Full Length Research Paper

Sources of real exchange rate volatility in the Ghanaian economy

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Real exchange rate volatility is an important contributor to risks in the financial world. During periods of excessive fluctuations in exchange rates, foreign trade and investments could be affected negatively. The objective of this study is to determine the sources of exchange rate volatility in Ghana. The methodology employed is a dynamic econometric technique based on the Autoregressive Distributed Lag (ADL) Model to account for psychological inertia among others. The study used annual data covering the period 1980 to 2012 to investigate the determinants of real exchange rate volatility in Ghana. Consistent with the empirical literature, government expenditure is a major determinant of real exchange rate volatility. There existed a positive relationship between them. Further, both domestic and external debts were negatively related to real exchange rate volatility. Current external debt and a four year lag of domestic debt had significant impacts on real exchange rate volatility. The main contribution of this paper is empirical and methodological. Empirically, it adds new empirical evidence and new dimensions to the literature on determinants of exchange rate volatility in developing economies.

Key words: Exchange rate volatility, Generalized Auto-Regressive Conditional Heteroscedasticity, autoregressive distributed lag.

INTRODUCTION

Exchange rate volatility is an important contributor to risks in the financial world. During periods of excessive fluctuations in exchange rates, foreign trade and investments could be affected negatively. Following Baig (2001) and Hviding et al. (2004), the collapse of the Bretton Woods Institution in 1973 led to an increase in real interest rate volatility. This occurrence led to a switch from fixed to floating exchange rates and this had marked effects on economic growth, capital movements and international trade.

There are various possible factors that could account for exchange rate volatility. As noted by Froot and Rogoff (1991), increases in government consumption tend to increase the relative price of nontradables which forms a large proportion of government spending. De Gregorio et al. (1994) also support the claim that increases in government consumption is associated with real appreciation. According to Stancik (2007), several factors explain the source of exchange rate volatility. Among them he outlined the domestic and foreign money supply, inflation, level of output and the exchange rate regime. The rest are interest rates, the openness of an economy and central bank independence. In a related study on the determinants of exchange rate volatility, Juthathip (2009) asserted that there were five medium to long-term fundamental variables that determined the real exchange rate. The five medium to long-term fundamental variables identified included productivity differentials, openness

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and terms of trade. The remaining are net foreign assets and government spending.

The importance of exchange rate stability cannot be understated. Apart from being a relative price of one currency in terms of another, it connects domestic and foreign markets for goods and assets. Also, it signals the international competitiveness of a country in global market. As opined by Williamson (1994), estimating the degree of exchange rate volatility and misalignment remains a challenging empirical problem in macroeconomics. He noted further that there is no simple answer to explain the determinants of equilibrium exchange rate.

The objective of this study is to determine the sources of exchange rate volatility in Ghana. With this, a discussion of exchange rate volatility as endogenous is possible. The basis for this study is the fact that there exists exchange rate volatility in the economy of Ghana as found by Insah (2013). He noted that a GARCH (1,1) model explained real exchange rate volatility in Ghana.

The main contribution of this paper is empirical and methodological. Empirically, it adds new empirical evidence and new dimensions to the literature on determinants of exchange rate volatility in developing economies. Methodologically, a dynamic econometric technique based on an Autoregressive Distributed Lag (ADL) Model is applied in the analysis to account for psychological inertia among others.

The layout of the paper is the following. The second section reviews literature sources of exchange rate volatility. The data and econometric methodology are outlined in the third section. The fourth section comprises some stylized facts and a discussion of empirical results. Lastly, section five concludes.

LITERATURE REVIEW

Empirical studies have found that there is a link between real exchange rate depreciation and government expenditures. It is noted that an unexpected exogenous increase in government expenditure leads to a depreciation in the real exchange rate (Corsetti and Müller, 2006; Enders et al., 2011; Monacelli and Perotti, 2010). They asserted further that this relationship exists for different countries and sample periods, and therefore has become a known fact. According to Kollmann (2010), an increase in public spending in one country can depreciate its real exchange rate, provided that labor supply is highly elastic. In this study, a two-country model with incomplete financial markets and flexible prices was used to derive his findings.

Bouakez and Eyquem (2011) in a related study found out that an unexpected increase in public expenditures leads to a fall in the risk-adjusted long-term real interest rate causing the real exchange rate to depreciate. In their study, they proposed a small-open-economy model that features three key ingredients: incomplete and imperfect international financial markets, sticky prices, and a not-too-aggressive monetary policy. In a similar study, Corsetti et al. (2011) developed a two-country model with complete markets, sticky prices and wages, and spending reversals. The main assumption of this study is that debt-financed increases in government spending will cause subsequent spending to fall below its steady state level for some time. Consequently, this lowers the long-term real interest rates and leads to an appreciation of the currency in real terms. Furthermore, Ravn et al. (2011) used a two-country model with complete financial markets and assumed that consumers form deep habits and would affect markets in which aggregate demand raises habits at the level of individual varieties of goods. The study asserted that with increases in government spending in the domestic economy, markups on domestically sold goods will be lower than markups abroad. This would in turn make those goods relatively cheaper in the domestic economy and consequently a depreciation of the real exchange rate.

According to Morana (2009), long-term fundamental linkages can be found between exchange rate volatility and macroeconomic indicators. There existed bidirectional causality between the two afore mentioned. He however noted that the causality was stronger from macroeconomic volatility to exchange rate volatility than the other way. Adom et al. (2012) examined the impact of real demand, aggregate supply and monetary shocks on real exchange rates in 13 West African countries. Their findings revealed that a lot of real exchange rate fluctuations emanated from real demand shocks. They asserted further that controlling government expenditure and taxes was an appropriate demand management strategy.

Mcgibani and Nourzad (1995) examined the effect of changes in exchange rates volatility on the demand for money. Their study was based on an error correction model and a partial adjustment model. They noted that real exchange rate volatility was negatively related to the demand for real M2 balances. Real exchange rate volatility, they suggested, affected both the volatility of domestic prices relative to foreign prices and to the nominal exchange rate. In a recent study by Ajao and Igbekoya (2013), an error correction model was used to investigate the determinants of real exchange rate volatility. Their results indicated that openness of the economy, government expenditures, interest rate movements as well as a lag of the exchange rate were among the major significant variables that influenced real exchange rate volatility in Nigeria.

As noted by Samara (2009) the real exchange rate reaction to monetary shocks is very similar to those in the Dornbusch model. Following Dornbusch (1976) the unanticipated monetary policy shocks were able to generate disproportionately large fluctuations in the exchange rates. These occurrences are referred to as the overshooting effect. However, the effect of persistent real shocks on the real exchange rate is permanent according to the Dornbusch model. In the model, an increase in

money supply leads to an exchange rate depreciation higher than its long-run depreciation rate. This is the overshooting hitherto alluded to, when the immediate response to a disturbance is greater than its long-run response. The level of government expenditures affects real exchange rate movements due to the allocation of government expenditures between tradable and non-tradable goods. Further, the effect of government expenditures depends on the Balassa Samuelson hypothesis, which posits that the real exchange rate is fully determined by the supply side of the economy. Edwards (1989) also noted further that increasing public expenditures caused an appreciation of the real exchange rate. In a related study, Frenkel and Mussa (1985) opined that an appreciation of the equilibrium real exchange rate in the long-run is attributable to a permanent increase in government spending.

As indicated by Bretscher (1995) the least-squares method is usually credited to Carl Friedrich Gauss in 1795 but it was first published by Adrien-Marie Legendre. Also, Abdi (2007) asserted the use of Least Squares method in a modern statistical framework can be traced to Galton who used it in his work on the hereditability of size which laid down the foundations of correlation and regression analysis. In further support, the method of least squares that is used to obtain parameter estimates was independently developed in the late 1700's and the early 1800's by the mathematicians Karl Friedrich Gauss, Adrien Marie Legendre and Robert Adrain working in Germany, France and America, respectively (Stigler, 1978, 1986; Harter, 1983). The term least squares describes a frequently used approach to solving over-determined or inexactly specified systems of equations in an approximate sense. Instead of solving the equations exactly, we seek only to minimize the sum of the squares of the residuals. The minimization process reduces the overdetermined system of equations formed by the data to a sensible system.

THEORETICAL FRAMEWORK AND METHODOLOGY

Econometric model and methodology

From the literature, an empirical model based on the Balassa-Samuelson theory may be formulated with government expenditure explaining exchange rate volatility while controlling for the effects of money supply, domestic debt and external debt. The functional form of this model is specified as

$$EXVOL = f(GEXP, MS, DD, ED) \tag{1}$$

where EXVOL is exchange rate volatility, GEXP is government expenditure, MS is money supply, DD is domestic debt and ED is external debt.

The econometric specification of this general model expressed in log is

$$\ln EXVOL_t = \beta_0 + \beta_1 \ln GEXP_t + \beta_2 \ln MS_t$$
$$+ \beta_3 \ln DD_t + \beta_4 \ln ED_t + u_t \tag{2}$$

with u_t as the disturbance term.

The generalized econometric form of the ADL(p,q) model is

$$Y_t = \alpha + \beta_1 Y_{t-1} + ... + \beta_p Y_{t-p} + \delta_0 X_t$$
$$+ \delta_1 X_{t-1} + ... + \delta_q X_{t-q} + u_t \tag{3}$$

and expressing Equation (3) in lag polynomials, becomes

$$\beta(L)Y_t = \beta_0 + \delta(L)X_{t-1} \tag{4}$$

where $\beta(L)$ and $\delta(L)$ are the lag polynomials. Introducing k number of additional predictors, that is ADL(p,q₁,...,qₖ), the lag polynomial form is

$$\beta(L)Y_t = \beta_0 + \delta_1(L)X_{1,t-1}$$
$$+ \delta_2(L)X_{2,t-1} + ... + \delta_k(L)X_{k,t-1} \tag{5}$$

Extending the ADL(p,q,r,s,u) in first differences to be built into the model:

$$\ln EXVOL = \alpha + \beta_0 \ln EXVOL_{t-1}$$
$$+ ... + \beta_{p-1} \ln EXVOL_{t-p+1} + \delta \Delta \ln GEXP_t$$
$$+ \delta_1 \Delta \ln GEXP_{t-1} + ... + \delta_{q-1} \Delta \ln GEXP_{t-q+1} + \phi \Delta \ln MS_t$$
$$+ \phi_1 \Delta \ln MS_{t-1} + ... + \phi_{r-1} \Delta \ln MS_{t-r+1} + \psi \Delta \ln DD_t$$
$$+ \psi_1 \Delta \ln DD_{t-1} + ... + \psi_{s-1} \Delta \ln DD_{t-s+1}$$
$$+ \gamma \Delta \ln ED_t + \gamma_1 \Delta \ln ED_{t-1} + ... + \gamma_{u-1} \Delta \ln ED_{t-u+1} + u_t \tag{6}$$

Annual data for the period 1980 to 2012 was used for the study. The traditional way of measuring volatility is the standard deviation method (Kenen and Rodrik, 1986; Caballero and Corbo, 1989). Using this method, the *RER* volatility is measured by computing the annual standard deviation of the *RER*. This study however used the Generalized Auto-Regressive Conditional Heteroscedasticity (GARCH) developed by Bollerslev (1986).

The volatility data is a GARCH(1,1) series. Government expenditure is total government spending. Money supply is M1. Domestic debt is government debt obligations within the country. External debt is government borrowing from the rest of the world. Before estimating Equation (6) we verify if the series described are stationary. The Augmented Dickey-Fuller, Philips Perron and KPSS tests for stationarity would be employed. The series is investigated for stationarity both with and without a deterministic trend. The method of least-squares regression technique was used to estimate the rate of change of volatility with respect to the explanatory variables in a single equation model. This estimation technique suits the analysis because multiple regression models are adjusted by the Least Squares method. This minimizes the sum of the squares of the prediction errors. Also, Vector Autoregressive (VAR) and Structural Vector Autoregressive (SVAR) techniques could be employed. These are not chosen since it is not based on any theory. An alternative estimation technique is the maximum likelihood which is not appropriate because it only gives the likelihood of the sample maximum.

RESULTS AND DISCUSSION

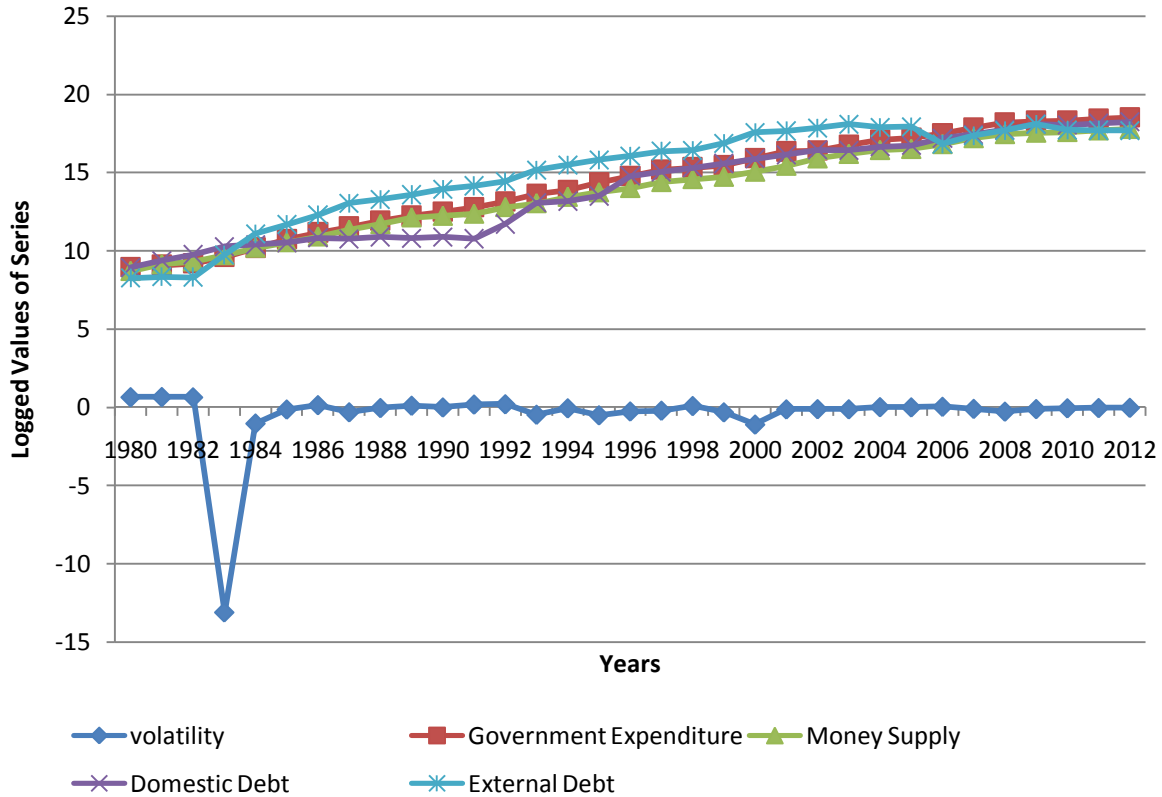The change in exchange rate regime from fixed to

Figure 1. Trend of volatility, government expenditure, money supply, domestic debt and external debt.
Source: Author's construct.

floating exchange rate in 1983 caused a spike in exchange rate volatitily. The path of the exchange rate volatility series displays a non-trending pattern. Consequently, external debt increased sharply within the same period. This could result from the acquisition of loans or the exchange rate depreciation that increased the value of debt. Meanwhile, money supply and government expenditure trended smoothly throughout the period under study thus displaying a non stationary pattern. The variables described are displayed in Figure 1.

The results from the stationarity tests indicate that the volatility series is I(0), that is it is stationary. On the other hand the remaining variables; Government expenditure, Money supply, Domestic and External debt are I(1), that is they are first difference stationary. However, money supply and external debt were 1(0) without the trend. These series displayed non-stationarity but when test was conducted including the trend. The results for the stationarity tests are shown in Table 1.

A general ADL model that included a maximum of four (4) lags was estimated. The Schwartz and Akaike information criteria from an unrestricted VAR were used to determine the general to specific nature of the model.

Results from the model are characterized by coincident and various degrees of lagged variables. The model indicates that money supply does not contribute to real

exchange rate volatility as theory postulates. The coefficient is 0.47 and negative but not statistically significant. Existing literature supports this result, especially Mcgibani and Nourzad (1995) found a negative relationship between real exchange rate volatility and the demand for real money. This could be due to the level of financial development in the country. Consistent with the empirical literature, government expenditure is a major determinant of real exchange rate volatility.

The elasticity of a one year lag in government expenditure is 0.68 and significant at the 5% level. It means that a one unit increase (decrease) in government expenditure will lead a 68% increase (decrease) in real exchange rate volatility. This result is confirmed by the fact that, Bouake and Eyquem (2011), Corsetti and Müller (2006), Enders et al. (2011), Monacelli and Perotti (2010) have found that an exogenous increase in government expenditure led to a depreciation of the real exchange rate. In contrast to real exchange rate depreciation, Edwards (1989), Frenkel and Mussa (1995) have noted that increasing government expenditures caused an appreciation of the real exchange rate. Since Government expenditure is always increasing following Wagner's law, it is the increase in volatility that is important for the study. Further, both domestic and external debts have negative coefficients. The interpretation

Table 1. Results of unit root tests with and without trend.

		Level		First difference	
	Variable	Constant	Constant+Trend	Constant	Constant+Trend
ADF test	lnVOL	-5.539703*	-5.771691*	-8.861007*	-8.720161*
	lnGEXP	-2.517735	0.589237	-3.359409**	-5.892186*
	lnMS	-3.212684**	0.423267	-3.718491**	-4.527092*
	lnDD	-0.861616	-1.302238	-4.535362*	-4.491538*
	lnED	-3.273726**	-0.844581	-4.058196*	-5.495394*
Phillips-Perron test	lnVOL	-5.546394*	-6.109341*	-25.85766*	-26.00035*
	lnGEXP	-2.500787	2.082594	-3.403959**	-5.092035*
	lnMS	-3.745597**	0.654832	-3.740861*	-4.428718*
	lnDD	-0.838005	-1.647829	-4.493204*	-4.448967*
	lnED	-4.973906*	-0.207124	-4.038569*	-7.506126*
KPSS test	lnVOL	0.235414*	0.216892*	0.500000**	0.500000*
	lnGEXP	0.658060**	0.196703**	0.461560	0.135127
	lnMS	0.661604**	0.181529**	0.556560**	0.121719
	lnDD	0.648440**	0.091605	0.119140	0.094625
	lnED	0.701579**	0.196388**	0.597064**	0.234118

ADF and PP: Null hypothesis is that the variable being examined is non-stationary.
KPSS: Null hypothesis is that the variable being examined is stationary.
* and ** denotes statistical significance at 1% and 5% levels, respectively

Table 2. Model estimation results.

Dependent variable: lnVOL	Coefficient	t-statistic
ΔM	-0.472 (0.323)	-1.458
ΔG_{t-1}	0.683** (0.292)	2.339
ΔDD_{t-3}	-0.159 (0.106)	-1.497
ΔDD_{t-4}	-0.294* (0.110)	-2.671
ΔED	-0.333* (0.112)	-2.975

Adjusted R^2 = 0.41; Wald's test (F-value =7.45*, p-value= 0.003); JB
test (p-value) = 0.65*
CUSUM (See Appendix); CUSUMSQ (See Appendix).
* and ** denote 1% and 5% levels of significance respectively. Figure
in ( ) indicates standard error
Source: Author's construct.

is that an increase (decrease) in domestic and external debts will lead to a decrease (increase) in real exchange rate volatility. A four year lag of domestic debt has coefficient of 0.29 and statistically significant at the 1% level. Also, external debt has a bigger elasticity of 0.33 and significant at the 1% level. The CUSUM and CUSUMSQ results indicate that the model is stable. The Jarque-Bera test for normality indicates that the chi-squared value does not exceed the critical values from the chi-squared distribution. Therefore the population distribution is normal. With the Wald's test, the low probability value and the level of significance of the F-statistic indicate that the coefficients are statistically

different from zero. These are shown in Table 2.

Conclusion

Annual data covering the period 1980 to 2012 was used to investigate the determinants of real exchange rate volatility in Ghana. An ADL model was employed for the estimation. The findings from the study revealed that money supply, though exerting a negative influence on real exchange rate volatility was not statistically significant. Consistent with the empirical literature, government expenditure is a major determinant of real exchange rate volatility. There existed a positive relationship between them. What this means is that an increase (decrease) in government expenditure will lead to an increase (decrease) in real exchange rate volatility. Since Government expenditure is always increasing following Wagner's law, it is the increase in volatility that is important for the study. Further, both domestic and external debts are negatively related to real exchange rate volatility. The effect on the economy is that an increase (decrease) in domestic and external debts will lead to a decrease (increase) in real exchange rate volatility. Current external debt and a four year lag of domestic debt had significant impacts on real exchange rate volatility. As a policy move, a reduction in the rate of growth of government spending would help manage real exchange rate volatility in Ghana. Also, an increase in

external debt is not problematic if real exchange rate volatility management is the macroeconomic policy objective of the government.

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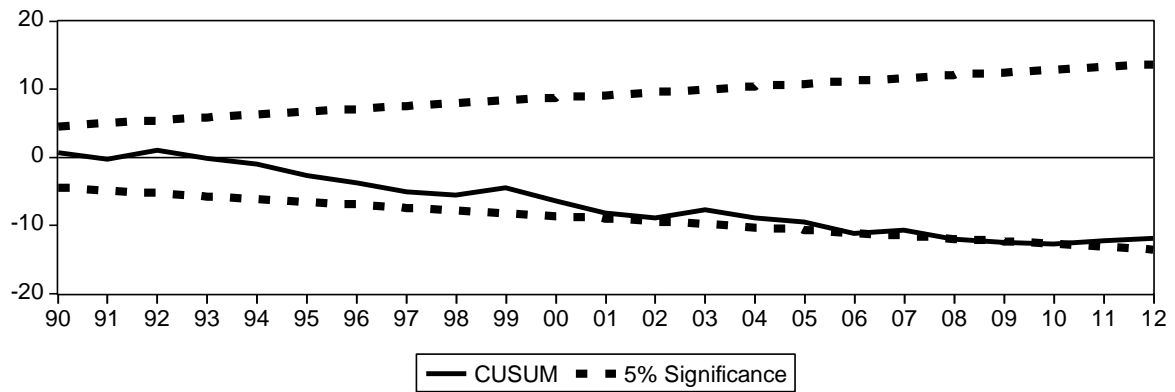
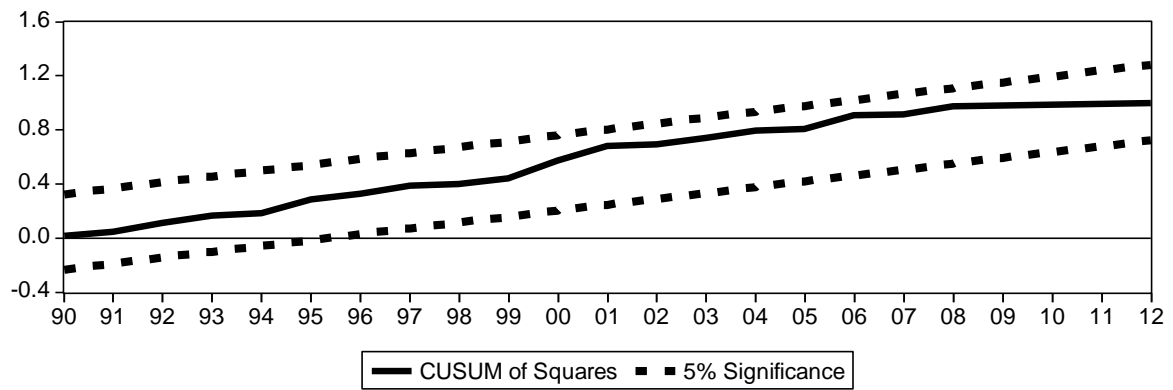**Appendix:** Stability tests

Figure 1A. Cusum cumulative histogram.

Figure 2A. Cusum of squares cumulative histogram.