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EXCHANGE RATE DYNAMICS AND MONETARY UNIONS IN AFRICA:

A FRACTIONAL INTEGRATION AND COINTEGRATION ANALYSIS

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Abstract

This paper uses fractional integration and cointegration techniques to analyze nominal exchange rate dynamics in three groups of African countries aiming to form currency unions in the near future. The proposed unions are the WAMZ (West African Monetary Zone), the EAC (East African Community), and the SADC (South African Development Community). The univariate results indicate that in all but three countries (Democratic Republic of Congo, Mauritius and Madagascar) the nominal exchange rate series exhibit a unit root. Concerning the multivariate results, for the WAMZ cointegration is only found in the case of Ghana with both Gambia and Guinea; for the EAC for Rwanda with Burundi, and Tanzania with both Rwanda and Uganda. Finally, for the SADC, cointegration is found in only 15 out of 66 cases, including Swaziland with South Africa, Zambia with Malawi, and Mozambique with both Lesotho and Tanzania. The policy implications of these findings are also discussed.

Keywords: Monetary Unions, Africa, Exchange Rates

JEL classification: C22, C32, E31, F15

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1. Introduction

In this paper we examine nominal exchange rate dynamics in three groups of African countries that are expected to form currency unions in the near future in order to assess the viability of the latter. The proposed unions are the following: the West African Monetary Zone (WAMZ), formed by Gambia, Guinea, Ghana, Liberia, Nigeria and Sierra Leone ; the East African Community (EAC) formed by Burundi, Kenya, Rwanda, Tanzania and Uganda; and the South African Development Community (SADC) formed by Angola, Botswana, Congo Democratic Republic, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, South Africa, Seychelles, Swaziland, Tanzania, Zambia and Zimbabwe.

Each of the these three groups of countries is at a different stage in the process of introducing a common monetary policy and/or a common currency. After discussing briefly the background to the planned creation of new monetary unions, we then investigate the statistical properties of the nominal exchange rates of the currencies of these sets of countries. As it is stated by the Optimal Currency Area (OCA) a certain degree of stability and possibly similar patterns in their behaviour are desirable with a view to forming a currency union. It is therefore our aim to determine if that is the case for these currency unions, our goal being to determine whether the univariate and cointegration properties of the exchange rates series provide us with sufficient evidence to determine if the formation of these currency unions would be appropriate. The analysis is carried out using fractional integration and cointegration techniques on monthly data, as specified below. The aim of the analysis is to provide empirical evidence on the feasibility of African monetary unions.

The paper is organized as follows: Section 2 provides some background information about the proposed currency unions. Section 3 briefly reviews the relevant literature. Section 4 describes the data and the methodology. Section 5 discussed the empirical results, while Section 6 offers some concluding remarks.

2. Monetary Unions in Africa

The Optimum Currency Area (OCA) theory is used to analyze the suitability of a monetary union for a given region; it explores the criteria as well as the costs and benefits of forming a common currency area. The concept of currency areas was founded by Mundell (1961) in his seminal paper titled “A Theory of Optimum Currency Areas”, followed by Mckinnon (1963), Kenen (1969) who described the characteristics that potential monetary union members should possess before they form a single common currency and surrender their national monetary policy and exchange-rate adjustment of their national currencies. In the following section we discuss each of the three proposed African monetary unions, emphasizing their different history structures and motivations to form a common currency union.

<u>West African Monetary Zone (WAMZ)</u>

Constituted by six countries, this area of mostly Anglophone West African countries aims to adopt a single currency named the ECO in the near future, with the ultimate goal of joining the mostly francophone countries that belong to the West African Economic and Monetary Union (WAEMU or UEMOA from the French *Union Economique et Monétaire Ouest Africaine*), who for decades have already been a monetary union with the CFA as their currency. The country members of the Economic Community of Central States (ECCS or CEMAC from the French *Communauté Économique des États de l’Afrique Central*) who share the CFA as common currency with the country members of WAEMU (however with different central banks and monetary policies) will not be part of this monetary union since they are not members of the Economic Community of West African States (ECOWAS). At the moment the country members of the WAMZ are Gambia, Guinea, Ghana, Liberia, Nigeria and Sierra Leone.

East African Community (EAC)

The East African Community (EAC) is an intergovernmental organization comprising five countries in the African Great Lakes region in eastern Africa: Burundi, Kenya, Rwanda, Tanzania and Uganda. It was originally founded in 1967, but collapsed in 1977. Kenya, Tanzania and Uganda signed the Treaty for the establishment of the EAC in 1999, which entered into force in July 2000. In 2007 the Treaty was signed by Burundi and Rwanda, expanding the EAC to five countries. In 2008, after negotiations with the Southern Africa Development Community (SADC) and the Common Market for Eastern and Southern Africa (COMESA), the EAC agreed to an expanded free trade area including the member states of all three, thus becoming an integral part of the African Community. The EAC is a potential precursor to the establishment of an East African Federation. In 2010 the EAC launched its own common market for goods, labor and capital within the region, with the goal of creating a common currency union and eventually a full political federation. In November 2013 a protocol was signed outlining the plans of the five member countries to launch a monetary union within ten years.

South African Developmnet Community (SADC)

The South African Development Community (SADC) originated during the 1960s and 1970s, when the leaders of majority-ruled countries and national liberation movements coordinated their political, diplomatic and military struggles to bring an end to colonial and white-minority rule in southern Africa. The immediate forerunner of the political and security cooperation leg of today's SADC was the informal Frontline States (FLS) grouping, which was formed in 1980. The SADC has its origins in the Southern African Development Coordination Conference (SADCC), which was established in 1980. In 1992 the Member States signed the Declaration and Treaty establishing SADC as a replacement to the SADCC**.** Currently SADC has 15 member states: Angola, Botswana, Democratic Republic of Congo (DRC), Lesotho, Madagascar Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Seychelles, Swaziland, United Republic of Tanzania, Zambia and Zimbabwe. The final step in the process of deepening regional economic integration in SADC is the implementation of a single currency**.** The Regional Indicative Strategic Development Plan Implementation Framework targets 2018 for the attainment of this milestone.

3. Literature review

Most of the literature on African monetary unions concerns the current aim of creating a new currency area known as the ECO. This currency union of Anglophone West African countries could come into existence in the near future under the name of the West African Monetary Zone (WAMZ). By using fractional integration, it has been established that some significant differences exist between these countries. It has been shown, for instance, that shocks to inflation in Sierra Leone are not mean-reverting, while the results for Gambia, Ghana, and Guinea suggest some inflation persistence and mean reversion (Alagidede, Coleman, and Cuestas, 2010). Balogun (2007) proved that independent monetary and exchange rate policies have been relatively ineffective in influencing the domestic economy (especially, GDP and inflation) and, therefore, a currency union could benefit the region. Gil-Alana and Carcel (2014) conducted a fractional integration analysis for the West African Economic and Monetary Union (WAEMU) and concluded that the eight countries that share the CFA as a common currency are tied together not because of their economic homogeneity but rather owing to their strong historical and traditional ties to France.

Several papers have examined the prospects for the East African Community. Using the Optimal Currency Area (OCA) approach, Mafusire and Brixiova (2013) investigated the degree of shock synchronization among the EAC members, stressing that if the countries in the union have major structural differences, a common monetary policy would have differential impacts that may not be helpful to some members. Durevall (2011) pointed out that the EAC has a number of convergence criteria, but these need to be improved and revised for the union to succeed, and Kishor and Ssozi (2009) found that the proportion of shocks which are common across different countries is small, implying weak synchronisation, although this has become stronger after the signing of the EAC treaty in 1999. Several authors have studied the viability of a monetary union in the EAC using different models and reaching different conclusions. For example, Buigut and Valev (2005) estimated a two-variable SVAR model to test for shock correlations in the EAC countries; they found that forming a monetary union in the EAC is not feasible. Mkenda (2001) and Falagiarda (2010) instead employed the G-PPP approach based on cointegration analysis and concluded that a monetary union in East Africa could be a viable option. Lastly, Sheikhet al. (2011) and Opolot and Osoro (2004) studied the feasibility of forming a monetary union in the EAC using the business cycle synchronisation approach of Hodrick-Prescott and Baxter-King filter; they found a low degree of synchronisation between EAC members, but this appears to have become stronger in recent years.

The United Nations Economic Commission for Africa (2011) has addressed the challenges of macroeconomic policy convergence in the SADC region. According to Bala (2011) there are only few convergence studies focusing on Sub-Saharan Africa, and even less dealing with SADC, which suggests that there is room for further empirical investigations. Kumo (2011) analysed growth and macroeconomic convergence in southern Africa, showing with ADF unit root tests that Botswana and South Africa's real per capita GDP converge to a common stochastic trend, while GDP in the other countries is characterised by a drift. Breitenbach et al. (2014) tested PPP in the SADC economies and found non-linearities in the real exchange rates in SADC, and other papers testing unit roots in exchange rates include Parikh and Wakerly (2000), Hüseyin (2005) and Sahin and Cengiz (2011)

4. Methodology

We start by carrying out unit roots tests (ADF, Dickey and Fuller, 1979; Kwiatkowski et al., KPSS, 1992; and Elliot et al., ERS, 1996) on the original and the first differenced data. Then, since such tests have very low power if the true data generating process (DGP) is fractionally integrated[1], we also estimate the order of integration of the series applying fractional integration techniques, specifically a parametric Whittle method in the frequency domain (Dahlhaus, 1989) and a semiparametric one using only a band of frequencies close to zero (Robinson, 1995).

[1] See Diebold and Rudebusch (1991), Hassler and Wolters (1994) and Lee and Schmidt (1996).

In the second part of the analysis, we test the null hypothesis of no cointegration against the alternative of fractional cointegration, i.e., we test for long run equilibrium relationships between each pair of exchange rates in each of the three groups of countries. As a first step, we test for the homogeneity in the order of integration of the variables by using an adaptation of Robinson and Yajima (2002) statistic $\hat{T}_{xy}$ to log-periodogram estimation. The statistic is:

$$\hat{T}_{xy} = \frac{m^{1/2}\left(\hat{d}_x - \hat{d}_y\right)}{\left(\frac{1}{2}\left(1 - \hat{G}_{xy}^2 / (\hat{G}_{xx}\hat{G}_{yy})\right) + h(n)\right)^{1/2}} \qquad (1)$$

where m is a bandwidth parameter, d_x and d_y are the orders of integration of each of the series, $I(\lambda_j)$ is the cross-periodogram in the bivariate representation of the series, $h(n) > 0$ and $\hat{G}_{xy}$ is the $(xy)^{th}$ element of

$$\hat{G} = \frac{1}{m}\sum_{j=1}^{m} R\left[\hat{\Lambda}(\lambda_j)^{-1} I(\lambda_j) \hat{\Lambda}(\lambda_j)^{-1*}\right], \quad \hat{\Lambda}(\lambda_j) = diag\left\{e^{i\pi \hat{d}_x/2}\lambda^{-\hat{d}_x}, e^{i\pi \hat{d}_y/2}\lambda^{-\hat{d}_y}\right\},$$

with a standard normal limit distribution (see Gil-Alana and Hualde, 2009, for evidence on the finite sample performance of this procedure), and, in case of similarity in the degree of integration of the two series, we test the null hypothesis of no cointegration using the Hausman test of Marinucci and Robinson (2001), comparing the estimate $\hat{d}_x$ of d_x with the more efficient bivariate one of Robinson (1995), which uses the information that $d_x = d_y = d_*$. Marinucci and Robinson (2001) show that

$$H_{im} = 8m\left(\hat{d}_* - \hat{d}_i\right)^2 \rightarrow_d \chi_1^2 \qquad as \quad \frac{1}{m} + \frac{m}{T} \rightarrow 0, \qquad (2)$$

with i = x, y, and where m < [T/2] is again a bandwidth parameter, analogous to that considered above; $\hat{d}_i$ are univariate estimates of the parent series, and $\hat{d}_*$ is a restricted estimate obtained in the bivariate context under the assumption that $d_x = d_y$. In particular,

$$\hat{d}_* = -\frac{\sum_{j=1}^{s} 1_2' \hat{\Omega}^{-1} Y_j v_j}{2 1_2' \hat{\Omega}^{-1} 1_2 \sum_{j=1}^{s} v_j^2}, \qquad (3)$$

where 1_2 indicates a (2x1) vector of 1s, and with $Y_j = [\log I_{xx}(\lambda_j), \log I_{yy}(\lambda_j)]^T$, and $v_j = \log j - \frac{1}{s}\sum_{j=1}^{s} \log j.$ The limiting distribution above is presented heuristically, but the authors argue that this is sufficiently convincing for the test to warrant serious consideration.

5. Data and Empirical Results

5.1. Data

We employed monthly data values ranging from January 1995 up to December 2014, all data figures having been obtained from the historical data publically available by OANDA corporation online. All the time series analyzed correspond to the nominal nominal exchange rate of the countries belonging to the three unions that we attempt to analyze. These series correspond to the EAC formed by Burundi, Kenya, Rwanda, Tanzania and Uganda; the WAMZ, formed by Gambia, Ghana, Guinea, Liberia, Nigeria and Sierra Leona; and finally the SADC: Angola, Botswana, Congo, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Swaziland, Tanzania (also a member of the EAC union), Zambia and Zimbabwe.

5.2. Unit Root Tests

First of all we carry a battery of unit root tests (the Augmented Dickey-Fuller test (ADF, 1979); Kwiatkowski, Phillips, Schmidt and Shin (KPSS, 1992) and Elliott, Rothenberg and Stock (ERS, 1996) tests) on the nominal exchange rate series for twenty-five countries grouped in three different unions.

[Insert Tables 1 and 2 about here]

In all cases we obtain strong evidence of unit roots in the original series, and I(0) stationarity in the first differences (see Table 1 and 2), regardless of the type of test carried out and of whether an intercept or both an intercept with a linear time trend are included.

5.3 Fractional Integration

Table 3 displays the estimates of d based on a Whittle parametric approach assuming three different types of disturbances: white noise, AR and Bloomfield. The 95% confidence bands are also reported in each case. It can be seen that, consistently with the unit root results, the I(1) hypothesis is almost never rejected. The only exceptions are the Democratic Republic of Congo and Mauritius (where the estimated values of d were significantly higher than 1) and Madagascar (with d significantly lower than 1). In all the other cases we find at least one case when the unit root null cannot be rejected.

[Insert Tables 3 and 4 about here]

Table 4 displays the estimates of d using the "local" Whittle semiparametric method of Robinson (1995). Since the series are clearly nonstationary, first differences were taken for estimating d, then adding 1 to obtain the estimates.[1] We present the results for a selected number of bandwidth parameters m = 11, 12, …, 14 and 15 (≈ $T^{0.5}$), …, 18 and 19: they are generally consistent with the parametric ones reported in Table 3. For the Democratic Republic of Congo and Mauritius the estimated values of d are significantly above 1 practically in all cases; on the contrary, for Madagascar and Sierra Leone the estimates of d are below 1, which implies mean reversion, i.e in these two countries the effects of shocks disappear over time without the need for policy actions. A cautious monetary policy that has brought inflation down to single-digit figures, and has limited central bank intervention to smoothing out major exchange rate fluctuations can be the explanation for the case of Madagascar. The case of Sierra Leone responds to the tight measures its government carried out in the recent years to prevent inflation.

5.4 Fractional Cointegration

Next we examine nominal exchange rate linkages within each prospective currency union. A necessary condition for cointegration in a bivariate context is that the two parent series should display the same degree of integration. Therefore, the first step is to test for homogeneity in the order of integration of the series: only for Sierra Leone (in the WAMZ) and the Democratic Republic of Congo, Madagascar and Mauritius (for the SADC group) evidence against homogeneity is found, and therefore these exchange rate series are not included in the fractional cointegration analysis. We follow a fractional cointegration testing procedure rather than applying the more standard Engle-Granger (1987) and Johansen (1995) tests given the fact that long memory has been proven to matter within a cointegration framework as emphasized in Johansen (2008) and further

[1] Extensions of this method to the nonstationary case have been developed by Velasco (1999), Phillips and Shimotsu (2004) and Abadir et al. (2007) among others. These methods, however, require additional user-chosen parameters.

explained in Johansen and Nielsen (2012). Moreover, performing the analysis with fractional degrees of integration allows for a much greater degree of flexibility not achieved with only integer differentiation, and includes the latter as a special case with orders of integration equal to 1 and 0 respectively for the individual series and the cointegration relations. [2]

Table 5 reports the cointegration results for the three unions considered. In the case the WAMZ (see Table 5a) we only found evidence of cointegration between the series for Ghana and those for both Gambia and Guinea; in both cases the degree of integration of the residuals (0.540 and 0.442 respectively) is lower compared to that of the parent series. As for the other cases, there is strong evidence against cointegration between the series for Guinea and Gambia, Liberia and Ghana, and Nigeria and both Gambia and Guinea. This comes to show that achieving homogeneity among the members of the WAMZ is still at this stage a complicated task and efforts to establish the ECO as common currency can be considerably high.

[Insert Table 5 about here]

Concerning the EAC (see Table 5b), cointegrating relationships between the exchange rate series are found in the cases of Rwanda and both Burundi and Tanzania, as well as Uganda and Tanzania, whilst no cointegration appears to hold in the cases of Kenya and both Burundi and Rwanda, and Uganda and both Burundi and Kenya. Finally, regarding the SADC countries (see Table 5c), cointegration is found in only 15 out of 66 cases: Mozambique with Lesotho, Namibia with Lesotho and Malawi, South Africa with Malawi, Swaziland with Malawi and South Africa, Tanzania with Mozambique, Zambia with Malawi, and Zimbabwe with Angola, Namibia, Seychelles, South Africa, Swaziland and Zambia. In general, the degree of integration of the

[2] When using Engle and Granger's (1987) two-step methodology for cointegration, the results provide evidence against cointegration in all the cases for the three monetary unions examined. These are available from the authors upon request.

cointegrating residuals is much lower compared to that of the parent series, especially in the cases of Swaziland and South Africa (0.289), Zambia and Malawi (0.409), Mozambique and Lesotho (0.508) and Tanzania and Mozambique (0.511). These results showing lack of cointegration come to show how this region has a lot of divergences among the exchange rates of its countries.

6. Conclusions

This paper examines the statistical properties of exchange rates in three prospective currency unions in Africa in order to evaluate their feasibility and long-run sustainability. The existing monetary unions analyzed are the WAMZ (West African Monetary Zone), formed by Gambia, Guinea, Ghana, Liberia, Nigeria and Sierra Leone, the EAC (East African Community): Burundi, Kenya, Rwanda, Tanzania and Uganda, and the SADC (South African Development Community) formed by Angola, Botswana, Dem. Rep. of Congo, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe.

The univariate analysis includes standard unit root tests which indicate that all series are nonstationary, and fractional integration methods providing evidence of orders of integration higher than 1 in the cases of the exchange rates of the Democratic Republic of Congo and Mauritius, and mean reversion in the cases of Sierra Leone and Madagascar. Concerning the bivariate equilibrium relationships within each union, evidence of fractional cointegration was obtained for the relationships between the exchange rates of Ghana and both Gambia and Guinea for the WAMZ union; Rwanda – Burundi, Tanzania – Rwanda, and Uganda – Tanzania for the EAC union, and also in 15 out of 66 cases for the SADC union, where the strongest evidence of cointegration was obtained in the cases of Swaziland and South Africa, Zambia and Malawi, Mozambique and Lesotho and Tanzania with Mozambique.

According to the OCA theory, it is important to take into account the homogeneity, that is to say, the similarities in the behaviour of the exchange rate series among the members of a hypothetical new currency union. With the recent will in the African continent to form such unions, it becomes necessary to assess this feature, and analyse macroeconomic variables to draw policy implications. In our study we have carried out a fractional integration and cointegration study on the exchange rate series of the countries belonging to three African monetary unions. Our results prove clearly that homogeneity within each of the three regions is far from a reality, and therefore time will be required to achieve it and currency unions to become optimal.

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Table 1: Unit root test results (level)

Regions	Countries	ADF		KPSS		ERS	
		Intercept	Trend	Intercept	Trend	Interceptpt	Trend
WAMZ	Gambia	-1.527067	-0.950206	1.622184***	0.404449***	257.8544	47.46977
	Guinea	-1.526386	-1.336676	1.823357***	0.400357***	205.5206	18.50168
	Ghana	-2.887584**	-2.970222	0.275831	0.091932	1.325387***	4.079491**
	Liberia	-2.682296*	-2.865188	0.401991*	0.129533*	1.865185***	6.833910*
	Nigeria	-5.070449***	-4.976713***	0.916766***	0.220964***	59.46049	38.12108
	Sierra L.	-2.596671*	-3.523692**	1.041597***	0.083329	2.974175**	1.581816***
EAC	Burundi	1.189626	-0.885778	1.598470***	0.469124***	81.47087	49.32353
	Kenya	-3.710955***	-4.176737***	1.404759***	0.276613***	79.01792	31.95505
	Rwanda	1.636625	-0.107541	1.277836***	0.312117***	99.05595	39.71609
	Tanzania	-2.330472	-2.245405	1.814881***	0.471689***	294.4453	18.42368
	Uganda	-1.478731	-2.436094	1.710962***	0.269832***	42.78552	7.986480
SADC	Angola	-2.518130	-2.596198	0.225210	0.139474*	2.429094**	8.146151
	Botswana	0.771200	-0.988497	1.658293***	0.245249***	67.25342	18.82075
	D Congo	-1.387655	-1.031333	0.940116***	0.214891**	52.06493	24.53724
	Lesotho	-2.341061	-2.835401	1.453094***	0.276112***	65.88497	19.15607
	Madagascar	-3.086072**	-5.517845***	1.744994***	0.323522***	14.49708	3.656495***
	Malawi	-5.204014***	-4.926791***	1.060534***	0.301124***	99.82616	59.04774
	Mauritius	-4.298560***	-2.163016	1.361853***	0.416838***	464.4942	185.1759
	Mozambique	-2.698136*	-3.064457	1.539625***	0.341156***	36.15686	13.99565
	Namibia	-2.488818	-2.334202	1.222449***	0.291134***	112.2887	41.36124
	Seychelles	-0.612297	-2.154698	1.626799***	0.292560***	37.39879	13.83024
	S.Africa	-2.547319	-2.406226	1.205795***	0.285496***	122.4845	46.33288
	Swatziland	-2.544938	-2.399948	1.229669***	0.286068***	126.1596	46.69571
	Tanzania	-2.330472	-2.245405	1.814881***	0.471689***	294.4453	18.42368
	Zambia	-6.043075***	-4.628190***	1.327530***	0.426412***	359.5884	179.4672
	Zimbawe	-3.241444**	-2.164579	1.391368***	0.440044***	169.0910	52.19187

*Rejection al the 10%; **Rejection at the 5%; ***Rejection at the 1%

Table 2: Unit root test results (first differences)

Regions	Countries	ADF		KPSS		ERS	
		Intercept	Trend	Intercept	Trend	Interceptpt	Trend
WAMZ	Gambia	-11.63735***	-11.71402***	0.468058**	0.173204**	0.254384***	0.885396***
	Guinea	-15.86086***	-15.93004***	0.242979	0.054570	0.209790***	0.777667***
	Ghana	-8.410133***	-8.393603***	0.020041	0.018724	2.164949**	8.06880
	Liberia	-14.75218***	-14.72358***	0.036675	0.032006	0.204499***	0.760688***
	Nigeria	-12.37287***	-12.51408***	0.338371	0.105379	0.216031***	0.808765***
	Sierra L.	-8.549335***	-8.532293***	0.019518	0.018465	1.680067***	6.258216*
EAC	Burundi	-12.02117***	-12.26035***	0.633800**	0.066219	0.460858***	1.319934***
	Kenya	-12.87034***	-12.97026***	0.285753	0.099174	0.213165***	0.796350***
	Rwanda	-16.41462***	-16.66984***	0.465540**	0.129004*	0.269527***	0.995164***
	Tanzania	-13.82535***	-14.02910***	0.488859**	0.065768	0.141447***	0.515228***
	Uganda	-19.73215***	-19.70431***	0.066046	0.037295	0.217988***	0.810317***
SADC	Angola	-12.69597***	-12.67528***	0.056170	0.044444	0.211684***	0.787488***
	Botswana	-10.67519***	-10.79346***	0.349653*	0.113779	0.253645***	0.906925***
	D Congo	-7.532436***	-7.587909***	0.160595	0.108526	1.798113***	3.315885***
	Lesotho	-12.16861***	-12.18954***	0.162895	0.073939	0.228203***	0.820704***
	Madagascar	-19.12708***	-19.11180***	0.172032	0.044374	0.214344***	0.798261***
	Malawi	-10.11120***	-10.37946***	0.458365*	0.110160	0.191498***	0.697630***
	Mauritius	-13.70308***	-14.43945***	0.998211***	0.192429**	0.215836***	0.832278***
	Mozambique	-15.42725***	-15.46665***	0.126863	0.020929	0.204882***	0.764759***
	Namibia	-10.38010***	-10.46250***	0.263810	0.121035*	0.176060***	0.622009***
	Seychelles	-9.279646***	-9.273011***	0.121728	0.080663	0.266872***	0.979856***
	S.Africa	-10.39122***	-10.47313***	0.296151	0.138463*	0.170861***	0.615590***
	Swatziland	-10.32292***	-10.40831***	0.289900	0.133239*	0.171052***	0.617600***
	Tanzania	-13.82535***	-14.02910***	0.488859**	0.065768	0.141447***	0.515228***
	Zambia	-6.043075***	-4.628190***	1.327530***	0.426412***	359.5884	179.4672
	Zimbawe	-15.48201***	-12.77338***	0.517712**	0.096751	0.157282***	0.153399***

*Rejection al the 10%; **Rejection at the 5%; ***Rejection at the 1%

Table 3: Fractional integration results

Regions	Countries	White noise	AR (1)	Bloomfield
WAMZ	Gambia	1.20 (1.11, 1.31)	**1.07 (0.98, 1.19)**	**1.08 (0.97, 1.20)**
	Guinea	**0.95 (0.87, 1.04)**	**0.92 (0.81, 1.07)**	**0.93 (0.81, 1.07)**
	Ghana	**0.95 (0.84, 1.07)**	**0.84 (0.59, 1.09)**	**0.80 (0.56, 1.07)**
	Liberia	**1.00 (0.91, 1.12)**	**0.81 (0.71, 1.13)**	**0.90 (0.72, 1.13)**
	Nigeria	**1.13 (1.04, 1.28)**	**0.85 (0.76, 1.09)**	**0.93 (0.78, 1.12)**
	Sierra Leone	1.24 (1.11, 1.41)	0.49 (0.36, 0.62)	**0.73 (0.49, 1.03)**
EAC	Burundi	1.13 (1.04, 1.27)	**0.98 (0.88, 1.11)**	**0.98 (0.90, 1.09)**
	Kenya	**1.10 (1.00, 1.23)**	**0.94 (0.82, 1.07)**	**0.90 (0.70, 1.09)**
	Rwanda	0.91 (0.85, 0.98)	**1.01 (0.91, 1.15)**	**1.02 (0.91, 1.17)**
	Tanzania	0.80 (0.73, 0.91)	**0.74 (0.65, 1.06)**	**0.73 (0.64, 1.03)**
	Uganda	0.77 (0.71, 0.86)	0.85 (0.73, 0.99)	**0.86 (0.69, 1.04)**
SADC	Angola	1.12 (1.02, 1.25)	**0.87 (0.75, 1.11)**	**0.92 (0.79, 1.11)**
	Botswana	1.24 (1.13, 1.39)	**0.95 (0.80, 1.09)**	**0.95 (0.85, 1.10)**
	D.R. Congo	1.27 (1.15, 1.43)	1.24 (1.04, 1.55)	1.25 (1.02, 1.54)
	Lesotho	1.14 (1.03, 1.28)	**0.91 (0.80, 1.04)**	**0.87 (0.71, 1.05)**
	Madagascar	0.65 (0.56, 0.78)	0.47 (0.39, 0.76)	0.55 (0.46, 0.75)
	Malawi	1.15 (1.04, 1.28)	**0.89 (0.77, 1.09)**	**0.94 (0.81, 1.10)**
	Mauritius	1.12 (1.05, 1.20)	1.13 (1.06, 1.22)	1.14 (1.04, 1.26)
	Mozambique	**0.94 (0.85, 1.07)**	**0.89 (0.71, 1.06)**	**0.82 (0.64, 1.07)**
	Namibia	1.25 (1.14, 1.40)	**0.94 (0.78, 1.09)**	**0.92 (0.82, 1.06)**
	Seychelles	1.38 (1.22, 1.56)	**0.90 (0.78, 1.06)**	**0.96 (0.84, 1.13)**
	South Africa	1.24 (1.13, 1.39)	**0.94 (0.77, 1.10)**	**0.93 (0.81, 1.03)**
	Swatziland	1.25 (1.14, 1.41)	**0.96 (0.79, 1.10)**	**0.93 (0.81, 1.10)**
	Tanzania	0.80 (0.73, 0.91)	**0.74 (0.65, 1.00)**	**0.73 (0.64, 1.01)**
	Zambia	**1.07 (1.00, 1.16)**	**1.05 (0.96, 1.14)**	**1.04 (0.88, 1.16)**
	Zimbawe	0.68 (0.63, 0.74)	**0.80 (0.73, 1.01)**	**0.85 (0.76, 1.05)**

In bold, evidence of unit roots (i.e., d = 1) at the 5% level.

Table 4: Estimates of d based on a Whittle semiparametric approach

		11	12	13	14	15	16	17	18	19
WAMZ	Gambia	1.338	**1.229**	**1.206**	**1.214**	1.214	1.354	1.288	**1.192**	**1.178**
	Guinea	**1.170**	**1.134**	**1.132**	**1.196**	**1.185**	**1.159**	**1.173**	**1.119**	**1.168**
	Ghana	**0.801**	**0.813**	0.731	0.749	0.768	**0.791**	**0.810**	**0.843**	**0.874**
	Liberia	0.500	0.564	0.636	**0.789**	**0.819**	**0.877**	0.779	**0.819**	**0.825**
	Nigeria	**1.008**	**1.000**	**1.003**	**1.006**	**0.998**	**0.994**	**0.985**	**0.978**	**0.981**
	Sierra Leone	0.402	0.389	0.390	0.407	0.407	0.406	0.429	0.454	0.469
EAC	Burundi	**1.182**	**1.192**	**1.147**	**1.074**	**1.027**	**1.051**	**1.069**	**1.069**	**1.062**
	Kenya	**0.886**	**0.895**	**0.921**	**0.955**	**0.951**	**0.909**	**0.942**	**0.973**	**0.975**
	Rwanda	**1.095**	**1.067**	**1.033**	**1.066**	**1.043**	**0.978**	**0.978**	**0.990**	**1.015**
	Tanzania	**0.973**	**1.017**	**1.066**	**1.118**	**0.955**	**0.966**	**0.978**	**0.951**	**0.913**
	Uganda	**0.815**	**0.788**	**0.847**	**0.793**	**0.846**	**0.826**	**0.856**	**0.903**	**0.888**
SADC	Angola	**0.881**	**1.036**	**1.154**	**1.166**	**1.086**	**1.003**	**0.945**	**0.917**	**0.910**
	Botswana	**1.145**	**1.126**	**1.092**	**1.143**	**1.172**	**1.152**	**1.094**	**1.076**	**1.092**
	D Congo	**1.183**	**1.118**	1.259	1.249	1.280	1.329	1.329	1.384	1.421
	Lesotho	**0.957**	**0.990**	**0.900**	**0.927**	**0.957**	**0.969**	**0.954**	**0.967**	**0.951**
	Madagascar	0.433	0.489	0.490	0.455	0.490	0.506	0.517	0.554	0.509
	Malawi	**1.013**	**1.014**	**1.019**	**1.022**	**1.015**	**1.013**	**1.021**	**1.024**	**1.016**
	Mauritius	1.500	1.441	1.400	1.361	1.375	1.332	1.304	1.282	1.289
	Mozambique	0.681	0.749	0.762	**0.797**	**0.817**	**0.831**	**0.809**	**0.816**	**0.817**
	Namibia	**1.157**	**1.092**	**1.087**	**1.111**	**1.158**	**1.138**	**1.102**	**1.104**	**1.125**
	Seychelles	1.263	**1.053**	**1.028**	**0.983**	**0.971**	**0.989**	**0.954**	**0.954**	**0.969**
	S.Africa	**1.199**	**1.111**	**1.105**	**1.135**	**1.183**	**1.149**	**1.112**	**1.110**	**1.122**
	Swatziland	**1.219**	**1.145**	**1.113**	**1.136**	**1.179**	**1.158**	**1.107**	**1.103**	**1.115**
	Tanzania	**0.973**	**1.017**	**1.066**	**1.118**	**0.955**	**0.966**	**0.978**	**0.951**	**0.951**
	Zambia	**1.247**	**1.213**	**1.216**	**1.211**	**1.217**	1.217	**1.169**	**1.177**	**1.201**
	Zimbawe	1.317	1.321	1.303	**1.199**	**1.201**	**1.202**	**1.186**	**1.108**	**1.114**
95% Lower Band		0.752	0.762	0.771	0.780	0.787	0.794	0.800	0.806	0.811
95% Upper Band		1.247	1.237	1.228	1.219	1.212	1.205	1.199	1.193	1.188

Table 5a: Testing the null of no cointegration: WAMZ

	Gambia	Guinea	Ghana	Liberia	Nigeria
Guinea	0.151 0.348 1.044	---	---	---	---
Ghana	**10.494** **67.500** **0.540**	**7.871** **63.712** **0.442**	---	---	---
Liberia	1.141 33.641* 0.693	1.314 32.235* 0.686	2.030 0.981 0.661	---	---
Nigeria	1.936 0.853 1.011	0.031 3.752 1.022	0.030 8.507* 0.971	13.333* 1.844 0.678	---

The first two values refer to the test statistics for H_x and H_y respectively using the Hausman test of Marinucci and Robinson (2001). The third value is the estimated value of d^*. $\chi_1^2(5\%) = 3.84$. In bold and with an asterisk, those cases where we reject the null hypothesis of no cointegration at the 5% level.

Table 5b: Testing the null of no cointegration: EAC

	Burundi	Kenya	Rwanda	Tanzania	Uganda
Kenya	0.127 0.938 0.987	---	---	---	---
Rwanda	**9.101** **9.647** **0.795**	2.714 0.169 0.918	---	---	---
Tanzania	4.241* 2.463 0.933	10.066* 1.844 0.883	**6.613** **3.971** **0.887**	---	---
Uganda	0.198 2.463 0.886	0.004 1.214 0.852	0.348 7.745* 0.793	**12.930** **23.129** **0.523**	---

The first two values refer to the test statistics for H_x and H_y respectively using the Hausman test of Marinucci and Robinson (2001). The third value is the estimated value of d^*. $\chi_1^2(5\%) = 3.84$. In bold and with an asterisk, those cases where we reject the null hypothesis of no cointegration at the 5% level.

Table 5c: Testing the null of no cointegration: SADC

	ANG.	BOTS	LES.	MAL.	MOZ.	NAM	SEYC	S.AF	SWAT	TANZ	ZAMB	ZIMB
Botwana	0.010 0.127 1.134	---	---	---	---	---	---	---	---	---	---	---
Lesotho	0.093 5.517* 0.955	0.539 2.788 0.993	---	---	---	---	---	---	---	---	---	---
Malawi	0.001 2.569 1.022	0.097 2.751 0.994	6.786* 2.394 0.788	---	---	---	---	---	---	---	---	---
Mozambique	1.639 29.03* 0.682	0.071 10.96* 0.773	**10.35** **21.75** **0.508**	1.844 14.92* 0.675	---	---	---	---	---	---	---	---
Namibia	8.158* 0.402 1.054	1.095 0.476 1.205	**23.022** **7.561** **0.680**	**13.171** **6.961** **0.785**	11.07* 0.678 0.723	---	---	---	---	---	---	---
Seychelles	0.040 1.499 1.001	0.678 0.916 1.057	0.523 3.415 1.093	0.507 0.077 1.047	0.793 0.031 0.833	1.048 0.160 1.075	---	---	---	---	---	---
South Africa	0.188 0.027 1.096	0.040 0.012 1.153	14.66* 2.292 0.791	**17.990** **8.901** **0.754**	17.61* 0.188 0.758	2.867 2.030 0.983	0.097 4.015* 1.163	---	---	---	---	---
Swatziland	0.374 0.111 1.081	0.583 0.416 1.201	12.93* 1.610 0.813	**19.533** **9.925** **0.739**	21.447 0.734 0.720	**31,606** **28.554** **0.631**	0.111 4.150* 1.166	**50.131** **49.973** **0.500**	---	---	---	---
Tanzania	2.094 3.926* 0.988	0.491 0.178 1.181	11.52* 1.610 0.813	1.095 0.003 1.024	**45.663** **10.337** **0.511**	2.258 2.030 0.983	0.461 0.678 1.057	1.154 2.062 1.006	1.554 2.098 1.006	---	---	---
Zambia	1.998 0.091 1.084	0.021 0.813 1.224	5.889* 0.539 0.993	**62.651** **33.770** **0.500**	25.997 0.239 0.753	3.882 0.734 1.034	0.539 10.71* 1.277	2.394 0.491 1.072	4.957* 1.936 1.011	1.289 0.010 1.109	---	---
Zimbawe	**33.512** **23.129** **0.679**	0.090 0.104 1.172	23.45* 3.292 0.764	11.22* 1.095 0.898	36.67* 2.499 0.655	**14.495** **7.995** **0.857**	**20.328** **4.427** **0.794**	**26,224** **19.435** **0.739**	**28.198** **21.242** **0.722**	1.198 0.262 1.072	**15.443** **17.243** **0.838**	---

The first two values refer to the test statistics for H_x and H_y respectively using the Hausman test of Marinucci and Robinson (2001). The third value is the estimated value of d^*. $\chi_1^2(5\%) = 3.84$. In bold and with an asterisk, those cases where we reject the null hypothesis of no cointegration at the 5% level.