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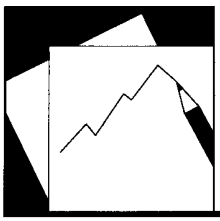

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Estimation of a Behavioral Equilibrium Exchange Rate Model for Ghana

Plamen Iossifov and Elena Loukoianova

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Estimation of a Behavioral Equilibrium Exchange Rate Model for Ghana

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Abstract

The paper estimates a behavioral equilibrium exchange rate model for Ghana. Regression results show that most of the REER's long-run behavior can be explained by real GDP growth, real interest rate differentials (both relative to trading-partner countries), and the real world prices of Ghana's main export commodities. On the basis of these fundamentals, the REER in late 2006 was found to be very close to its estimated equilibrium level. The results also suggest, that deviations from the equilibrium path are eliminated within two to three years.

JEL Classification Numbers: F31, F41

Keywords: real effective exchange rate, competitiveness, Ghana, BEER

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Contents Page

I. INTRODUCTION

In this paper, we estimate a behavioral equilibrium exchange rate model for Ghana to establish to what extent REER movements have been driven by an adjustment to its equilibrium values, consistent with changing fundamentals. The real effective exchange rate (REER) of the Ghanaian cedi depreciated sharply in 2000 as a result of a large negative terms-of-trade shock and the collapse of the cedi in nominal terms in 1999–2000. Since then the cedi has been appreciating in real effective terms, despite the depreciation of the nominal effective rate. What factors are driving the REER in Ghana? Is there a misalignment between the actual and equilibrium REER at present? In this paper these questions are addressed by estimating a behavioral equilibrium exchange rate (BEER) model for the REER of the cedi using quarterly data from 1984 to 2006.

The paper is organized as follows: Section II presents the trends of alternative measures of Ghana's external competitiveness. Section III reviews the theoretical REER literature with the view of selecting a model to be estimated. Section IV describes the data used in the empirical analysis and investigates the presence of a long-run cointegrating relationship between the REER and a set of fundamentals. The results are then used to derive measures of the equilibrium REER and the gap between the actual and estimated equilibrium values of the REER. Section V concludes.

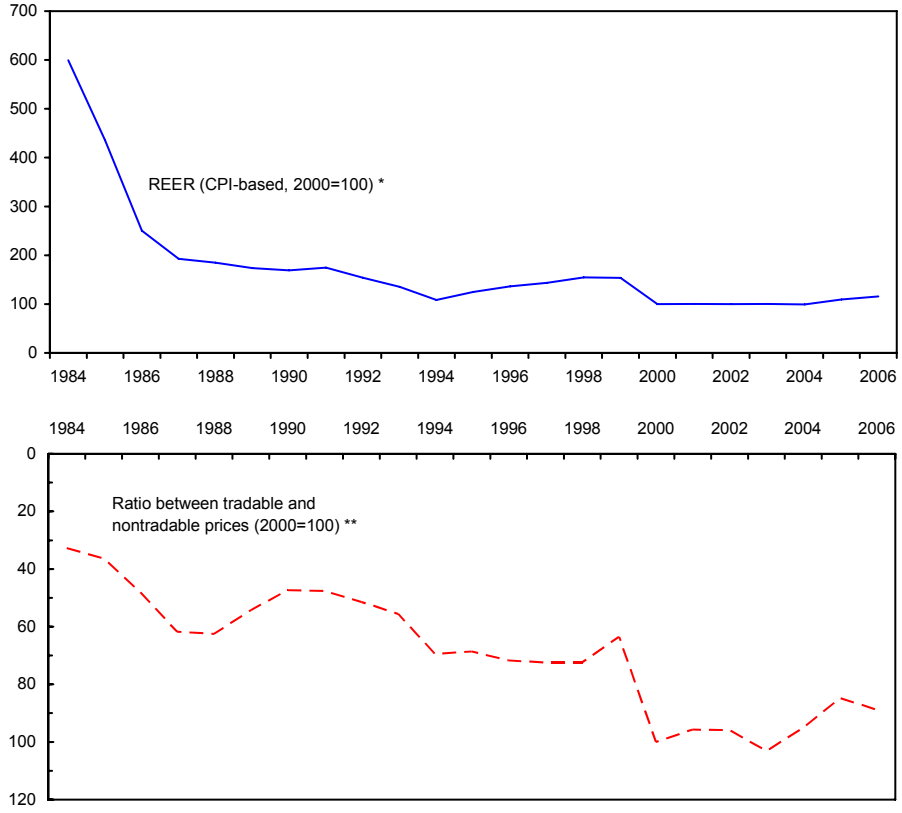
II. TRENDS IN GHANA'S EXTERNAL COMPETITIVENESS

There are two main approaches in assessing external competitiveness: one is based on relative price indicators and the other one – on current account flows. The first approach makes use of various measures of the REER based on CPI, PPI, and unit labor cost, as well as the ratio between tradable and nontradable prices. The second approach, based on current account flows, relies on traditional and nontraditional competitiveness indicators. The traditional competitiveness indicators look at export growth, market shares, and overall current account position. Increasingly, non-traditional competitiveness indicators, which aim at assessing the quality of the business climate and hence the country's attractiveness for investors, have been included in competitiveness assessment. This section briefly reviews the traditional competitiveness indicators for Ghana before moving to the analysis of the REER.

Four distinct periods can be seen in the evolution of Ghana's external competitiveness, as measured by the REER, and the ratio of the prices of tradable and nontradable goods: (i) an improvement from 1984 though 1994; (ii) some deterioration in 1995-99; (iii) a rapid improvement in 1999-2000; and (iv) some worsening since 2000 (figure 1). Both indicators

based on aggregate price indices (for tradables and nontradables)[2] suggest deterioration in external competitiveness after 2003 of around 10 to 15 percent in magnitude.

Figure 1. Ghana: Measures of External Competitiveness Based on Aggregate Price Indices, 1984-2006



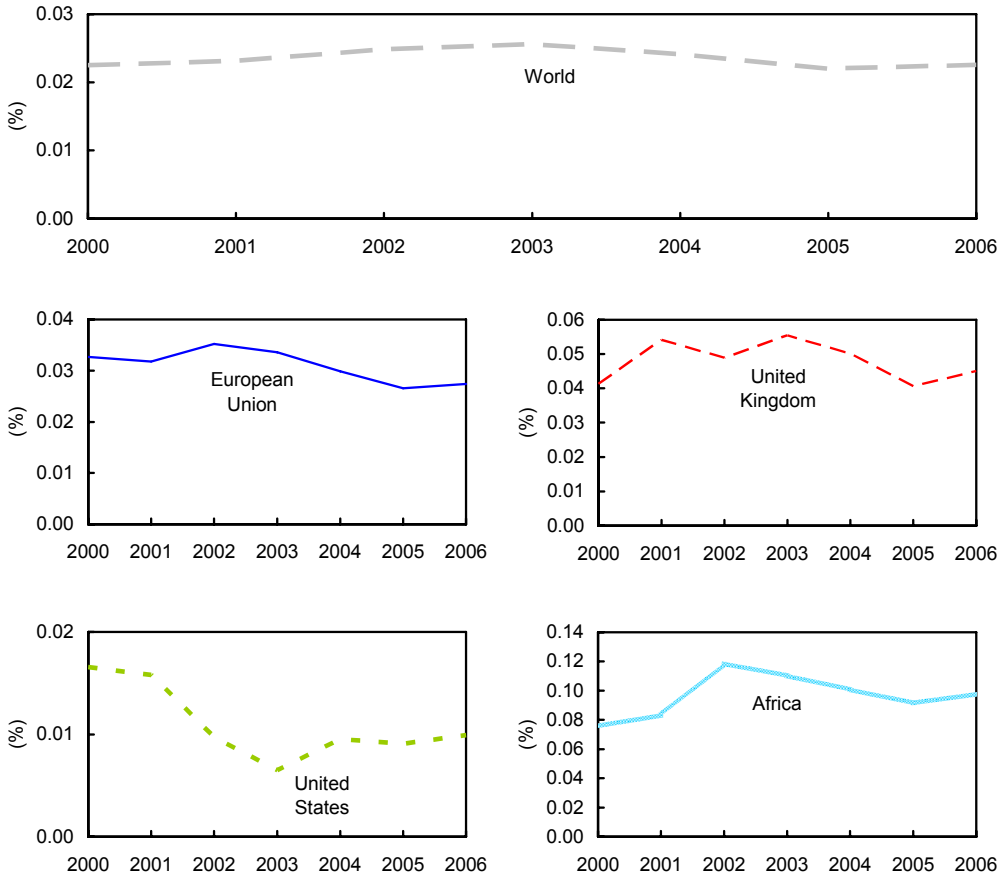
Source: IMF, Information Notice System, national authorities, and IMF staff estimates.
* An increase in the indicator implies a deterioration of competitiveness; a decrease implies an improvement.
** Ratio of export price index (2000=100) to tetriary GDP deflator (2000=100). An increase in the indicator implies an improvement in competitiveness; a decrease implies a deterioration.

Competitiveness indicators based on Ghana's export performance exhibit different time patterns than measures based on aggregate price indices (figure 2). Since 2000, the market share of Ghana's exports in total world imports has hovered around 0.023 percent, showing little sign of loss of competitiveness. Over the same period, the market share of Ghana's

[2] "The intuition behind measures of competitiveness based on aggregate price indices is that they give an indication of differences across countries in the extent of resource pulls between traded and nontraded goods sectors. Specifically, if prices of traded goods in different countries are closely related through international competition, then a real appreciation of the currency based on aggregate prices would suggest that developments in the internal terms of trade are more favorable to nontraded goods in the appreciating country. From this it is implicitly inferred that resources are being drawn out of the production of traded goods into that of nontraded goods at a faster pace than in other countries—a process that should weaken the external trading position of the appreciating country." (Lipschitz and McDonald, 1991).

exports in total imports of Africa and to a lesser extent the United Kingdom have increased. On the other hand, the market share of Ghana's exports in total imports of the United States and to a lesser extent the European Union have declined. The evidence derived from export market shares is discounted because these measures are heavily influenced by factors that affect the relative prices of Ghana's export commodities compared to other imports of trading partners (e.g., crude oil) and the specifics of its exchange rate management. For example, the observed "loss of market share" in the United States after 2002 is most likely an artifact of the sizable depreciation of the U.S. dollar against most currencies, though not the cedi. This increased the dollar-equivalent of total U.S. imports with no effect on the dollar-equivalent of imports from Ghana.

Figure 2. Ghana: Measures of External Competitiveness Based on Export Market Shares, 1984–2006 [1]



Source: IMF, Directions of Trade database; and IMF staff estimates.

[1] Ghana exports to certain countries as percent of total imports of those countries.

In the rest of the paper, we turn to the estimation of a formal regression model to establish to what extent the evolution of the REER in Ghana has been driven by an adjustment to its equilibrium values, consistent with changing fundamentals.

III. MODEL SELECTION

This section reviews selected theoretical literature on REERs in order to identify a model for estimation. The starting point is modeling the short-run behavior of the REER using the uncovered interest rate parity (UIP) condition. Following Frankel and Rose (1995), the expectations of the inflation differential are subtracted from both sides of the UIP equation and it is reinterpreted as stating that the real interest rate differential is equal to the expected depreciation of the REER plus a risk premium:

$$r_t - r_t^* = E_t(q_{t+1} - q_t) + \rho_t, \qquad (1)$$

where, r_t and r_t^* are expected domestic and foreign real interest rates defined by $r_t = i_t - E_t(p_{t+1} - p_t)$ and $r_t^* = i_t^* - E_t(p_{t+1}^* - p_t^*)$; q_t is (log) real exchange rate defined by $q_t = e_t + p_t^* - p_t$; e_t is (log) nominal exchange rate (domestic currency units per unit of foreign exchange); p_t and p_t^* are (log) corresponding domestic and foreign prices; and ρ_t is the (time-varying) risk premium.

In the long run, the REER will revert toward an equilibrium time-varying path (Frankel and Rose, 1995):

$$E_t(q_{t+1} - q_t) = -\theta\left(q_t - \bar{q}_t\right), \qquad (2)$$

where $\bar{q}_t$ is the long-run equilibrium real exchange rate.

Combining (1) and (2) yields

$$q_t = \bar{q}_t - \frac{1}{\theta}\left(r_t - r_t^*\right) + \rho_t \qquad (3)$$

There are two approaches for modeling the long-run equilibrium value of the REER:[3] the fundamental equilibrium exchange rate (FEER) and the behavioral equilibrium exchange rate (BEER). In the FEER approach the notion of equilibrium that is considered relevant for assessing current exchange rates is that of macroeconomic balance. This concept is absent

[3] See MacDonald (1999) for a detailed survey of existing approaches.

from the BEER approach, where the relevant notion of equilibrium is the value given by an appropriate set of explanatory variables.[4]

The FEER and BEER approaches identify different sets of explanatory variables as the main determinants of the equilibrium REER (MacDonald, 1998). FEER models single out variables that affect the equilibrium current and capital account balances, such as domestic and foreign real incomes, and factors influencing national savings and investment, such as permanent fiscal consolidation. BEER models, on the other hand, emphasize variables that affect the relative prices of traded to nontraded goods at home and in foreign countries, such as differing trends in productivity in traded goods sectors and asymmetric terms-of-trade shocks. In the BEER framework, the equilibrium REER ($\bar{q}_t$) in equation (3) is proxied by its determinants, such as macroeconomic fundamentals.

In empirical studies, the REER is based on a definition of the nominal effective exchange rate in terms of foreign currency units per unit of the domestic currency, whereas in theoretical models the convention is to base the REER on a definition of the nominal effective exchange rate in terms of domestic currency units per unit of foreign exchange. As a result, the coefficients in front of the explanatory variables that affect the REER in the short-run (i.e., the real interest rate relative to trading partners (*rirr*) and the time-varying risk premium (ρ)) in the estimated regression models in section IV translate into coefficients of the opposite sign in equation (3) above.

IV. Empirical Analysis

A. Regression Specification

This paper employs the BEER methodology to estimate the equilibrium real exchange rate in Ghana. As part of a vector error correction model (VECM), a version of equation (3) is estimated. In this model, the short-run and long-run elasticities of the real exchange rate with respect to macroeconomic fundamentals are evaluated simultaneously. A long-run equilibrium path of the real exchange rate is then obtained by applying the long-run elasticities to the actual values of macroeconomic fundamentals in a given period.

The measure of the real exchange rate in Ghana is the log of the real effective exchange rate (*lreer*), based on a definition of the nominal exchange rate in terms of foreign currency units per unit of the domestic currency. The choice of macroeconomic fundamentals is informed by the FEER and BEER approaches to modeling the long-run equilibrium real exchange rate. In addition to the real interest rate relative to trading partners *(rirr)*, the empirical model uses variables that capture productivity differences across countries (the Balassa-Samuelson

[4] Clark and MacDonald (1998).

effect[5]), terms-of-trade shocks,[6] fiscal stance (*fby)*,[7] trade openness (*openy*) as a proxy for commercial policies that may affect the equilibrium current account balance, and net foreign assets of the banking system (*nfy*) as a proxy for changes in the equilibrium capital account balance. Following MacDonald and Ricci (2003), we use the log of real GDP at PPP per capita relative to main trading-partner countries (*lgdppcpppr)* as a proxy for the Balassa-Samuelson effect, and various measures of the real world prices of Ghana's main export commodities (*lrpr4_gh and other price variables*) as proxies for terms-of-trade shocks.[8] Different subsets of these macroeconomic fundamentals have been found to be statistically significant determinants of real exchange rates in a number of African countries.[9]

The expected signs of the different explanatory variables in the equation for the equilibrium real exchange rate are, according to MacDonald (1997) and MacDonald and Ricci (2003):

$$\overline{lreer} = f(lgdppcpppr^{+}, rirr^{+}, lrpr4\_gh^{+}, nfy^{+}, fby^{+/-}, openy^{-}) \qquad (4)$$

B. Data Patterns

Figure 3 plots the evolution over time of the REER determinants included in equation (4). Data patterns in explanatory variables[10] that are worth highlighting are:

- The volatility of the real interest rate differential relative to trading partners before 1998 mirrors a high inflationary period in Ghana. The inflation rate was high and volatile throughout 1980-2000, reflecting political instability, poor fiscal discipline,

[5] If a country experiences an increase in the productivity of the tradable sector (relative to its trading partners), its real exchange rate would tend to appreciate, because the productivity gains would push up the wages in the tradables sector, which would lead to a demand-driven faster increase in the price of nontradables in the domestic economy relative to its trading partners (MacDonald and Ricci, 2003).

[6] A positive terms of trade shock would either lead to nominal exchange rate appreciation, or would tend to increase domestic demand putting an upward pressure on the price of nontradables, or both, resulting in an appreciation of the REER.

[7] The impact of the fiscal stance on the REER would depend on how an extra fiscal stimulus is spent on tradable and nontradable goods. If it mostly goes toward purchases of nontradables/tradables, it would tend to appreciate/depreciate the REER.

[8] See appendix I for definitions of the variables.

[9] South Africa: MacDonald and Ricci (2003); Algeria: Koranchelian (2005); Madagascar: Cady (2003); Botswana: Iimi (2006); CEMAC and WAEMU: Abdih and Tsangarides (2006). Loukoianova (2007) provides a survey of empirical estimations of equilibrium REER conducted for a number of sub-Saharan African countries.

[10] Variables available only at annual frequency, such as GDP and commodity price measures, are interpolated into quarterly observations using the standard interpolation procedure in Eviews.

shortfalls in aid flows in the 1990s, and a collapse of the cedi in 1999/2000. In particular, a hike in inflation in 2000 was largely driven by the need to provide monetary finance for fiscal slippages and shortfalls in donor support, as well as triggered by the sharp fall in world cocoa prices. The decline in the real interest rate differential in the years following the 1999/2000 collapse of the cedi reflects the normalization of the economic climate in Ghana and the renewed confidence.

- The sharp decline of real GDP at PPP per capita with respect to main trading partners, which started in the early 1980s and was a result of: (i) political unrest in the 1980s; (ii) negative terms-of-trade shocks; (iii) high inflation resulting in macroeconomic instability in the late 1980s and through the 1990s; and (iv) to some extent, depreciation of the cedi in nominal terms. This was followed by a steady increase in real GDP after 2000 mainly because of improved macroeconomic stability.

- The continued increase in trade openness after 1983 because of growing exports of both traditional and nontraditional commodities, rising imports of investment goods, and, more recently the favorable external environment.

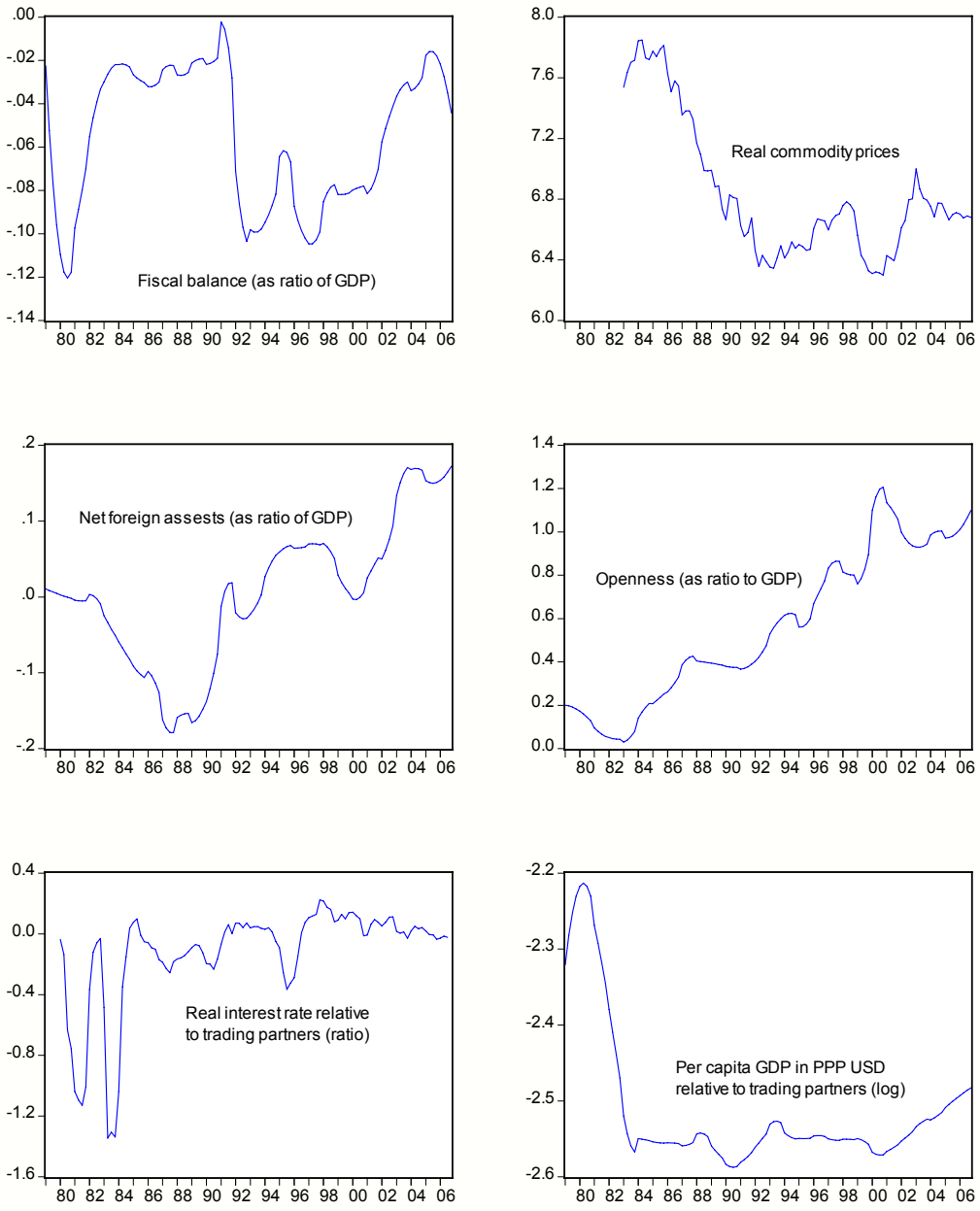
- Stronger fiscal performance since 2002, as measured by the fiscal balance.[11]

- An improvement in net foreign assets starting in 1988, though with some backsliding around 1999–2000 as a result of a severe terms-of-trade shock and macroeconomic stability.

- Finally, the weighted average of the real prices of Ghana's main export commodities—cocoa, gold, timber, and cocoa products—experienced a protracted decline in 1982-92; followed by a partial rebound through 1999; then a deterioration following the severe terms of trade shocks in late 1999–2000; and a later increase and stabilization in 2004–06.

[11] Except for 2006 when the fiscal balance deteriorated due to a slippage in fiscal policy.

Figure 3. Ghana: Determinants of the Real Effective Exchange Rate, 1979–2006



Source: IMF, Information Notice System, International Financial Statistics, World Economic Outlook, Ghanaian authorities, DataStream, and IMF staff estimates.

Analysis of the order of integration of the REER and different measures of what from a theoretical standpoint are its most important fundamental determinants indicates that Ghana's relative per capita GDP in PPP U.S. dollars and all measures of the real world prices of Ghana's main export commodities are integrated of order one (table 1, based on the preferred specifications of the Augmented Dickey-Fuller [ADF] tests). The evidence on the order of integration of the REER is mixed, with the I(1) hypothesis being accepted in the base ADF-

test specification but rejected in favor of the I(0) hypothesis in the preferred ADF-test specification at the 95 percent level of confidence. The real interest rate relative to trading partners, on the other hand, appears to be stationary. Given the small sample size, which limits the precision of the conducted unit-root tests, we proceed on the hypothesis that all variables except the real interest rate relative to trading partners are integrated of order one.

Table 1. Tests of the Order of Integration

Variable	ADF Specification			Null Hypothesis	
				I(1)	I(2)
	p	c	t	ADF Statistic	
lreer	4	1	1	-3.46	-3.83 *
	3	1	0	-3.3 *	-3.83 **
lgdppcpppr	4	1	1	-2.54	-2.97
	2	1	1	-2.59	-3.67 *
rirr	4	1	1	-4.28 **	…
	4	0	0	-4.27 **	…
lrcbeans_gh	4	1	1	-2.14	-4.32 **
	0	1	0	-2.15	-10.86 **
lrcbeans_uscpi	4	1	1	-2.11	-4.25 **
	0	0	0	-1.36	-10.26 **
lrpr3_gh	4	1	1	-1.84	-4.04 *
	4	1	0	-2.55	-3.7 **
lrpr3_gh_uscpi	4	1	1	-1.7	-3.86 *
	4	1	0	-2.16	-3.63 **
lrpr4_gh	4	1	1	-1.86	-3.98 *
	4	1	0	-2.49	-3.67 **
lrpr4_gh_uscpi	4	1	1	-1.73	-3.82 *
	4	1	0	-2.14	-3.6 **

Notes: The augmented Dickey-Fuller (ADF) test for I(*j*) against I(*j-1*) is provided by the t-statistic on $\hat{\beta}$ in: $\Delta^j x_t = c + \mu t + \beta \Delta^{j-1} x_{t-1} + \sum_{i=1}^{p} \gamma_i \Delta^j x_{t-1} + u_t$, where $\Delta^0 x_t = x_t$, $\Delta^1 x_t = x_t - x_{t-1}$, and $\Delta^2 x_t = \Delta^1 x_t - \Delta^1 x_{t-1}$.

In table 1, for each hypothesis tested we present two values of the ADF statistic. The base model, estimated in each case over the period 1984:Q2–2006:Q3, includes a constant, a trend, and five lags of the dependent variable in levels. For each variable, the second model includes only the statistically significant regressors from the base specification. Significance levels: ^ at 10% level, * at 5% level, ** at 1% level.
… – not applicable.

C. Regression Results

The exploratory stage of the regression analysis starts with the estimation of an unconstrained vector autoregression (VAR). The VAR includes an intercept, trend, and five lags of the dependent and explanatory variables used in equation (4). Then the Johansen (1995) procedure is employed to test for the existence and number of cointegrating equations

between the seven variables; the results show at least three in the initial set of dependent and explanatory variables.[12] Because the presence of more than one cointegrating equation complicates the identification of the equilibrium relationship between the REER and its fundamental determinants, we search for a combination of explanatory variables that includes the most important REER determinants, while yielding just one cointegrating vector.[13] Once the preferred VECM specification is identified, *ad hoc* specification tests are performed by adding the explanatory variables dropped in previous rounds one at a time and test for their significance. For robustness check, the paper also re-estimates the preferred VECM specification using different measures of the real world prices of Ghana's main export commodities.

In the preferred specification, the unconstrained VAR includes an intercept, trend, and five lags of the variables: *lreer*, *lgdppcrppp, rirr*, and the broadest measure of the real world prices of Ghana's main export commodities (*lrpr4_gh*) (table 2, model 1).[14] The sample period is from the first quarter of 1983 to the third quarter of 2006. Results from the Johansen trace and maximum eigenvalue cointegration tests suggest that there is one cointegrating vector in the estimated system at the 99 percent level of confidence. In the vector error correction model (VECM) estimated with the Johansen (1995) procedure, the coefficients of the cointegrating vector are plausible in magnitude and statistically significant, and they have the expected signs.

The VECM analysis of the determinants of the REER rate in Ghana points to the existence of a long-run relationship between the REER, per capita GDP in PPP U.S. dollars in Ghana relative to that in its main trading-partner countries,[15] the real interest rate differential with Ghana's main trading–partner countries, and the real world prices of Ghana's main export commodities (table 2, model 1). The results suggest the following:

- A 1 percentage point increase in the differential between the rate of growth of the real per capita GDP in Ghana and its main trading partners is associated with a 4.7 percentage point appreciation of the REER in the long run.

[12] The results are available from the authors upon request.

[13] Due to the small size of the sample, we do not attempt to carry out the analysis with multiple cointegrating vectors.

[14] All estimations are performed using STATA 9.2 and PcGive 10 econometric software packages.

[15] Hereafter, relative real GDP per capita.

- A 1 percentage point increase in the differential between the real interest rate in Ghana and the weighted average real interest rate of its main trading partners is associated with a 1.1 percentage point appreciation of the REER in the long run.[16]

- A 1 percentage point increase in the weighted average real world price of Ghana's four main export commodities is associated with an 0.35 percentage point appreciation of the REER in the long run.

- The REER in Ghana exhibits a long-run tendency to depreciate by around 4.9 percentage points annually, independent of developments in the fundamentals discussed above (see below for an interpretation of this finding).

The speed of adjustment of actual to equilibrium REER in Ghana is relatively fast compared to findings for other African countries.[17] The estimate of the error-correction coefficient in the REER equation of the VECM based on the preferred regression specification suggests that in each quarter 14 percentage points of any misalignment between the actual and equilibrium REER is corrected (table 2, model 1). In other words, the mean lag of the adjustment is about 6 quarters.

The preferred VECM specification passes a number of *ad hoc* specification tests. The coefficients of the included explanatory variables remain stable, when additional variables are added to the model (table 2, models 2 through 9).[17] None of the explanatory variables, dropped in previous rounds, enters significantly in the preferred model (table 2, models 2 through 4). At the same time, the coefficients of the dropped explanatory variables are plausible in magnitude and have signs consistent with theoretical considerations. Finally, using different measures of the real world prices of Ghana's main export commodities does not affect materially the results of the analysis (table 2, models 5 through 9).

[16] Except when the net foreign assets of the banking system (*nfy*) is added to the model (table 2, model 3), in which case the coefficient of real per capita income relative to main trading partners (*lgdppcpppr)* drops in value and becomes insignificant, signalling that the two variables are highly correlated.

[17] For example, MacDonald and Ricci (2003) report the statistically insignificant error-correction coefficient of (–0.08) for South Africa.

Table 2. Regression Results

	Preferred VECM	Specification tests on preferred VECM							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
					Unrestricted VAR / VECM specifications				
Intercept [1]	Y / Y	Y / Y	Y / Y	Y / Y	Y / Y	Y / Y	Y / Y	Y / Y	Y / Y
Trend [2]	Y / Y	Y / Y	Y / Y	Y / Y	Y / Y	Y / Y	Y / Y	Y / Y	Y / Y
Lags	5 / 4	5 / 4	5 / 4	5 / 4	5 / 4	5 / 4	5 / 4	5 / 4	5 / 4
					Number of cointegrating vectors				
Trace statistic									
H0 (p=0)	76.1 **	113.6 **	101.9 **	99.6 **	77.5 **	74.6 **	74.2 **	75.9 **	72.7 **
H0 (p<=1)	34.9	63.5 *	59.3 *	59.7	34.8	35.0	33.4	33.4	33.6
H0 (p<=2)	14.6	39.4	34.5	33.6	14.9	14.6	14.2	14.6	14.3
H0 (p<=3)	6.0	19.0	12.7	13.4	6.0	5.0	5.3	5.4	5.4
Max eigenvalue statistic									
H0 (p=0)	41.2 **	50.1 **	42.6 **	39.9 *	42.7 **	39.6 **	40.9 **	42.4 **	39.1 **
H0 (p<=1)	20.3	24.1	24.8	26.1	19.9	20.4	19.2	18.9	19.3
H0 (p<=2)	8.6	20.4	21.8	20.2	9.0	9.6	9.0	9.2	8.9
H0 (p<=3)	6.0	12.2	9.0	8.3	6.0	5.0	5.3	5.4	5.4
					Cointegrating vector				
lreer	1	1	1	1	1	1	1	1	1
lgdppcpppr	-4.68 *	-3.67 ^	-1.13	-4.59 ^	-4.48 *	-5.16 *	-3.84	-3.62	-4.25 ^
	(2.21)	(2.18)	(2.52)	(2.43)	(2.15)	(2.25)	(2.49)	(2.43)	(2.53)
rirr	-1.11 **	-1.48 **	-0.86 **	-1.00 **	-1.10 **	-0.95 **	-1.24 **	-1.25 **	-1.02 **
	(0.32)	(0.36)	(0.29)	(0.31)	(0.31)	(0.32)	(0.36)	(0.35)	(0.35)
lrpr4_gh	-0.35 **	-0.49 **	-0.39 **	-0.31 **					
	(0.10)	(0.13)	(0.10)	(0.10)					
fby		-1.91							
		(1.57)							
nfy			-1.00						
			(0.84)						
openy				0.17					
				(0.42)					
lrpr3_gh					-0.34 **				
					(0.10)				
lrcbeans_gh						-0.37 **			
						(0.12)			
lrpr4_gh_uscpi							-0.35 **		
							(0.12)		
lrpr3_gh_uscpi								-0.35 **	
								(0.11)	
lrprcbeans_uscpi									-0.38 *
									(0.15)
Trend	0.012 **	0.01 **	0.01 **	0.009	0.011 **	0.012 **	0.009 **	0.009 **	0.009 **
	(0.002)	(0.003)	(0.003)	(0.006)	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)
Intercept	-15.11	-11.60	-5.82	-15.13	-14.65	-16.00	-12.76	-12.23	-13.37
					Error-correction coefficient				
lreer equation of VECM	-0.141 **	-0.10 **	-0.16 **	-0.12 **	-0.143 **	-0.141 **	-0.132 **	-0.133 **	-0.135 **
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.03)	(0.03)	(0.03)
Log likelihood of VECM	805.1	1172.5	1120.4	1032.6	807.2	791.1	796.4	797.7	786.8
Number of observations	90	90	90	90	90	90	90	90	90
Sample					1984:Q2-2006:Q3				

Source: Authors' estimates.

Notes: Standard errors in parentheses.

Significance levels: ^ at 10% level, * at 5% level, ** at 1% level.

[1] Unrestricted in VECM.

[2] Restricted to coIntegration space in VECM.

D. The Equilibrium Real Exchange Rate

The estimated long-run relationship between the REER and its determinants allows us to derive estimates of the equilibrium REER from the preferred VECM specification. In principle, this involves applying the long-run elasticities to the actual values of the macroeconomic fundamentals in a given period to obtain a consistent long-run equilibrium value for the REER. However, the explanatory variables may exhibit a substantial degree of short-term "noise" or business-cycle fluctuations (figure 3), whereas the long-run equilibrium REER should not do so. The Hodrick-Prescott (HP) filter (with the standard smoothing factor of 1600 for quarterly data) is used to smooth out the estimated equilibrium REER. The actual and smoothed-out equilibrium REER are plotted in figure 4.

The negative time trend in the cointegrating vector, and therefore in the equilibrium REER in Ghana can be associated with a permanent positive risk premium (ρ_t) in equation (3).[18] In other words, throughout most of the sample the nominal interest rate in Ghana remained above the level that would have equated it with the sum of the foreign interest rate and the expected depreciation of the domestic currency, the difference being the reward required by investors to tolerate the macroeconomic uncertainty endemic prior to the reforms of the mid-1990s. In the future, as the relative weight of the prereform observations in the sample declines, the time trend will tend to disappear.

According to our estimates, at the end of the third quarter of 2006 the actual REER appeared to be close to its equilibrium estimate (figure 4).[19] Its steep depreciation in 1999–2000 had brought REER significantly below its equilibrium value and the gradual appreciation thereafter could be viewed as a return to a level consistent with macroeconomic fundamentals. In the second part of 2005, the REER moved above its equilibrium values, possibly as a result of overshooting, but the gap has since narrowed. The decline of the equilibrium level over the whole period is mainly due to a plunge in the real weighted-average commodity export prices, especially in the 1980s and early 1990s, and the associated sharp decline of the relative real GDP per capita early in the 1980s. Since 2001 the appreciating influence of the steady growth of relative real per capita GDP on the equilibrium REER has been fully offset by the downward drift of the real interest rate differential and a zigzag pattern in the real prices of Ghana's export commodities.

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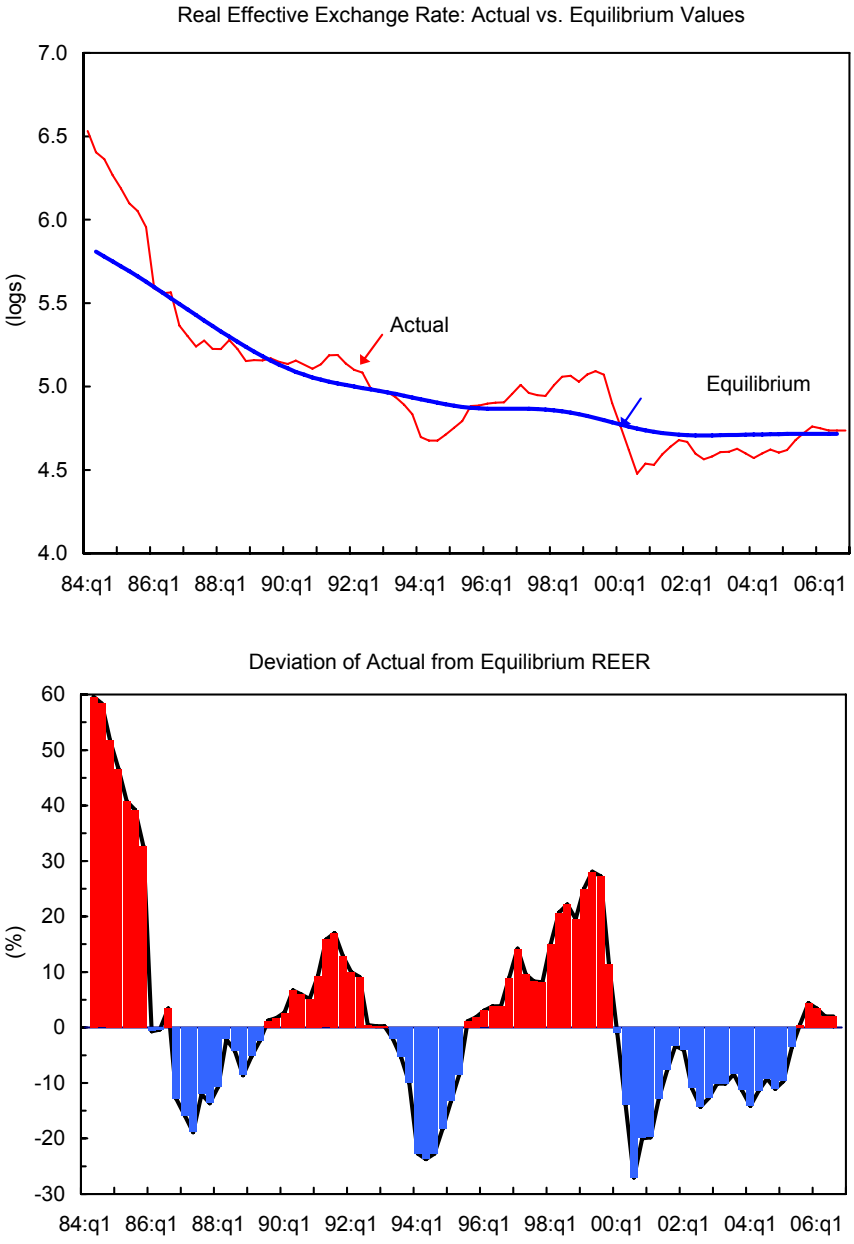
[18] In the regression model, the REER is based on a definition of the nominal effective exchange rate in terms of foreign currency units per unit of the domestic currency, whereas in equation (3) the REER is based on a definition of the nominal effective exchange rate in terms of domestic currency units per unit of foreign exchange. As a result, the coefficients in front of the explanatory variables that affect the REER in the short-run (i.e., the real interest rate relative to trading partners and the time-varying risk premium) in the estimated regression model translate into coefficients of the opposite sign in equation (3).

[19] Opoku-Afari (2007) reached a similar result using a dynamic VAR model in which the determinants of the REER include total factor productivity, terms of trade, capital flows, and trade openness.

Figure 4. Ghana: Actual and Equilibrium Real Effective Exchange Rate, 1984–2006



Sources: IMF, Information Notice System (INS), International Financial Statistics (IFS), World Economic Outlook Database; Ghanaian authorities; Datastream; and IMF staff estimates.

It is important to note that the estimates of the equilibrium REER in Ghana are not absolute, but are subject to statistical uncertainty and conditioned on the estimated regression model. Small deviations of the REER from its estimated equilibrium values may well be statistically insignificant. Furthermore, estimation of alternative equilibrium REER models (such as the FEER) may lead to different conclusions regarding the evolution of the REER relative to its

equilibrium values. This calls for caution when using the results from this study in policy decision-making and underlines the need for further research on the topic.

V. Conclusion and Policy Implications

According to our estimates, the main fundamental determinants of the REER in Ghana are the GDP at PPP per capita relative to Ghana's main trading partners, the real interest rate differential with those trading partners, and the weighted average real world prices of Ghana's main export commodities. When temporary shocks cause the REER to deviate from its equilibrium level, it reverts fairly quickly to the equilibrium path (within two to three years) in the absence of further shocks.

At the end of the third quarter of 2006 the actual REER appeared to be close to its estimated equilibrium level. The steep REER depreciation in 1999–2000 brought it significantly below the estimated equilibrium value and the gradual appreciation thereafter could be viewed as a return to a level consistent with macroeconomic fundamentals. In the second part of 2005 the REER overshot its equilibrium values but the gap has since narrowed. Other measures of external competitiveness point in the same direction: indicators based on aggregate price indices (for tradables and nontradables) suggest a 10 to 15 percent worsening in external competitiveness after 2003. However, competitiveness indicators based on the market share of Ghana's exports in its most important trading partners exhibit different time patterns, which do not show a deterioration of competitiveness since 2000. Ghana's dependence on a few main commodity exports, combined with observed volatility of the world's commodity prices suggests that the government's efforts to diversify the country's export base will be important to maintain competitiveness.

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APPENDIX I. VARIABLES' DEFINITIONS AND SOURCES

The dataset consists of quarterly and annual data from January 1980 to December 2005 for Ghana and, where applicable, for its four main trading partners:

- ***lreer* - Real effective exchange rate (log)**. Source: International Monetary Fund, *Information Notice System (INS)*.

- ***rirr* - Real interest rate relative to trading partners (ratio).** Real rates equal nominal interest rates on 91-day treasury bills[20] minus inflation (over the last four quarters in the case of quarterly data). The weighted average real interest rate of Ghana's four main trading partners is obtained using the INS weights for the REER: European Union (Germany as a proxy, 51 percent), the United Kingdom (22 percent), United States (16 percent), and Japan (11 percent). Source: International Monetary Fund, *International Financial Statistics (IFS)*.

- ***lgdppcpppr* - Per capita GDP in PPP U.S. dollars relative to trading partners (log).** The weighted average per capita GDP in PPP U.S. dollars of Ghana's four main trading partners is obtained using the same weights as above. Source: International Monetary Fund, *World Economic Outlook Database*.

- ***lrpr4_gh* and other price variables – Log of real commodity prices (*lrpr*).** 12 different measures of commodity prices are constructed, based on three methods of aggregating the main commodities exported by Ghana and two ways of deflating their prices. The aggregation methods include weighted averages of the prices in US dollars of the top four, three, and one exported commodity(ies) (with respective suffixes to the variable name stem of: *4*, *3*, and *cbeans*). The weights are the normalized shares of these commodities in Ghana's exports in each year of the sample. The table below shows the sample-average normalized weights of different commodities in Ghana's exports. The deflators used are the price deflator for G-7 countries' exports (no suffix to the variable name stem) and the US consumer price index (suffix: *_uscpi*). Two different series for cocoa prices are used: the spot world cocoa price (no suffix to the variable name stem) and the cocoa price, which COCOBOD locks prior to the harvest for more than 90 percent of cocoa export (suffix: *_gh*). For example, in the case of the broadest index, the combinations of different measures of the price of cocoa and deflators generate, respectively: *lrpr4, lrpr4_gh, lrpr4_uscpi, lrpr4_gh_uscpi*. Sources: Ghanian authorities, DataStream, and *IFS.*

[20] In the case of Japan, we use the discount rate due to data unavailability.

Ghana: Normalized Sample-Average Weights of Main Export Commodities

Commodity	Weight(4)	Weight(3)	Weight(cocoa beans)
Cocoa beans	0.47	0.5	1.0
Gold	0.36	0.4	0.0
Timber	0.12	0.1	0.0
Cocoa products	0.05	0.0	0.0

- ***openy -*** Ratio of the sum of exports and imports of goods and nonfactor services to GDP. Sources: Ghanaian authorities and *IFS.*

- ***fby -*** Ratio of the fiscal balance to GDP. Source: International Monetary Fund, *International Financial Statistics (IFS)*.

- ***nfy -*** Ratio of end of period net foreign assets of the banking system (monetary authorities and commercial banks) to GDP. Sources: Ghanaian authorities and *IFS.*