Determinants of the Cedi/Dollar Rate of Exchange in Ghana:
A Monetary Approach

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Abstract

This paper derives a simple monetary model of exchange rate determination for Ghana and employs the technique of co-integration analysis to empirically investigate the principal factors driving the Cedi/Dollar rate of exchange since the adoption of floating exchange rate regime in the country. We augment the basic model with political variables to examine any potential impact on the exchange rate. The empirical results corroborate the model, with the effect that macroeconomic fundamentals play an important role in the cedi-dollar rate dynamics. Similarly speculation based on recent past behaviour of the Cedi/Dollar (to extrapolate the future behaviour of the rate) is crucial and this has been linked largely to underdevelopment of the financial system and the exchange rates market. However, while our political variable is correctly signed, it is not significant at conventional levels of significance. Finally, we examined the effectiveness of Bank of Ghana intervention (as measured by non-oil forex sales) on the value of the cedi.

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1. Introduction

Prior to the advent of the economic recovery program, Ghana’s exchange rate policy had involved the maintenance of a fixed exchange rate regime with occasional devaluation, and exchange rationing. However, from 1988, the country adopted the flexible exchange rates regime\(^1\) in whose wake the national currency, the cedi (£), has experienced instability for the most part.

Against this background, one of the most important issues in Ghana’s policy arena over the past years has been that of exchange rate stabilisation as demonstrated by successive budget and policy statements. Notwithstanding these concerns however, maintenance of a stable value for the cedi vis-à-vis major international currencies has continued to pose challenge to policy makers. In the year 2000 the cedi was described variously as being in a ‘free fall’. At the same time, parallel market operations had re-emerged just a decade after foreign exchange was liberalised. The natural question which follows is: what are the forces behind the movement of the cedi on the foreign exchange market?

A graphical analysis of the correlation of exchange rate movements with key macroeconomic variables suggests that the exchange rate is significantly correlated with inflation, interest rates and the money supply (see charts below).

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\(^1\) Strictly speaking however, Ghana’s exchange rate regime could be described as a managed float system.
Exchange Rate Depreciation and Money Supply Growth

Exchange Rate Depreciation and Interest rate

Real and Nominal Effective Exchange Rates Indices of the Cedi (against USD, GBP and EUR) (Jan.2002=100)
While the nominal exchange rate is of interest, it is the real exchange rate that matters for the competitiveness of the Ghanaian economy. The above graph of the nominal effective exchange rate and the real effective exchange rate indicates that while the nominal exchange rate has been depreciating, the real exchange rate of the cedi appreciated in the last quarter of 2000 and the second quarter of 2001, and has been relatively stable since.

This paper attempts to investigate the determinants of exchange rates in Ghana with more rigour, using econometric techniques of cointegration and error correction modelling of a simple asset market model of exchange rate determination. The model is extended to incorporate political factors in order to investigate any impact political developments may have on the exchange rate. The role of expectations is also analysed.

The rest of the paper is organised as follows. Section 2 examines the issue of seasonality of exchange rate movements of the cedi. Section 3 presents the basic monetary model of exchange rate determination and its extension to reflect political variables. Section 4 contains the model estimation while section 5 examines the effectiveness of Bank of Ghana intervention (as measured by non-oil forex sales) on the value of the cedi. Section 6 provides the conclusions and policy implications of the findings.

2. Seasonality Analysis on the Exchange Rate of the Cedi

The issue of Seasonality was looked at in establishing whether or not a unique seasonal pattern exists on the Interbank and Forex Bureaux Exchange markets.

The following conclusions can be derived from the seasonal analysis:

1. No clear cut seasonal patterns exist in both the interbank market...
and forex bureaux markets for Ghana in the first three quarters of the year.

(2) Pressure begins to mount on the exchange rate usually during the last quarter of each year and this causes the exchange rate to move above its estimated trend path.

(3) The only exception to this trend was the trend observed in 1999. In that year the intensity of pressure on the exchange rate in both the interbank and forex bureaux markets was sharply reduced. In that year the last quarter saw the exchange rate moving below its estimated trend line. This fact could be attributed to the strong macroeconomic fundamentals.

3. Exchange Rate Determination – Theoretical issues

Several views on exchange rate determination have over the years evolved to delineate the factors responsible for exchange rate movements in the world economy. Notable among these are the monetary approach to the exchange rate (in flexible-price, sticky price and real interest differential formulations); and the portfolio balance approach. There are other strands (such as the news approach) but these generally derive from one or more of the above theories.

A number of researchers have estimated the flexible price model equivalent under the floating rate regime. Among the earliest tests of the monetary model was Bilson (1978) who tested the deutsche mark pound sterling exchange rate over the period January 1972 through April 1976 and found results that were in broad accordance with the monetary approach. Similarly, Dornbusch (1979) incorporating long-term interest rate differential as an econometric expedient presented results, which were also largely supportive of the FLMA. His interpretation of the long-term interest rate differential term has been consistent with Frankel’s real interest differential equation.

While the earlier (up to the late 1970s) tests were generally in line with the predictions of the monetary approach, the picture altered dramatically once the sample period was extended. Estimates of the real interest differential model for instance, reported by researchers including Dornbusch (1980), Haynes and Stone (1981), Frankel (1984), and Backus (1984) cast serious doubt on its ability to track the exchange rate in sample. In fact, few coefficients were correctly signed (many were wrongly signed); the equations had poor explanatory power as measured by the coefficient of determination; and residual autocorrelation was a problem. In particular, estimates of monetary exchange rate equations of the deutsche mark – US dollar for the post – 1978 period often report coefficients that suggest that a relative increase in the domestic money supply leads to a rise in the foreign currency value of the domestic currency (exchange rate appreciation). Frankel (1982) called this phenomenon – the price of the mark rising as its supply is increased – “mystery of the multiplying marks”.
Frankel (1982) provided an alternative explanation for the poor performance. He attempted to explain the “mystery of the multiplying marks” by introducing wealth into the money equations. Germany, he argued was running a current account surplus in the 1970s which was redistributing wealth from US residents to German residents, thus increasing the demand for the marks and reducing and demand for the dollars independently of the other arguments in the money demand functions. By including home and foreign wealth (defined as the sum of government debt and cumulated current account surpluses) in his empirical equation, and by not insisting that domestic and foreign income, wealth, and inflation terms had to have equal and opposite signs, Frankel came up with a monetary approach equation that fit the data well. In addition, all variables, apart from the income terms, were correctly signed and most were statistically significant.

A few studies have been conducted on exchange rates in Ghana. However, fewer still are those that even consider the determination of exchange rates, perhaps due to the lack of a generally accepted model of exchange rate determination. Jebuni, Sowa and Tutu (1991) looked at the effects of real exchange rate on output, exports and imports. The study found the real exchange rate as a significant explanatory variable for output with appreciation in the rate causing a decline in output. Similarly, they found that depreciation of the real exchange rate had a positive effect on exports and a negative effect on imports.

Chhibber and Shafik (1991) on the other hand, using a macroeconomic model investigated the determinants of black market premium and inflation in Ghana with emphasis on their link to the monetary, fiscal and real sides of the economy. Their model was estimated for the period 1965 – 1988 using two-stage least squares regression. Chhibber and Shafik discovered that the premium was determined by the real effective official exchange rate, with devaluation of the latter reducing the premium. Interest rate differentials between Ghana and the rest of the world were also significant, with widening differentials causing an increase in the premium. Uncertainty about future exchange rates, with expectations of official devaluation also cause a decrease of the premium.

Gyimah – Brempong (1992), using quarterly data for the period 1972 – 1987 in a four – equation simultaneous model, also investigated the determinants of the parallel market exchange rate. He found that official exchange rate policy affects the parallel market rate both directly and indirectly. The direct effort works through official devaluation and exchange law enforcement and policing effects2. The indirect effect works through changes in imports and exports and hence the supply and demand for black-market foreign exchange. Similarly, like Chhibber and Shafik, Gyimah – Brempong finds that devaluation of the official exchange rate leads to an appreciation of the black market premium.

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2 Increased enforcement and policing of exchange laws decrease the supply of foreign exchange to the black market more than it decreases demand, resulting in a depreciation of the domestic currency on the black market and widening premium.
3.1. The monetary model:

A convenient starting point is the demand for money function, which is central to the behavioural equation of the monetary approach. This is assumed to be of the Cagan functional form as:

\[
\frac{M}{P} = k e^{-\varepsilon y} \eta y \quad \text{(3.1)}
\]

where: \(M\) represents the nominal money stock; \(P\), the price level; \(i\), the interest rate; \(y\), the real income and \(k, \varepsilon, \eta\) are parameters.

In the simple model considered, real income and money stock are assumed to be exogenous so that movements in the nominal exchange rate are assumed to primarily reflect the exogenous movements in the expected rate of inflation. Consequently, money market equilibrium is achieved via movements in the price level.

The model assumes the purchasing parity condition as following:

\[
P = P^* \quad \text{(3.2)}
\]

where \(S\) is the current spot rate (cedis/dollar); \(P\) and \(P^*\) denote domestic (Ghana) and foreign (US) price indices respectively.

Monetary models of exchange rate determination assume the uncovered interest parity (UIP) condition. This condition implies that the domestic – foreign interest rate differential is just equal to the expected depreciation of the domestic currency as:

\[
\Delta S_{t+1}^e = (i - i^*) \quad \text{(3.3)}
\]

Now, substituting equation (3.1) and an analogous equation for the foreign country into equation (3.2) and arithmetically manipulating slightly, we arrive at the equilibrium exchange rate as:

\[
S = \frac{M}{M^*} \left[ \frac{y}{y^*} \right] \frac{k^*}{k} e^{(i - i^*)} \quad \text{(3.4)}
\]

Equation (3.4) is the basic equilibrium exchange rate that brings forth the economic fundamentals that affect the exchange rate.

In the model, movements in the nominal rate of interest are assumed to reflect movements in the participants’ expectations of the exchange rate depreciation or appreciation. An increase

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4 All variables with ‘*’ denote foreign country variables.
5 The exchange rate in this paper is defined as the cedi price of a unit of dollar (i.e. cedis per dollar).
in the domestic interest rates will decrease the demand for the domestic currency and
depreciation of the domestic currency relative to the foreign currency. Consequently,
speculation enters the model via the interest rate differential. In addition, speculation could
enter the model from a slightly different angle. Under the rational expectations hypothesis, a
monetary expansion not only triggers depreciation of the exchange rate directly, but it may
also induce a further depreciation of the exchange rate by creating expectations of a further
monetary growth. It should be noted however that within the Dornbusch (1976) sticky price
model (which has Keynesian features in the short run but accords with the implications of the
monetary approach accords, in the long run), an increase in the relative domestic interest rate
leads to an appreciation of the domestic currency \(\beta_5<0\). This conclusion is the same
under the Mundell-Fleming fixed price model. This model generally regards an increase in
domestic real income as leading to a worsening trade balance and therefore a depreciation of
the exchange rate. In addition, a relative increase in the domestic interest rate leads to capital
imports, and hence an appreciation of the exchange rate.

Note that the expected change in the exchange rate term \((i – i^*)\) can enter into equation (3.4)
in a slightly different way. Assuming nominal interest rates obey the Fischer parity
condition\(^6\), then the expected change in exchange rate given in equation (3.3) could be
rewritten as:

\[ \Delta S^e = (i – i^*) = (pe – pe^*) \] \(\text{(3.5)}\)

where \((pe – pe^*)\) denotes expected inflation differential between domestic and foreign
countries.

Real incomes are also included in the function both as a proxy for the wealth of domestic
residents, who presumably have a preference for the domestic currency, and as an index of
the volume of transactions undertaken in the currency. Monetary theory predicts that an
increase in real income will appreciate the exchange rate under all circumstances.

Thus equation (3.4) forms the basis for the tests that will be undertaken in the next section.
The tests will be based on the following argument: that if the monetary approach is ‘correct’,
the parameter estimates obtained from the sample data should be consistent with other
estimates of the money demand function. The sample evidence will not support the approach
if, for example, higher real income depreciated the exchange rate, even if the forecast power
of the model were high.

The next task is to state equation (3.4) in a more formal and testable form. In this regard,
starting with the shift factor, \(k^*/k\), an attempt is made to allow for some exogenous
movement in the relative demand for the two currencies. Of the factors responsible for such a
change, uncertainty about monetary and fiscal policy would appear to be important. Besides,
the instability of the cedi/dollar rate may have led to a declining role of the cedi as a store of
value and thus a decline in the demand for the cedi relative to the dollar. These factors are
explained by allowing for a trend, \(t\), in the shift factor as specified in equation (3.6) below:\(^7\)

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\(^6\) That is \(i=r+pe, \text{and } i^*=r^*+pe^*\), so that if \(r \text{ and } r^*\) are assumed to be equal, then \((i – i^*) = (pe – pe^*)\), where \(r\)
= real interest rate and \(pe\) = expected inflation rate.

\(^7\) See Bilson, 1978, p.55.
\[
\ln \left( \frac{k^*}{k} \right) = k_0 + \lambda t \tag{3.6}
\]

where: \(k_0\) is a constant; \(\lambda\) is the rate of growth in the relative money demand and \(t\) is the trend.

Finally, in order to allow for the sluggish adjustment of the actual price level, a distributed lag mechanism of the partial adjustment form is adopted (ibid.). Thus the change in the price level is proportional to the difference between the actual and equilibrium values. This assumption which is adopted in the following analysis implies that the actual exchange rate adjusts toward the equilibrium rate according to the equation (3.7) as:

\[
\ln(S) - \ln(S_{-1}) = \gamma \left[ \ln(S) - \ln(S_{-1}) \right] \tag{3.7}
\]

where: \(\gamma\) and \(\overline{S}\) respectively denote the partial adjustment coefficient and the equilibrium exchange rate defined in equation (3.4) above.

From equations (3.3) and (3.4) through (3.7), it is easy to derive in addition to an error term, the following estimable equation:

\[
\ln(S) = \gamma \left( k_0 + \ln(M) - \ln(M^*) - \eta \ln(y) + \eta \ln(y^*) + \left( 1 - \frac{1}{\theta} \right) \ln(i - i^*) + \frac{1}{\theta} \ln(pe - pe^*) + \lambda t \right) + (1 - \gamma)S_{-1} + \mu \tag{3.8}
\]

Or equivalently,

\[
\ln(\text{ExR}) = \beta_0 + \beta_1 \ln\text{GM} + \beta_2 \ln\text{USM} + \beta_3 \ln\text{GI} + \beta_4 \ln\text{USI} + \\
\beta_5 \text{RIRD} + \beta_6 \ln\text{INFLD} + \beta_7 \text{TREND} + \beta_8 \ln\text{ExR}_{-1} + \mu \tag{3.8'}
\]

where: \(\beta_0 = \gamma k_0, \beta_1 = \gamma, \beta_2 = -\gamma, \beta_3 = -\gamma \eta, \beta_4 = \gamma \eta, \beta_5 = \gamma (1/\theta), \beta_6 = \gamma / \theta, \beta_7 = \gamma \lambda\)

and \(\beta_8 = 1 - \gamma\).

where ExR is the nominal exchange rate (the cedi price of a dollar); GM is the money supply in Ghana; USM – US money supply; GI – Ghana income; USI – US income; RIRD – real interest rate differential; INFLD – inflation differential. All variables except the real interest rate differential are in logs.

According to equation (3.8’), an increase in domestic (foreign) money supply will lead the domestic currency to depreciate (appreciate). An increase in the domestic income will raise the money demand, causing the domestic currency to appreciate (depreciate). Finally, an increase in the home interest rate (foreign) interest rate will result in depreciation (appreciation) of the exchange rate via a reduction in the demand for money. Specifically, an increase in money supply leads to an increase in prices and since PPP is assumed to hold continuously, this also implies a depreciation of the domestic currency. The converse is true for the foreign country if the foreign money supply were to increase.

On national income levels, if the domestic income were to rise, this will increase the transactions demand for money. The increased demand for money means that if the money

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stock and interest rates are held constant, the increased demand for real money balances can only come about through a fall in domestic prices. The fall in domestic prices then requires an appreciation of the domestic currency to maintain PPP. An analogous reasoning on the other hand leads to a depreciation of the domestic currency when there is a rise in the foreign income.

An increase in the domestic interest rate is expected to lead to a depreciation of the domestic currency. The reasoning here is that, a rise in the domestic interest rate leads to a fall in the demand for money and hence, a depreciation of the domestic currency. Another rationalisation of the effect can be made through the relative expected price inflation variable, \((pe - pe^*)\). An increase in domestic inflation expectations will lead to a decreased demand for money and an increased expenditure on goods, and this in turn leads to a rise in domestic prices. The rise in domestic prices then requires a depreciation of the domestic currency to maintain PPP. Conversely, a rise in the foreign interest rate reduces foreigners’ money demand, leading to increased expenditure on foreign goods and a rise in the foreign price level, requiring an appreciation of the domestic currency to maintain PPP. These conclusions are the opposite of those expected under the Mundell-Fleming and the Dornbusch sticky price models which have Keynesian features in the short run.

Thus \(\beta_1, \beta_4, \beta_5, \beta_6, \beta_8 > 0; \quad \beta_0 = 0; \quad \beta_2, \beta_3 < 0\)

It is interesting to note that the effect of the income variable is opposite that expected in the Mundell-Fleming fixed price model. This model generally regards an increase in domestic real income as leading to a worsening trade balance and therefore a depreciation of the exchange rate. In addition, a relative increase in the domestic interest rate leads to capital imports, and hence an appreciation of the exchange rate.

### 3.2. Modifying the Standard Monetary Model to Reflect Political Variables:

Since political events may also systematically affect the exchange rate, we extend the standard model above to include political factors, specifically, election effects. Thus rewriting equation (3.8) in a slightly different but equivalent form as:

\[
s_t - s_{t-1} = H_{t-1} + \delta E_{t-1}(s_t - s_{t-1}) + \epsilon_t\]

where: \(s_t\) is the log of the exchange rate; \(H_{t-1}\) is the linear combination of the economic fundamentals and \(E_{t-1}\) is the expected appreciation or depreciation of the exchange rate as of time period \(t-1\). Assuming the economic fundamentals follow a random walk (with a drift term), forward expansion implies:

\[
s_t - s_{t-1} = \alpha + \epsilon_t\]

so that the exchange rate follows a random walk (with a drift term \(\alpha\)), \(\epsilon_t\) represents the revision in the economic fundamentals (i.e. innovations), which determine exchange rates.
To examine whether political variables (ELECTION) can help in predicting exchange rate movements, we assume that economic fundamentals follow a random walk as in equation (3.10). We also assume that events in time period $t-1$ are signals of possible future policy changes that affect the exchange rate independent of the state of the economy. Hence political events are correlated with innovations - $\varepsilon$, but are uncorrelated with the linear combination of economic fundamentals, $H_{t-1}$.

In general, ELECTION here is a political variable, which proxies the opportunistic manipulation of the economy due to up-coming elections (Blomberg and Hess, 1997). The intuition for incorporating election period effects, ELECTION, into our empirical model for exchange rates is based on the ‘rational opportunistic political business cycle’ model of Rogoff and Sibert (1988). Here, we assume that just prior to an election, the incumbent government manipulates the economy in a way as to appear more competitive. For instance, salary increases and a rash to begin certain development projects such as extension of electricity to rural areas and some road construction starts, as well as on other political activities that do not contribute to output at least in the short term. Although voters have to rationally infer the incumbent’s true competency from its performance, such actions temporarily drive up government’s budget deficits, which cause the exchange rate to rise, ($\beta >0$). As it were, the first multiparty elections under Ghana’s new constitution were held in 1992. In the run-up to the election, the incumbent government abandoned its fiscal targets and a budgeted surplus of 1.6 per cent of GDP turned into a deficit of nearly 9 per cent. The pattern was repeated prior to the 1996 election and, to a lesser extent, in 2000 (IMF Country report, July 2004). We therefore generalise our model as:

$$\ln ExR_t = \beta_0 + \beta_1 \ln GM_t + \beta_2 \ln USM_t + \beta_3 \ln GI_t + \beta_4 \ln USI_t + \beta_5 \ln IRD_t + \beta_6 \ln INFLD_t + \beta_7 \ln TREND + \beta_8 \ln ExR_{t-1} + \beta_9 \text{ELECTION}_t + \mu_t$$

where all variables are as defined above.

Thus the model suggests the following hypotheses concerning the coefficients in equation (3.11):

$\beta_1, \beta_4, \beta_5, \beta_6, \beta_8 >0; \quad \beta_0 =0; \quad \beta_2, \beta_3 <0$

In terms of the specific effects of the variables in the model, we present the following:

In general, according to the monetary model, the coefficients of the relative money supplies are expected to add to unity in absolute value, confirming the neutrality of money. The elasticity coefficient of relative incomes should be in the neighbourhood of 1.0, and the interest elasticity of demand for money should be in the neighbourhood of 0.04 for the monthly data (Levich, 1985).
3.3 Definition of Variables:

Time series data for the period 1992:12 – 2003:11 on the following macro variables have been used in the study:

**ExR, GM, USM, GI, USI, RIRD and INFLD**

Where: ExR is the nominal cedi/dollar exchange rate; GM is Ghana money supply (M2+); USM is US money supply (M2); GI and USI denote Ghana income and US income respectively. However, since monthly data on incomes are not available, we have rather resorted to the use of proxies, where we used exports for the GI and industrial production for the USI similar to Bilson (1978) and Gesongo, (1997). The choice of the former has been necessitated by that size of the external sector in Ghana vis à vis its role in the cedi/dollar dynamics. In the case of the latter, the choice has been motivated by the size of the US industrial output as well as its potential effects on the movements of the dollar market. RIRD and INFLD respectively represent the differentials between Ghana and US rates of interest and inflation. The ninety-one day Treasury bill rate has been used for both countries. The choice of this also follows from preliminary experiments with other analogous rates and the suitability of the Treasury bill rate.

4. Model Estimation

This section focuses on the empirical estimates of the model developed in the previous section. We start by considering the time series characteristics of the data.

4.1 Time series characteristics of the data:

4.1. Unit Root Tests:

The unit root tests using the augmented Dickey-Fuller (ADF)\(^{10}\) test are shown in Table 2. The results indicate that with the exception of \(G_x\), all the variables are non-stationary in levels and stationary in first differences; that is, they are integrated of order one, I(1).

The implications of our unit root test results for testing the long-run monetary model is to use cointegration procedures.

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\(^{10}\) The Phillips-Perron test produced similar results and therefore was not shown in the Table.
4.2 Testing For Cointegration:

According to the Johansen cointegration test, reported in Table 3, both the maximum eigenvalue and the trace test reject the null of no cointegrating equation. The maximum eigenvalue test result suggests that there are two cointegrating vectors at the 5 percent significance level but one at the 1 percent significance level. The trace test on the other hand indicates that there are two cointegrating vectors at both 1 percent and 5 percent levels of significance.  

The results of our model presented in tables 4 and five corroborate the monetary model of exchange rate determination. The fit of the model is satisfactorily high, with the residuals showing no sign of serial correlation. All the effects except exports (which was used as a proxy for domestic income) are correctly signed and significant (especially the immediate past values of the rate itself which is even significant at the one per cent) in jointly explaining the exchange rate movement. In particular, both the domestic money supply ($\Delta LGM$) and foreign money supply ($\Delta LUSM$) variables have been correctly signed with the sum of their absolute elasticities approximating unity – a result that is robustly consistent with the postulates of the monetary model. This in simple terms means that the supply conditions of the cedi (money supply in Ghana) and those for the US are significant in explaining movements in the cedi dollar rate. Specifically, higher levels of monetary growth are associated with higher levels of depreciation. While this result is consistent with the postulates of the monetary model, it should be noted that the extent to which this influences the exchange rate is much lower than that based on speculation emanating from the immediate past values of the rate itself (as indicated by the rather low elasticity of the domestic money supply).

Similarly, the interest semi-elasticity of -0.0023 is correctly signed and significant at the 10% level. This coefficient which measures agents’ expectations about exchange rate movement as analysed earlier implies that a one percent change in the real interest rate differential results in an about -0.23 percentage points change in the cedi/dollar rate. This however is consistent with the Mundell-Fleming and the Dornbusch sticky price model.

Similarly, the inflation price differential variable, is significant at the 5% level and has an elasticity of 4.6 percent in determining movement in the exchange rate.

The single most important driving force behind the exchange rate in Ghana has been shown to be the immediate past history of the exchange rate itself. This variable did not only come out with the expected sign, but also evidently significant at the one- percent level. The

11 The Engle-Granger two-stage approach which was also utilized confirmed the presence of a cointegration relation
rationalisation of this could in part be that, in a typical developing country like Ghana, the financial system remains essentially underdeveloped with several bottlenecks. As a result, the vast majority of the populace base their immediate expectations about the exchange rate on the immediate past history of the rate itself, perhaps, what has been referred to in the literature as the Chartists approach to exchange rates determination. Consequently, a given depreciation of the exchange rate engenders a series of buying or hoarding, which cause a further depreciation of the cedi against the dollar. This is because economic agents will tend to view the latter as a hedge against further depreciation and its attendant potential exchange losses. However, the increase in the demand for foreign currency (dollar) results in a further depreciation of the cedi. Indeed, this is consistent with the observed patterns of exchange rates movement in Ghana – what might be referred to as rapidly depreciating currency generating further rapid depreciation with extreme difficulty in stemming the phenomenon. It is similarly consistent with Nurske’s 1944 findings on Chartism.

However, while our political variable is correctly signed, it is not significance at the conventional levels of significance.

The coefficient of the ecm(-1) measures the speed of adjustment of the exchange rate to its long run values. This coefficient which is significant at the 5 per cent and one per cent respectively in the basic and election augmented model imply that there are forces in place to restore equilibrium following a short run deviation. About 5.4 percent and 5.8 per cent of disequilibria are “corrected” respectively in the models by changes in the variables.

Turning now to the various diagnostic tests above, the model can generally be said to be relatively complete. The DW Statistic which indicates the presence or otherwise of autocorrelation in the error terms points to the absence of autocorrelation. This stance is reinforced by the AR test, which also does not reject the null hypothesis of no error autocorrelation at the conventional levels of significance.

Further, the Xi*Xj that also tests for heteroscedasticity due to omission of the squares of the regressors points to the fact that the errors generated from the dynamic error-correction model are homoscedastic. This is also confirmed by the Autoregressive Conditional Heteroscedasticity (ARCH) test, which is a test for the error terms being generated from an autoregressive process.

Similarly, the tests also indicate the absence of any functional form misspecification as epitomised by the Ramsey reset test. The errors generated from the model are also normally distributed with constant variance, as the tests could not reject the null of normality.

5. Bank of Ghana intervention and the Cedi Exchange Rate.

Is there any relationship between the BOG’s intervention in the forex market and the depreciation of the cedi against the major foreign currencies? This section attempts to answer this question by using a regression analysis (OLS methodology) for a very simple model of exchange rate determination. The model explains cedi depreciation as a function of BOG intervention and inflation differences between Ghana and the United States. We experiment
with intervention levels and rates, as well as current and lagged values of intervention over the period 1990-2002.

The inflation variable is included because economic theory suggests that the depreciation of the cedi against the dollar will be related to inflation differentials between the United States and Ghana as analyzed in the preceding sections. We experiment with current and lagged values of the inflation variable. Table 6 presents the estimated regression coefficients with t-statistics in parenthesis.

Table 6 about here

5.1. **Interpreting the Regression Results**

The first regression suggests that the current level of intervention in the forex market is not a significant explanatory variable of current cedi depreciation. This result is consistent through regressions 2 and 3 where we control for the current and lagged inflation differentials.

Regressions 4-6 suggest however that the previous months’ level of BOG intervention is a small but significant explanatory variable of current cedi depreciation. These regressions suggest that a 1% increase in the level of BOG intervention reduces the rate of cedi depreciation by about 0.001%. Regressions 5 and 6 suggest that the lagged value of the inflation differential explain cedi depreciation better than lagged intervention levels. This implies that intervention is not very effective and to the extent that it is, might slow down the rate of depreciation but not prevent it. Ultimately, the fundamentals matter.

Regressions 7-9 suggest that to the extent that it is significant, increasing the rate of intervention serves to increase the rate of cedi depreciation. This might be because if the higher rate of intervention is because of a worsening fundamental situation, the intervention might prove ineffective.

6. **Conclusions and Policy Implications**

The principal objective of this paper has been to investigate the possible determinants of exchange rates in Ghana using the techniques of cointegration and error correction modelling. Theoretical and empirical foundations were established to ensure that results obtained could be interpreted within conventional research requirements. A number of revelations emerged from the study.

First is the role of expectations in the cedi/dollar rate dynamics, which results from one of two sources, viz., interest rate differentials and the previous values of the exchange rate. Evidently, the answer to the question: what drives the exchange rate in Ghana, seems to be a combination of both the economic fundamentals and speculation based on the immediate past history of the rate itself.
The analysis indicated that both the Treasury bill and inflation rates help in explaining the cedi/dollar dynamics. Specifically, higher levels of domestic inflation rate relative to foreign inflation rate result in a depreciation of the cedi against the dollar. Higher levels of domestic interest on the other hand result in expected strengthening of the cedi against the dollar at least in the short run. This is however lower than the effect based on the immediate past history of the exchange rate.

Both domestic and foreign money supply conditions matter in the cedi/dollar dynamics.

On the role of Bank of Ghana Intervention on the foreign exchange market, the study finds that the level intervention operates with a lag on cedi depreciation but the effect is very small.

Furthermore, it has been shown that increasing the rate of intervention might have a counter-productive effect by increasing the rate of depreciation. The moral of the story is that the rate of interventions should be kept stable. The BOG exchange market interventions have no apparent effect on market fundamentals, but may influence expectations.

The results also suggest that inflation explains depreciation better than intervention. The BOG has to pay attention to the fundamentals.
APPENDICES

Appendix Table:1  Fiscal Slippage During Recent Election Years

The government abandoned its fiscal targets and a budgeted surplus of 1.6 per cent of GDP turned into a deficit of nearly 9 percent. The pattern was repeated prior to the 1996 election and, to a lesser extent, in 2000.

Election-Year Budgets and Outturns, 1992, 1996 and 2000

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total revenue and grants</td>
<td>14.6</td>
<td>14.4</td>
<td>14.0</td>
</tr>
<tr>
<td>Tax revenue</td>
<td>13.5</td>
<td>11.3</td>
<td>11.3</td>
</tr>
<tr>
<td>Total expenditure</td>
<td>13.0</td>
<td>23.3</td>
<td>13.6</td>
</tr>
<tr>
<td>Recurrent Expenditure</td>
<td>9.6</td>
<td>13.5</td>
<td>11.0</td>
</tr>
<tr>
<td>Wages and salaries</td>
<td>4.0</td>
<td>5.8</td>
<td>3.8</td>
</tr>
<tr>
<td>Interest</td>
<td>1.2</td>
<td>2.1</td>
<td>2.7</td>
</tr>
<tr>
<td>Capital Expenditure</td>
<td>2.7</td>
<td>9.8</td>
<td>2.4</td>
</tr>
<tr>
<td>Overall balance</td>
<td>1.6</td>
<td>-8.9</td>
<td>0.5</td>
</tr>
<tr>
<td>Arrears (clearance)</td>
<td>0.7</td>
<td>-0.1</td>
<td>-0.8</td>
</tr>
<tr>
<td>Overall balance, after arrears clearance</td>
<td>1.6</td>
<td>-8.2</td>
<td>0.5</td>
</tr>
<tr>
<td>Primary balance</td>
<td>2.8</td>
<td>-6.9</td>
<td>3.2</td>
</tr>
</tbody>
</table>

Memorandum items

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Real GDP (annual percentage change)</td>
<td>5.0</td>
<td>3.9</td>
<td>5.0</td>
</tr>
<tr>
<td>Consumer Prices (annual percentage change, e.o.p.)</td>
<td>5.0</td>
<td>13.3</td>
<td>8.0</td>
</tr>
<tr>
<td>Exchange rate (annual percentage change, e.o.p.)</td>
<td>33.3</td>
<td>30.3</td>
<td>99.4</td>
</tr>
</tbody>
</table>

Source: IMF Country Report No. 04/210, July 2004

Table 2: ADF(k) Unit Root Test Results/1

<table>
<thead>
<tr>
<th>Variables</th>
<th>k</th>
<th>(Levels) A</th>
<th>(First Differences) B</th>
</tr>
</thead>
<tbody>
<tr>
<td>lexr</td>
<td>4</td>
<td>-3.105</td>
<td>-0.689</td>
</tr>
<tr>
<td>lgm</td>
<td>0</td>
<td>-1.442</td>
<td>0.268</td>
</tr>
<tr>
<td>Lusm</td>
<td>4</td>
<td>-1.991</td>
<td>2.799</td>
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<tr>
<td>Lgi</td>
<td>1</td>
<td>0.030</td>
<td>-2.196</td>
</tr>
<tr>
<td>Lusi</td>
<td>4</td>
<td>-2.989</td>
<td>-1.533</td>
</tr>
<tr>
<td>Rird</td>
<td>1</td>
<td>-1.951</td>
<td>-1.781</td>
</tr>
<tr>
<td>Infd</td>
<td>1</td>
<td>-1.585</td>
<td>-1.354</td>
</tr>
<tr>
<td>1% crt. Value</td>
<td>1.6</td>
<td>-4.039</td>
<td>-3.487</td>
</tr>
<tr>
<td>5% crt. Value</td>
<td>-3.449</td>
<td>-2.579</td>
<td>-3.448</td>
</tr>
</tbody>
</table>

Notes:
1. k is the number of lagged dependent variables in the ADF regression.
2. Columns A and B give the t-statistics from the ADF regression including constant and trend, and constant respectively.
3. The superscripts * and ** denote rejection at 5% and 1% critical values respectively.
ADF is modelled as $\Delta X_{it} = \alpha + \beta X_{t-1} + \sum_{i=1}^{1} \delta \Delta X_{t-i} + \epsilon_i$.

**Table 3: Johansen Cointegration Test**

| Null Alternative | Maximum $\lambda_{max}$ | 95% C.V. | Trace Alternative | $\lambda_{trace}$ | 95% C.V.
|------------------|--------------------------|----------|------------------|------------------|----------
| $r = 0^{**}$     | $r = 1$                  | 69.17    | 45.28            | $r >= 1$         | 174.83   | 124.24
| $r <= 1^{*}$     | $r = 2$                  | 39.81    | 39.37            | $r >= 2$         | 105.66   | 94.15
| $r <= 2$         | $r = 3$                  | 25.94    | 33.46            | $r >= 3$         | 65.85    | 68.52
| $r <= 3$         | $r = 4$                  | 24.00    | 27.07            | $r >= 4$         | 39.91    | 47.21
| $r <= 4$         | $r = 5$                  | 8.12     | 20.97            | $r >= 5$         | 15.91    | 29.68
| $r <= 5$         | $r = 6$                  | 6.44     | 14.07            | $r >= 6$         | 7.79     | 15.41
| $r <= 6$         | $r = 7$                  | 1.35     | 3.76             | $r >= 7$         | 1.35     | 3.76

(***)* Significant at the (1%)5% level.
Trace test indicates 2 cointegrating equation(s) at both 5% and 1% levels
Max-eigenvalue test indicates 2 cointegrating equation(s) at the 5% level
Max-eigenvalue test indicates 1 cointegrating equation(s) at the 1% level

**Table 4: Parsimonious error-correction model results:**

**Modelling DLExR by OLS**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Model 1 The basic model</th>
<th>Model 2 The Extended model</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td>Prob. value</td>
</tr>
<tr>
<td>ΔLEXR_1</td>
<td>0.58740</td>
<td>0.000</td>
</tr>
<tr>
<td>ΔLEXR_3</td>
<td>0.616241</td>
<td>0.004</td>
</tr>
<tr>
<td>Ecm_1</td>
<td>-0.54024</td>
<td>0.010</td>
</tr>
<tr>
<td>ΔIRD_1</td>
<td>-0.93351</td>
<td>0.005</td>
</tr>
<tr>
<td>ΔLUSM_1</td>
<td>0.00230</td>
<td>0.082</td>
</tr>
<tr>
<td>ΔLGX_2</td>
<td>0.042562</td>
<td>0.030</td>
</tr>
<tr>
<td>ΔLGX_3</td>
<td>0.042562</td>
<td>0.030</td>
</tr>
<tr>
<td>Constant</td>
<td>0.0066310</td>
<td>0.230</td>
</tr>
<tr>
<td>ΔLINFD_4</td>
<td>0.0066310</td>
<td>0.230</td>
</tr>
</tbody>
</table>

$R^2$ 0.47 0.51
Table 5: Diagnostic Tests Results:
AR 1–6 $ F(6, 79) = 0.82099(0.5570) $
ARCH 6 $ F(6, 73) = 0.28251(0.9435) $
Normality Chi² (2) = 3.02968(0.1943)
Xi² F (13, 71) = 1.2968(0.2355)
Xi*Xj $ F(34, 50) = 0.81925(0.7277) $
RESET $ F(1, 84) = 1.7093(0.1946) $

NOTE: Probability values in brackets.

Table 6: Regression Results. Dependent Variable- Cedi Depreciation Rate

<table>
<thead>
<tr>
<th>Regression</th>
<th>Intervention Level</th>
<th>Intervention Rate</th>
<th>Lagged Intervention Level</th>
<th>Inflation Differential (Ghana-US)</th>
<th>Lagged Inflation Differential</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-0.01589 (-0.989)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>-0.0110 (-0.682)</td>
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<td></td>
<td>0.03915 (1.822)</td>
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<tr>
<td>3</td>
<td>-0.01369 (-0.877)</td>
<td></td>
<td></td>
<td>0.06003 (2.894)</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>-0.0012 (-3.146)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>-0.0463 (-2.985)</td>
<td></td>
<td>0.03548 (1.725)</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>-0.04299 (-2.77)</td>
<td></td>
<td>0.05201 (2.55)</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td>0.003232 (1.51)</td>
<td></td>
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</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
<td>0.00366 (1.752)</td>
<td>0.04511 (2.143)</td>
<td></td>
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<tr>
<td>9</td>
<td></td>
<td></td>
<td>0.00348 (1.703)</td>
<td></td>
<td>0.062322 (3.033)</td>
</tr>
</tbody>
</table>

T-values in parenthesis
Figure 1: Graphs of Variables in Log Levels

Figure A1b: Graphs of Variables in First Difference
REFERENCES


IMF Country Report No. 04/210 July 2004


The Economist, July 22nd, 2000, p.44.