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REER Imbalances and Macroeconomic Adjustments in the Proposed West African Monetary Union

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Abstract

With the spectre of the Euro crisis hunting embryonic monetary unions, we use a dynamic model of a small open economy to analyze REERs imbalances and examine whether the movements in the aggregate real exchange rates are consistent with the underlying macroeconomic fundamentals in the proposed West African Monetary Union (WAMU). Using both country-oriented and WAMU panel-based specifications, we show that the long-run behavior of the REERs can be explained by fluctuations in the terms of trade, productivity, investment, debt and openness. While there is still significant evidence of cross-country differences in the relationship between underlying macroeconomic fundamentals and corresponding REERs, the embryonic WAMU has a stable error correction mechanism with four of the five cointegration relations having signs that are consistent with the predictions from economic theory. Policy implications are discussed and the conclusions of the analysis are a valuable contribution to the scholarly and policy debate over whether the creation of a sustainable monetary union should precede convergence in macroeconomic fundamentals that determine REER adjustments.

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Keywords: Exchange rate; Macroeconomic impact; Proposed WAMU

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1. Introduction

In light of the Euro crisis, we use a dynamic model of a small open economy to investigate whether variations in the aggregate real exchange rates are consistent with the underlying macroeconomic fundamentals in the proposed West African Monetary Union (WAMU). After its first decade, the euro has come under immense pressure. Triggered by adjustments in the fiscal accounts of Greece, the crisis that initially spread to Ireland and Portugal has become a significant threat to the euro zone's existence after Spanish and Italian sovereigns have begun experiencing funding pressures. This crisis mirrors banking sector fragilities and intertwined public debt made worse by apparently weak growth prospects, as well as substantial external liabilities (in gross and net terms)[2]. German firms have continued their outward integration by setting-up production platforms in emerging Europe in order to take advantage of lower wage costs and higher return on capital that have boosted exports and competitiveness.

This mode of financing continued until the crisis erupted and allowed deficit countries to sustain appreciating real effective exchange rates (that have also been driven by the nominal appreciation of the euro) and has retarded the adjustment needed to end the growing divergence of trade performance within the monetary union (Chen et al., 2012). Owing to the importance of export promotion (for the generation of optimal paths of employment and output), the debate in the literature on structural adjustment and macroeconomic stabilization has emphasized the crucial role played by real exchange rate (Mussa, 1974; Edwards & Van Wijnbergen, 1986; Obstfeld & Rogoff, 1996; Acemoglu et al., 2003; Abdih & Tsangarides, 2010).

The spectre of the Euro crisis is hunting existing and embryonic monetary unions (Asongu, 2013a,b). The maintenance of exchange rates at an appropriate threshold has been

[2] For instance, net external liabilities of close to 100% of GDP in Greece, Ireland, Portugal and Spain.

credited for the success of certain developing countries. In the same vein, it is believed that a distinguishing feature of East and Southeast Asia's success with sustainable growth has been the consistent avoidance of overvaluation (Abdih & Tsangarides, 2010). To this end, some studies have also focused on analyzing the feasibility of forming a monetary union in the Economic Community of West African States (ECOWAS). In this strand, Celasun & Justiniano (2005) have used a dynamic factor analysis to assess the synchronization of output fluctuations among candidate countries. Their findings show that, small countries within ECOWAS experience relatively more synchronized output variations. Hence, they suggest that, in comparison to wider monetary integration, monetary unification among subsets of countries is preferable.

Using a model of monetary and fiscal policy interactions, Debrun et al. (2005) have also investigated the potential for monetary integration in the ECOWAS. Their findings suggest that the proposed monetary union is appealing for most non-West African Economic and Monetary Union (WAEMU) countries, but not for the existing WAEMU candidate countries. Tsangarides & Qureshi (2008) through the application of hard and soft clustering algorithms to a set of variables (suggested by the convergence criteria and the theory of optimal currency areas), have examined the suitability of countries in the West African region to form the proposed monetary union (WAMU). Findings show substantial dissimilarities in the economic characteristics of member countries. Much recently, Alagidede et al. (2011) have also assessed the inflation dynamics and common trends in the real domestic products of candidate countries to the embryonic WAMU to draw attention to the fact that less emphasis has been placed on the extent to which the dynamics of inflation and economic trends in individual countries are (dis)similar.

An earlier study by Alagidede et al. (2008) had concluded that the success of a secondary monetary zone in West Africa depended on well coordinated macroeconomic

policies and on minor divergence in prices and exchange rates to eliminate excessive arbitrage profits that may arise. In order to ensure timely and effective implementation of the road map to a single currency in the WAMU, the Convergence Council has urged members states to pursue appropriate monetary and fiscal policies, as well as rigorous implementation of the structural and institutional policies under the ECOWAS Multilateral Surveillance Mechanism, in order to achieve convergence and a durable monetary union on a sustainable basis (Asongu, 2013a).

A major lesson of the EMU crisis is that, serious disequilibria result from regional monetary arrangements not designed to be robust to a variety of shocks (Asongu, 2013b). In light of the above, assessing the competitiveness and feasibility of the embryonic WAMU requires quantitative analysis of the actual and equilibrium exchange rates as well as adjustments of macroeconomic fundamentals to corresponding exchange imbalances. In this paper, we complement existing literature by analyzing the movements of the real effective exchange rates (REERs) of countries within the WAMU zone vis-à-vis long-term values[3]. Findings on this proposed WAMU valuation could hold substantial policy implications particularly on how REER misalignment could be corrected in the run-up to the monetary union.

In light of the above, the paper has a threefold contribution to existing literature. First, it steers clear of and/or complements Adbih and Tsangarides (2010), a study closest to the current in the literature by: (1) focusing on the proposed WAMU instead of existing monetary zones; (2) using an updated dataset (1980 to 2009 vs 1970 to 2005); (3) presenting both country-specific and panel-based estimation contrary to the underlying study which is based only on the latter estimation and: (4) employing additional variables on macroeconomic characteristics. Second, given the ongoing debate on the future of existing monetary unions

[3] This is because, like in the current euro crisis, macroeconomic fundamentals maybe different across the proposed WAMU candidate countries. Hence, the need for country-specific and panel analyses to assess the states of equilibrium.

(especially the EMU), assessing this embryonic zone provides policy makers and scholars with the much needed insight into the feasibility of the project. Third, the paper complements literature on convergence in the African continent that is relevant for ongoing policy initiatives on more regional integration (Keane et al., 2010).

The rest of the paper is structured as follows. Section 2 examines the theoretical framework, presents the data and discusses the methodology. Section 3 covers the empirical analysis and corresponding discussion. Section 4 concludes.

2. Theoretical framework, Data and Methodology

2.1 FEER model specification

We assess the reduced form of the Fundamental Equilibrium Exchange Rate (FEER) model (Edwards, 1989) using the Johansen's (1995) cointegration methodology in order to extract the equilibrium trajectories and corresponding misalignments for the period 1980-2009. The FEER estimation strategy is particularly appropriate in examining if the movement of the REER represents a misalignment or whether the Equilibrium Real Effective Exchange Rate (EREER) itself has shifted because of changes in the macroeconomic fundamentals (Abdih & Tsangarides, 2010). Accordingly, we define equilibrium as the rate that results in the simultaneous attainment of internal and external equilibrium in the economy (Asongu, 2013c). Thus, internal equilibrium is achieved when the market for non-tradable commodities clears in the present (and expected to clear in the future) as wage and price flexibility ensure that demand equals supply (that is, the conditions of internal balance are satisfied). On the other hand, external equilibrium is attained when the current account balance is at a 'sustainable' threshold as implied by the sustainable level of capital flows. Consistent with the literature, long-term determinants of the EREER are defined by the following fundamentals (Abdih & Tsangarides, 2010; Asongu, 2013c). (1) 'Productivity' with an expected positive

sign that captures the Balassa-Samuelson effect[4]. (2) The terms-of-trade (TOT) in goods with (also) an expected positive sign that captures the wealth-effect[5]. (3) 'Investment' (of an ambiguous sign) which is included in the theoretical model because of supply-side effects that are dependent on the relative factor intensities across sectors[6]. (4) 'Degree of trade controls/restrictions' for which the sign is ambiguous[7]. (5) Liabilities in terms of external debt that partially reflect fiscal policies[8].

3.2 Data and Methodology

We examine a sample[9] of 4 potential WAMU countries (The Gambia, Ghana, Nigeria and Sierra Leone) with annual data for the period 1980-2009 from African Development Indicator of the World Bank[10]. Guinea and Liberia are left-out due to constraints in data availability. The data include the following variables: the REER, productivity, the TOT, investment, openness and external debt. Consistent with Abdih & Tsangarides (2010), the variables are presented in terms of natural logarithm to ease comparability and compatibility.

[4] An increase in the productivity of tradables vis-à-vis non-tradables of one country relative to a foreign country increases its relative wage, which leads to an increase in the relative price of non-tradables and hence, causes a REER appreciation.

[5] An appealing TOT shock induces an increase in the domestic demand, a corresponding increase in the price of non-tradable goods which leads to a REER appreciation. Alternatively, from an internal-external balance angle, an increase in the TOT leads to an increase in real wages of the export sector and a trade surplus. For the external balance to be restored, the REER must appreciate.

[6] Since investment in a developing country may have a high import content, a rise in the investment share of GDP could shift spending towards traded goods, thus depreciate the REER. Hence, we expect a negative sign.

[7] As trade controls and barriers are lifted, increase in trade may either be import or export skewed and hence, the need for depreciation or appreciation of the REER respectively.

[8] An increase in external debt without a corresponding increase in domestic structures to accommodate the wealth-effect will lead to an increase in non-tradable goods and imports which ultimately will appreciate the REER.

[9] The WAMU variables represent a panel of four countries: The Gambia, Ghana, Nigeria and Sierra Leone. While the panel is a priori unweighted, the weight of the variables with respect to country-specific GDPs affects the results.

[10] It should be noted that any issues of degrees of freedom are not unprecedented and avoidable. The potential issues of sample selection bias may not much apply because the monetary zone has only a few countries (unavoidability dimension). Moreover, recent monetary policy literature that has focused on the CFA zone and other African embryonic monetary zones faces the same data constraints (not unprecedented side). It is worthwhile backing these assertions with recent cointegration literature that is based on similar degrees of freedom as in our case. (1) Saxegaard (2006, p.5) has used quarterly data from 1990-2004 for individual African countries (15*4*1). (2) Waliullah et al. (2010) have used annual data for the period 1970 to 2005 for Pakistan (1*36). (3) Asongu (2013d) has recently taken a short-run Schumpeterian trip to embryonic African monetary zones with a sample of 4 West and 5 East African countries for the period 1980-2010.

The summary statistics of the variables and correlation analysis are presented in Appendix 1 and Appendix 2 respectively. Definition of variables (with corresponding) sources is presented in Appendix 3.

In accordance with the literature (Abdih & Tsangarides, 2010; Asongu, 2013c) we employ a Vector Error Correction Model (VECM). Employment of the VECM presupposes the exhibition of unit roots in levels and the existence of a long-run equilibrium (cointegration). First, we use the Augmented Dickey Fuller (ADF) test for unit roots to examine the order of integration of the series. Next, the Johansen (1988, 1991, 1995) maximum likelihood procedure enables us to test for the corresponding long-run cointegration relationships between the exchange rates and their fundamentals. Then, the equilibrium thresholds of the fundamentals are computed specifically by extracting the permanent component from the fundamentals' series. Last, the vector of long-run parameters and the extracted permanent component are combined to calculate the EREER, with the misalignment estimated as the shift of the REER from its value in equilibrium. The methodological underpinnings are consistent with Abdih & Tsangarides (2010) on which the paper is positioned.

4. Empirical analysis

4.1 Integration analysis

The standard ADF test is employed both in levels and first differences of the variables under consideration. Optimal lag selection for goodness of fit in the ADF specification is by the Akaike Information Criterion (AIC). Based on the reported t-ADF statistics in Panel A of Table 1, the variables have in unit root in levels for the most part. Hence, the null hypothesis of unit root is not rejected in levels. However, this null of a unit root in first difference is strongly rejected in all countries for a clear majority of the variables. Therefore, we conclude

that the variables are overwhelmingly integrated in the first order; that is, they can be differenced once to obtain stationarity.

Table 1: Unit root test for variables

Countries	Variables	Level		First difference	
		c	ct	c	ct
	Panel A: Country-specific (ADF) unit root test				
The Gambia (1980-2009)	REER(ln)	-0.626	-2.233	**-4.579*** **	**-4.506*** **
	TOT(ln)	-1.312	-1.792	**-4.204*** **	**-4.812*** **
	Openness(ln)	-1.910	-2.732	**-7.186*** **	**-7.208*** **
	Productivity(ln)	-1.632	-1.760	**-5.536*** **	**-5.632*** **
	FDI(ln)	-1.912	-2.515	**-3.133***	-1.214
	External Debt(ln)	-2.627	-2.337	**-5.233*** **	**-5.572*** **
Ghana (1980-2009)	REER(ln)	-1.456	-1.725	**-5.505*** **	**-5.671*** **
	TOT(ln)	**-2.667***	-2.992	**-6.465*** **	**-6.407*** **
	Openness(ln)	-1.337	-1.225	**-4.315*** **	**-8.011*** **
	Productivity(ln)	0.098	-0.827	**-3.971*** **	**-4.145** **
	FDI(ln)	-0.885	-2.610	**-5.088*** **	**-5.074*** **
	External Debt(ln)	-1.112	-1.039	**-4.751*** **	**-5.126*** **
Nigeria (1980-2009)	REER(ln)	-1.619	-1.452	**-4.073*** **	**-4.102** **
	TOT(ln)	**-3.756*** **	**-5.504*** **	na	na
	Openness(ln)	-1.331	-1.292	**-5.071*** **	**-5.004*** **
	Productivity(ln)	-0.572	-2.050	**-4.015*** **	**-5.538*** **
	FDI(ln)	**-3.044** **	**-3.303***	na	na
	External Debt(ln)	0.028	-1.414	**-3.474** **	**-4.100** **
Sierra Leone (1980-2009)	REER(ln)	-1.055	-1.728	**-4.204*** **	**-4.132** **
	TOT(ln)	-1.357	**-3.323***	**-6.033*** **	**-6.065*** **
	Openness(ln)	**-3.085** **	**-3.581** **	na	na
	Productivity(ln)	-2.106	-2.066	**-5.132*** **	**-5.382*** **
	FDI(ln)	**-4.710*** **	0.421	-0.015	**-13.013*** **
	External Debt(ln)	-1.002	-0.936	**-4.522*** **	**-5.071*** **
	Panel B : Panel unit root tests				
WAMU Homogenous Panel LLC Test (1980-2009)	REER(ln)	-0.907	-0.266	**-5.706*** **	**-6.370*** **
	TOT(ln)	**-1.499***	**-2.993*** **	na	na
	Openness(ln)	**-2.211** **	-0.570	**-7.688*** **	**-7.900*** **
	Productivity(ln)	1.133	-0.922	**-3.042*** **	**-2.597*** **
	FDI(ln)	-1.232	**-1.578***	**-9.499*** **	**-3.441*** **
	External Debt(ln)	2.513	0.808	**-5.482*** **	-1.249
WAMU Heterogeneous Panel IPS Test (1980-2009)	REER(ln)	-0.537	-2.096	**-6.015*** **	**-5.819****
	TOT(ln)	**-1.946** **	**-3.348*** **	na	na
	Openness(ln)	**-2.746*** **	-0.140	**-9.018*** **	**-10.061*** **
	Productivity(ln)	-0.265	-0.065	**-6.033*** **	**-6.300*** **
	FDI(ln)	-0.987	-1.252	**-8.250*** **	**-5.242*** **
	External Debt(ln)	-0.186	1.883	**-5.314*** **	**-4.213*** **

Notes. ***, **, *: denote significance at 1%, 5% and 10% respectively. 'c' and 'ct': 'constant' and 'constant and trend' respectively. REER: Real Effective Exchange Rate. TOT: Terms of Trade. ln: logarithm. FDI: Foreign Direct Investment. WAMU: West African Monetary Union. Maximum lag is 8 and optimal lags are chosen via HQC for LLC test and AIC for IPS test. Optimal lag for the most part is 2. LLC: Levin, Lin & Chu (2002). IPS: Im, Pesaran & Shin (2003).

In Panel B of Table 1, we test for unit root with two types of first generational panel unit root tests. Two main types of panel unit root tests have been documented: first generational (which assumes cross-sectional independence) and the second generational (premised on cross-sectional dependence). A precondition for employing the latter generational test is a cross-sectional dependence test that is only applicable on condition that the number of cross-sections (N) in the panel exceed the number of periods in the cross-sections (T). Given that we have 30 periods (T) and 4 cross-sections (N), we are limited to the first generational type. Accordingly, both the Levin, Lin & Chu (LLC, 2002) and Im, Pesaran & Shin (IPS, 2003) tests are applied. Whereas the former is a homogenous based panel unit root test (common unit as null hypothesis), the latter is a heterogeneous oriented test (individual unit roots as null hypotheses). When the findings are different, IPS (2003) takes precedence over LLC (2002) in decision making because, according to Maddala & Wu (1999), the alternative hypothesis of LLC (2002) is too strong. Consistent with Liew (2004), goodness of fit (or optimal lag selection) is in accordance with the Hannan-Quinn Information Criterion (HQC) and the Akaike Information Criterion (AIC) for the LLC (2002) and IPS (2003) tests respectively[11]. From the results reported in Panel B of Table 1, it could be observed that the variables are overwhelmingly stationary in first difference. These findings indicate the possibility of cointegration (long-run equilibrium) among the variables; because with respect to the Engel-Granger theorem, two or more variables that are not stationary could have a linear combination in the long-run (Engle & Granger, 1987).

[11] "*The major findings in the current simulation study are previewed as follows. First, these criteria managed to pick up the correct lag length at least half of the time in small sample. Second, this performance increases substantially as sample size grows. Third, with relatively large sample (120 or more observations), HQC is found to outdo the rest in correctly identifying the true lag length. In contrast, AIC and FPE should be a better choice for smaller sample. Fourth, AIC and FPE are found to produce the least probability of under estimation among all criteria under study. Finally, the problem of over estimation, however, is negligible in all cases. The findings in this simulation study, besides providing formal groundwork supportive of the popular choice of AIC in previous empirical researches, may as well serve as useful guiding principles for future economic researches in the determination of autoregressive lag length"* (Liew, 2004, p. 2).

4.2 Cointegration analysis

4.2.1 Cross-sectional cointegration

Consistent with the literature (Gries et al., 2009; Abdih & Tsangarides, 2010; Asongu, 2013c), let us specify a vector of variables Y_t as a vector autoregressive (VAR) equation in the form:

$$\boldsymbol{Y}_t = \pi_0 + \sum_{i=1}^{P} \pi_i \boldsymbol{Y}_{t-i} + \psi \boldsymbol{D}_t + \varepsilon_t \qquad (1)$$

Where Y_t is a (6×1) vector:

$$Y_t = \begin{pmatrix} REER_t \\ Terms\text{-}of\text{-}trade\ of\ goods_t \\ External\ Debt_t \\ Openness_t \\ Productivity_t \\ Investment_t \end{pmatrix}$$

where π_0 is a (6×1) vector of constants; π_i are (6×6) matrices of coefficients of lags of Y_t; p is the optimal lag length; D_t is a vector of the dummy-type variables; and ε_t is the (6×1) vector of independent and identically distributed error terms that are assumed to be normal with zero mean and covariance matrix Ω. As such, the VAR consists of a system of six equations where the right-hand side of each equation entails a common set of lagged and deterministic regressors. Therefore, the VAR specification in Eq. (1) provides the basis for cointegration analysis. Hence, adding and subtracting various lags of Y_t yields the following expression for the VAR in first difference:

$$\Delta \boldsymbol{Y}_t = \pi_0 + \pi \boldsymbol{Y}_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta \boldsymbol{Y}_{t-i} + \psi \boldsymbol{D}_t + \boldsymbol{e}_t \qquad (2)$$

where Δ denotes the difference operator, $\Gamma_i = -(\pi_{i+1}+,...,+\pi_p)$ is a (6×6) coefficient matrix, and $\pi \equiv \left(\sum_{i=1}^{P} \pi_i\right) - I$

(i) If (rank) $\pi = 6$ or (rank) $\pi = 0$, then no cointegration exist among the variables. In this case, it is appropriate to estimate the model in levels [for rank $\pi = n$] and first difference [for rank $\pi = 0$].

(ii) If (rank) $\pi > 0$ or (rank) $\pi \equiv r < 6$, then there are r cointegrating vectors/relationships. In this case, matrix π can be expressed as the outer product of two full column rank $(6 \times r)$ matrices α and β, where $\pi = \alpha\beta$.

From the Johansen results presented in Table 2 below, the second condition (ii) for cointegration above is satisfied[12]. Thus, there is evidence of a long-run equilibrium between the REERs and their identified fundamentals for all the four countries under investigation. It should be noted that we have reported the two Johansen tests at our disposal (trace statistics and maximum eigenvalue), but based our decisions only on the trace statistics in a bid to obtain more robust results (Cheung & Lai, 1993; Lutkepohl et al., 2000; Gries at al., 2009; Asongu, 2013e). Accordingly, in small samples the power of the trace test is superior to that of the maximum eigenvalue test (Lutkepohl et al., 2000, p.1).

This information criterion is relevant in the co integration decisions of The Gambia and Sierra Leone.

Table 2: Johansen cointegration test

	Hypothesized No of CE(s)	Eigen value	Trace test	Max-Eigen test	Decision on number of co integration relationships
	None	0.682	**103.36****	33.244	
	At most 1	0.575	70.118	24.880	At most 5 co integration vectors.
The	At most 2	0.496	45.238	19.900	The chosen vector is that which
Gambia	At most 3	0.390	25.338	14.362	specifies the REER as an
(1980-	At most 4	0.260	10.976	8.735	imbalance.
2009)	At most 5	0.074	2.240	2.240	

[12] When the null hypothesis for 'no cointegration' is rejected, the cointegration rank is greater than zero but less than the number of variables (6). This is consistent with point (ii) of Section 4.2.1 on the empirical underpinnings. It should be noted that, there are at most 5 cointegration relations. Hence, besides specifying the REER as an imbalance, four other macro fundamental characteristics could as well be specified as imbalances. However, in light of our problem statement, we are only considering one cointegration relation.

	None	0.804	**107.51****	**47.348*****	
	At most 1	0.578	60.165	25.054	At most 5 co integration vectors.
Ghana	At most 2	0.449	35.111	17.295	The chosen vector is that which
(1980-	At most 3	0.343	17.816	12.205	specifies the REER as an
2009)	At most 4	0.120	5.610	3.720	imbalance
	At most 5	0.063	1.890	1.890	
	None	0.841	**112.58****	**51.604*****	
	At most 1	0.620	60.972	27.106	At most 5 co integration vectors.
Nigeria	At most 2	0.427	33.866	15.628	The chosen vector is that which
(1980-	At most 3	0.290	18.238	9.622	specifies the REER as an
2009)	At most 4	0.231	8.615	7.358	imbalance
	At most 5	0.043	1.257	1.257	
	None	0.703	**102.49***	35.281	
	At most 1	0.693	67.207	**34.271***	At most 5 co integration vectors.
Sierra	At most 2	0.418	32.935	15.734	The chosen vector is that which
Leone	At most 3	0.253	17.201	8.472	specifies the REER as an
(1980-	At most 4	0.211	8.729	6.902	imbalance
2009)	At most 5	0.061	1.827	1.827	

Notes. ***, **, *: denote significance at 1%, 5% and 10% respectively. Model specification is by the AIC. Restricted constant in the cointegration test. While there may be at most 5 co integration relationships, the study only focuses on those for which the REER represents imbalances, given the problem statement (title) of the paper. This is consistent with Abdih & Tsangarides (2010). While 'imbalance' in the equation specification refers to the main endogenous variable (REER), it also denotes deviations from the long-run equilibrium or cointegration relation (with the macroeconomic fundamentals).

4.2.2 Panel cointegration tests

In accordance with Abdih & Tsangarides (2010), the equations in Section 4.2.1 above can be generalized to panel data without the need for additional specifications. To investigate the panel long-run relationship, we test for cointegration using Engle-Granger based Pedroni and Engle-Granger Kao tests. In accordance with Camarero & Tamarit (2002), the advantage of applying these two tests is that, while the former (Pedroni; 1999) is heterogeneous, the latter (Kao; 1999) is homogenous. Implementation of both tests is in line with our earlier employment of both homogenous (LLC) and heterogeneous (IPS) unit root tests. Similar deterministic trend components used in the unit root tests are also employed. Normally, the Pedroni (1999) test should be given priority in event of conflict of results because, it has more deterministic components[13]. Optimal lag selection for goodness of fit is by the AIC.

[13] Whereas, Pedroni (1999) is applied in the presence of both 'constant' and 'constant and trend' Kao (1999) is based only on the former (constant).

Table 3: Panel cointegration tests (WAMU)

	Panel A: Engle-Granger based Pedroni test for heterogeneous panel						
	Panel Statistics				Group Statistics		
	v-stats	rho-stats	PP-stats	ADF-stats	rho-stats	PP-stats	ADF-stats
Constant	-2.555	1.793	1.709	1.377	1.965	0.918	0.737
Constant and trend	-2.734	2.363	2.883	2.281	2.653	2.221	4.243

	Panel B: Engle-Granger based Kao test for homogenous panel
Constant	**-2.257****

	Panel C: Johansen Fisher					
Hypothesized No of CE(s)	None	At most 1	At most 2	At most 3	At most 4	At most 5
Trace test	**30.393*****	**11.379***	**23.540*****	5.984	3.393	1.000
Maximum Eigen value	**25.997*****	8.277	**21.153*****	5.724	5.396	1.000

Notes: *, **, *** denote significance at 10%, 5% and 1% respectively. 'c' and 'ct': 'constant' and 'constant and trend' respectively. PP: Phillips-Peron. ADF: Augmented Dickey Fuller. CE: Cointegration Equations. No deterministic trend assumption. Maximum lags is 8 and optimal lags are chosen via AIC. Optimal lags for the most part is 1. In the decision on the number of co integration vectors, there are at most 5 co integration relationships. Consistent with Table 2 above, the chosen vector is that which specifies the REER as an imbalance.

Table 3 above reports results of the cointegration tests. While Panel A reports the long-term relationship based on Pedroni (1999) heterogeneous test, Panel B reveals findings for the long-run equilibrium based on Kao (1999) homogenous test. It could be observed from the Engle-Granger based Kao test that, there is overwhelming evidence of a long-term relationship between the REER and its determinant. However, the absence of significant findings in the Pedroni (1999) results invite us to further assess the validity of the Kao (1999) results with the panel Johansen cointegration test. Thus, Panel C confirms the results of Panel B. It follows that in the long-run, permanent changes in fundamental determinants affect permanents changes in the REER. Hence, the need to investigate short-term adjustments to this long-run equilibrium with the VECM. The panel analysis is presented in the last column of Table 4 below.

With condition (ii) satisfied, the VAR can be expressed as a VECM:

$$\Delta Y_t = \pi_0 + \alpha\beta' Y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta Y_{t-i} + \psi D_t + e_t \qquad (3)$$

The matrix β' contains the cointegrating vector(s) and also has the weighting elements for the rth cointegrating relation in each equation of the VAR. The matrix rows of

$\beta' Y_{t-1}$ are normalized on the variable(s) under investigation in the cointegrating relation(s) and interpreted as deviations from the long-term relationship (equilibrium) condition(s). In this context, the column of α denotes the speed of adjustment to the long-term equilibrium. The estimated vector can be used to provide a measure of the EREER and also quantify the misalignment margin between the prevailing exchange rate and its equilibrium (long-term) level. The estimated α that is associated with the REER captures the speed at which the real exchange rate converges to the equilibrium state. Optimal lag selection for goodness of fit in model specifications is consistent with the recommendations of Liew (2004).

4.3 Cointegration coefficients and adjustments

We have observed from Table 3 that, there is evidence of a long-term relationship between the REERs and their identified fundamentals in the four WAMU countries investigated. Table 4 below contains the results from estimating the VAR/VECMs in Eq. (3) for each of the four countries. The table is divided into two panels, with Panel A reporting estimates for the cointegrating vectors (the βs) with their corresponding standard errors and Panel B reporting the adjusting (feedback) coefficients estimates (the αs) together with their t-statistics.

Table 4: Cointegration and short-term adjustment coefficients

	The Gambia	Ghana	Nigeria	Sierra Leone	WAMU
	Panel A: Estimates of cointegration relationships				
Openness(ln)	-17.450	0.958	-3.969	11.251	-2.670
	[3.569]	[0.145]	[1.314]	[1.308]	[0.772]
Productivity(ln)	30.403	0.817	13.171	-6.855	1.273
	[6.510]	[0.464]	[2.388]	[2.225]	[1.597]
TOT(ln)	-4.089	-2.849	5.434	3.031	0.801
	[4.868]	[0.437]	[1.369]	[0.869]	[0.930]
Debt(ln)	26.327	0.523	6.488	-3.639	1.057
	[4.159]	[0.312]	[1.230]	[0.967]	[0.962]
FDI(ln)	-2.075	-0.238	6.020	-1.200	0.860
	[0.735]	[0.041]	[0.781]	[0.229]	[0.257]
constant	-223.01	-16.986	-99.69	7.023	-6.281
	[50.638]	[3.633]	[18.051]	[14.736]	

	Panel B: Estimates of short term adjustment coefficients				
D[REER(ln)]	-0.001	**-0.685*** **	0.025	**0.053*** **	**-0.076*** **
	(-0.300)	**(-4.906)**	(1.388)	**(3.474)**	**(-3.642)**
D[Openness(ln)]	0.003	0.038	0.0004	**-0.071*** **	**0.049*** **
	(0.440)	(0.339)	(0.041)	**(-3.985)**	**(3.279)**
D[Productivity(ln)]	**0.014** **	0.034	0.018	0.011	-0.012
	(2.321)	(0.428)	(1.646)	(0.650)	(-0.943)
D[TOT(ln)]	-0.005	0.039	**-0.027***	-0.027	-0.004
	(-1.291)	(0.689)	**(-1.894)**	(-1.092)	(-0.278)
D[Debt(ln)]	**-0.034*** **	-0.121	**-0.060*** **	-0.013	0.025
	(-3.685)	(-0.923)	**(-3.104)**	(-0.393)	(0.916)
D[FDI(ln)]	0.040	**0.940*** **	**-0.098*** **	0.106	**-0.192*** **
	(1.329)	**(3.657)**	**(-3.428)**	(0.888)	**(-3.021)**

Notes. *, **, ***: denote significance levels at 10%, 5% and 1% respectively. Model specification is by AIC with 2 maximum lags. The deterministic trend assumption is a restricted constant. [ ]: standard errors. ( ): t-statistics. D[ ]: First difference. While there may be many relationships, consistent with Abdih & Tsangarides (2010), the study only focuses on those for which the REER represents imbalances, owing to the problem statement (title) of the paper.

The cointegration relations in Panel A have most signs that are consistent with the predictions from economic theory. These asymmetric country-specific dynamics are not reflected from a panel-based analysis (see last column). Indeed the panel-based results appear to overwhelmingly reflect the signs of Nigeria. This confirms previous findings on the substantial weight the Nigerian economy would exert on the potential monetary union (Debrun et al., 2005). Accordingly, the following findings could be established. (1) Increased openness to trade is associated with a depreciation in the REER. Thus, openness is associated with more import of tradable goods which leads to depreciation in the REER of Nigeria and The Gambia. A reverse tendency is experienced by Ghana and Sierra Leone. (2) With the exception of Sierra Leone, the Balassa-Samuelson effect is confirmed in the remaining three countries as well as from the panel-based perspective. Hence, there is a relative high long-term impact of technological progress (proxied by the relative real GDP per capita) on the appreciation of the REER[14]. (3) But for The Gambia and Ghana, the TOT is positively correlated with the REER such that, an increase in the TOT results in the appreciation of the

[14] According to the Balassa-Samuelson effect, an increase in the productivity of tradables vis-à-vis non-tradables of one country relative to a foreign country increases its relative wage, which leads to an increase in the relative price of non-tradables and hence, causes a REER appreciation.

long-run EREER through a possible wealth-effect[15]. (4) Apart from Sierra Leone, external debt is positively correlated with REER appreciation[16]. (5) Foreign direct investment is negatively correlated with the REER in most countries (with Nigeria an exception), confirming the hypothesis that investment of high import content increases spending towards tradable goods.

Panel B of Table 4 shows the feedback coefficients for the cointegrating vectors or the short-run adjustments of the REER and its fundamentals. Some adjustments are significantly different from zero, implying that these fundamentals are not weakly exogenous with respect to the parameters of the cointegration relationship in Panel A. In event of any deviation from the long-term equilibrium, these variables jointly respond and adjust the system back to equilibrium. The fundamentals of openness and foreign direct investment are particularly significant in adjusting the potential WAMU system to the equilibrium. The sign and interval[17] of the Error Correct Terms (ECTs) for the potential monetary union suggests the stability of the error correction mechanism[18]. Implying, the feasibility of equilibrium restoration in event of a fundamental macroeconomic shock. Only the ECTs of Ghana and Sierra Leone are significant, with that of the latter depicting an unstable country-specific error correction mechanism. Hence, a shock in the fundamentals of the REER for Sierra Leone may result in the establishment of a new country-specific long-run equilibrium. All the fundamentals are significant in at least one specification in the adjustment to the long-term

[15] An appealing TOT shock induces an increase in the domestic demand, a corresponding increase in the price of non-tradable goods which leads to a REER appreciation. Alternatively from an internal-external balance angle, an increase in the TOT leads to an increase in real wages of the export sector and a trade surplus. For the external balance to be restored, the REER must appreciate.

[16] An increase in external debt without a corresponding increase in domestic structures to accommodate the wealth-effect will lead to an increase in non-tradable goods and imports which ultimately will appreciate the REER.

[17] For the stable error correction mechanism, the short-term adjustment of the parameters should be between zero and 'minus one' (0, -1).

[18] "*The error correction term tells us the speed with which our model returns to equilibrium following an exogenous shock. It should be negatively signed, indicating a move back towards equilibrium, a positive sign indicates movement away from equilibrium. The coefficient should lie between 0 and 1, 0 suggesting no adjustment one time period later, 1 indicates full adjustment. The error correction term can be either the difference between thedependent and explanatory variable (lagged once) or the error term (lagged once), they are in effect the same thing*" (Babazadeh & Farrokhnejad, 2012, p.73).

equilibrium; with FDI having the highest number of significant adjustments, followed by external debt and openness (with two significant adjustments) and lastly by productivity and the TOT (with one significant feedback) for adjusting the equilibriums of The Gambia and Nigeria respectively.

While there is still significant evidence of cross-country differences in the relationship between underlying macroeconomic fundamentals and corresponding REERs, the embryonic WAMU has a stable error correction mechanism with four of the five co integration relations having signs that are consistent with the predictions from economic theory. The conclusion on the stability of the WAMU error correction model is based on the 'D[REER(ln)]' coefficient in fourth column of Table 4, Panel B. In the same vein, the conclusion on 4 out of 5 cointegration relations has three premises: (1) it is based on the fourth column of Table 4, Panel A; (2) it is with respect to sign expectations discussed on Section 2.1 on 'FEER model specification' and; (3) it is based only on the nature of the expected signs and not on the significance of these expected signs.

5. Conclusion and policy implications

With the spectre of the Euro crisis hunting embryonic monetary unions, we have used a dynamic model of a small open economy to analyze REERs imbalance and have examined whether the movements in the aggregate real exchange rates are consistent with the underlying macroeconomic fundamentals. Using both country-oriented and WAMU panel-based specifications, we have found that the long-run behavior of the REERs can be explained by fluctuations in the terms of trade, productivity, investment, debt and openness. We have also found evidence of significant misalignments in the REER only in Ghana and Sierra Leone. The negative adjustment terms of the combined (WAMU) exchange rate suggest stability in the error correction mechanism.

In light of the five main findings discussed above, the conclusions of our analysis are a valuable contribution to the scholarly and policy debate over whether the creation of a sustainable monetary union should precede convergence in macroeconomic fundamentals that determine REER adjustments. Accordingly, four main policy implications could be extracted from these findings. (1) The Nigerian economy significantly influences the sign of the equilibrium relationship between macroeconomic fundamentals and the REER. (2) The adjustment terms of Ghana and Sierra Leone are the most significant for the WAMU short-term adjustment and restoration of or deviation from the EREER respectively. (3) There are significant cross-country differences in the relations between economic fundamentals and the long-run equilibrium. A finding that confirms recent studies that have found considerable dissimilarities in the economic characteristics of the proposed WAMU candidate countries (Tsangarides & Qureshi, 2008; Asongu, 2013a). (4) With the exception of FDI, the macroeconomic fundamentals for the proposed union (in relation to the long-run equilibrium) have signs that are consistent with the predictions from economic theory. A possible explanation for this exception in FDI could be borrowed from the failed privatization programs (Rolfe & Woodward, 2004) and/or 'lower than expected' foreign participation (e.g due to concerns about corruption and a high cost of doing business (Alagidede, 2008)).

Appendices

Appendix 1: Summary statistics and presentation of countries

Panel A: Summary statistics

Variables	Mean	Standard Deviation	Minimum	Maximum	Observations
REER	5.118	0.686	4.059	8.158	120
Openness	4.115	0.547	1.843	4.932	120
Productivity	5.827	0.451	4.878	7.222	120
Terms of Trade	-0.184	0.309	-0.808	0.691	120
External Debt	4.312	0.799	1.511	5.305	120
FDI	0.422	1.404	-4.160	2.783	100

Panel B: Presentation of countries (WAMU)

The Gambia, Ghana, Guinea*, Nigeria, Sierra Leone

REER: Real Effective Exchange Rate. FDI: Foreign Direct Investment. *Guinea is not included in the WAMU Analysis owing to constraints in data availability. WAMU: West African Monetary Union.

Appendix 2: Correlation matrix (WAMU)

REER	Openness	Productivity	TOT	Debt	FDI	
1.000	-0.627	-0.031	-0.015	-0.124	-0.544	REER
	1.000	0.094	-0.061	0.226	0.585	Openness
		1.000	0.156	-0.864	0.141	Productivity
			1.000	-0.195	0.174	TOT
				1.000	0.002	Debt
					1.000	FDI

REER: Real Effective Exchange Rate. TOT: Terms of Trade. FDI: Foreign Direct Investment. WAMU: West African Monetary Union.

Appendix 3: Variable definitions

Variables	Signs	Variable definitions	Source
Real Effective Exchange Rate	REER	Log. of REER	WDI (World Bank)
Openness	Trade	Log. of Imports plus Exports of Commodities (% of GDP)	WDI (World Bank)
Productivity	Prod.	Log. of real GDP per capita.	WDI (World Bank)
Terms of Trade	TOT	Log. of Exportable Commodities/Importable Commodities	WDI (World Bank)
External Debt	Debt	Log. of External Debt (% of GDP)	WDI (World Bank)
Foreign Direct Investment	FDI	Log. of FDI (% of GDP)	WDI (World Bank)

Log: Logarithm. GDP: Gross Domestic Product. WDI: World Domestic Indicators.

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