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Nominal Exchange Rates and Price Convergence in the West African Monetary Zone

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Abstract

We investigate nominal exchange rates and nominal price convergence in the West African Monetary Zone. Using data for the first quarter of 1974 through the first quarter of 2007, we find that real exchange rates in The Gambia, Ghana, Nigeria, and Sierra Leone follow a random walk. Further, we show that nominal exchange rates and nominal prices adjust at different speeds to achieve long-run purchasing power parity, with the former adjusting faster than the latter. Finally, we argue that the success (or otherwise) of a second monetary zone in West Africa depends on well coordinated macroeconomic policies and on minor divergence in prices and exchange rates to eliminate excessive arbitrage profits that may arise.

Key words: purchasing power parity; real exchange rate stationarity; convergence; West African Monetary Zone

JEL classification: F31; C32

1. Introduction

The purchasing power parity (PPP) hypothesis has become one of the most important cornerstones in international finance. Besides being an essential element in most macroeconomic models, PPP plays a central role in the theoretical underpinnings of balance of payments and the external competitiveness of a country or economic region (see Cassel, 1922; Balassa, 1964; Officer, 1976; Dornbusch, 1988).

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Although widely tested, the evidence regarding short- and long-run convergence of nominal exchange rates and prices has often produced mixed verdicts. For most short-run studies, the empirical literature presents considerable evidence against PPP. Earlier studies on PPP in the long-run have not been conclusive either. The apparent lack of consensus has forced researchers to resort to different methods and statistical techniques in order to obtain more conclusive evidence. Some studies (Abuaf and Jorion, 1990; Kim, 1990; Hakkio, 1984; Cheung and Lai, 1993a; Liu, 1992) provide empirical support for long-run PPP, holding that it ensures that prices of goods in different countries converge to a long-run equilibrium. Others (e.g., Krugman, 1978; Frenkel, 1978; Dornbusch, 1980; Taylor, 1988) do not find support for this hypothesis.

At the same time, the literature is replete with evidence on the causes of divergence between nominal exchange rates and prices. In what is referred to as the Balassa-Samuelson hypothesis, Balassa (1964) and Samuelson (1964) assert that productivity differentials between developed and less-developed countries result in higher aggregate price indices in developed countries, which causes purchasing power disparities between the two countries in terms of aggregate prices. Since the law of one price assumes well integrated commodity markets, Dornbusch (1976, 1988) argue that trade impediments and differential speed of response of exchange rates and commodity prices to new information across different locations leads to substantial and consistent exchange rate departures from PPP. Moreover, imperfections in commodity markets, appreciation and depreciation of the US dollar, short time series, misspecification, and measurement errors (Cheung and Lai, 1993b), among other institutional factors, may cause prices and exchange rates to significantly diverge from each other.

Although PPP has been around for a very long time, the evidence regarding African economies is very scant. Some earlier researchers (e.g., Roll, 1979; Adler and Lehman, 1983; Bahmani-Oskooee, 1993; Salehizadeh and Taylor, 1999) included some African countries in their studies. More recently the issue of bilateral and black market rates has been examined for a subset of African countries (Kargbo, 2003a). As elsewhere, the validity of PPP theory in Africa is mixed; this reflects the different datasets and econometric techniques used for different time periods. For instance, employing unit root tests for individual country quarterly data covering 1974 to 1997, Holmes (2000) finds evidence to reject PPP for 27 African countries. Interestingly, the study supports PPP when panel unit roots are used for the same dataset. Other panel studies include Hassanain (2004), but as Sarno and Taylor (2002) argue, conclusions drawn by panel studies could be misleading in the sense of misinterpreting the non-stationarity null, thereby rejecting the null hypothesis even if only one of the series considered is stationary.

This paper departs from the panel studies and examines whether nominal exchange rates and prices converge among members of West Africa's would-be second monetary zone. Given recent interest in monetary integration, the extent of convergence between these variables will not only inform policy regarding the

direction of the West African Monetary Zone (WAMZ) experiment in particular but will also inform exchange rate policy in West Africa in general.

In determining the extent to which nominal exchange rates and prices converge, it is, therefore, well worth exploring the economic fundamentals of the countries studied, and the history of monetary integration in West Africa. That in itself is of interest, and it may also be of interest in the future. Section 2 explores the background of the WAMZ and justifies the timeliness of our research. This sets the scene for econometric modeling using data for the last 30 years, which is reported in Section 3. Section 4 looks at exchange rate stationarity, and Section 5 concludes.

2. The West African Monetary Zone

(a) Background

Prior to the 1970s, fixed exchange rates were in vogue all over the world, with infrequent adjustments. The result of fixing the exchange rate is that severe terms of trade shocks, particularly to primary commodity exporting African countries, led to overvalued exchange rates which were sustained by more stringent rationing of foreign exchange. Parallel market activities for foreign exchange, which started in Africa with the outbreak of World War II, have been on the increase since then, with the volume of illegal transactions becoming more substantial relative to the size of the exchange rate risk premium in other developing regions (Kargbo, 2003a). Following the collapse of the so-called Bretton Woods system in the early 1970s and the pursuit of market reforms, interbank markets for foreign exchange now operate in West African countries, with market-determined and convertible exchange rates.

The recent interest in PPP studies in Africa has emanated from the fact that African countries are becoming more integrated with the de facto adoption of more flexible exchange rate regimes associated with the economic reform programs pursued since the days of structural adjustment. As noted by Kargbo (2000), most African countries have recorded high volatility in exchange rates and prices since liberalization in the 1980s. The majority of econometric analyses that consider the relationship between the exchange rate and inflation in the continent indicate that currency depreciation is associated with a reduction in output and an increase in inflation (e.g., Odusola and Akinlo, 2001). In response, a number of exchange rate policies have been adopted to improve the external competitiveness of the countries as well as expedite action towards the introduction of a single currency at the sub-regional level. To a large extent, these policies have their roots in the empirical validity of PPP, which implies price level convergence in the various countries.

The past three and a half decades have seen substantial policy initiatives to promote integration as a means of stimulating economic development in Sub-Saharan Africa. The Economic Community of West African States (ECOWAS) has championed the objective of increasing trade since its formation in 1975 and has intensified its course towards financial integration recently. In April 2000, The Gambia, Ghana, Guinea, Nigeria, and Sierra Leone announced their intent to create

the WAMZ. The antecedents to this are not new as West Africa has had a history of two monetary unions: the former British colonies of The Gambia, Ghana, Nigeria, and Sierra Leone had the West African Currency Board, which had sole responsibility of issuing currency in these countries. The currency board existed from 1912 until the establishment of formal central banks after independence, from the late 1950s to early 1960s. Thus one could argue that the birth of central banks in British West Africa meant the demise of the currency board. In Francophone Africa, however, the monetary union among the former French colonies survived. After independence in the 1960s, responsibility for issuing the CFA franc and overseeing the functioning of the zone was shifted to two regional central banks. The zone currently comprises eight members of the West African Monetary Union: Benin, Burkina Faso, Cote d'Ivoire, Guinea-Bissau, Mali, Niger, Senegal, and Togo. Their common currency is the "franc de la Communauté Financière de l'Afrique" (CFA franc), which is issued by the "Banque des Etats de l'Afrique d'Ouest." The other CFA zone comprises Cameroon, the Central African Republic, Chad, the Republic of Congo, Equatorial Guinea, and Gabon. Until the adoption of the Euro by France, the stability of the CFA was linked to the French Franc.

Under the auspices of the ECOWAS, The Heads of State of ECOWAS adopted the ECOWAS Monetary Cooperation Programme in 1987 to accelerate the process of integration within the sub-region. This program entails the adoption of collective policy measures designed to achieve a harmonized monetary system. A single monetary zone for the ECOWAS member states was envisaged by 2003 under which convergence criteria included the following:

- A ceiling on central bank financing of budget deficits of 10% of the previous year's tax revenue.
- The maintenance of a single digit inflation rate for all countries.
- A restriction of the budget deficit to no more than 5% of GDP, reducing progressively to 3% thereafter.
- Countries with floating exchange rates were to reduce variability of nominal exchange rates to less than 10%, reducing progressively to 5%.

These criteria, necessary for the sustainability of any monetary union experiment, failed to be met by participating countries. Following the lack of progress with meeting these criteria, at the 22nd Summit of the Authority of Heads of State and Government of ECOWAS held in Lome, Togo, in 1999, a two-track approach to integration in the sub-region was agreed upon. A second monetary zone in West Africa involving non-members of the Union Economique et Monétaire Ouest Africaine could be created to facilitate the integration process as it would be easier to merge the two regional currencies that would emerge into a single currency by 2004. It was also agreed that any two countries can commence the two-track approach within the framework of the ECOWAS Monetary Programme. In the spirit of the Lome Agreement, Nigeria and Ghana, and later Guinea, Sierra Leone, and The Gambia agreed to establish a second monetary zone, the WAMZ by 2003. There have been several failed attempts to meet the various convergence criteria,

and the latest deadline is December 2009 for members to establish the monetary zone with an independent central bank, the ECO, issuing a common currency.

(b) Economic Fundamentals within the WAMZ

Since 1975, ECOWAS has facilitated the free movement of goods and services through various protocols, embraced a common external tariff for non-member states, harmonized economic and financial policies, and there has been a common currency within the Francophone divide and an effort to establish a second monetary zone. In spite of these efforts, West Africa's integration lags far behind other regions in the world.

Table 1 presents key economic indicators of the countries we investigate. The evidence presented in the table indicates that, with the exception of Sierra Leone, real GDP growth has been positive during the past decade (see also World Bank, 2006). A quick glance at Table 1, coupled with the economic structure of the countries, however, reveals important stylized facts: Nigeria, The Gambia, and Guinea depend on a single commodity for 50% or more of their export earnings. Crude oil constitutes over 60% of exports for Nigeria, while The Gambia depends solely on groundnuts exports. The economic structure and external trade sector of the WAMZ countries are not sufficiently aligned with the rest of West Africa. According to a US Central Intelligence Agency (2007) estimate, Nigeria continues to be the dominant economic force in the WAMZ, with GDP about 255 times that of the smallest economy, The Gambia, and contributes over 80% to WAMZ GDP. This increases the probability of Nigeria exerting unnecessary influence in the zone, implying that Nigeria's underlying fiscal imbalance could fuel excessive inflation in the sub-region. As leading net oil exporter, Nigeria's terms of trade is expected to negatively correlate with the other countries in times of higher oil prices, leading to balance of payment difficulties and exchange rate instability in the other countries.

Another stylized fact is the lack of intraregional trade and fiscal convergence, which might account for the slow pace of integration in the sub-region. As shown in Table 1, average exports among WAMZ countries constituted less than 3% of the region's total exports between 2000 and 2007.

Developments in consumer prices are as important as trade flows and real GDP growth is for the realization of a monetary zone. Single digit inflation is one of the primary convergence criteria for members acceding to the WAMZ. With the exception of Sierra Leone and Guinea, all counties achieved the single digit target in 2007. Although the inflation rate in Guinea declined from 34.4% in 2006 to 22.9% in 2007, it remained the highest in the sub-region. This experience could be attributed to the low export receipts from its main export (bauxite) and to deterioration in its gross foreign external reserves. Also, with the exception of Ghana, all counties met the requirement of a budget deficit of less than 5% of GDP in 2007. Given this brief sketch we are now in a position to examine the convergence between nominal exchange rates and prices in the WAMZ.

Table 1. Summary of Key Indicators in WAMZ

Indicator	Country	1997-2000	2001	2002	2003	2004	2005	2006	2007
Real GDP Growth	Nigeria	2.7	3.1	1.5	10.3	10.6	5.4	6.2	6.4
	Ghana	4.2	4.2	4.5	5.2	5.6	5.9	6.4	6.4
	Gambia	5.8	5.8	−3.2	6.9	7.2	5.1	6.5	7.0
	Guinea	4.1	4.0	4.2	1.2	2.7	3.3	2.2	1.5
	Sierra Leone	−0.9	26.8	9.4	9.5	7.4	7.3	7.4	6.8
Consumer Prices (annual percent change)	Nigeria	10.0	18.0	13.7	14.0	15.0	17.8	8.3	5.5
	Ghana	22.6	32.9	14.8	26.7	12.6	15.1	10.9	9.6
	Gambia, The	2.6	4.5	8.6	17.0	14.3	5.0	2.1	5.0
	Guinea	4.7	5.4	3.0	12.9	17.5	31.4	24.7	22.9
	Sierra Leone	17.3	2.6	−3.7	7.5	14.2	12.1	9.5	11.7
Overall Fiscal Balance (excluding grants as % of GDP)	Nigeria		−4.9	−4.2	−1.1	−6.3	8.1	7.7	0.9
	Ghana		−7.7	−5.0	−8.0	−9.5	−6.9	−12.4	−11.6
	Gambia, The		−13.9	−4.6	−7.2	−10.2	−10.3	−8.2	−3.3
	Guinea		−4.1	−4.4	−8.9	−5.9	−2.1	−4.3	−1.8
	Sierra Leone		−8.8	−8.3	−14.4	−12.4	−12.8	−11.0	−6.0
Terms of Trade (index, 2000=100)	Nigeria				91.3	109.9	151.6	178.9	199.3
	Ghana				127.2	108.0	100.6	106.4	115.5
	Gambia, The				118.9	76.9	64.1	62.3	51.7
	Guinea				92.0	87.1	82.3	87.9	82.6
	Sierra Leone				100.4	95.7	91.2	85.6	85.3
Foreign Reserve (months of imports of goods and services)	Nigeria				3.1	7.5	9.5	12.4	12.7
	Ghana				4.1	3.7	3.2	3.1	2.1
	Gambia, The				3.6	3.6	3.8	4.7	4.2
	Guinea				1.9	1.4	1.6	1.5	1.3
	Sierra Leone				2.0	4.1	4.5	4.8	5.3
Exchange rate depreciation (local Currency/USD)	Nigeria			10.6	7.4	−3.1	−2.6	−0.6	−8.7
	Ghana			13.2	4.7	2.2	0.8	1.1	—
	Gambia, The			27.6	24.4	−4.3	−5.5	−0.3	−24.4
	Guinea			−0.6	1.2	21.6	43.6	—	—
	Sierra Leone			1.4	14.5	10.4	2.5	1.4	0.1

Source: Regional Economic Outlook, Sub-Saharan Africa, Various Editions. Exchange rate depreciation is estimated from IMF International Financial Statistics, September, 2008.

3. Modeling Price and Exchange Rate Convergence

The real exchange rate q_t is calculated as:

$$q_t = e_t + p_t^f - p_t^d, \tag{1}$$

where e is the nominal (dollar) exchange rate expressed in the domestic currency, p^d and p^f are the domestic and foreign price levels respectively, and all variables are expressed in logarithms. Quarterly data on consumer price indices (CPIs) and exchange rates for The Gambia, Ghana, Nigeria, and Sierra Leone are examined for first quarter 1974 through first quarter 2007. The data were extracted from the International Financial Statistics (September 2008 online edition) issued by the International Monetary Fund. While Guinea and Liberia are also WAMZ members, they are excluded from the current analysis due to lack of exchange rate and CPI data.

Following the seminal work of Engle and Granger (1987), a cointegrated time series system has an equivalent vector error correction (VEC) representation. Let $Y_t = [e_t\, p_t]'$. The long-run PPP restriction on Y_t is that $B'Y_t = e_t - p_t$ is stationary. The VEC model is given by:

$$\Delta Y_t = \mu - \Pi Y_{t-1} + \Gamma_1 \Delta Y_{t-1} + ... + \Gamma_{k-1} \Delta Y_{t-k+1} + u_t \,, \tag{2}$$

where $\Delta = 1 - L$, Π can be written as $\Pi = \alpha\beta'$, and $u_t = [u_{1t} u_{2t}]'$ is a vector of white noise innovations with $E(u_t u_t)' = \Omega$. Specifically, the VEC model with PPP restriction has the following form:

$$\Delta e_t = \mu_1 - \alpha_1 z_{t-1} + \sum_{i=2}^{k} \tau_{1i} \Delta e_{t-i+1} + \sum_{m=2}^{k} \delta_{1m} \Delta p_{t-m+1} + u_{1t} \tag{3}$$

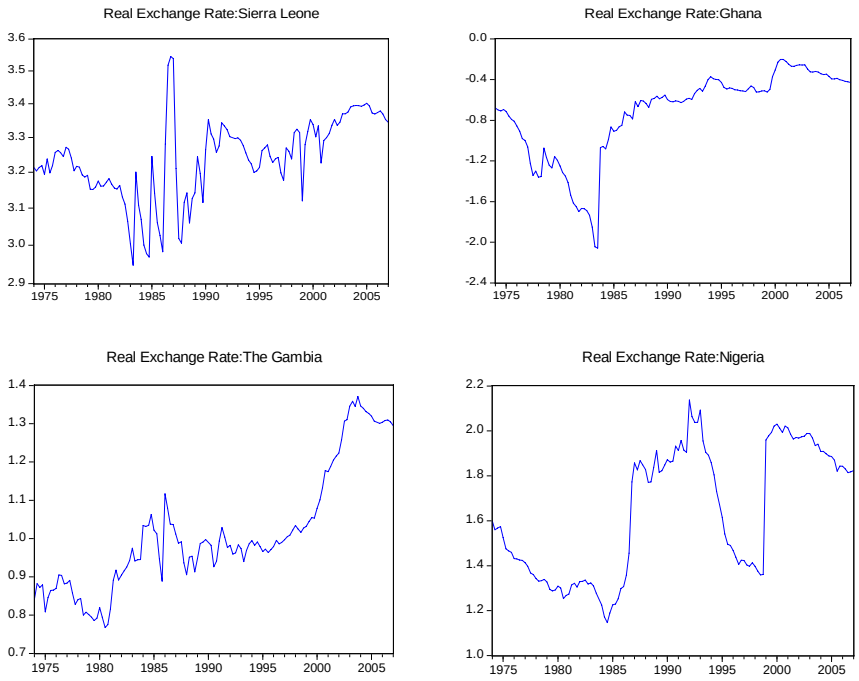
$$\Delta p_t = \mu_2 + \alpha_2 z_{t-1} + \sum_{i=2}^{k} \tau_{2i} \Delta e_{t-i+1} + \sum_{m=2}^{k} \delta_{2m} \Delta p_{t-m+1} + u_{2t} \,, \tag{4}$$

where $z_{t-1} = \beta' Y_{t-1} = q_{t-1}$ represents the error correction term with coefficients $1 > \alpha_1 > 0$ and $1 > \alpha_2 > 0$. In a trivariate system of e, p^d, and p^f, Engel and Morley (2001) report that p^d and p^f share similar convergence speeds, and so the theoretical symmetric condition holds. Imposing the symmetric condition we consider a bivariate model of e_t and p_t for simplicity.

4. Random Walks in Real Exchange Rates

The long-run PPP relationship crucially depends on the integration and stationarity properties of real exchange rates. A strict version of PPP requires that the real exchange rate be constant. Termed as stage two tests by Froot and Rogoff (1995), the test is based upon whether the real exchange rate contains a unit root. If this hypothesis is rejected then there is evidence of mean reversion, i.e., the real exchange rate is not governed by permanent shocks. We first verify the long-run PPP relation in the WAMZ. A plot of real exchange rates for all countries is shown in Figure 1. The evidence from Figure 1 indicates varied real exchange rate behavior within the WAMZ. There is strong evidence of trend stationarity for Sierra Leone. Also real exchange rates appear very volatile in all countries, suggesting that temporary shocks might be driven by monetary developments.

Figure 1. Real Exchange Rates in the WAMZ



(a) Unit Root and Stationarity Tests

We employ two unit root tests (DF-GLS and ADF) and one stationarity test (KPSS). Elliot et al. (1996) devised the DF-GLS test, which is more efficient than the usual ADF. The KPSS tests the null of stationarity, whereas ADF and DF-GLS test the null of a unit root. If the KPSS test rejects the null but ADF and DF-GLS do not, we can say that all tests support the same conclusion, namely that the series in question is an $I(1)$ process. The results are shown in Table 2. As indicated by the ADF and DF-GLS, the null of a unit root in the real exchange rate for all countries cannot be rejected at the 1% level (the only exception is The Gambia where the null is not rejected at the 5% level).

However, as Kwiatkowski et al. (1992) argue, traditional unit root tests such as the ADF may fail to reject the null frequently because of low power against relevant alternatives. They propose the KPSS statistic, which tests stationarity against the alternative of a unit root. However, as noted by Caner and Kilian (2001), the KPSS test could suffer from serious size distortion. They argue that such tests should complement unit root tests and that by testing both the unit root hypothesis and the stationarity hypothesis, one can distinguish series that appear to be stationary, series that appear to be integrated, and series that are not very informative about whether or not they are stationary or have a unit root. The KPSS test for real exchange rates

in WAMZ countries indicates that the null of stationary under KPSS is strongly rejected at the 1% level. These results are robust to alternative specifications, such as including a time trend and correction for residual correlation.

Table 2. Univariate Unit Root Test on Real Exchange Rates

Test	The Gambia		Ghana		Nigeria		Sierra Leone	
	Levels	First Diff	Levels	First Diff	Levels	First Diff	Levels	First Diff
DF-GLS	0.66	−2.07*	−1.38	−4.76**	−1.92	−3.30**	−2.01	−6.90**
ADF	−0.35	−5.43**	−1.35	−5.03**	−1.93	−4.27**	−2.08	−7.36**
KPSS	1.09**	0.1	0.95**	0.13	0.73**	0.07	0.90**	0.14
SL	−1.512	−6.94**	−0.236	−6.222**	−2.201	−5.68**	−1.748	−8.66**
Break Date	1981Q2		1983Q4		1986Q4		1987Q2	

Notes: The null hypothesis for the DF-GLS and ADF test is that the data process under examination contains a unit root. Critical values at 1% and 5% significance levels for DF-GLS are 2.58 and 1.94, (Elliot et al., 1996) for ADF are −3.43 and −2.86 (MacKinnon, 1991), for KPSS are 0.73 and 0.46 (Kwiatkowski et al., 1992), and for Saikonnen and Lutkepohl (2002) unit root test are −3.55 and −3.03 (Lanne et al., 2002). ** and * indicate significance at 1% and 5% levels. In both ADF and DF-GLS, a lag length of 4 was appropriate, whereas the Newey-West bandwidth was used in the case of KPSS.

However, the real exchange rates in Figure 1 depict the possibility of structural breaks in the data generating process, which may distort the ADF and DF-GLS tests, leading to incorrect failure to reject the non-stationary null. We therefore implement the Saikonnen and Lutkepohl (2002) test to check the possibility of structural breaks. Adding a rational shift function to the deterministic term resulted in break dates of last quarter 1986 for Nigeria and last quarter 1983 for Ghana. Interestingly, these dates mark the onset of the floating period in the two countries. For Nigeria, the naira was floated in 1986 following the introduction of structural adjustment policies, and the monetary authorities returned to a pegged exchange rate after the political upheavals of the early 1990s. After maintaining an overvalued exchange rate for most of the 1970s, Ghana floated the cedi with the onset of the Economic Recovery Programme in 1983. As reported in the lower panel of Table 2, however, and consistent with the ADF and DF-GLS, we conclude that all real exchange rates are first-difference stationary, indicating possible cointegration of nominal exchange rates (e_t) and prices (p_t) with a VEC representation $\beta = [1, -1]'$. Unit root tests on nominal exchange rates and prices reveal that the series follow a random walk; this evidence is consistent with Kargbo (2003a, 2003b, 2004, and 2006). Test results are not reported to save space but are available on request.

(b) The Validity of PPP in the WAMZ

Given our unit root tests, our analysis proceeds with empirical examination of the long-run PPP condition in the WAMZ. We employ the Johansen (1991) cointegration test for a variety of reasons: (a) the technique is more powerful than the usual Engle-Granger approach, (b) it is robust to various departures from normality in that it allows any of the variables in the model to be used as response

variable while maintaining the same cointegration results, (c) it also allows for hypothesis testing, and (d) we can generate various scenarios to analyze the short-run dynamics versus the long-run relationship between nominal exchange rates and prices. Johansen's method however, suffers from small sample bias (Cheung and Lai, 1993b). The lag length is selected to ensure there is no further residual correlation using the Akaike Information Criterion; results for each country are reported in Table 3. We include two dummy variables in our estimation. The first dummy, d_1, takes the value 1 for the period after the Structural Adjustment Programme, leading to the adoption of floating exchange rates, which interestingly coincides with the break dates reported in the lower panel of Table 2, and is 0 otherwise. The second, d_2, takes the value 1 for the period before the birth of the WAMZ in 2000 to account for the fiscal and monetary policy changes aimed at meeting the convergence criteria for the introduction of the single currency and is 0 otherwise.

Table 3. Long-Run Relationship in the WAMZ

	The Gambia		**Ghana**		**Nigeria**		**Sierra Leone**	
	λ_{trace}	$\lambda_{\max}$	λ_{trace}	$\lambda_{\max}$	λ_{trace}	$\lambda_{\max}$	λ_{trace}	$\lambda_{\max}$
Lags	2		1		2		2	
$r = 0$	65.25*	46.83*	74.46*	45.66*	59.42*	36.89*	44.65*	30.89*
$r \leq 1$	18.41	12.54	28.8	14.133	22.52	13.64	13.76	8.412

Notes: λ_{trace} and $\lambda_{\max}$ give the trace statistic and the maximal eigenvalue. The null hypothesis for these two tests here is that the data generating processes under consideration are not cointegrated. Critical values for trace and maximum eigenvalue at the 5% level are 15.49 and 3.84 (MacKinnon et al., 1999).

The results from Table 3 reveal that there is at least one cointegrating vector in The Gambia, Ghana, Sierra Leone, and Nigeria, indicating that nominal exchange rates and prices in all countries are cointegrated. This also indicates that the system is stationary in one direction. As postulated by the absolute version of the PPP, we expect the long-run vector to be close to one, thus $\beta = [1, -1]'$. Our estimate models are summarized as follows.

The Gambia:

$$e_t = -1.660 - 2.950\,p_t + 0.270 d_{1t} - 0.243 d_{2t}$$
$$[14.32] \quad [4.230] \quad [9.757]$$

Ghana:

$$e_t = -1.645 + 0.762\,p_t + 0.604 d_{1t} - 0.443 d_{2t}$$
$$[2.496] \quad [1.560] \quad [1.508]$$

Nigeria:

$$e_t = -0.258 + 1.121\,p_t + 0.579 d_{1t} + 0.645 d_{2t}$$
$$[8.487] \quad [5.822] \quad [7.640]$$

Sierra Leone:

$$e_t = 1.702 + 1.153\,p_t + 0.644 d_{1t} + 0.063 d_{2t}$$
$$[6.861] \quad [2.437] \quad [0.440]$$

By normalizing on the nominal exchange rate we find that the restriction is indeed the case for Nigeria, Sierra Leone, and The Gambia. Even for Ghana, the long-run vector is statistically indistinguishable from unity. These results rest well with the literature on PPP for Africa and other countries; see, for example, Kargbo (2003a, 2003b, 2004, 2006) and Krichene (1998) for several African countries, Aggarwal and Simmons (2002) for Caribbean countries, and Bahmani-Oskooee (1993a, 1993b) and Salehizadeh and Taylor (1999) for several emerging economies.

(c) Response of Nominal Exchange Rates and Prices to Shocks

In order to provide insight into the deviations between nominal exchange rates and prices, we resort to impulse response analysis. Following Pesaran and Shin (1996), the impulse response function of q_t, denoted ψ_{qc}, with respect to a unit composite innovation $\beta' u_t$ can be obtained from the VEC model as follows:

$$\psi_{qc}(t) = \left\{ (\beta' C_t \Omega C_t' \beta)(\beta' \Omega \beta)^{-1} \right\}^{1/2}, \tag{5}$$

where C_t is defined by the recursive equation:

$$C_t = A_1 C_{t-1} + A_2 C_{t-2} + \cdots + A_k C_{t-k}, \tag{6}$$

for $t = 1, 2, \ldots$ with $C_0 = 1$ and $C_t = 0$ for $t < 0$. Here $\{C_t\}$ represent the sequence of coefficient matrices of the moving average representation of Y_t. Based on ψ_{qc}, we compute the first 24 impulse responses, which correspond to a time span of 6 years for quarterly data. We next decompose the real exchange rate dynamics and analyze the paths of the nominal exchange rate and price adjustments separately. The generalized impulse response approach recommended by Pesaran and Shin (1998) is applied. Unlike traditional impulse response analysis (e.g., Lutkepohl and Reimers, 1992), which considers orthogonalized shocks based on Cholesky decomposition, the new approach desirably yields unique impulse response functions (IRFs) that are invariant to the ordering of variables. The generalized IRF for $Y_t = [e_t\, p_t]'$ with respect to a unit innovation to the j th variable ($j = 1$ for a nominal exchange rate innovation and $j = 2$ for a price innovation) is given by:

$$\psi_{Yj}(t) = C_t \Omega_{\gamma j} / \sigma_{jj}, \tag{7}$$

for $t = 0, 1, 2, \ldots$ where C_t is computed from (6) recursively, γj is a selection vector with 1 as the j th element and 0 elsewhere and σ_{jj} is the j th diagonal element of $\Omega \psi_{Yj}(t)$, which gives separate IRFs for nominal exchange rate and price

adjustments. The generalized IRF for real exchange rate adjustment in response to a unit innovation to the j th variable is given by:

$$\psi_{qj}(t) = \beta' C_t \Omega_{\gamma j} / \sigma_{jj} , \tag{8}$$

for $t = 0, 1, 2, \ldots$. A shock to PPP can come about as an exchange rate innovation or as a price innovation. An increase in q_t , for example, can be induced by either a negative innovation to p_t or a positive innovation to e_t . In fact, the IRFs of q_t , e_t , and p_t are linked to one another as follows:

$$\psi_{qj}(t) = \psi_{ej}(t) - \psi_{pj}(t) . \tag{9}$$

The results for real exchange adjustments to innovations in prices and nominal exchange rates and own shocks are indicated in Tables 4 and 5 respectively. The responses are derived for various time horizons, up to 24 quarters (Graphs of impulse response not reported to save space but are available from the authors on request).

Table 4. Innovations in Nominal Exchange Rates and Prices

	The Gambia		Ghana		Nigeria		Sierra Leone	
Quarters	**p → e**	**e → p**	**p → e**	**e → p**	**p → e**	**e → p**	**p → e**	**e → p**
1	0.010	0.003	−0.004	−0.001	0.008	0.001	0.009	0.003
4	0.027	0.008	−0.019	−0.003	0.005	0.004	−0.002	0.007
7	0.029	0.010	−0.016	−0.008	0.000	0.007	0.005	−0.001
8	0.028	0.010	−0.015	−0.010	−0.002	0.008	0.006	−0.002
12	0.027	0.011	−0.010	−0.016	−0.005	0.010	0.012	−0.009
13	0.027	0.011	−0.009	−0.018	−0.005	0.010	0.013	−0.011
15	0.027	0.011	−0.007	−0.018	−0.006	0.010	0.016	−0.015
18	0.027	0.011	−0.004	−0.025	−0.006	0.011	0.020	−0.020
21	0.027	0.012	−0.001	−0.030	−0.006	0.011	0.024	−0.025
22	0.027	0.012	0.000	−0.031	−0.006	0.011	0.025	−0.027
24	0.027	0.012	0.002	−0.034	−0.006	0.011	0.028	−0.031

From Tables 4 and 5, a generalized one standard deviation shock on e_t causes the real exchange rate in all countries to rise to a peak within two quarters of impact. This peak response ranges between 3% for The Gambia and 9% for Ghana. After this increase, e_t begins to fall sluggishly in all the countries to a minimum of 2% and 6% above the baselines within 24 quarters for The Gambia and Sierra Leone respectively. In response to this innovation, prices in all countries rise, except in the case of Ghana where prices decline instantly. In Ghana, prices fall about 0.07% below the baseline within the first quarter to a minimum of 3% within 24 quarters in response to the shock in the Ghanaian exchange rate. The response of p_t to an innovation in e_t in the other countries rises over the baseline without any decline. This indicates that exchange rate depreciation in The Gambia, Nigeria, and Sierra

Leone can cause prices to increase by at least 0.8% within 2 years. The magnitude of the responses in these countries is not considerably different from a 1% rise within 24 quarters.

Table 5. Response of Exchange Rate and Prices to Their Own Shocks

	The Gambia		Ghana		Nigeria		Sierra Leone	
Quarter	**p → p**	**e → e**	**p → p**	**e → e**	**p → p**	**e → e**	**p → p**	**e → e**
1	0.007	0.030	0.019	0.097	0.012	0.068	0.019	0.061
4	0.012	0.030	0.026	0.093	0.016	0.064	0.018	0.048
7	0.015	0.029	0.029	0.085	0.017	0.050	0.021	0.038
8	0.015	0.028	0.029	0.082	0.017	0.047	0.022	0.035
12	0.016	0.027	0.032	0.073	0.018	0.042	0.025	0.023
13	0.016	0.027	0.033	0.070	0.018	0.041	0.026	0.020
15	0.017	0.027	0.035	0.060	0.018	0.040	0.028	0.014
18	0.017	0.027	0.037	0.059	0.019	0.039	0.030	0.006
21	0.017	0.027	0.039	0.052	0.019	0.038	0.033	−0.002
22	0.017	0.027	0.039	0.050	0.019	0.038	0.034	−0.005
24	0.017	0.027	0.041	0.046	0.019	0.038	0.036	−0.010

Considering the effects of generalized one standard deviation p_t innovations, Table 5 indicates that prices in all countries rise without any decline. Within the 24 quarters, prices in Ghana rise from 1% within 3 quarters to a high of 4%. However, the response of e_t to a shock to p_t is mixed. In Sierra Leone, the rise in e_t continues throughout the 24 horizons except from the second to fourth quarters, while for The Gambia and Nigeria, e_t rises to a peak within the sixth and fourth quarters respectively and then begins to fall. In The Gambia e_t remains above baseline, but in Nigeria e_t falls below its baseline within 2 years.

(d) How Fast Do Nominal Exchange Rates and Prices Converge?

Given observed deviations between nominal exchange rate and prices, an important issue worth addressing is how fast we observe PPP reversion due to these deviations. This is important not only in the context of exchange rate policy design but also to ensure that the single monetary experiment is not fraught by significant divergence that would encourage arbitrage profits within the union. Although a substantial portion of the literature present this analysis in terms of half-lives, we depart from this and concentrate on the speed of adjustment parameter estimated from the error correction term. Table 6 shows the signs and magnitudes of these convergence parameters and the mechanics towards long-run equilibrium following a temporary deviation between nominal exchange rates and prices.

Table 6. Speed of Convergence Parameters

Series	The Gambia	Ghana	Nigeria	Sierra Leone
e_t	−0.21**	−0.04**	−0.08*	−0.07**
	[−4.40]	[−3.63]	[−2.01]	[−4.18]
p_t	0.03*	−0.01*	0.02*	−0.03**
	[2.65]	[−6.12]	[2.89]	[−6.05]

Note: t-statistics in [ ]. ** and * indicate significance at 1% and 5% levels respectively.

A cursory glance at Table 6 shows that the error correction term, which captures the speed of adjustment in exchange rates and prices necessary to offset deviations from the long-run equilibrium, is negative and statistically significant for all countries under consideration. Our results show that the adjustment to changes in exchange rates is fairly quick, where the correction takes between 1 and 7 years. This result compares well with the findings of Kargbo (2003a, 2003b, 2004, 2006, 2009). For example, Kargbo (2006) reports that the nominal exchange rate for WAMZ countries takes between 3 and 9 years to readjust. Also, estimates from Kargbo (2009) suggest that adjustments to exchange rate and price shocks take 1 to 9.5 years to return to equilibrium levels, pointing out that adjustment towards PPP will be achieved through exchange rate depreciation.

Importantly, we have established an empirical fact that both nominal exchange rates and prices need not have the same convergence rates as in most sticky price and rational expectations models of exchange rate behavior (e.g., Engel and Morley, 2001). These results reveal structural issues that impinge on the full equalization of prices and exchange rates following temporary deviation. Crucially, our results indicate that the fundamental assumptions underpinning PPP are not withheld due to impediments to the movements of goods and services within the sub-region. Existing trade barriers manifest in poor road and air transport infrastructure. Financial markets are equally not aligned, and the extent of macroeconomic coordination among West African economies is minimal. These points account for divergent rates of adjustment between nominal exchange rates and prices. There may also be the possibility of the Balassa-Samuelson effect as argued by previous studies (for details see MacDonald and Ricci, 2001; Lothian and Taylor, 2008).

5. Concluding Remarks

This paper examines nominal exchange rate and nominal price convergence, and the extent to which temporary deviations are brought back to equilibrium in four West African countries: The Gambia, Ghana, Nigeria, and Sierra Leone. These countries, together with Guinea and Liberia, have been making efforts to establish a second monetary zone since 2000. We argue that the success or failure of such a monetary union depends not only on getting key economic fundamentals, such as getting inflation and government debt, to acceptable levels but also wider integration of product and capital markets, and the extent to which nominal exchange rates and

prices revert to their equilibrium values following temporary shocks. Our results indicate that real exchange rates in all countries follow a random walk, pointing to significant long-run relationships between nominal exchange rates and prices.

Further we find that deviations from PPP are offset by an increase in real exchange rate (depreciation) to restore equilibrium. In effect there is no uniform adjustment between nominal prices and nominal exchange rate that govern the long-run PPP proposition. These findings hold important lessons for policy makers in West Africa since the second monetary zone would be best served when there are well coordinated policies and significantly small divergence in prices and exchange rates to eliminate excessive arbitrage profits that may arise.

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