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On the causes and effects of exchange rate volatility on economic growth: Evidence from Ghana

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Abstract
What drives exchange rate volatility, and what are the effects of excessive fluctuations in the exchange rate on economic growth in Ghana? These questions are the subject matter of this article. The results showed that while shocks to the exchange rate are mean reverting, misalignments tend to correct very sluggishly, with painful consequences in the short run as economic agents recalibrate their consumption and investment choices. About three quarters of shocks to the real exchange rate are self-driven, and the remaining one quarter or so is attributed to factors such as government expenditure and money supply growth, terms of trade and output shocks. Excessive volatility is found to be detrimental to economic growth; however, this is only up to a point as growth-enhancing effect can also emanate from innovation, and more efficient resource allocation.

Keywords: *Volatility, GDP growth, Exchange Rates, GARCH, GMM, Ghana*

JEL classification: *F4; F31; F32; C1*

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1. Introduction

The Bretton Woods system marked a period of the largest experiment of fixed exchange rate regime in the post-World War II era. The system, however, was doomed to failure at birth, and by 1973, the international monetary and financial system embraced floating exchange rates. The antecedents to the collapse of the Bretton Woods were driven by large U.S. balance of payments deficits, significant gold outflows, and the unwillingness of major trading partners to realign currency values. The unilateral termination of convertibility of the US dollar to gold by the Nixon administration thus brought the Bretton Woods experiments to its knees. Subsequently a number of currencies began to be freely determined by market forces. The debate regarding the relative merits of fixed versus floating exchange rates continue to dominate discussions in international money and finance, and it remains unsettled after over 4 decades of the post Bretton Woods epoch.

Proponents of fixed exchange rate have often argued that flexible exchange rate increases trade uncertainty and may in fact reduce trade volumes as it exposes importers to greater risks on account of fluctuations. Indeed, there is evidence that hard exchange rate pegs promote trade openness and economic integration (Rose, 2000; Frankel and Rose, 2002). Beyond gains from trade, Hanke and Schuler (1994) argue that hard exchange rate

pegs could improve fiscal institutions thus propelling sounder budgetary management as governments lose power to print money to finance spending. These notwithstanding, advocates of the flexible exchange rate assert that external risks are rendered benign through adequate systematic hedge hence leaving trade flows unaffected. Furthermore, Tornell and Velasco (2000) opine that flexible exchange rates actually induce fiscal discipline by allowing the effects of unsound fiscal policies to immediately manifest via movements in exchange rate and price level. Studies such as Calvo and Mendoza (2000), Calvo (2001) have argued that the floating exchange rate system may allow too much flexibility and discretion to policy makers and may be unable to provide relatively sufficient nominal anchor.

Exchange rate volatility – defined as the persistent fluctuations of the exchange rate – has dominated recent literature in international finance owing to its effects on developing economies. In both developed and developing economies, concerns about exchange rate fluctuations have evolved in an astonishing manner largely on its impact on exports (Wang and Barrett, 2007; Assery and Peel, 1991; Arize et al. 2000), employment growth (Belke and Setzer, 2003; Belke and Kaas, 2004), trade (Doyle, 2001; Clark et al. 2004; Bredin et al. 2003; Tenreyro, 2007); inflation (Danjuma et al., 2013); investment (Serven, 2003; Kiyota and Urata, 2004; Fuentes, 2006), and more generally economic activity (Kandil, 2004; Adewuyi and Akpokodje, 2013) and growth (Mundell, 1995; Levy–Yeyati and Sturzenegger, 2002; Danne, 2006; Holland et al. 2011).

In Ghana, the advent of the Financial Sector Adjustment Programme (FINSAP) – a component of the Economic Recovery Programme (ERP) – introduced major reforms in the financial sector including the jettison of the fixed exchange rates in favour of the free floating regime in the 1980s. Among others, this transition was done under the premise that flexible exchange rates would curb the boom–and–bust syndrome as well as turn the country towards a trajectory of growth with the growth–enhancing effect emanating from the exchange rate pass–through on consumer prices, terms of trade, trade volumes and investments.

Since the adoption of the flexible exchange rate regime in Ghana, the Ghana Cedi has depreciated against major currencies especially the US Dollar (US$), albeit, not monotonically, as the Ghana Cedi recorded a modicum of stability between 2002 and 2007. Ghana redenominated her currency on 1st July 2007 where US$1 was exchanged for 93 pesewas. This move saw a depreciation of the Cedi overtime and by the end of July 2009, the US$ was exchanged for GH¢1.49. However, between August 2009 to March 2010, the Cedi marginally appreciated by 3% and was consequently exchanged for US$= GH¢1.49 in April 2010. Most recently, the Cedi has been very volatile. For instance, at the beginning of January 2014, a US$ was exchanged for GH¢2.21 and by the end of September 2014, the Cedi–Dollar exchange rate stood at GH¢3.20 – denoting about 44.65% depreciation. Arguably, this level of depreciation contributed to a rise in consumer price inflation which stood at 17% in December 2014 from 13.8% in January 2014. GDP growth which stood at 15.0% in 2011 dropped to 8.8% in 2012 and further to 7.6% in 2013. In fact, GDP growth rate for 2014 was 4.2% down from a revised initial target of 7.1%.

While anecdotally the volatility of exchange rate has been linked to macroeconomic instability, very little attempt has been made to examine the factors behind it and the impact it has for both internal and external stability. Moreover, discussions surrounding the fluctuations in Ghana's exchange rate are only gleaned from public discourses on the economy with very little empirical and theoretical content. Understanding the key drivers of exchange rate volatility and the channels of manifestation is an empirical matter and this study examines the causes of exchange rate volatility and its impact on growth performance with the view to informing policy towards maintaining stable currency.

This study critically analyzed the causes of real exchange rate volatility and its effect on economic growth in Ghana relying on annual data spanning 1980 to 2013. Results show

that in the short-run, output is the most important driver of exchange rate fluctuations. In the long run, exchange rate volatility is significantly influenced by government expenditure and money supply growth and terms of trade shocks. Shocks to the real exchange rate are found to be mean reverting. We document a rather U–shaped relationship between real exchange rate fluctuation and long–term growth suggesting that effect on growth of volatility is not always deleterious.

The rest of the study is organised as follows. Section 2 discusses the empirical literature on the causes of exchange rate volatility and its effects on economic growth. Section 3 outlines the empirical strategy and model specifications while section 4 presents the empirical results. We discuss the implications of the long and short run determinants of exchange rate volatility and the volatility growth-nexus. Section 6 concludes.

2. Exchange rate volatility and economic growth: a review

The theoretical literature on the effect of exchange rate volatility on the economy is still a matter of great debate among economist. At the theoretical level, while some studies (see Obstfeld and Rogoff, 1998) posit that large swings in exchange rates can be costly to the domestic economy, studies such as Devereux and Engel (2003) contend that the welfare effects of exchange rate volatility are conditional upon the manner in which prices are set. The empirical literature is equally unsettled regarding the effects of exchange rate volatility on economic growth. In this brief review we survey the literature with the view to disentangle the various factors documented in the literature as important in driving the exchange rate volatility-growth nexus.

Following the liberalization of global foreign exchange markets, MacDonald and Nagayasu (1999) identify two compelling areas of particular interest for exchange rate dynamics: (i) significant long–run relationship between real exchange and fundamentals and (ii) relative significance of shocks in total exchange rate volatility. Generally, the causes of exchange rate volatility can be grouped into domestic real shocks affecting supply, domestic real shocks affecting demand, external real shocks and nominal shocks reflecting changes in money supply. In the standard Dornbursch (1976) model, unanticipated monetary policy shocks generate large variations in the exchange rate. Here, nominal shocks affect real exchange rate but only in the short-run. Because real exchange rate deviates from its long-run equilibrium path, extant studies on the cause of the deviations and results are largely torn between two schools. The first documents significant relationship between real exchange rate fundamentals including supply and demand factors where the former largely relate to the level of output capacity and expected to follow the Balassa–Samuelson hypothesis. This hypothesis assumes that productivity increases tradable sectors hence pushing up sector wages. This in effect puts an upward pressure on wages in the non–tradable sector and the economy as a whole. Because productivity does not increase in response to wage rise, prices of non-tradable goods are expected to rise leading to increase in the relative price of non-tradable to tradable goods, hence, an appreciation of the domestic real exchange rate. The demand factors relate to the role of government expenditure while the external shocks reflect changes in terms of trade, trade openness and capital flows. The second strand identifies the effects of real shocks in exchange rate volatility.

According to Clarida and Gali (1994), business cycles shocks are at the heart of fluctuations in real exchange rate. Gauthier and Tessier (2002) assess the effect of supply shock on the real exchange rate dynamics in Canada by employing the structural vector error correction model. They found that while majority of the stochastic depreciation of the exchange rate is accounted for by supply shocks, results from their study contradict the Balassa–Samuelson hypothesis as they found the exchange rate to appreciate in response to a

positive supply shock. For developing countries Kandil and Mirzaie (2008) decomposition of exchange rate movements into anticipated and unanticipated concludes theoretically that the unanticipated exchange rate movements significantly determine aggregate demand via exports, imports and the demand for local currency. However, unanticipated currency fluctuations affect aggregate supply through the cost of imported inputs. Conversely, the effect of anticipated increase in exchange rate on the supply channel has a limited effect on output growth and price. Hausmann et al. (2006) reveals that developing countries' real exchange rate is more volatile than that of the industrialized countries on account of high exposure to shocks (both real and nominal) by variations in the sensitivity of real exchange rate to shocks.

However, in their cross–country study, Devereux and Lane (2003) reveal that real exchange rate volatility in developing countries is reduced by external financial liabilities as external debt contracts financial constraints thus reducing the sensitivity of exchange rate to external shocks. Beyond the traditional causes of exchange rate volatility, Hausmann et al. (2006) examined the role of institutions proxied by rule of law on real exchange rate volatility and found a strong correlation between the two.

While a plethora of studies exist on the causes of exchange rate volatility, some authors remain sceptical whether volatility actually impacts on welfare. For instance, Devereux and Engel (2003) show that exchange rate volatility does not entail welfare cost and argue that domestic consumption is unaffected if prices are fixed to the currency of the foreign country. However, Obstfeld and Rogoff's (1998) theoretical work reveals that exchange rate volatility is indeed costly to the domestic economy through its direct and indirect effects on households and firms respectively. The former effect is based on the premise that households remain unhappy about exchange rate movements because of the difficulty in consumption smoothening as well as fluctuations in leisure consumption. The indirect effect however assumes that, in an attempt to hedge exchange rate risk, firms set higher prices in the form of risk premium. Empirically, Pallage and Robe (2003) found that in many poor countries, the welfare gain from expunging volatility could far outweigh the welfare gain from percentage-point increase in growth. Straub and Tchakarov (2004) also found evidence that even small effects of non-fundamental volatility can have a large effect on welfare.

Bacchetta and Van Wincoop (2000) examine the impact of volatility on trade and welfare in the context of both fixed and flexible exchange rate regimes. They employ the general equilibrium model on the assumption that uncertainty arises only from monetary and fiscal policy. An interesting finding from their study show that the monetary stimulus in a country that causes depreciation of its currency may not have much impact on its trade as depreciation of the exchange rate on one hand reduces imports but on the other hand, the increase in domestic demand relating to the monetary stimulus may increase imports in the same magnitude.[1]

On whether exchange rate volatility impacts on growth, Dollar (1992) found a negative relationship between growth and exchange rate volatility in a sample of 95 developing countries. Bosworth et al. (1996) study show that real exchange rate volatility reduces growth by lowering total factor productivity. Kandil (2004) examines the effects of exchange rate fluctuations on real output growth and price inflation in a sample of 22 developing countries. The authors argue that depending on the degree of openness, exchange rate volatility and depreciation in particular hurts economic performance by contracting

[1] Indeed, the net effect on trade will depend on factors such as demand elasticities for imports and ability of domestic producers to adjust to the depreciation. This will also follow the Marshall–Lerner condition that depreciation would improve a country's trade balance if the sum of the elasticities of import and export exceeds unity.

output growth and inflation. In the long-run, anticipated exchange rate fluctuations significantly increase and decrease inflation and output growth respectively.

Holland et al. (2011) examines the impact of real exchange rate volatility on long–run economic growth for advanced and emerging economies over the period 1970–2009 and found that, high (low) exchange rate volatility positively (negatively) affects real GDP growth rate. However, controlling for exchange rate volatility in a model containing levels of exchange rate and exchange rate misalignment renders the variables insignificant suggesting that exchange rate stability is more crucial in propelling long–run growth than exchange rate misalignment. However, while finding no significant link between exchange rate volatility and long–run productivity growth, Gadanecz and Mehrotra's (2013) recent study reveal non-linearities between real exchange rate volatility and output volatility among emerging market economies. Their finding suggests that real exchange rate volatility aids in absorbing shock as well as limit output volatility but too much of volatility in exchange rate increases output volatility.

Aghion et al. (2009) examines the role of financial development on the exchange rate volatility–productivity growth nexus exploiting panel data for 83 countries over 1960–2000. The authors argue that higher levels of exchange rate volatility adversely affect growth especially in economies with thin capital markets. They show that this effect is consistent with a model where real exchange rate uncertainty thwarts investment especially when agents are more credit constrained. It is reasonable to think that firms in higher income economies are more likely to internalise exchange rate fluctuations by effectively hedging against exchange rate risk. Broda (2004) and Edwards and Levy–Yeyati (2005) opine that flexible exchange rate regimes neutralize the effects of terms of trade shocks on growth. Aghion et al. (2009) however notes that even though exchange rate flexibility absorbs the effects of terms of trade shocks, its overall impact on growth is negative only for countries with less financial development. Ndambendia and Alhayky (2011) further examined the threshold effect in 15 sub-Saharan African countries and found that, volatility in exchange rate is deleterious to growth only when the ratio of domestic credit to GDP falls below 57%.

Regionally, Tarawalie et al. (2012) investigates the effects of exchange rate volatility on output growth and inflation in the West African Monetary Zone (consisting of Ghana, The Gambia, Guinea, Liberia, Nigeria and Sierra Leone) following exchange rate regime shift. Results from their study reveal that while exchange rate volatility is inflationary across all the countries, its effect on output growth differ. Specifically, volatility and depreciation in particular negatively affects real GDP growth in Liberia and Sierra Leone but positively impacts on output in the other countries albeit weakly. The difference in direction and magnitude of effect is not far-fetched from the differences in macroeconomic conditions prevailing in each country.

Eichengreen (2008) argues that maintaining appropriate and stable exchange rate volatility enables countries to explore their growth and development capacities. Excess exchange rate volatility has been identified to reduce the level of economic growth by creating business uncertainty, deteriorates competitiveness, lower productivity and profits as well as increasing domestic prices. This clearly has welfare implications and should be a policy concern. Changes in real exchange rate need to be guided by aligning exchange rate with fundamentals. This in effect maintains external competitiveness and domestic stability. In this study, we attempt to closely identify the causes of exchange rate volatility and the dynamic linkages between exchange rate volatility and economic growth in Ghana.

3. Data and empirical strategy

3.1. Data description and definition of variables

This study relies on annual time series data gleaned from different sources. Data on nominal exchange rates (RER) and interest rates (INTR) are obtained from the Bank of Ghana and Datastream. Data on real GDP per capita (RGDP), trade openness (OPEN), government expenditure (GEXP), money supply (MS), foreign direct investment and portfolio flows (FDI), output (OUTPUT), terms of trade (TOT), domestic credit provided to private sector (DOMCR), labour (LAB), gross fixed capital formation (GFCF) and inflation (INFL) were sourced from the World Development Indicators (WDI) of the World Bank. Real GDP per capita is used to denote economic growth while trade openness is defined as the ratio of the summation of imports and export to nominal GDP. Government expenditure is used as a measure of final government consumption expenditure expressed as a percentage of GDP. The money supply variable is proxied by broad money taken as proportion of GDP. FDI (net inflows) is expressed as a percentage of GDP and taken to include portfolio investments. This variable is used to proxy the country's integration with the international financial markets. The output variable refers to real GDP measured on annual basis in millions of US$, with 2000 as the base year. Terms of trade is the net barter terms of trade index, computed as the percentage ratio of the export unit value indexes to the import unit value indexes, using year 2000 as a reference. Labour is proxied by the percentage of economically active population. Domestic credit is measured relative to GDP and used to denote the financial resources provided by banks to the private sector. Capital formation is used as a proxy for investment rates and measured as a percentage of GDP. The inflation variable is the annual percentage change in the consumer price index and used to proxy macroeconomic (in)stability. Time series data for all the variables spanned 1980–2013 thus covering a 34–year period. This period is particularly relevant for the study as it captures Ghana's pre-transition period from fixed to a fairly floating regime. The period also coincides with the launch of the ERP.

3.2. Empirical strategy

Because changes in world prices or fluctuations in nominal exchange rate leads to instability in international commodity trade, this paper uses the real exchange rate to capture the effect of inflation differentials to provide a robust measure of the price of foreign currency in real terms. Following this, we construct our measure of real effective exchange (RER) as follows:

$$\mathrm{RER} = \mathrm{NER} \times {}^{\mathrm{P^w}}/_{\mathrm{CPI}} \qquad (1)$$

where NER is the nominal exchange rate defined as the amount of GH¢ needed to exchange US$1; $\mathrm{P^w}$ is the US price level proxied by the wholesale price index while CPI is the consumer price index reflecting domestic price levels. Thus, a rise (fall) in RER implies a real depreciation (real appreciation) of the Cedi.

3.2.1. Modelling volatility

To measure volatility, some authors have used the standard deviations where exchange rate volatility is measured according to the degree to which exchange rate fluctuates in relation to its mean overtime (Carrera and Vuletin, 2002; Schnabl, 2007; Gadanecz and Mehrotra, 2013). Using this measure is not without challenges. First, it assumes that, the empirical distribution of the exchange rate is normal. Second, it does not reflect the distribution between an unpredictable component of the exchange rate process hence failing to capture the past information of the exchange rate. The empirical flaws of this measure restricts its use hence the use of the autoregressive conditional heteroskedasticity (ARCH) or generalised ARCH (GARCH). In this study, we rely on the GARCH developed by Bollerslev (1986) not

only because exchange rate best follow the GARCH process (McKenzie, 1999), but because it captures past values of the exchange rate as opposed to the ARCH. Allowing the log of the real exchange rate to depend on its previous value for the mean equation, we derive our GARCH model as follows:

$$\mathrm{InRER_t} = \propto_1 + \beta^{|}\mathrm{InRER_{t-1}} + \mu_t \quad (2)$$

$$\mu_t|\Omega_t \sim iid\ \mathrm{N}(0, h_t)$$

$$h_t = \gamma_0 + \delta\mu_{t-1}^2 + \varphi h_{t-1} \quad (3)$$

where $\gamma_0 > 0$, $\delta \geq 0$ and $\varphi \geq 0$

Therefore, our conditional variance h_t captures the mean (γ_0), information about the previous volatility, μ_{t-1}^2 (ARCH term) and the past forecast error variance, h_{t-1} (GARCH term). Thus, our GARCH model allows the error term to have a time varying variance conditional on the past behaviour of the series hence reflecting the actual volatilities as perceived by agents.

The first step in determining cointegration is to test the integration properties of our variables relying on three different unit root tests: augmented Dickey–Fuller test (1979); Phillip–Perron test (1988) and the Kwiatkowski et al. test (1992). We compute the real exchange rate volatility in a vector autoregressive (VAR) model in the framework of Johansen and Juselius (1990) cointegration in order to determine the short– and long–run causes of real exchange rate volatility.

Starting with the VAR(q), we define Y_t as the unrestricted vector of variables integrated of order one (I(1)) as follows:

$$Y_t = A_0 + A_1 Y_{t-1} + \ldots\ldots\ldots\ldots\ldots + A_q Y_{t-q} + \varepsilon_t \quad (3)$$

where Y_t is $n \times 1$ vector; A's is an $n \times n$ matrices of parameters and ε_t is an $n \times 1$ vector of constant terms. The vector error correction model (VECM) can then be formulated by estimating the above equation in its first difference form as follows:

$$\Delta Y_t = \mu + \Gamma_1 \Delta Y_{t-1} + \ldots\ldots\ldots\ldots\ldots + \Gamma_{q-1}\Delta Y_{t-q-1} + \Pi Y_{t-q} + \varepsilon_t \quad (4)$$

where Δ is the difference operator; $\Gamma_i = (I - A_1 - A_2 - \ldots\ldots\ldots\ldots\ldots - A_q)$ (i = 1, 2, ….. q–1), $\Pi = -(I - A_1 - A_2 - \ldots\ldots\ldots\ldots\ldots - A_q)$, I is the identity matrix while $\Pi = n \times n$. While Γ_i captures the short–run effects, Π measures the long-run changes in Y_t. We remodel equation (2) into an error correction model as:

$$\Delta Y_t = \mu + \sum_{i=1}^{q-1} \Gamma_i \Delta Y_{t-1} + \Pi_i X_{t-q} + \varepsilon_t \quad (5)$$

The Johansen approach specifies the rank of matrix Π and can be further formulated as $\Pi = \alpha\beta'$ where α denotes the adjustment parameters entering each equation of the VECM while β'contains information about the long-run matrix of coefficients with α and β matrices dimensioned $n \times r$. When Π has a full rank (that is $r = n$), then our variables in Y_t would be stationary. However, when the rank of Π is zero (that is non-existence of linear combination of the variables in Y_t), then there would be no cointegration. Meanwhile, when Π has a reduced rank $0 < r < n$, then there would be r cointegrating relationships. The trace test statistics is used to determine the number of cointegration equations: the trace and maximum eigenvalue tests which test where the former and latter respectively tests the null hypothesis of at most r cointegrating relation. The appropriate lag length of the VECM is chosen according to the Akaike's information criterion. We examine the effect of exogenous shock

on exchange rate volatility using the impulse response function and variance decompositions of the forecast errors based on the VAR.

The second overarching aim of this paper is to determine the effect of exchange rate volatility on growth. On this score, our empirical strategy is based on estimation of a simple baseline equation relating growth and exchange rate volatility to a set of standard controls augmented by initial growth condition. In other words, we estimate the following growth equation:

$$y_t = \varpi_0 + \varpi_1 y_{t-1} + \varpi_2 \mathrm{RERV}_t + \varpi_3 Z_t + \varepsilon_t \quad (6)$$

where y_t is economic growth at time *t* proxied by log of real GDP per capita; y_{t-1} is the initial growth condition; RERV_t is the exchange rate volatility at time *t*; Z_t is a vector of control variables including gross fixed capital formation, government expenditure, labour, inflation, trade openness and indicators of financial development while ε_t is the error term.

The expected signs of the coefficients of our controls follow the standard growth literature which hypothesizes a positive relationship between growth, capital stock and labour. Terms of trade, financial development and openness are also expected to propel growth. While inflation is expected to negatively influence growth; the coefficient of government expenditure is mixed. Following from the Keynesian proposition, we expect government spending to boost economic growth by raising aggregate demand. However, higher government expenditure could also negatively affect growth because of crowding-out effect of private investment especially when the expenditure is heavily financed with taxes. It is imperative to note that, the inclusion of lag dependent variable poses potential endogeneity problems. To address this, the study utilizes the generalised methods of moments (GMM) developed by Arellano and Bover (1995) which combines the equation of interest in first differences (with lagged levels as instruments) and in levels (using lagged differences as instruments). Yielding robust GMM estimator depends on the validity of the instruments and this is checked using Hansen's test of over–identification of restrictions which evaluates the validity of the instrument subset by testing the null hypothesis that the set of identified instruments are uncorrelated with the residuals. In this test, failure to reject the null hypothesis show robust instruments. However, if the null hypothesis is rejected, we conclude that the estimators are not robust because the restrictions imposed by relying on the instruments are invalid. We also include a square of exchange rate volatility in the growth equation in order to examine possible non-linearities and threshold effect of volatility on growth. We posit three (3) main channels through which exchange rate stability affects growth: interest rate (as influenced by debts of firms denominated in foreign currency), trade (as influenced by international competitiveness) and macroeconomic stability (as influenced by a favourable environment for investment and consumption). We examine the transmission channels of volatility to growth by including in our growth equation (6), the interaction terms of exchange rate volatility and each of the channels. Regarding a prior expectation, exchange rate stability is expected to promote growth by lowering interest rates, promoting trade and subsequently lowering inflation. We use the 91–Day Treasury bill rate to proxy interest rate while trade and macroeconomic stability are proxied by exports and inflation respectively.

4. Results and discussions

4.1. Preliminary analysis

This section presents the results of our empirical analysis. We start by showing descriptive statistics of the indicators employed in our study. This gives us a good idea of the patterns in the data and the nature of the estimations and diagnostics to be carried out. Tables 1 and 2

below respectfully present the descriptive statistics and correlation coefficients of the variables.

Table 1:Descriptive statistics

	Mean	Median	Max	Min	Std. Dev.	Skewness	Kurtosis	J-B	CV
RER	3.69	0.44	21.75	0.00	5.97	1.85	5.38	27.44 [0.00]	1.62
TOT	133.67	125.42	209.52	89.22	32.30	0.72	2.43	3.39 [0.18]	0.24
RGDP	455.26	417.71	769.28	320.77	112.97	1.28	3.95	10.53 [0.01]	0.25
OPEN	62.72	65.64	116.05	6.32	31.08	-0.19	2.00	1.63 [0.44]	0.50
MS	22.59	22.69	34.11	11.30	6.93	0.00	1.70	2.41 [0.30]	0.31
DOMCR	8.47	7.11	16.00	1.54	5.19	0.12	1.39	3.77 [0.15]	0.61
EXPORT	26.02	25.11	48.80	3.34	13.20	0.04	1.99	1.46 [0.48]	0.51
FDI	2.58	1.61	9.52	0.05	2.97	1.17	3.00	7.78 [0.02]	1.15
GEXP	11.35	11.12	20.99	5.86	2.94	1.07	5.16	13.13 [0.00]	0.26
OUTPUT	8.5E+09	7.3E+09	2.0E+10	3.8E+09	4.4E+09	1.09	3.34	6.85 [0.03]	0.51
GFCF	18.04	20.57	31.13	3.53	7.78	-0.43	2.07	2.25 [0.32]	0.43
INFL	28.93	23.44	122.87	8.73	26.36	2.47	9.00	85.68 [0.00]	0.91
INTR	23.60	21.12	47.89	9.94	10.89	0.66	2.41	2.94 [0.23]	0.46
LAB	54.76	54.68	58.06	51.68	1.98	0.06	1.74	2.29 [0.32]	0.04

Notes: RER= real exchange rate, TOT= terms of trade, RGDP= real GDP, OPEN= trade openness, MS= money supply, DOMCR= domestic credit, EXPORT= export, FDI = foreign direct investment and portfolio investment, GEXP= government expenditure, OUTPUT= output, GFCF= gross fixed capital formation, INFL= inflation, INTR= interest rate, LAB= labour. Number of Observations= 34. *p*–values are shown in [ ].

While the mean value of the real exchange rate is GH¢3.69, the value of the standard deviation is 5.97 showing a higher degree of variability. The value of the skewness shows real exchange rate is highly skewed to the right. The value of the kurtosis and skewness show a non-normal distribution of real exchange rate suggesting that our exchange rate distribution is leptokurtic. A formal test of normality is the Jarque-Bera (J-B) test which is asymptotically chi-squared distributed with 2 degrees of freedom (Asteriou and Hall, 2011). From Table 1 we report a high J-B test statistic for the real exchange rate, real GDP, FDI, government expenditure, output and inflation, thus flatly rejecting the null hypothesis of normality in these series. The non–normality of the exchange rate is akin to empirical evidence in the literature (see Koay and Kwek, 2006 for instance). Broad money supply (MS) is perfectly symmetrical given the value of its skewness and has a mean value of 22.59%. Apart from being normally distributed given the J-B test statistic and p-value, money supply does not show much variability over the sample period. Furthermore, with the exception of trade openness (OPEN) and gross fixed capital formation (GFCF), all the variables are positively skewed. The average real GDP per capita is US$455.26 reiterating the low income level of Ghana during the sample period. Also, its standard deviation shows significant variations in

the income levels. While the standard deviation measures absolute variability, the coefficient of variation (CV) computed as the ratio of standard deviation to mean measures the relative dispersion of the variables. This implies that the higher the CV, the greater the variability thus allowing the direct comparison of the relative volatility of our series given the differences in means. The results suggest that the most volatile variable is real exchange rate. Exogenous variables vary far less than exchange rate. Real variables exhibit different levels of variability with terms of trade showing the least. Volatility in FDI and portfolio flows is exceedingly higher than the terms of trade, government expenditure and output. Among the exogenous variables, inflation exhibited more volatility given its relatively higher CV followed by domestic credit. Trade openness and export show similar variability perhaps due to the direct relationships.

Table 2: Correlation coefficients

Variables	RERV	OUTPUT	MS	TOT	RGDP	INTR	FDI
RERV	1.000						
	–						
OUTPUT	-0.591*	1.000					
	[0.000]	–					
MS	-0.606*	0.761*	1.000				
	[0.000]	[0.000]	–				
TOT	0.135	0.587*	0.246	1.000			
	[0.453]	[0.000]	[0.168]	–			
RGDP	-0.545*	0.996*	0.736*	0.614*	1.000		
	[0.001]	[0.000]	[0.000]	[0.000]	–		
INTR	-0.327*	-0.170	0.120	-0.560*	-0.186	1.000	
	[0.063]	[0.346]	[0.505]	[0.001]	[0.301]	–	
FDI	-0.486*	0.865*	0.599*	0.575*	0.858*	-0.142	1.000
	[0.004]	[0.000]	[0.000]	[0.001]	[0.000]	[0.431]	–

Notes: Variable definition and comments same as Table 1 above.

Table 2 presents the correlation coefficients of real exchange rate volatility and other variables including real GDP per capita, money supply, terms of trade, output, interest rate and FDI. Here, we pay special attention to the correlation between real exchange rate and all the other variables. Our results suggest that, real exchange rate volatility is negatively and significantly correlated with all the variables except terms of trade which is positive and insignificant. Correlations between real exchange rate volatility and money supply on one hand and exchange rate volatility and output on the other hand are much stronger. Real GDP is positively correlated with output, money supply and terms of trade. These correlations are unsurprising given the role of productivity, financial deepening and terms of trade in GDP. Apart from volatility, terms of trade positively correlates with output and money supply. However, only its correlation with output is significant.

4.2 Estimation of real exchange rate volatility

This section presents the results of the estimation of exchange rate volatility using a GARCH (1, 1) model (see Table 3). The robustness of our results is examined to ensure model adequacy. The Ljung-Box statistics on the standardized residuals and the standardized squared residuals of the estimated GARCH models show no evidence of serial correlation. And so is the ARCH LM test which suggests that there is no evidence of conditional heteroskedasticity given the rather low LM statistic (8.0651) and high *p*-value (0.7800).

Table 3: Estimation of real exchange rate volatility

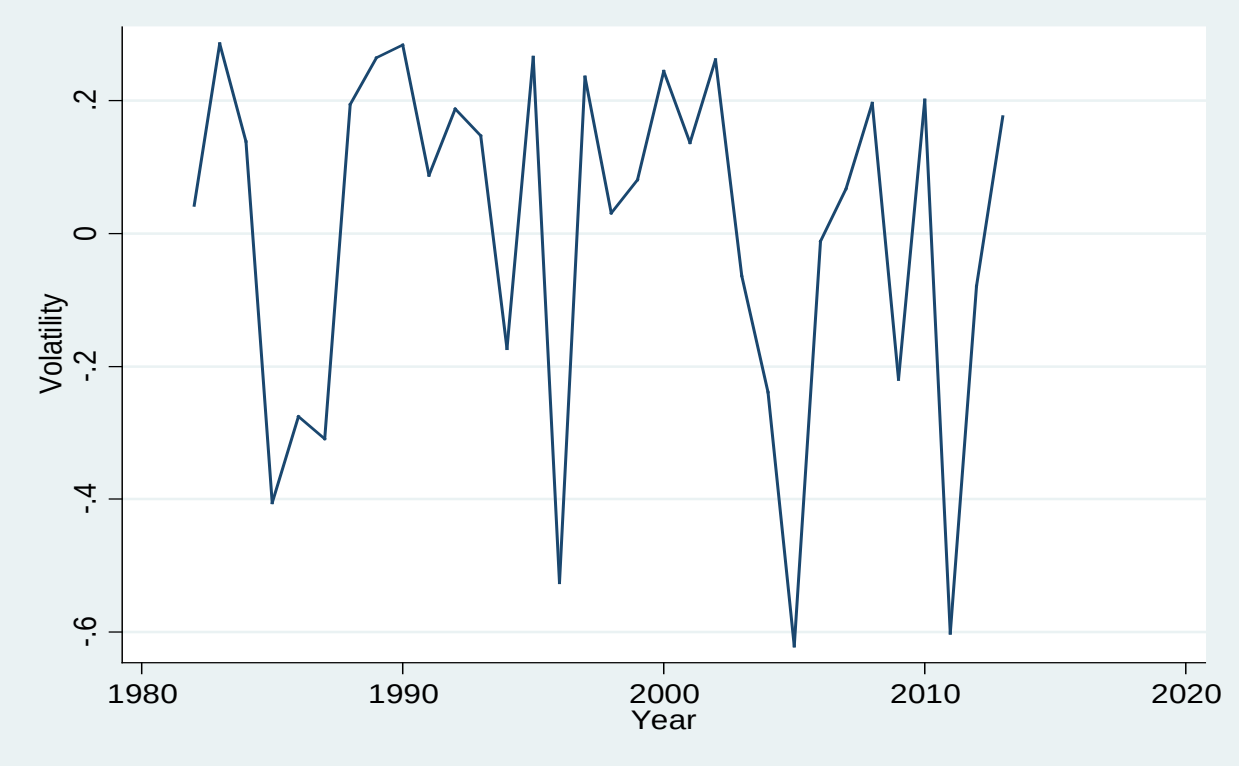
Variable	Coefficient
Mean equation	
Constant	0.1183
	(3.572)***
LRER(-1)	0.9359
	(30.51)***
Variance equation	
Constant	0.0008
	(0.241)
ARCH(1)	-0.2201
	(-0.870)
GARCH(1)	1.154***
	(3.271)
LBQ[12]	15.834[0.199]
LBQ^2[12]	8.801[0.720]
ARCH[12]	8.0651[0.7800]
ARCH[1]	0.00202 [0.9642]

Notes: Test statistics are shown in ( ) while *p*-values are in [ ]. LBQ[12] and LBQ^2[12] are the Ljung-Box test on the residuals and the squared residuals of the GARCH model for 12 lags respectively. ARCH [1] and ARCH [12] is the Lagrange Multiplier (LM) test on the residuals.

*** Significant at 1% significance level.

Results from the conditional variable equation reveal that the mean γ_0 from equation (3) is positive albeit insignificant. The previous forecast error – GARCH term (h_{t-1}) – is however positive and significant at 1%. Interestingly, further results reveal that previous information about the real exchange rate volatility as measured by the squared residual (μ^2_{t-1}) from the mean equation is negative and flatly insignificant at conventional levels. The insignificance of the ARCH effect is consistent with LM test on the residuals thus indicating that GARCH specification is appropriate for modelling exchange rate volatility. The sum of the coefficient on the lagged squared error (δ) and lagged conditional variance (φ) is very close to unity ($0.93 \approx 1$) implying that volatility shocks are highly persistent suggesting the presence of volatility clustering – a period where large (small) changes in exchange rate shock is followed by large (small) changes over a longer period. The volatility clustering is obvious from Figure 1 below. Similar to most financial and economic time series variables, the exchange rate exhibits significant periods of high volatility followed by relatively more tranquil periods of low volatility.

Figure 1:Real exchange rate volatility



The real exchange rate volatility is presented above with the hope of providing some insights on the degree of exchange rate risk at least over the sample period. Overall, exchange rate has been very volatile. The change from fixed to "managed" floating regime in 1986 saw a sharp decline in volatility followed by marginal rise. The volatility trend show visible but sharp decline in 1995–1996 perhaps due to the abolishing of wholesale auction system which ushered both the commercial banks and foreign exchange bureau into a competitive financial environment. This period is followed by a modicum of stability until another deep spike is observed in 2004–2005. This downward trend could be attributed to the election and post-electoral period where government incurred higher expenditure thus contributing to currency depreciation.

4.3 Unit root tests

The results of the unit root test presented in Table 4 above are ran in two scenarios – first with constant and no trend; and second with constant and trend. The ADF test reveals non-stationary variables in their levels. However, all the series attained stationarity upon first differencing. This conclusion holds whether or not we include a trend. The unit root property of the variables remains robust to testing approach. Results of the PP and KPSS test indicate that each of the series is non–stationary when defined in level including or excluding a trend.

Table 4:Unit root results

Variables	ADF		PP		KPSS	
	Constant	Trend and constant	Constant	Trend and constant	Constant	Trend and constant
MS	-1.006	-2.898	-0.909	-2.960	0.573	0.114
ΔMS	-6.341*	-6.224*	-6.341*	-6.224*	0.125*	0.121*
INTR	-2.136	-2.078	-2.077	-1.958	0.176	0.175
ΔINTR	-5.986*	-5.951*	-6.105*	-6.615*	0.156*	0.178*
TOT	-1.718	-1.246	-2.175	-2.669	0.239	0.201
ΔTOT	-5.724*	-6.193*	-6.391*	-9.065*	0.462*	0.155*
OUTPUT	3.047	0.091	3.196	-2.283	0.673	0.205
ΔOUTPUT	-4.727*	-5.430*	-3.033**	-3.489***	0.581*	0.135***
FDI	-0.952	-2.754	-0.895	-2.740	0.570	0.071
ΔFDI	-5.251*	-5.186*	-5.287*	-5.199*	0.114*	0.104*
RERV	-1.696	-2.673	-1.776	-2.401	0.730	0.087
ΔRERV	-5.165*	-5.141*	-5.275*	-5.280*	0.153*	0.114*

Notes: The Bandwidth of PP is selected by Newey-West using Bartlett kernel.
* Significant at 1% significance level.
** Significant at 5% significance level.
*** Significant at 10% significance level.

First differencing the series eliminates the non-stationarity components and the null hypotheses of non-stationarity is robustly rejected at conventional levels suggesting that all our variables are integrated of order one, *I*(1). Thus, the precondition for cointegration is established since our variables are integrated of the same order. The next step to cointegration involves the estimation of the VAR model once the variables entering the general VAR are identified entails the determination of the lag length that minimizes information criteria. On this score, we select a lag length of one (1) based on the Schwarz information criterion (see Appendix).

4.4. Cointegration test

The results of the Johansen cointegration test based on the trace test are shown in Table 5 below. The test determines whether or not there exists a long–run relationship among volatility, output, FDI and portfolio investment, money supply, interest rate and terms of trade. We start with the null hypothesis of no cointegration and conclude on the existence of at least one (1) cointegrating vector if the null hypothesis is rejected.

Table 5:Johansen trace cointegration test

Null Hypothesis	Eigenvalue	Trace Statistics	0.05 Critical Value	Prob.**
r = 0	0.664571	113.2595	95.75366	0.0018*
r ≤ 1*	0.613556	79.39682	69.81889	0.0071*
r ≤ 2*	0.507551	49.92297	47.85613	0.0315**
r ≤ 3	0.375263	27.96366	29.79707	0.0802
r ≤ 4	0.263130	13.38047	15.49471	0.1016
r ≤ 5	0.118636	3.914819	3.841466	0.1479

Notes: * Significant at 1% significance level.
** Significant at 5% significance level.

From the Table 5, the results suggest at most 3 cointegrating equations thus providing evidence of a long–run relationship among the variables.

4.5. Drivers of real exchange rate volatility

Using the results obtained from the VECM, Table 6 reports the variables that determine the short-run volatility of exchange rates. We also report the error correction term indicating how short–run deviations are corrected according to the speed of adjustment.

Table 6:Drivers of real exchange rate volatility

Variable	Coefficient	Stand. Error	z–statistic	*p*–value
Constant	-0.076	0.052	-1.47	0.142
FDI	0.068	0.054	1.27	0.206
Government expenditure	0.015	0.014	1.07	0.312
Output	-0.025	0.002	-11.59	0.000*
Money supply	0.013	0.011	1.26	0.208
Terms of trade	0.007	0.010	0.65	0.518
ECM	-0.069	0.041	-1.70	0.090***
$\boldsymbol{R^2}$	0.202		HQIC	-14.471
$\boldsymbol{\chi^2}$ [*p*–value]	7.6097 [0.022]		SBIC	-13.950
AIC	-14.729		Log Likelihood	252.6589

Notes: * Significant at 1% significance level.
*** Significant at 10% significance level.

The value of the R^2 indicates that about 20% of the variation in exchange rate volatility is due to variations in the independent variables. The overall model significance is checked relying on χ^2 and *p*–value which show that our variables are jointly significant at 10% level. Results from the VECM reveal that terms of trade, money supply, government expenditure and the proxy for the international financial integration – FDI and portfolio investment – positively affects volatility albeit insignificantly. The insignificance of these shows that in the short-run, these variables are weakly exogenous and do not explain the short-term volatility. The coefficient of output is negative and significant at 5% level suggesting that decrease in output increases volatility in exchange rate. The coefficient of the error correction term (ECT) is negative and significant indicating that following a short run exchange rate shock, about 6.9% deviation from long run equilibrium is corrected per annum and takes approximately 14.5 years for all disequilibrium to realign fully to the long-run equilibrium. While this is the case, we further report the normalised cointegrating equation in Table 7 below by normalising the volatility since the interest lies on the drivers of volatility relying on the endogenous variables.

Table 7**:** Normalised cointegrating equation

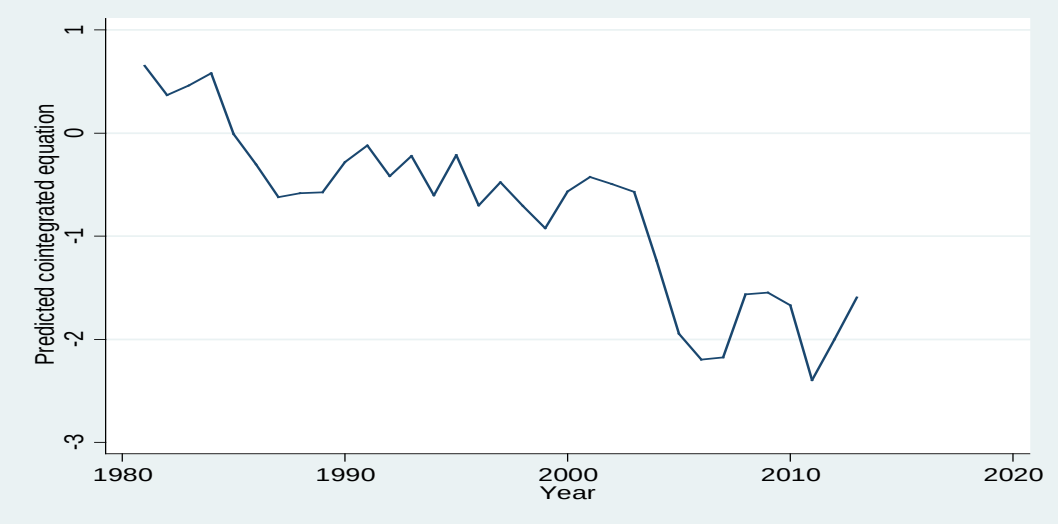
Variable	Coefficient	Stand. Error	z–statistic	*p*–value
Constant	70.704	–	–	–
FDI	0.879	.409	2.15	0.032**
GEXP	5.058	1.709	2.96	0.003*
OUTPUT	-10.146	2.040	-4.97	0.000*
MS	6.686	1.944	3.44	0.001*
TOT	-9.070	1.743	-5.20	0.000*

Notes: ** Significant at 5% significance level.
* Significant at 1% significance level.

The effect of output remains robustly negative and significant (at 1%) suggesting that volatility reduces (increases) in response to higher (lower) productivity. The results also show a negative and significant relationship between terms of trade and real exchange rate volatility. The implication is that an improvement in terms of trade reduces volatility. A plausible reasoning for this is as a result of improvement in external purchasing power capacity which reduces import prices. The coefficient of FDI is positive and statistically significant implying that integration into the international financial market increases long-run volatility. The effect of government expenditure is positive and significant at 1% suggesting that an expansion of government consumption expenditure increases exchange rate volatility. Here, demand factor – government expenditure – has similar effect as real effect. Nominal shock such as growth in money supply is positively associated with long-run exchange rate movements. A plausible explanation for this is that, the expansion in government expenditure increases the overall demand for non-tradable goods.

These findings thus suggest the importance of domestic real shocks affecting demand and supply as well as external and nominal shock in influencing long-term fluctuations in real exchange rate volatility. It is imperative to note that inferences on our parameters of the adjustment coefficients depend critically on the stationarity of the cointegrating equation. We thus present the cointegrated graph equation in checking the model specification.

Figure 2:Predicted cointegrating equation



The graph shows that large shocks are apparent and have visible effects on the predictions from the cointegrating equation. Notable are the significant negative trends between 1983–1987 and 2003–2006. These we respectively attribute to the effect of the gradual devaluation of the currency in 1983 as part of the ERP, the subsequent adoption of the "managed" floating regime in 1986 and the 2004 general elections. Also clear is the apparent sharp rise

in the volatility in 2007–2008 emanating from the effect of the cedi redenomination in 2007. Notwithstanding this, the graph generally reveals a negative trend.

4.7. Forecast error of volatility

In order to get a fair view of the contribution of the variables to shocks in the exchange rate we employ variance decomposition. We examine the dynamics of the VAR by looking at the proportion of the movements in the real exchange rate volatility that are due to "own" shocks, versus shocks to the other variables. The question we pose at this stage is, 'how much of the *s*-step ahead forecast error variance of exchange rate volatility is explained by innovations in output, FDI among others?' As discussed in Koop et al. (1996) and Pesaran and Shin (1998), the ordering of the variables is important in deriving the *s*-step ahead forecast error variance decompositions. To this end we carry a Cholesky decomposition of the variance–covariance matrix of error terms to orthogonalize shocks. We decompose the error variance by focusing on the real exchange rate volatility variable. The results are reported in Table 8.

Table 8:Variance decompositions

Period	S.E	RERV	FDI	TOT	GEXP	MS	OUTPUT
1	0.2669	100.00	0.0000	0.0000	0.000000	0.0000	0.0000
2	0.3274	93.956	3.4146	0.2857	1.838105	0.0597	0.4454
3	0.3607	85.560	9.3807	0.4187	2.888755	0.3498	1.4009
4	0.3851	78.086	15.419	0.3688	2.964932	0.6828	2.4779
5	0.4046	72.405	20.100	0.4733	2.717976	0.8786	3.4240
6	0.4209	68.315	23.139	0.8911	2.533386	0.9327	4.1873
7	0.4349	65.421	24.837	1.5356	2.483144	0.9129	4.8089
8	0.4472	63.377	25.647	2.2398	2.512597	0.8720	5.3505
9	0.4582	61.908	25.956	2.8794	2.559323	0.8319	5.8650
10	0.4684	60.801	26.020	3.4031	2.589213	0.7968	6.3886
11	0.4780	59.895	25.992	3.8108	2.592781	0.7665	6.9415
12	0.4874	59.079	25.950	4.1257	2.572855	0.7414	7.5305
Average		72.40	18.82	1.70	2.35	0.65	4.07

The variance decompositions suggest that shocks to exchange rate are typically driven by its own volatility especially in the 1st period where it fully accounts for all its own volatility. Conversely, in the 2nd period, exchange rate volatility explains about 94% of its volatility while FDI and government expenditure respectively (and marginally) accounts for about 3% and 5%. Apart from volatility itself, further results show that FDI significantly explains majority of the variance error of volatility relative to other variables. Money supply does not explain any significant variance of the exchange rate as its relative importance is less than 1%. However, while its ability to explain its volatility consistently decreases over time, it nonetheless explains majority of its volatility and by the end of the 12th period.

Figure 3: Average variance decompositions over 12 periods

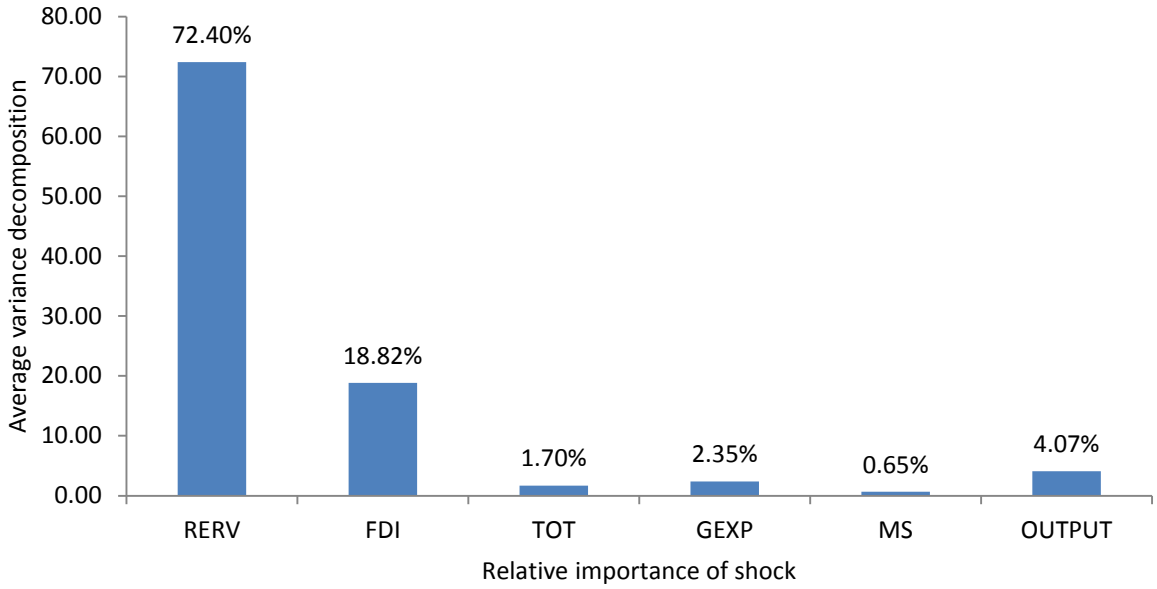


Figure 3 presents the average variance decomposition over 12 periods which clearly indicates that, 72% of the volatility in real exchange rate is largely explained by itself while 18.8% and 4.07% are respectively explained by changes in FDI and output with money supply explaining the least (0.65%). While real shock emanating from terms of trade significantly drives long-run exchange rate volatility, its contribution to overall exchange rate variance is only 1.7%.

4.8. Effect on growth of exchange rate volatility

While the preceding sections the documents the sources of real exchange rate volatility, the question of whether real exchange rate volatility affects economic growth remains an empirically unverified claim. Anecdotally, the uncertainty introduced by large swings in exchange rates affects investment and consumption decisions. These in turn may impact on economic growth performance. To guide policy, a clear understanding of the nexus between exchange rate volatility and economic growth is therefore important. The next section systematically examines the effect of real exchange rate volatility on economic growth. Table 9 reports the GMM results of 3 different specifications of the effect of real exchange rate volatility on economic growth. The Hansen test of over-identifying restrictions is used to assess the overall validity of the instruments. The low J statistics and the high *p*-values in all the models fail to reject the null hypotheses – evidence that our set of instruments is valid. The R-squares indicate that over 90% of the variation in growth is explained by variations in the independent variables. Furthermore, the high (low) Wald χ^2(*p*-values) shows the overall significance of the model.

Table 9:Effect of real exchange rate volatility on growth – GMM Estimations

Variable	1	2	3
Constant	-4.144 (3.201)	-4.015 (1.734)	-0.292 (1.607)
$RGDP_{t-1}$	0.706 (0.255)*	0.669 (0.152)*	0.913 (0.113)*
RERV	-0.008 (0.004)**	0.019 (0.032)	-0.114 (0.042)*
GEXP	0.079 (0.064)	0.070 (0.046)	0.003 (0.030)
GFCF	0.036 (0.037)	0.031 (0.025)	0.005 (0.025)
INFL	-0.024 (0.007)*	-0.023 (0.008)*	-0.083 (0.023)*
LAB	2.818 (2.231)	2.814 (1.211)**	0.344 (1.076)
OPEN	0.029 (0.022)	0.043 (0.029)	0.163 (0.045)*
DOMCR	0.070 (0.029)**	0.075 (0.023)*	0.057 (0.022)*
RERV square		0.004 (0.005)	0.019 (0.006)*
Interactions/Transmission channels:			
RERV*INFL			-0.023 (0.008)*
RERV*INTR			0.007 (0.004)***
RERV*TRAD			0.021 (0.011)***
$\boldsymbol{R^2}$	0.990	0.991	0.993
Wald $\boldsymbol{\chi^2}$	7240.45	5815.73	7683.08
p – value	0.000	0.000	0.000
Hansen's J statistic $\boldsymbol{\chi^2}$ [p – value]	8.528 [0.202]	9.783 [0.201]	9.321 [0.231]

Notes: Dependent variable is log of real GDP per capita. Values in ( ) are robust standard errors.
* Significant at 1% significance level.
** Significant at 5% significance level.
*** Significant at 10% significance level.

In model 1, our results indicate that real exchange rate volatility negatively and significantly affects growth suggesting that volatility is deleterious to long-term growth. In particular, a 1% increase in volatility reduces growth by 0.8%. Inflation negatively influences growth implying that macroeconomic instability is inimical to growth where a unit-percentage increase in inflation significantly reduces growth by 2.4%. Domestic credit is however growth-enhancing as its coefficients are positive and significant in all the models. However, capital formation, government expenditure, labour and trade openness are not significant drivers of growth.

Model 2 includes a quadratic term of exchange rate volatility and the results show a positive effect of volatility and its square on growth. However, none of these are statistically significant. The effect of labour on growth is positive and gains significance when the quadratic term is controlled for. In model 3, we examine the transmission channels of volatility on growth. Here, the effect of volatility is negative and significant (at 1% level). However, its quadratic term is positive (and significant at 1%) suggesting that volatility–growth nexus is intrinsically non-linear and U–shaped in particular.

Trade openness is positive and significant when the transmission channels are controlled for. The coefficients of all the channels are significant. The interaction term of volatility and trade is positive suggesting that real exchange rate fluctuations affect growth by impacting on the competitiveness of domestic export and import competing firms. However, excess volatility deteriorates competitiveness thus lowering firms' profit. Volatility also affects growth by lowering macroeconomic instability proxied by inflation. Interestingly, real exchange rate volatility affect growth by increasing interest rates. The implication is that sharp depreciation (appreciation) which raises (reduces) interest rates increases (decreases) capital inflows hence affecting growth.

5. Policy implications of the causes and effects of exchange rate volatility

Based on the results of our empirical analysis we highlight the drivers of exchange rate volatility in Ghana in the short and long run. We also examine the important channels of the effect of exchange rate volatility on economic performance. Given the overall objective of this research, we then examine the policy implications of our findings to help guide economic policy.

So far the literature is inconclusive on the drivers of exchange rate volatility. Focusing on the Gh¢/US$ exchange rate our study indicate that in the short run monetary variables are not significant in driving exchange rate volatility. It has been taken for granted in the international macroeconomics literature that a high correlation between the nominal and real exchange rate is evidence in support of the overshooting model of Dornbush (1976) which emphasizes monetary shocks and sticky prices. However, shocks to taste, technology, fiscal and trade may even be more important than monetary shocks particularly for developing countries. This statement holds irrespective of the exchange rate regime a country operates (see Stockman, 1987 and 1988). The most important driver of exchange rate volatility in Ghana is changes in output. We particularly found an inverse relationship between output and real exchange rate volatility, suggesting that decreases in output heighten volatility in real exchange rates. From the traditional monetary version of exchange rate volatility, one should expect these shocks to manifest in nominal exchange rates as the authorities attempt to stabilise the price level. However, we do not see this in the Ghanaian case. Rather we document that output fluctuations mirror in weakening economic fundamentals, including wide movements in exchange rates. In the era of flexible regimes[2], output fluctuations should be moderated by changes in the nominal exchange rate, since that is probably the strongest appeal of floating exchange rates in the first place. To this end, interventions, whatever their motivations to short run output fluctuations, first may be too costly, and second may not necessarily yield the intended benefits. In the light of our findings, therefore, optimal policy should be one that focuses on the source of the output fluctuations rather than intervening in the foreign exchange market. Specifically, the impact of the ongoing energy crisis and its attendant effect on domestic firm performance, the increasing deterioration in productivity may be important avenues of concern. We therefore hold the view that interventions such as those introduced by the Bank of Ghana in February 2014 to stem the tide of the depreciating Cedi typically came too late to prevent severe currency misalignments. These interventions, in turn, may exacerbate the currency depreciation and trigger major economic distortions such as increased black market transactions. And as emphasized by Tweneboah and Alagidede (2015), a switch to a more stable international currency such as the US dollar by domestic agents may ensue if volatility is excessive.

One important implication of our results on the financial sector is the finding that portfolio flows is not important driver of exchange rate volatility in the short run. In contrast to large emerging markets where hot money inflows tend to cause large swings in the exchange rate, Ghana's relatively small and illiquid financial sector seem to be insulated from the ravages of hot money flows. Not only is the economy not receiving sufficient hot money flows, the few that do flow are not of the disruptive type.

[2] Under a fixed regime, the domestic authorities could potentially respond to stem the tide of loss international reserves to forestall devaluation. Optimising agents foresee that the authorities would take these actions to stabilise the exchange rate. This may either lead to a self-fulling crisis whether the expectation of further depreciation leads to speculative attacks and abandonment of the peg, or on the positive side, the expectation of the authorities' intervention stabilizes the exchange rate at its current equilibrium level.

What is surprising in our results is the fact that short run changes in the money supply are insignificant. Standard macroeconomic theory is at variance with this conclusion. However, our results do suggest that domestic economic policy geared at moderating output fluctuations could correspondingly lessen the impact of large fluctuations in the exchange rate. In terms of our results, the real action seems to be in the long run to which we now turn our attention. Concluding on the short run, our estimates indicate that the terms of trade, domestic money supply, government expenditure and capital flows (as measured by FDI and portfolio investment) tend to be exogenous.

We show that a shock to the terms of trade affect volatility of exchange rate in the long run. Government spending also affect the exchange rate only in the long run. Consistent with theory, a shock to the exchange rate tends to mean revert. Our estimates indicate that about 6.9% deviation is corrected per annum. And this takes approximately 14.5 years for all disequilibrium to realign fully to the long-run equilibrium. Although flexible exchange rate allows relative prices to adjust through changes in the nominal exchange rate, the rather long period and slow adjustment process could have severe welfare implications for producers and consumers as the effects of large swings in the exchange rate impact on input prices, amplify investment uncertainties and impact on consumption decisions. Summarising the main drivers of exchange rate volatility, we note that own volatility tends to be more important than real and nominal factors in Ghana. This is estimated to be over 70% from our variance decomposition. The rather large impact of own shocks clearly highlights the important role of speculators, noise and fads in the foreign exchange market in Ghana. We posit that some of these could be due to microstructure biases and the activities of uninformed traders in assimilating macroeconomic news. This finding opens the door for further studies on the role of speculation and noise in exchange rate dynamics in Ghana. Overall we show that FDI, output and government expenditure are important drivers of exchange rate volatility, accounting for 19%, 4.1% and 2.4% respectively. Terms of trade (1.7%) and money supply (0.7%) account for the remaining volatility of real exchange rates. In the long run therefore, both real and monetary factors are important in explaining exchange rate volatility.

Ghana's electioneering and government expenditure nexus deserves nuanced attention. From the 4th Republic to date, the four–year political cycle has seen remarkable spending excesses in each election year. Ghana's experience in election years has been but predominantly fiscal indiscipline leading to excessive large fiscal deficits culminating in exchange rate depreciation. The remnants of the past three elections (2004, 2008 and 2012) were marked by an excessive expenditure – largely recurrent – in the form of wages and subsidies. It is therefore not surprising that these periods saw massive depreciation of the currency. In fact, the excesses of government in the 2008 election led to a sustained depreciation of the Cedi from the second half of 2008 until July 2009 which ensued an epoch of austerity measures. Experience in 2012 was not different. Government expenditure as a proportion of GDP was up from 16.64% in 2011 to 20.98% in 2012. The resultant effect was a rather high exchange rate volatility largely driven by fiscal pressures.

On the exchange rate volatility–economic growth nexus, our study found a negative and significant relationship between the two. We conjecture a number of possible channels through which this can occur in practice after implementing a bunch of controls in our regressions. One channel is through trade which has been addressed in a vast number of studies (see Dell'Ariccia, 1999; Arize et al, 2000; McKenzie, 1999) and confirmed by this current study. As a commodity dependent country if commodity traders are sufficiently risk averse (or even risk neutral), higher exchange rate volatility may lead to a reduction in the volume of trade as agents expected profits may be negatively affected (see Brodsky, 1984). Greater volatility may even lead economic agents to demand higher prices to cover their exposure to currency risk. This may then put pressure on the domestic price level. These

connections are at the heart of the recent experience of the Ghanaian economy. Moreover, the volatility of the exchange rate is likely to impact on FDI because foreign investors tend to choose locations that have stable political regimes and economies. Excessive volatility in exchange rates adds substantial risk premiums to foreign investors' returns and negatively affects their appetite for volatile economies. Sowa (2006) note that imbalances on both the domestic and external front of an economy do not send the right channels to investors. Foreign direct investment will be lower under higher exchange rate volatility given that investors would factor in the currency risk as an input in the decision to invest. Recent data from the World Development Indicators show that Ghana's FDI inflows as a share of GDP which stood at 8.14% in 2011 successively decreased to 7.89% and 6.70% in 2012 and 2013 respectively. Specifically, FDI inflows to the country reduced from US$ 3.293 billion in 2012 to US$ 3.226 billion in 2013 (UNCTAD, 2015). Given that Ghana already receives less FDI this may be detrimental to growth. Assuming it was possible to diversify currency risk, domestic policy would still have to adjust to accommodate this risk. This may reflect in domestic tax concessions and rebates, among other incentives that are typically put in place to attract FDI. The long run consequences of these on growth performance are always negative.

The consequences of exchange rate volatility also hold lessons for debt. A strong depreciation of the Cedi against the US dollar, for example, implies a higher cost of servicing an external debt that is mainly denominated in dollars. For instance, recent data from World Bank's International Debts Statistics reveals that Ghana's external debt amounted to US$ 7.17 billion in 2005 and decreased to US$ 3.68 billion in 2007. Because exchange rate was relatively stable during this period, interest payments amounted to US$ 112.7 million and US$ 103.3 million respectively. It is needful to note that after 2007, Ghana's external debt position continued to rise annually. In 2009, the external debt which stood at US$ 7.2 billion increased by US$ 2.1 billion in 2010 with total debt accumulating to US$ 15.8 billion in 2013. The rise in debt stock was accompanied by higher debt servicing. While the interest payments on external debt was US$ 139.6 million in 2009, the total amount of interest paid on the debt increased to US$ 335.7 million in 2013 up from US$ 128.7 million and US$ 219.9 million in 2011 and 2012 respectively. Arguably, this higher cost of servicing external debts and the growing size of the debt leave painful consequence of reduced spending on social protection programmes and other developmental commitments (Sowa, 2002) with its preeminent effect on welfare.

Exchange rate volatility has also proven crucial in the real estate sector particularly on mortgage financing. The uncertainty generated by the high volatility does not only disrupt timely repayments but also negatively affects access to mortgages quoted in foreign currencies especially the US Dollar. Apart from decreasing the welfare gains of existing mortgages in the form of higher financing, depreciation of the Cedi denies would be property owners from accessing and owning mortgage house(s) on account of rather high pricing.

The net effect of our study establishes that excessive volatility is detrimental to growth. But is this always the case? If indeed the answer was in the affirmative, the consequences could be dire. However, our study confirms that, exchange rate volatility–economic growth nexus is U–shaped. In other words, real exchange rate volatility is detrimental to growth up to a certain threshold where it begins to positively influence long-term growth. Thus higher volatility does not always hurt growth. For instance, greater exchange rate fluctuations could lead to a more efficient resource allocation thus propelling growth. Furthermore, excessive volatility could promote firm innovation and productivity as domestic firms cannot fully rely on the undervalued exchange rates and intervention in foreign exchange market in order to maintain international competitiveness. This finding is particularly consistent with Gadanecz and Mehrotra (2013). The real challenge is whether

Ghanaian firms are able to reap the benefits arising from the volatile exchange rate environment, in particular if this interacts with erratic power supplies and other associated costs of doing business.

To the extent that variation in real exchange rate is largely accounted for by its own volatility, and the impact of exchange rate volatility on growth is non-linear, a number of policy insights can be gleaned by domestic policy authorities such as the Bank of Ghana. What is the optimal way to intervene in the exchange rate market? Our study suggests that as long as a floating exchange rate regime prevails, shocks to the exchange rate can be self-correcting. Continuing exchange rate interventions especially the unsterilized type are more likely to yield excessive real exchange rate volatility. This is clearly the case when the Bank intervened in the market in February, 2014. What is needed is a good understanding of the inputs that should enter the exchange rate policy equation in order to appropriately model and forecast both the level and volatility. The central bank can thus strengthen its research department in this regard through more robust analysis. Own volatility suggests that most of the news is not adequately reflected in the foreign exchange market. Transparency of forecast and policy decisions would help the public and markets understand central bank's actions thus decreasing the level of uncertainty and speculation.

There are important lessons for domestic price stability. Active intervention in exchange rate market may yield counterproductive policy response especially when shocks are real such as terms of trade and output. A depreciation of the currency on account of FDI and portfolio shock would require tightening the monetary policy by raising interest rate. By this way, inflation is also kept minimal. Appreciation of the exchange rate due to portfolio shock would require the opposite policy response. Currency depreciation stemming from a negative terms of trade shock that lowers demand for exports, reduces aggregate demand would require an expansionary monetary policy. These policy responses are less likely to be inflationary. However, currency depreciation/appreciation due to output/productivity shock would require no monetary policy intervention and such depreciation/appreciation should be seen to be in its equilibrium as determined by the market. This is because a highly misaligned exchange rate will exhibit excess volatility (both present and future) in order to find its equilibrium rate largely driven by its own forces. The central bank should not only care about reducing inflation volatility in an inflation–target regime but should equally pay crucial attention to reducing exchange rate fluctuations especially when the latter is self-driven. To avoid the likelihood of exchange rate taking the precedence over inflation targeting as the nominal anchor, the monetary authorities should increase transparency of monetary policy especially on managing exchange rates as this has potential channels of impact on internal and external stability.

Finally, the ultimate way for conducting an effective monetary policy requires policy makers to factor asset prices and exchange rates in particular in setting monetary policy instrument as this is in sync with the inflation targeting.

6. Concluding remarks

This study analyzed the causes of real exchange rate volatility and its effect on economic growth in Ghana relying on annual data spanning 1980 to 2013. Exploiting techniques from the time series literature, our results revealed that in the short run output is the main driver of exchange rate fluctuations in Ghana. In the long run, however, exchange rate volatility is significantly influenced by government expenditure growth, money supply, terms of trade shocks, FDI flows and domestic output movements. Decomposing the shocks indicates that almost three quarters of exchange rate volatility are self-driven. The remaining one quarter or so is accounted for by the factors alluded to previously. The implication of the results is that

since exchange rate volatility is almost self-driven, unbridled interventions may not only exacerbate volatility, but may also be costly in terms of output and welfare. Improving exchange rate modelling and forecast at the central bank level, while incorporating the impact of asset prices in domestic monetary policy could improve both the transparency and functioning of the foreign exchange market.

References

Adewuyi, A. O., and Akpokodje, G., (2013). Exchange Rate Volatility and Economic Activities of Africa's Sub-Groups, *The International Trade Journal*, *27*(4), 349-384. http://dx.doi.org/10.1080/08853908.2013.813352

Aghion, P., Bacchetta, P., Rancière, R., and Rogoff, K., (2009), Exchange Rate Volatility and Productivity Growth: The Role of Financial Development, *Journal of Monetary Economics*, *56*(4): pp 494-513. http://dx.doi.org/10.1016/j.jmoneco.2009.03.015

Arellano, M., and Bover, O., (1995), Another Look at the Instrumental Variable Estimation of Error Component Models, *Journal of Econometrics*, *68*(1), pp 29–51. http://dx.doi.org/10.1016/0304-4076(94)01642-d

Arize, A. C., Osang, T., and Slottje, D. J. (2000), Exchange Rate Volatility and Foreign Trade: Evidence from Thirteen LDCs, *Journal of Business and Economic Statistics*, *18*(1), pp 10-17, http://dx.doi.org/10.1080/07350015.2000.10524843

Asteriou, D. and Hall, S. G. (2011). Applied Econometrics, 2nd Edition, *Palgrave Macmillan.*

Assery A., and Peel, D. A. (1991). The Effects of Exchange Rate Volatility on Exports. *Economics Letters*, *37*(2), pp 173-177. http://dx.doi.org/10.1016/0165-1765(91)90127-7

Belke, A., and Kaas, L. (2004). Exchange Rate Movements and Employment Growth: An OCA Assessment of the CEE Economies. *Empirica 31*(2-3), pp 247–280. http://dx.doi.org/10.1007/s10663-004-0886-5

Belke, A., and Setzer, R. (2003). Exchange Rate Volatility and Employment Growth: Empirical Evidence from the CEE Economies. Paper prepared for the "*First Annual Conference of the Euro-Latin Study Network on Integration and Trade*" der Inter-American Development Bank, November 6–7. Barcelona.

Bollerslev, T. (1986), Generalised Autoregressive Conditional Heteroskedasticity, *Journal of Econometrics, 31*(3), pp 307-27. http://dx.doi.org/10.1016/0304-4076(86)90063-1

Bosworth, B. P., Collins, S, M., and Chen, Y., (1996). Accounting for Differences in Economic Growth. In: Kohsaka, A., Ohno, K. (Eds.). (1996), Structural Adjustment and Economic Reform: East Asia, Latin America, and Central and Eastern Europe, *Tokyo: Institute of Developing Economies.*

Bredin, D., Fountas, S. and Murphy, E., (2003), An Empirical Analysis of Short Run and Long Run Irish Export Functions: Does Exchange Rate Volatility Matter? *International Review of Applied Economics 17*(2), pp 193-208. http://dx.doi.org/10.1080/0269217032000064053

Broda, C., (2004). Terms of Trade and Exchange Rate Regimes in Developing Countries, *Journal of International Economics 63*(1), pp 31-58. http://dx.doi.org/10.1016/s0022-1996(03)00043-6

Brodsky, D. A. (1984). Fixed Versus Flexible Exchange Rates and the Measurement of Exchange Rate Instability. *Journal of International Economics 16*(3-4), pp 295–306. http://dx.doi.org/10.1016/s0022-1996(84)80006-9

Calvo, G. A., (2001). Capital Markets and the Exchange Rate: With Special Reference to the Dollarization Debate in Latin America. *Journal of Money, Credit, and Banking 33*(2), pp 312-334. http://dx.doi.org/10.2307/2673902

Calvo, G. A., and Mendoza, E. G., (2000). Capital-Market Crises and Economic Collapse in Emerging Markets: An Informational-Frictions Approach. *American Economic Review 90*(2), pp 59 – 64. http://dx.doi.org/10.1257/aer.90.2.59

Carrera, J., and Vuletin, G., (2002). The Effects of Exchange Rate Regimes on Real Exchange Rate Volatility: A Dynamic Panel Data Approach. *University of Maryland Working Paper*

Clarida, R., and Gali, J., (1994). Sources of Real Exchange Rate Fluctuations: How Important are Nominal Shocks? *Carnegie Rochester Series on Public Policy 41*(1), pp 1-56. http://dx.doi.org/10.1016/0167-2231(94)00012-3

Clark, P., Tamirisa, N., and Wei, S-J., (2004). A New Look at Exchange Rate Volatility and Trade Flows, *IMF Occasional Paper No. 235*. http://dx.doi.org/10.5089/9781589063587.084

Danjuma, B. F., Shuaibu, U., and Sa'id, U. Y., (2013). An Assessment of Exchange Rate Volatility and Inflation in Nigeria. *Journal of Emerging Issues in Economics, Finance and Banking 1*(4), pp 321–340

Danne C. (2006). Exchange Rate Stability and Economic Growth in the EMU Periphery, *Thesis at Tübingen University*.

Devereux, M. B., and Lane, P. R. (2003). Understanding Bilateral Exchange Rate Volatility, *Journal of International Economics 60*(1), pp 109-132. http://dx.doi.org/10.1016/s0022-1996(02)00061-2

Devereux, M., and Engel, C. (2003). Monetary Policy in Open Economy Revisited: Price Setting and Exchange Rate Flexibility. *Review of Economic Studies 70*(4), pp 765-783. http://dx.doi.org/10.1111/1467-937x.00266

Dell'Ariccia, G. (1999). Exchange rate fluctuations and trade flows: Evidence from the European Union. *IMF Staff Papers: 46*(3): pp 315–334, September–December. http://dx.doi.org/10.2307/3867646

Dickey, D. A., and Fuller, W. A. (1979). Distribution of Estimators for Autocorrelated Time Series with a Unit Root. *Journal of the American Statistical Association 74*(366), pp 427–31. http://dx.doi.org/10.2307/2286348

Dollar, D. (1992). Outward Oriented Economies Really Do Grow More Rapidly: Evidence from 95 LDCs, 1976-1985. *Economic Development and Cultural Change 9* (40-3), pp 523-544. http://dx.doi.org/10.1086/451959

Dornbusch, R. (1976). Expectations and Exchange Rate Dynamics. *Journal of Political Economy 84*(6), pp 1161–76. http://dx.doi.org/10.1086/260506

Doyle, E. (2001). Exchange Rate Volatility and Irish-UK Trade, 1979-1992. *Applied Economics 33*(2), pp 249-503. http://dx.doi.org/10.1080/00036840122999

Edwards, S., and Levy-Yeyati, E. (2005). Flexible Exchange Rates as Shock Absorbers, *European Economic Review 49*(8), pp 2079–2105. http://dx.doi.org/10.1016/j.euroecorev.2004.07.002

Eichengreen, B., (2008). The Real Exchange Rate and Economic Growth. *Commission on Growth and Development Working Paper* No. 4.

Frankel, J. and Rose, A. (2002). An Estimate of the Effect of Common Currencies on Trade and Income. *Quarterly Journal of Economics 117*(2), pp 437 - 466. http://dx.doi.org/10.1162/003355302753650292

Fuentes, O. M., (2006). Exchange Rate Volatility and Investment: Evidence at the Plant-Level. Boston University, *mimeo.*

Gadanecz, B., and Mehrotra, A. (2013). The Exchange Rate, Real Economy and Financial Markets. *BIS Papers*, No 73.

Gauthier, C., and Tessier, D. (2002). Supply Shocks and Real Exchange Rate Dynamics: Canadian Evidence. *Bank of Canada Working Paper* No. 2002-31.

Hanke, S., and Schuler, K. (1994). *Currency Boards for Developing Countries: A Handbook.* San Francisco: *ICS Press.*

Hausmann, R., Panizza, U., and Rigobon, R. (2006). The Long-Run Volatility Puzzle of the Real Exchange Rate. *Journal of International Money and Finance 25(1)*, pp 93-124. http://dx.doi.org/10.1016/j.jimonfin.2005.10.006

Holland M., Vieira F. V., Silva, C. G., and Bottecchia, L. C. (2011). Growth and Exchange Rate Volatility: A Panel Data Analysis. *Textos Para Discussão* 296.

Johansen, S., (1988). Statistical Analysis of Cointegration Vector. *Journal of Economic Dynamics and Control 12*(2-3), pp 231–254. http://dx.doi.org/10.1016/0165-1889(88)90041-3

Johansen, S., and Juselius, K. (1990). Maximum Likelihood Estimation and Inference on Cointegration with Application to the Demand for Money. *Oxford Bulletin of Economics and Statistics 52*(2), pp 169–210. http://dx.doi.org/10.1111/j.1468-0084.1990.mp52002003.x

Kandil, M. (2004). Exchange Rate Fluctuations and Economic Activity in Developing Countries: Theory and Evidence. *Journal of Economic Development 29*(1), pp 85-108.

Kandil, M., and Mirzaie, I. A. (2008). Comparative Analysis of Exchange Rate Appreciation and Aggregate Economic Activity: Theory and Evidence from Middle Eastern Countries. *Bulletin of Economic Research 60*(1), pp 45-96. http://dx.doi.org/10.1111/j.1467-8586.2007.00272.x

Kiyota, K., and Urata, S. (2002). Exchange Rate, Exchange Rate Volatility and Foreign Direct Investment. *University of Yokohama Working Paper* No. 186.

Koop, G., Pesaran, M. H., and Porter, S. M., (1996). Impulse Response Analysis in Nonlinear Multivariate Models, *Journal of Econometrics, 74*(1), pp 119–147. http://dx.doi.org/10.1016/0304-4076(95)01753-4

Kwek, K. T and Koay, K. N., (2006). Exchange Rate Volatility and Volatility Asymmetries: An Application to Finding a Natural Dollar Currency, *Applied Economics 38*(3), pp 307– 323. http://dx.doi.org/10.1080/00036840500368672

Kwiatkowski, D., Phillips, P. C. B., Schmidt, P., and Shin, Y., (1992), Testing for the Null Stationarity Against the Alternative of a Unit Root. *Journal of Econometrics 54*, pp 159–178. http://dx.doi.org/10.1016/0304-4076(92)90104-y

Levy-Yeyati, E., and Sturzenegger, F. (2003). To Float or to Fix: Evidence on the Impact of Exchange Rate Regimes on Growth. *American Economic Review 93*(4), pp 1173-1193. http://dx.doi.org/10.1257/000282803769206250

MacDonald, R., and Nagayasu, J. (1999). The Long-Run Relationship Between Real Exchange Rates and Real Interest Rate Differentials: A Panel Study. *IMF Working Paper* No. 99/ 37. http://dx.doi.org/10.5089/9781451845556.001

McKenzie, M. D., (1999). The Impact of Exchange Rate Volatility on International Trade Flows. *Journal of Economic Surveys, 13*(1), pp 71–106. http://dx.doi.org/10.1111/1467-6419.00075

Mundell, R. (1995). Exchange Rate Systems and Economic Growth. *Rivista de Politica Economica 85*, pp 1–36. http://dx.doi.org/10.4324/9780203031223.pt1

Ndambendia, H., and Alhayky, A. (2011). Effective Real Exchange Rate Volatility and Economic Growth in Sub-Saharan Africa: Evidence from Panel Unit Root and Cointegration Tests. *The IUP Journal of Applied Finance 17*(1), pp 85-94.

Obstfeld, M. and Rogoff, K. (1998). Risk and Exchange Rates. *National Bureau of Economic Research Working Papers Series*, WP 6694. http://dx.doi.org/10.3386/w6694

Pallage, S., and Robe, M. A. (2003). On the Welfare Cost of Economic Fluctuations in Developing Countries. *International Economic Review 44*(2), pp 677 – 698. http://dx.doi.org/10.1111/1468-2354.t01-2-00085

Pesaran, M. H., and Shin, Y., (1998). Generalised Impulse Response Analysis in Linear Multivariate models, *Economics Letters, 58*(1), pp 17–29. http://dx.doi.org/10.1016/s0165-1765(97)00214-0

Phillip, P. C. B., and Perron, P. (1988). Testing for a Unit Root in Time Series Regression, *Biometrika 75*(2), pp 335–346. http://dx.doi.org/10.1093/biomet/75.2.335

Rose, A. K. (2000). One Money, One Market: Estimating the Effect of Common Currencies on Trade, *Economic Policy 15*(30), pp 7-45. http://dx.doi.org/10.1111/1468-0327.00056

Schnabl, G., (2007), Exchange Rate Volatility and Growth in Small Open Economies at the EMU Periphery, *European Central Bank Working Paper No 773*. http://dx.doi.org/10.2139/ssrn.955250

Serven, L. (2002). Real Exchange Rate Uncertainty and Private Investment in Developing Countries. *Policy Research Paper* No. 2823, Washington, D.C.: The World Bank. http://dx.doi.org/10.1596/1813-9450-2823

Sowa, N. K., (2002). Managing Ghana's Domestic Debt, *Centre for Policy Analysis (CEPA) Working Paper Series,* Accra.

Sowa, N. K., (2006). Promoting Investment in Africa, This paper is prepared for presentation at the first African Economic Conference under the theme "Five Years into the Twenty-First Century", African Development Bank, Tunis, Tunisia, November, 22-24.

Straub, R., and Tchakarov, I. (2004). Non-fundamental Exchange Rate Volatility and Welfare. *European Central Bank Working Paper* No. 328.

Stockman, A.C. (1987). The Equilibrium Approach to Exchange Rates. Economic Review. Federal Reserve Bank of Richmond, (March/April) pp 13-31.

Stockman, A.C. (1988). Real Exchange Rate Variability under Pegged and Floating Nominal Exchange Rate Systems: An Equilibrium Theory, in K. Brunner and A Meltzer(eds), Carnegie Rochester Conference on Public Policy 29, pp 259-294. http://dx.doi.org/10.1016/0167-2231(88)90016-4

Tarawalie, A. B., Sissoho, M., Conte, M., and Ahortor, C. R. (2012). Exchange Rate, Inflation and Macroeconomic Performance in the West African Monetary Zone (WAMZ). *WAMI Occasional Paper Series No*. 2

Tenreyro, S. (2007). On the Trade Impact of Nominal Exchange Rate Volatility. *Journal of Development Economics 82*(2), pp 485–508. http://dx.doi.org/10.1016/j.jdeveco.2006.03.007

Tornell, A., and Velasco, A. (2000). Fixed Versus Flexible Exchange Rates: Which Provides More Fiscal Discipline? *Journal of Monetary Economics, 45*(2), pp 399-436. http://dx.doi.org/10.1016/s0304-3932(99)00057-4

Tweneboah, G., and Alagidede, P. (2015). Dollarisation in Ghana: Measurements, Determinants and Policy Implications. Working Paper No. 315, African Finance and Economics Consult.

UNCTAD, (2015). World Investment Report: Reforming International Investment Governance, United Nations, Geneva.

Wang, K-L., and Barrett, C. (2007). Estimating the Effects of Exchange Rate Volatility on Export Volumes. *Journal of Agricultural and Resource Economics, 32*(2), pp 225-255.

Appendix 1

VAR lag order selection criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	96.74930	NA	9.50e-11	-6.049954	-5.769714	-5.960303
1	262.2468	253.7629*	1.78e-14*	-14.68312	-12.72145*	-14.05556*
2	295.2557	37.41006	2.98e-14	-14.48371	-10.84060	-13.31825
3	345.2386	36.65410	3.18e-14	-15.41590*	-10.09135	-13.71253

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