola, Botswana, Mauritius, Malawi and Tanzania, respectively. These findings suggest that there are indeed asymmetries in exchange rate adjustment process to any disequilibrium in the SADC region. In other words, there are differences the manner in which the currencies in the region respond to any given shock in the long run. Similar findings are reported in East Asia by Mishra and Sharma (2010:211) who applied the GPPP analysis. The differences in the size of coefficients also suggest that the aggregate demand patterns in the region are dissimilar (Enders & Hurn, 1994:179; Beirne, 2008:9).

Table 5: Normalised long-run cointegrating equations (SADC)

Country	Coefficients	Standard error	T-statistics
South Africa	1		
Angola	-0.072175	-0.02650	-2.72390
Botswana	-1.167550	-0.64911	-1.79869
DRC	0.006082	-0.00276	2.20719
Madagascar	0.001896	-0.00163	1.16149
Mozambique	0.283531	-0.12305	2.30413
Mauritius	-0.301054	-0.18656	-1.61367
Malawi	-0.009215	-0.00649	-1.42062
Tanzania	-0.010342	-0.00401	-2.57831
Zambia	2.514395	-0.51446	4.88746

3.4 Vector error correction model on SADC

Having established the long-run relationship between the exchange rates and price levels in SADC, the next step was to examine the speed of adjustment from short-run to long-run equilibrium through the VECM. The VECM error correction terms (ECT) coefficients reported in Table 6 reflect the speed of adjustment parameters of real exchange rates in the SADC region and can be interpreted as a measure of quickly each of the real exchange rate converge to GPPP (Beirne, 2008:10). The short-run adjustment coefficients indicate the speed at which the various real exchange rates in the region adjust/correct towards their long-run equilibrium in response to any shock or deviation from the GPPP. In other words, these coefficients describe how quickly a change in the real exchange rate system in the region is inclined to correct itself.

The ECT coefficients for the currencies of South African, Botswana, Mozambique, Mauritius, Malawi and Zambia are negative and significant at the 0.05 significance level. The larger the ECT coefficient (absolute value) of a currency, the quicker it corrects itself towards its long-run equilibrium in response to any shock or deviation from the GPPP. Thus, the currency with the biggest ECT coefficient reaches its long-run equilibrium in the shortest time period since rate of correction is high.

The ECT coefficient of -0.037525 for the South Africa's rand implies that the real exchange rate adjusts at the rate of 3.7525 percent per month towards the long-run equilibrium, meaning it takes approximately about 27 (=1/0.037525) months to reach to the long-run equilibrium. The ECT coefficient of -0.022083 for the Botswana's pula implies that the real exchange rate adjusts at the rate of 2.2083 percent per month towards the long-run equilibrium, meaning it takes approximately about 45 (=1/0.022083) months to reach to the long-run equilibrium. The ECT coefficient of -0.042099 for the Mozambique's metical implies that the real exchange rate adjusts at the rate of 4.2009 (=1/0.042099) percent per month towards the long-run equilibrium, meaning it takes approximately about 24 months to reach to the long-run equilibrium. The ECT coefficient of -0.011812 for the Mauritius' rupee implies that the real exchange rate adjusts at the rate of 1.1812 percent per month towards the long-run equilibrium, meaning it takes approximately about 85 (=1/0.011812) months to reach to the long-run equilibrium (attributed to its relatively small ECT coefficient). The ECT coefficient of -0.84442 for the Malawi's kwachas implies that the real exchange rate adjusts at the rate of 84.442percent per month towards the long-run equilibrium, meaning approximately only 1 month is need for the shock in the short-run to be corrected (attributed to its relatively large ECT coefficient). The ECT coefficient of -0.02528 for the Zambia's kwacha implies that the real exchange rate adjusts at the rate of 2.528percent per month towards the long-run equilibrium (i.e. it takes approximately about 40 months to reach to the long-run equilibrium).

However, the ECT coefficient for the currencies of Angola, DRC, Madagascar and Tanzania are positive and significant at the 0.05 significance level. The interpretation of the positive ECT coefficient is that, these currencies, instead of correcting themselves to a long-run equilibrium, they deviate and move away from the long-run equilibrium. For a given shock in the system, Angola's new kwana moves away from its long-run equilibrium by approximately 23 percent, 86 percent the DRCs franc Congolais, 252 percent the Madagascar's Malagasy arirary and 140 percent Tanazania's shilling. A larger coefficient is not ideal when the ECT is positive. The implication of this finding is that any change/shock/disequilibrium of real exchange rate in the region may cause unintended currency flow from one region to the other in the short-run constraining the possibility of an effective and efficient monetary union.

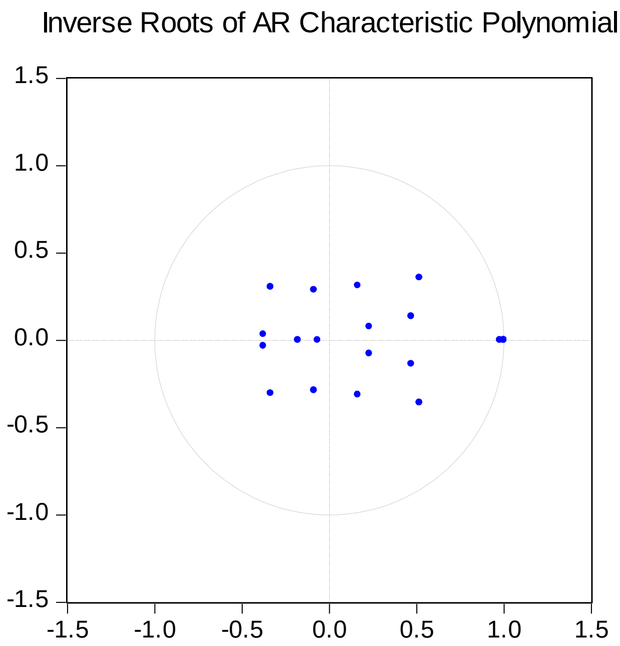
Table 6: The VECM`s Error Correction Terms (SADC)

Country	Currency	Coefficients	Standard error	T-statistics
South Africa	Rand	-0.037525	-0.01027	-3.65511
Angola	New kwana	0.233425	-0.05805	4.02101
Botswana	Pula	-0.022083	-0.00569	-3.88094
DRC	Franc congolais	0.857905	-2.53345	0.33863
Madagascar	Malagasy arirary	2.515349	-1.95232	1.28839
Mozambique	Metical	-0.042099	-0.02423	-1.73773
Mauritius	Mauritian rupee	-0.011812	-0.02005	-0.58920
Malawi	Kwachas	-0.844416	-0.36590	-2.30780
Tanzania	Tanzanian shilling	1.396490	-0.95814	1.45750
Zambia	Kwacha	-0.025281	-0.00769	-3.28670

3.5 Diagnostic checks of the VECM

This study adopted various tests including test for serial correlation and heteroskedasticity to validate the robustness of the results of VECM. The estimated model passed diagnostic tests; there were no serial correlation and no heteroskedasticity in residuals, at 5 percent significance level. Furthermore, the study also conducted a stability check using the inverse roots of AR characteristic polynomial to investigate whether the long-run relationships established are stable. As displayed in Figure 1, most of the roots of the characteristic AR polynomial have absolute value less than one and fall within the unit circle indicating the stability properties of a good model. However, one root of the polynomial absolute value is equal to one, but is statistically insignificant since it does not lie outside the circle.

Figure 1: Inverse roots of AR characteristic polynomial



4. CONCLUSION AND RECOMMENDATIONS

The feasibility of a monetary union in the region was assessed using the GPPP framework consistent with the OCA theory on price and inflation rates and exchange rates. In line with previous studies, individual unit root tests, Johansen cointegration test, panel unit root test, Pedroni's panel cointegration test and VECM were tested to establish whether GPPP holds in the SADC region so determination is made whether there is evidence in support of a monetary union in the region. Various diagnostic tests were conducted to confirm the validity and the stability of the econometric model.

Trace statistic and max-Eigen statistic confirm that there is one cointegrating equation indicating long-run association of real exchange rates in the SADC region. The presence of cointegrating vector(s) is supportive of an OCA and can be interpreted as similarities of fundamental macroeconomic factors that derive real exchange rate in the region. The results also suggest the countries share similar real disturbance in as far as real exchange rate is concerned. In essence this suggests that indeed SADC does constitute an OCA. This finding was also supported by Pedroni's panel cointegration test. However, the differences in the size of coefficients in the case of normalised long-run cointegrating equation suggested that the aggregate demand patterns in the region are dissimilar and indicate asymmetries in exchange rate adjustment process to any disequilibrium in the SADC region. Yet, another concern is the result of the ECT coefficient. The result of the ECT coefficient suggest that any change/shock/disequilibrium of real exchange rate in the region may cause unintended currency flow from one region to the other in the short-run constraining the possibility of an effective and efficient monetary union. In light of the finding of this study, it is recommended to only expand the existing Common Monetary Area (CMA), which includes South Africa, Lesotho, Namibia and Swaziland, gradually to other qualifying countries in the region instead of embarking a SADC-wide approach to a monetary union. Other economic concerns such as business cycle synchronisation, and convergence of key macroeconomic variables including budget deficit, government debt and foreign reserves cover should be thoroughly investigated before the said economic union is implemented.

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