Economics Bulletin

Volume 30, Issue 2

Inflation divergence within the SADC

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Abstract

This study investigates the feasibility of a monetary union in the Southern African Development Community (SADC) by testing for inflation convergence for 11 members. Quarterly data over the period 1992:3 – 2001:4 are employed. Various panel unit root tests are applied to test whether the purchasing power parity (PPP) holds. Overall, strong evidence of a unit root is found. This implies inflation divergence among the SADC members.

I would like to thank the two anonymous referees for their constructive comments and suggestions on the previous version of this paper. Errors, if any, are solely mine.
Citation: Jaunky Chandr Vishal, (2010) "Inflation divergence within the SADC", *Economics Bulletin*, Vol. 30 no.2 pp. 1137-1143.
Submitted: Jun 19 2008. **Published:** May 03, 2010.

1 Introduction

The SADC as a regional body started in 1980 with the establishment of the Southern African Development Coordinating Conference (SADCC). In August 1992, the SADDC was transformed from a conference to a community. It is set to institute a free trade area by 2008, a customs union by 2010, a common market by 2015, monetary union with a SADC Central Bank by 2016 and a regional currency by 2018 (Jefferis, 2006). In line with the Treaty of Maastricht on European Union (EU), SADC members are required to achieve macroeconomic convergence which includes avoiding high inflation, unstable currencies and other forms of imbalances.

One way of investigating the feasibility of a monetary union is to test for inflation convergence. This can be done by testing the strong form of the PPP hypothesis. This theorem deals with a proportional relationship between the nominal exchange rate and relative price ratio. Therefore one way of evaluating whether the general price level is converging among SADC countries is to test for PPP. Such test primarily consists of exploring whether the real exchange rate (RER) follows a random walk. If the process is I(0), then shocks are deemed to be temporary and the PPP will hold in the long run. This implies no exchange rate risk and that at least one of the Maastricht-type criteria for a monetary union is satisfied.The mean-reversion concept has been studied at length in the literature (for e.g., refer to Koedijk *et al*, 2004; Drine and Rault, 2005; Caporale and Cerrato, 2006 for a panel data application). As to the SADC, Agbeyegbe (2003) finds evidence of non-convergence of nominal exchange rate and consumer price for nine members. Mokoena *at al* (2009) also finds that the RER series for the SADC members follows a non-stationary which is at odds with mean-reversion.

This paper examines the inflation convergence for 11 SADC members[1] using quarterly data over the period 1992:3 – 2001:4. Data are obtained from the International Financial Statistics. The rest of the paper is organized as follows: Section 2 presents the testing framework of the PPP, section 3 provides the empirical analysis and section 4 summarizes and concludes.

2 The Testing Framework

By definition, RER is given as:

$$LRER = S - P + P^* \qquad \text{---- (1)}$$

, where S is the nominal exchange rate, P^* is consumer price index (CPI) of the foreign country (i.e. South Africa) while P is the consumer price index (CPI) of the home country, all measured in natural logs. *LRER* is the natural logarithmic of RER. If strong PPP holds, the RER will revert to its long-run equilibrium value subsequent to a shock. Failure to find evidence of mean-reversion is synonymous of inflation divergence. The formal test (Dickey and Fuller, 1979) of the PPP can take the form the traditional augmented Dickey-Fuller (ADF) unit root test type such as:

[1] There are fourteen countries in the SADC area. These are Angola, Botswana, Congo DR, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, South Africa, Swaziland, Tanzania and Zambia and Zimbabwe. Lesotho and Zambia are excluded from the dataset because of missing observations. South Africa is taken as the reference country.

$$\Delta LRER_{it} = \mu_i + \beta_i t + \rho LRER_{it-1} + \alpha_{im} \sum_{m=1}^{k_i} \Delta LRER_{it-m} + \varepsilon_{it} \qquad \text{----- (2)}$$

, where $\Delta LRER_{it} = LRER_{it} - LRER_{it-1}$, t is the time trend, k is the lag length and ε is the error term. If the null hypothesis (H_0: $\rho = 0$) is accepted (i.e. *LRER* follows a random walk), then *LRER* will be driven by separate stochastic trends signifying that inflation diverges over time.

3 Results

To inspect the above hypothesis, a battery of panel unit root tests is performed. Panel data techniques which combine time-series and cross-section data whilst enabling a substantial increase in testing power are exploited. The use of panel data techniques can reduce multicollinearity problems (Caporale and Cerrato, 2006) while they may alleviate spurious regression problems (Phillips and Moon, 1999).

Levin, Lin and Chu (2002, LLC) were among the first to test for a unit root in panel data. Their test is based on the assumption of homogeneity in the AR(1) coefficients of the ADF specifications. The LLC *t*-statistics are reported in Table 3(a). H_0 cannot be rejected at conventional levels of significance. Nonetheless, the LLC assumptions are rather restrictive. The need for further tests which control for heterogeneity, structural break or cross-sectional dependence arises to obtain more robust results. Im, Pesaran, and Shin (2003, IPS) and Hadri (2000) propose a test which allows for heterogeneity between the groups. The LLC and IPS tests are both based on the averaged of *N* country-specific ADF *t*-statistics as presented in Table 2 while Hadri's tests on the mean of the Kwiatkowski *et al* (KPSS, 1992) test statistic. The IPS unit root test tends to have high and low power in panels with large *T* and small *T* respectively (Karlsson and Löthgen, 2000) whereas the Hadri test performs well for panel data with short *T* (Barhoumi, 2005). The IPS and Hadri test statistics are reported in Tables 3(b) and 3(c) respectively. All theses tests strongly support the hypothesis that the RER series of the SADC contains a unit root.

SADC members may have experienced major structural transformations over the period in consideration. A structural break can have an impact on the trend and mean value of a series. The ignorance of such break can lead to a fall in power to reject a unit root even if the trend stationarity alternative is true (Perron, 1989).To account for an endogenous structural break in the panel, the Im *et al* (2005) tests are conducted. For comparison, individual and panel unit root tests results without and with a break are computed and depicted in Table 3(d). For instance, the unit root null is rejected in four cases (Angola, Malawi, Mozambique and Tanzania) as indicated by the univariate unit root test without a break compared to six cases (Angola, Malawi, Mauritius, Mozambique, Swaziland and Tanzania) following the univariate test with a break. The panel unit roots LM test statistics without and with an endogeneous break are -2.456 and -6.465 respectively. In contrast to previous results, the absence of a unit root in the sample is synonymous to inflation convergence.

One major drawback of the above four panel unit root tests is their assumption about cross-sectional independence. The presence of cross-sectional dependence biases the panel data unit root tests towards the alternative hypothesis (Banerjee *et al*, 2004). Table 1 shows pair-wise correlations of the first differences in the *LRER* series of the 11 SADC states. Virtually all correlations are positive and rather substantial. These suggest that it is essential to control for cross-sectional dependence when analyzing the PPP in the SADC region. The LLC and Im *et al* tests fail to allow for cross-sectional dependence. The IPS and Hadri tests control for cross-sectional dependence by using demeaned data. This approach assumes the existence of one common factor with the same effect on all the individuals which is somewhat restrictive. Pesaran (2007) proposes a test which allows for the presence of more general cross-sectional dependence patterns. Results of the Pesaran covariate-augmented Dickey-Fuller (CADF) test are illustrated in Table 3(e). Overall, strong evidence against inflation convergence is found. Economic shocks to *LRER* tend to be permanent.

4 Conclusion

The paper has examined the feasibility of a monetary union in the SADC by analyzing the inflation convergence process of 11 member-states in a panel dimension for the period 1992:3 –2001:4. Various panel unit root tests have been used and evidence suggests non-convergence of the price level among the SADC nations. In the quest to meet some vital form of a Maastricht-type criterion, policies should be targeted at contributing towards a common trend in inflation and exchange rates.

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Table 1: Pair-Wise Correlations of Δ*LRER*

Country	Ang	Bot	Con	Mad	Mal	Mau	Moz	Nam	Swa	Tan	Zim
Angola	1.000	0.174	0.213	-0.207	0.219	-0.004	-0.154	0.062	0.095	0.106	0.247
Botswana		1.000	0.036	0.308	0.455	0.578	0.396	0.335	0.103	0.253	0.652
Congo DR.			1.000	-0.043	0.284	-0.160	-0.090	0.014	-0.097	-0.005	0.129
Madagascar				1.000	0.257	0.322	0.315	0.014	-0.062	0.288	0.048
Malawi					1.000	0.335	0.243	0.084	0.149	0.362	0.598
Mauritius						1.000	0.460	-0.024	0.044	0.309	0.469
Mozambique							1.000	-0.070	0.039	0.773	0.220
Namibia								1.000	-0.328	-0.126	0.269
Swaziland									1.000	0.101	0.365
Tanzania										1.000	0.194
Zimbabwe											1.000

Source: Computed.

Table 2: ADF Times-Series Unit Root Tests for *LRER*

Country	*t*-statistics	ρ

Angola	-2.748	0
Botswana	-0.485	0
Congo DR.	-3.185	4
Madagascar	-2.904	1
Malawi	-3.375‡	3
Mauritius	-2.795	0
Mozambique	-4.106**	1
Namibia	-0.862	0
Swaziland	-3.326‡	0
Tanzania	-2.759	0
Zimbabwe	-2.988	4

Source: Computed. Note: To select the optimal order of lag ρ for the ADF test, the maximum lag length of 4 is chosen and pared down as per the Akaike Information Criterion (AIC). There is no general rule on how to choose the maximum lag to start with. Researchers usually employ a rule of thumb which is the cube root of T (Al Mamun and Nath, 2005) i.e. $\sqrt[3]{38} \approx 3.362$. The bandwidths are chosen be 4. For lag 0, 1, 2, 3 and 4 the MacKinnon (1991) critical values for the ADF unit root tests which include a constant and a trend are -4.270, -3.552 and -3.211; -4.279, -3.556, and -3.214; -4.288, -3.560 and -3.216; -4.297, -3.564 and -3.218; and -4.306, -3.568 and -3.221 at 1%, 5% and 10% significance level respectively. *, **, ‡ denote 1%, 5% and 10% significance level respectively.

Table 3(a): LLC Panel Unit Root Test statistics

Variable	Data	Deterministics	*t*-value	*t**
LRER	Raw	Constant + Trend	-7.130	-0.903 [0.183]

Source: Computed. Note: The LLC test can be viewed as a pooled Dickey-Fuller test, or an Augmented Dickey-Fuller (ADF) test when lags are included, with the null hypothesis that of non-stationarity (I(1) behavior). The lag lengths for the panel test are based on those employed in the univariate ADF test as reported in Table 2. These statistics are distributed as standard normal as both N and T grow large. Assuming no cross-country correlation and T is the same for all country, the normalized t^* test statistic is computed by using the t-value statistics. After transformation by factors provided by LLC, the t^* tests is distributed standard normal under the null hypothesis of non-stationarity. Hence, it is compared the 1%, 5% and 10% significance levels with the one-sided critical values of -2.326, -1.645 and -1.282 correspondingly. The p-value is in square brackets.

Table 3(b): IPS Panel Unit Root Test Statistics

Variable	Data	Deterministics	*t*-bar	Ψ_t
LRER	Raw	Constant + Trend	-2.127	0.084 [0.533]
	Demeaned	Constant + Trend	-2.178	-0.122 [0.451]

Source: Computed. Note: The IPS test statistics are computed as the average ADF statistics across the sample. The lag lengths for the panel test are based on those employed in the univariate ADF test as reported in Table 2. These statistics are distributed as standard normal as both N and T grow large. t-bar is the panel test based on the ADF statistics. Critical values for the t-bar statistics with trend at 1%, 5% and 10% significance levels are -2.550, -2.440 and -2.380 respectively. Assuming no cross-country correlation and T is the same for all country, the normalized Ψ_t test statistic is computed by using the t-bar statistics and is compared to the left tail. The Ψ_t tests for H_0 of joint non-stationarity and is compared to the 1%, 5% and 10% significance levels with critical values of -2.326, -1.645 and -1.282 correspondingly.

Table 3(c): Hadri LM Panel Unit Root Test Statistics

Variable	Homoskedastic Disturbances	Heteroskedastic Disturbances	Controlling for Serial Dependence
LRER	30.781 [0.000]*	20.827 [0.000]*	4.116 [0.000]*

Source: Computed. Note: The test statistics are for a model which included a deterministic trend. The lag truncation equals to 6 when controlling for serial dependence in errors in a demeaned model of trend stationary. The test is distributed as $N(0, 1)$ asymptotically and tests statistics are compared to the right tail. The one-sided critical values are 1%, 5% and 10% significance levels with critical values of 2.326, 1.645 and 1.282 correspondingly. H_0: all 11 time-series in the panel are stationary processes.

Table 3(d): Im *et al* Individual and Panel LM Unit Root Tests for *LRER*

Country	Without Break			With Break		
	LM Statistic	ρ	Break Point	LM Statistic	ρ	Break Date
Angola	-2.906‡	0	0	-3.756**	4	1994:1
Botswana	-1.150	0	0	-1.777	4	1998:3
Congo DR.	-1.458	4	0	-1.653	4	1998:3
Madagascar	-2.051	0	0	-2.730	1	1994:4
Malawi	-3.506**	3	0	-3.856**	3	1999:4
Mauritius	-2.400	0	0	-3.577**	0	1996:4
Mozambique	-4.200*	1	0	-5.223*	1	1998:3
Namibia	-1.406	0	0	-2.378	1	2000:2
Swaziland	-3.115‡	0	0	-3.697**	0	1996:2
Tanzania	-2.671	4	0	-3.955**	1	2000:2
Zimbabwe	-1.504	3	0	-1.856	3	2000:1
Panel	-2.456*	-	-	-6.465*	-	-

Source: Computed. Notes: ρ_{max} is chosen to be 4. Critical values for the LM unit root test with no break are -3.90, -3.18, and -2.85 at the 1%, 5%, and 10% significance levels, respectively (Schmidt and Phillips, 1992). Critical values for the test with one break are -4.239, -3.566, and -3.211 at the 1%, 5%, and 10% levels, respectively (Lee and Strazicich, 1999).Critical values for the LM panel unit root test (with or without breaks) are distributed asymptotic standard normal and are -2.326, -1.645, and -1.282 at the 1%, 5%, and 10% levels, respectively. The minimum LM unit root test which accounts for a break in the data is employed. Time dummies are included when performing the panel unit root test in the presence of a structural break.

Table 3(e): Pesaran CADF Panel Unit Root Test statistics

Variable	Data	Deterministics	*t*-value	*Z*[*t*-bar]
LRER	Raw	Constant + Trend	-2.035	1.148 [0.875]

Source: Computed. Note: The CADF test statistics are computed as the average ADF statistics across the sample. The lag lengths for the panel test are based on those employed in the univariate ADF test as reported in Table 2. These statistics are distributed as standard normal as both N and T grow large. *t*-bar is the panel test based on the ADF statistics. Critical values for the *t*-bar statistics with trend at 1%, 5% and 10% significance levels are -2.930, -2.760 and -2.660 respectively. Assuming no cross-country correlation and T is the same for all country, the normalized *Z[t*-bar] test statistic is computed by using the *t*-bar statistics and is compared to the left tail. The *Z*[*t*-bar]tests for H_0 of joint non-stationarity is compared to the 1%, 5% and 10% significance levels with critical values of -2.326, -1.645 and -1.282 correspondingly.