Revisiting the Diverse Empirical Findings on the Impact of Exchange Rate Volatility on Trade: Some Evidence from 3 Developing Economies

Abstract

Although exchange rate volatility is widely believed to negatively affect international trade yet empirical studies on this relationship have produced mixed results. This paper empirically examines this relationship for three Sub-Saharan developing countries namely Ghana, Mozambique and Tanzania, whose real growth policies depend heavily on international trade; taking into consideration that the choices of modelling specification, class of countries considered (develop vs. developing) and exchange rate proxies among other factors can potentially influence findings (Baum et al 2004 and also Ozturk 2006). Using three different exchange rate volatility proxies in an augmented gravity model (which in itself was estimated using two different techniques), it was observed that exchange rate volatility did not impact on trade for these three developing countries and their trade partners considered. However, findings from this study does not firmly support the suggestion that different model specifications affect empirical findings; it was however observed that to some extent, the nature of relationship between bilateral trade and some of the variables considered in the augmented gravity model can be sensitive to the exchange rate volatility proxy used as well as interestingly, the country trade pair under consideration.

Keywords: Exchange Rate Volatility, Bilateral Trade, Gravity Model, Sub-Saharan Africa

JEL Codes: F31, F17, C21, O24, O55

1. Introduction

Proponents of flexible exchange rate argue that since they are determined by market forces of demand and supply, they adjust to dampen the impacts of real exogenous shocks as well as restoring a country's balance of payments to equilibrium. In contrast to what Friedman (1953) envisaged, departures from the expected levels of exchange rates and persistence in volatility have been experienced by many economies which have adopted the flexible exchange rate system in the post Bretton-Woods era. Exchange rate volatility induced by domestic currency depreciation or appreciation is believed to hold the potential of affecting economic growth through net export which is directly reflected in GDP calculation. Also, the effects of a volatile currency have second round effects; a volatile exchange rate may negatively affect the economy by inducing an exchange rate pass or inflation pass through (see Goldberg and Knetter 1997).

Previous empirical evidence however does not lead to a clear cut consensus on the relationship between exchange rate volatility and trade (See Bacchetta and van Wincoop 2000).

Using data from the G-7 countries (UK, Canada, France, Germany, Italy, Japan and the USA) for the period between 1969 and 1982, the IMF (1984)[1] observed no significant effect of exchange rate volatility on trade among the developed G-7 countries. Aristotelous (2001) used an augmented gravity model to explore the effects

[1] Most of the studies on the effect of exchange rate volatility on trade emanates from the IMF (1984) research for the General Agreement on Tariffs and Trade (GATT) in the Post-Bretton Wood era. The model used for this work is based on the Cushman (1983) technique where bilateral export regressions were estimated with explanatory variables being real Gross National Product (GNP), real bilateral exchange rate, exchange rate volatility measured (measured as a standard deviation of the percentage changes in exchange rates over the preceding five years) and relative capacity utilization)

of exchange rate volatility[2] on the volume of UK exports to the USA for the period 1889 to 1999 and also observed no significant effect between these two variables. Also, using the augmented gravity model of trade, Dell' Ariccia (1999) investigated the effects of exchange rate volatility[3] on trade flows for fifteen western European countries and Switzerland for the period 1975 to 1994 and observed that exchange rate volatility has a small but significant negative effect on trade. Arize et al (2000) applied a traditional specification of the long-run export demand equations and cointegration analysis on thirteen Less Developed Countries (LDCs) and observed that for the period between 1973 and 1996, exchange rate volatility negatively and significantly affects export flows. Sauer and Bohara (2001) used similar long-run export demand equation to Arize et al (2000), but went step further and compared findings between sixty-nine developing and twenty-two developed and industrialized countries. To allow for cross-country structural and policy differences that may affect export performance, they estimated fixed and random effects models. Period of study was between 1973 and 1993. They applied three different proxies of exchange rate uncertainty measurement including an Autoregressive Conditional Heteroscedasticity (ARCH) generated variances of the real exchange rate, a moving standard error of the estimate of a first order geometric autoregressive process of the Real Exchange Rate (RER) and a moving standard error of the estimate from a second order linear time trend of the logarithm of RER. They found that all three proxies of exchange rate volatility have negative and significant effects on trade when all the ninety-one countries were considered as one entity. Interestingly, when the task was divided into sixty-nine LDCs and twenty-two

[2] Following Arize et al (2000), Aristotelous (2001) estimated time-varying exchange rate volatility using moving standard deviation of real effective exchange rate growth.

[3] Proxies for exchange rate volatility included standard deviation of the differences of logarithm of monthly average bilateral spot rate, sum of squares of forward errors, and the percentage changes between the maximum and the minimum nominal spot rates.

developed countries exchange rate volatility was observed to negatively affect trade in all the export demand equations that were specified for LDCs and not for the twenty-two developed countries (only three out of the eighteen specified export demand equations show evidence of negative and significant effect of exchange rate volatility on trade).Among the LDCs, negative effects of exchange rate volatility are significant in the African and South American countries but not significant in the Asian countries they considered.

Arize et al (2000) argued that the negative relationship between bilateral trade and exchange rate volatility is expected by suggesting that higher volatility leads to higher expenditure for risk-averse traders, and in effect lowers the urge for international trade. Normally, exchange rate is settled on the time of the trade contract and as payment is not made until after delivery takes place; in between the time the exchange rate is agreed and goods delivery, there is a possibility of exchange rate varying with time, which may affect earnings from international trade. However proponents of the argument that exchange rate volatility does not necessarily affect trade argue that in periods of trade uncertainty (as a result of exchange rate volatility); some traders may relatively increase the volume of trade. This relative increase in the volume of trade may result in a more than proportional increase in the earnings from international trade and thus, compensate for the effects that exchange rate volatility brings. De Grauwe (1988) attributed this to the behaviour of adequately risk adverse exporters; their marginal utility of revenue increases as exchange rate volatility increases. Baron (1976) also argued that exchange rate volatility may not necessarily affect trade if hedging opportunities exists. Arize et al (2000) however explained that exchange rate risk is not generally hedged in LDCs since forward markets are usually not available to many of the traders. For the few that are able to access forward markets, limitations such as the size of the contracts needed for hedging and short term maturity for some of the hedge funds makes hedging difficult.

Observations on previous empirical surveys by Baum et al (2004) and more recently Ozturk (2006) have added other dimensions to this mixed empirical findings; they observed that apart from the class of countries under consideration (developed versus developing), empirical findings can be sensitive to other factors including model specifications and exchange rate volatility used. Consequently, this paper is motivated in three parts: The nature of relationships between exchange rate volatility and bilateral trade for Ghana, Mozambique and Tanzania[4] (developing countries) and their respective biggest trade partners are investigated and simultaneously, explored whether findings are sensitive to either exchange rate volatility proxy used or model specification applied or both.

Three different measurements for exchange rate volatility (for each of the three developing countries under consideration) are used to investigate the nature of relationship between exchange rate volatility and trade in an augmented gravity model; which in itself, is estimated using two different estimation techniques. Results from the estimated models, suggested that generally, exchange rate volatility does not significantly affect trade for the three Sub-Sahara countries considered. In some instances, it is observed that the statistical significance of some of the variables included in our estimations is sensitive to the exchange rate volatility proxy used. It cannot however be firmly concluded that model specification significantly impacted empirical findings. The rest of the paper is organised as follows: In Section 2, the

[4] These three countries were chosen because they have gone through comparable policy engagements with the IMF, have followed similar floating exchange rate regimes and currently all adhere to the IMF convention of free current account convertibility and transfer.

gravity model, the variables, data and estimation techniques applied are presented. Section 3 presents analyses on findings and Section 4 concludes this paper.

2. The Gravity Model of Trade, Variables Measurements, and Estimation Techniques

In this section, the gravity model as applied to trade is introduced. Also, how the variables are measured in this exercise and estimation techniques used are also discussed.

2.1 The Gravity Model of Trade

The idea of using the gravity model[5] to explore relationships in the social sciences is attributed to Stewart (1941, 1947) and more pertinently to international trade by Tinbergen (1962) and Poyhonen (1963) independently. Analogous to the Newton Gravity model, Tinbergen (1962) and Poyhonen (1963) proposed that bilateral trade between two countries will depend directly on the sizes (usually either economic and/ population sizes[6]) and inversely on the distance between them.

The Basic form of the gravity trade model for international bilateral trade proposed by Tinbergen (1962) and Poyhonen (1963) is similar to;

$$Z_{ijt} = \beta_0 \frac{(Y_{it}Y_{jt})^{\beta_1}}{Dist_{ij}^{\beta_2}} \qquad (1)$$

[5] As its name suggests, the gravity model originated from the Newtonian Law of Universal Gravitation, expressed mathematically as - $F = G\frac{M_1 M_2}{Dist^2}$. *F* represents the force of attraction between two masses M_1 and M_2 and $Dist$ represents the distance separating the two masses; *G* is the gravitational constant.

[6] Linnemann (1966) proposed the inclusion of population as another input to cater for the size of the economy

Z_{ij} represents the value of bilateral trade between countries *i* and *j*. β_0 is a constant, Y_i and Y_j respectively represents sizes of economies of countries *i* and *j*. $Dist_{ij}$ represents the distance between the trading countries. β_1 and β_2 represents indices of Y_i and Y_j and distance between economies *i* and *j* respectively. The multiplicative nature of Equation 1 means that a log-linear relationship between the variables can be obtained, that is;

$$LogZ_{ijt} = \beta_0 + \beta_1 Log(Y_{it} Y_{jt}) - \beta_2 LogDist_{ij} \qquad (2)$$

The initial empirical success of the gravity trade model in describing international trade by Tinbergen (1962) and Poyhonen (1963) encouraged other researchers to improve and enhance the model. Although empirically, the gravity model has been successfully applied to international trade, critics questioned the theoretical underpinnings of the model until Anderson (1979) formally developed most of the theoretical foundations. Most of the underlying theories of the gravity models conforms in many ways to existing international trade theories. For instance Anderson (1979) used properties of expenditure functions in countries and justified the application of gravity model by assuming a Cobb-Douglas expenditure system and constant elasticity of substitution preferences. He assumed products are differentiated from their source countries. Bergstrand (1985) also justified the basis of the gravity model on similar arguments to Anderson (1979). Bergstrand (1985) argued for the inclusion of exchange rate and price in the gravity model as they play important role to trade. Deardoff (1995) observed that the gravity model conforms to the Ricardian and Heckschser-Ohlin models[7] with the

[7] The Ricardian and Heckschser-Ohlin trade models are built on the theory that factor endowment determines the pattern of trade between two countries. Countries tend to export goods whose production utilizes the factors they have in abundance, and import the goods that utilize the countries less abundance factors of production.

assumption of frictionless trade and different countries producing different goods. The gravity model applied in this paper is the augmented gravity trade model[8]. In the next section we explain the relevance of the variables used in our study and how they were measured.

2.2 The Variables

This section explains how the variables used in the augmented gravity trade models for Ghana, Mozambique and Tanzania were estimated.

Bilateral trade

Real bilateral trade (in logarithm) between country trade-pairs is calculated as

$$LogBTRADE = Log\left[\left(\frac{EXP_{ijt}}{USGDPD_t}\times 100\right)\times\left(\frac{IMP_{ijt}}{USGDPD_t}\times 100\right)\right] \tag{3}$$

Where EXP_{ijt} and IMP_{ijt} respectively represent the nominal values of exports and imports (in US dollars) between countries i and j; $USGDPD_t$ represents US GDP deflator[9].

Size of a Country

Two variables are used to proxy the sizes of country trade-pairs; these are annual GDPs (in constant 2000 US Dollars) and annual population sizes. Total GDPs of country trade-pairs i and j (in logarithm) is thus calculated as;

$$LogGDP_{ijt} = Log(GDP_{it}\times GDP_{jt}) \tag{4}$$

[8] The augmented gravity trade model, an extension of the standard gravity model of Tinbergen (1962) and Poyhonen (1963) allows us to test the explanatory significance of a variable on trade.

[9] Eichengreen and Irwin (1996) and more recently Baak (2004) used the US GDP deflator to calculate real exports from nominal exports values.

Where GDP_{it} represents the GDP of country i at time t, and GDP_{jt} represents the GDP of country j at time t.

The total population (in logarithm) for county trade-pairs, i and j is calculated as;

$$LogPOP_{ijt} = Log(POP_{it} \times POP_{jt}) \qquad (5)$$

Where POP_{it} represents the population of country i at time t and POP_{jt} represents the population of country j at time t.

Distance

In this research, distances ($Dist_{ij}$) between major goods and cargo ports (sea) serving countries trade pairs (in kilometres) are used (See Table 1 in Appendix). In the case of the distance between one of the developing countries under consideration and EU-12[10] however, an average of all the distances between the particular development country and each member country of the EU-12 is used.

Exchange Rate Volatility

Previous studies suggest that volatility (which is thought to reflect market uncertainty) is usually captured by variances in a data. The problem faced by practitioners and researchers is using the technique that best capture volatility in a particular series. For each developing country and her bilateral trade partner, three different estimation techniques are used to generate volatility series over the estimation period. Using two different specifications of an augmented gravity model, these generated volatility series

[10] The EU-12 (EU-15 without Denmark, Sweden and UK) includes member states of the European Union before expansion in 2004. The United Kingdom is treated differently because the British pound still remains her national currency. The EU-12 member states are Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, and Spain.

are experimented with to examine whether each one of them can influence empirical findings.

The three techniques used to generate exchange rate volatility were;

I.Autoregressive Conditional Heteroscedastic (ARCH) Technique

One stylised fact of foreign exchange market is that it is characterised by time-varying volatility (See Engle et al 1990). The literature on modelling the time-varying nature of volatility in the exchange rate market is however dominated by the ARCH family of models, introduced by Engle (1982). In the ARCH modelling technique, conditional variance of the current error term (or current volatility) is modelled as a function of variances of previous error terms. In an ARCH(q) specification, conditional variance is modelled mathematically as $\sigma_{x_t}^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \alpha_2 \varepsilon_{t-2}^2 + ... + \alpha_q \varepsilon_{t-q}^2$. For non-negative conditional variance, $\alpha_0 > 0$ and $\alpha_k \geq 0$ for *k=1, 2, 3…, q*; ε_{t-k} represents error terms from the exchange rate forecasting model of the experimenter choice.

Bollerslev (1986) developed the GARCH (Generalized ARCH) models to cater for the slow decaying nature of ARCH models. Also the GARCH models are less likely to breach the non-negative constraints required for the ARCH models. Nelson (1991) developed the EGARCH (Exponential GARCH) whilst Zakoian (1994) and also, Glosten, Jaganathan and Runkle (1993) independently developed the TARCH (Threshold ARCH) models to cater for asymmetric effects in financial time series[11] .

[11] See Bera and Higgins (1993) and Bollerslev et al (1994) for thorough overview of the ARCH family of models.

Robust measures of volatility are estimated by first testing the time series properties for all the monthly exchange rate percentage change series (x_t)[12] under consideration. Finding them stationary and highly autocorrelated, I then experimented with different ARMA specifications based on the general model,

$$\alpha(L)\alpha_S(L)\left[(1-L^m)x_t - \mu_t\right] = \beta(L)\beta_S(L)\varepsilon_t \tag{6}$$

Where α, α_s, β and β_s are well-behaved polynomials of adequate orders in the lag operator L, subscript s denotes the seasonal component that can be factorised and together with $m = 12$ captures any dynamics due to the months' effects, μ_t is a deterministic component which captures any mean-shifting across months using seasonal dummies and ε_t is an independently distributed random disturbance term. From these experiments, statistically robust and parsimonious empirical representations of the generating process for x_t are selected (See Table 1 in Appendix).

The empirical representations obtained based on Equation 6 for each monthly exchange rate series are conditional on the assumption that ε_t is homoscedastic. I therefore tested the homoscedasticity assumption (using the ARCH-LM test) which was strongly rejected in all cases. Using residuals from the estimated time series model for each exchange rate series, statistically robust and parsimonious ARCH family of models that adequately describes the conditional variances in the monthly exchange rate series under consideration are estimated (See Table 1 in Appendix). Annual forecasts from our obtained ARCH family of models by are estimated by taking the average over twelve months.

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[12] Percentage changes are calculated as the first difference of logarithm of each of the exchange rate series under consideration.

II.Exponentially Weighted Moving Averages (EWMA) Technique

Although this technique does not possess sophisticated mechanism like the ARCH family of models in its ability to capture some of the empirical regularities found in exchange rate markets, previous researches suggest that the EWMA can produce comparably good or better volatility forecasts (Lopez 2001 as well as Nelly and Weller, 2001). The technique attaches more importance to recent volatility innovations. A geometric random walk model of the form in Equation 7 below is first estimated.

$$x_t = a + \varepsilon_t,\ \varepsilon_t \sim iid \qquad (7)$$

Where a is the drift component. Residuals from the estimated geometric random walk models[13] of our monthly exchange rates series are then used to estimate volatility using an EWMA technique with RiskMetrics^{TM} smoothing factors[14] λ = 0.97. The monthly forecasts from our obtained EWMA models are then annualised by taking the average over twelve months.

III.Average Annualized Monthly Variances (AMV)

Similar to Dell' Ariccia (1999), annual variances to proxy annual volatilities for our exchange rate series under consideration are estimated as,

[13] In order to derive the recursive form of the EWMA model for volatility forecasts as suggested by the JP Morgan RiskMetrics group, it is assumed that infinite amount of data is available and also sample mean is zero. Hence, the use of residuals from the geometric random walk model in our volatility forecasts. The conditional variance of percentage changes in is accordingly expressed $\sigma_{x_t}^2 = \lambda\sigma_{x_t}^2 + (1-\lambda)x_{t-1}^2$, $0 < \lambda < 1$

[14] JP Morgan group analysed a very large number of financial time series and observed that on the average, the RiskMetrics smoothing factor λ = 0.97 produces optimal forecasts for most monthly financial time series(see J.P Morgan *RiskMetrics^{TM} Technical Document Part II: Statistics of Financial Market Returns,* Fourth Edition. New York: 1996).

$$\sigma^2{}_{x_t} = \frac{1}{12}\sum_{i=1}^{12}(x_t - \bar{x}_t)^2 \qquad (8)$$

Common Language

Many studies (for instance, Frankel and Rose, 2002) show significant evidence of the influence of a common language on international trade. This could stem from the fact that language (and other similar intangible factors including culture and ways in executing business) influences international trade relationships. Also, most countries sharing a common language tend to have previous colonial relationships; improved trade terms are now evident in the post colonial era. In this study, a dummy variable ($D1_{ij}$) is used to capture the influence of common language on the flow of trade in our gravity models. For each country under consideration and their respective bilateral trade partners, common language is given a score of one; otherwise a score of zero is given (see Table 1 in appendix).

In general, the coefficients of explanatory variables are a priori signed on the basis of the underlying economic theory. *Ceteris Paribus*, bilateral trade is expected to be higher the higher are incomes of trade partners. Population may take either signage in a gravity model (see Martinez-Zarzosa and Nowak-Lehman, 2002). Population may possess a negative sign if trade partners trade less when they become larger or a positive sign if they export more as they become larger. *Ceteris Paribus*, bilateral trade is expected to be higher between trade partners having a homogenous culture (share border, common language, colonial relationship, etc) and also bilateral trade is expected to be higher the closer the trading partners are, and as already explained in Section 1, bilateral trade is expected to be higher, the less volatile is the bilateral exchange rate between the trade partners.

2.3 Data and Estimation Technique

The data used in this study range from 1980 to 2005. Data on nominal bilateral trade were obtained from the International Financial Statistics of the International Monetary Fund (IMF). The US GDP deflator, nominal GDP, population sizes and nominal exchange rates were obtained from the US Department of Agriculture website. The distances between Ghana, Mozambique and Tanzania and each of their respective trading partners were obtained from the world ports distances website.

For the three Sub-Saharan developing countries under consideration, there are serious deficiencies in the availability of historical bilateral exchange rate and trade data between country trade pairs. In this study, bilateral country /US dollar[15] currency exchange rate data are used to generate volatility proxies for our period of study. The assumption made here is that a volatile domestic country /US dollar currency exchange rate have the potential to negatively affect trade.

The bilateral trade partners' considered for Ghana in this study are China, EU-12, India, Japan, Nigeria, the US and the UK. Mozambique trade partners considered were EU-12, India, the UK and the US. Finally for Tanzania, China, India, Japan, the US and the UK were considered.

Two different regression techniques were applied to the gravity trade model estimation. First, a standard time series cross section (STSCS) pool gravity trade model of the form below is estimated;

$$\begin{aligned} LogBTrade_{ijt} &= \alpha_0 + \beta_{1ijt} LogGDP_{ijt} + \beta_{2ijt} LogDist_{ij} + \beta_{3ijt} LogPop_{ijt} \\ &+ \beta_{4ijt} LogVol_{ijt} + B_{5ij} D_{1ij} + \varepsilon_{ijt} \end{aligned} , \varepsilon_{ijt} \sim iid \qquad (9)$$

[15] The preferred currency for cross border foreign exchange transactions in most developing countries is the US dollar.

Where $\alpha_0, \beta_{1ijt}, \beta_{2ijt}, \beta_{3ijt}, \beta_{4ijt} and \beta_{5ijt}$ respectively remain the same across country trade pairs. It is assumed that the disturbances are pair-wise uncorrelated and also all classical disturbance-term assumptions hold; thus the use of ordinary least squares technique to estimate the 'standard' time cross-sectional gravity model is justified. Next, to control for country trade-pairs heterogeneity, a fixed effects time series cross section (FETSCS) pool gravity trade model of the form below is estimated;

$$\begin{aligned} LogBTRADE_{ijt} &= \alpha_0 + \alpha_t + \beta_{0ij} + \beta_{1ijt} LogGDP_{ijt} + \beta_{2ijt} LogDIST_{ij} \\ &+ \beta_{3ijt} LogPOP_{ijt} + \beta_{4ijt} LogVOL_{ijt} + \beta_{5ijt} D1_{ij} + \varepsilon_{ijt} \end{aligned}, \varepsilon_{ijt} \sim iid \qquad (10)$$

Here, heterogeneity is controlled by allowing the parameter β_{0ij} to vary for each country pair. $\alpha_0, \beta_{1ijt}, \beta_{2ijt}, \beta_{3ijt}, \beta_{4ijt} and \beta_{5ijt}$ respectively remain the same across bilateral country trade-pairs. α_t is time specific component which is used to control for time specific events (example globalisation, technology, high oil prices, world economy situation and natural disasters) that impacted on bilateral trade relationships (between each of the three developing countries and their trade partners under consideration) from 1980 to 2005. Since distance and common language are time invariant, they are initially eliminated from the fixed effects pooled cross-sectional estimations; their respective statistical significance are then analyzed by regressing the country pair effects (β_{0ij}) on both the distance and same language variables (see Cheng and Wall, 2005), that is;

$$\beta_{0ij} = \gamma \ln DIST_{ij} + \vartheta D1_{ij} + \xi_{ij} \qquad (11)$$

Equation 11 is estimated using OLS with robust standard errors.

In all, 6 bilateral gravity trade equations are estimated[16] for each of the three Sub-Saharan developing economies under consideration and their respective trade partners.

3. Analyses of Findings

It cannot be firmly concluded in this paper that empirical findings were sensitive to model specifications; since (based on R^2 and Durbin-Watson statistics[17]) relative to the FETSCS gravity specification, the STSCS specification produced very inferior regression diagnostics (See Tables 2, 4, and 6 in Appendix).

Using results from all the FETSCS specified models, it can therefore be concluded that generally between 1980 and 2005, exchange rate volatility did not impact on bilateral trade for the three developing countries and their respective trade partners' considered.

To some extent findings from this study support Baum et al (2004) and Ozturk (2006) suggestion, that is the nature of relationships between bilateral trade and some of the regressors (apart from GDP[18]) are sensitive to the volatility proxy applied and interestingly the country trade pair under consideration, even when only the results from the FETSCS specified gravity models (See Tables 2, 4 and 6 in Appendix) are used for our analyses. For instance it is observed that the coefficient on population size is positive and statistically significant (at 1% level of significance) in explaining bilateral trade for Ghana (irrespective of the volatility measurement used) and Tanzania

[16] Three different volatility measures were experimented with for each of the time series cross-sectional estimation technique applied.

[17] As a rule of thumb, a Durbin Watson statistic (which is used to detect the presence of autocorrelation in regression) less than one is a cause of alarm, and any value close to two indicates no autocorrelation.

[18] Coefficient of GDPs in the estimated gravity models for each of the three developing countries and their respective trade partners are statistically significant (at 5%) and conform to the expected a priori sign as suggested by underlying theory.

(at 5% level of significance, only when AMV technique is used to generate volatility) but negative and significant (at 5% level of significance) in the case of Mozambique (irrespective of the volatility measurement used). Thus, using our fixed effects gravity model, it can be generally concluded that for Ghana and her respective trade partners in particular, increasing population sizes led to an increasing demand for goods and services, resulting in an increase in imports to meet the needs of the growing population. In a labour dependent economy like Ghana, increasing population may also help to stimulate growth in the production and manufacturing sector which could lead to a growth in the export side of the economy.

In the case of Mozambique, we cannot justify using the explanation given by Martinez-Zarzosa and Nowak-Lehman (2002) in explaining a negative relationship between population size and bilateral trade. Although Mozambique is endowed with natural resources, the country does not have the means to become self sustainable as population increases: Among the three developing countries considered, Mozambique has comparably experienced sustained periods of civil strife[19] particularly in the period under consideration. It can be argued that this civil strife impacted on the international trade to the detriment of an increasing population size.

4. Conclusion

Even though findings in this study suggested that exchange rate volatility did not generally impact bilateral trade from 1980 to 2005 for Ghana, Mozambique and Tanzania and their respective bilateral trade partners under consideration, the overall effects on the three Sub-Saharan developing countries' economies should not be

[19] For empirical evidence on how conflicts impacts trade, see studies by Awukuse and Gempesaw II (2005) and more recently Martin et al (2008).

underestimated. Since exchange rate risk hedging tools are almost non-existent in most developing Sub-Saharan countries like Ghana, Mozambique and Tanzania, the empirical findings could be attributed to two main reasons: Firstly, as developing economies, the need to import finished products for local consumption as well as intermediate and capital goods for exports production outweighed the detrimental effects of exchange rate volatility. Secondly, as argued by De Grauwe (1988), sufficiently risk-averse exporters see exchange rate volatility as an incentive to increase their exports to maximise their revenue; the increasing cost of imports resulting from a volatile domestic currency is usually passed on to consumers. The problem facing policymakers is how best they can take advantage of international trade whilst at the same time ensuring that exchange rate volatility does not affect economic and political stability via the channels of exchange rate or inflation pass through. Advisably, the economies of Ghana, Mozambique and Tanzania expands, avenues (including but not limited to currency hedging and currency swaps) should be readily available to local traders to help reduce the potential negative effects of exchange rate volatility on their economic performances.

Finally, although this findings from this paper does not firmly support the suggestion that different model specifications affect empirical findings, it can however be concluded that to some extent, the nature of relationship between bilateral trade and some of the variables considered in the augmented gravity model can be sensitive to the exchange rate volatility proxy used as well interestingly as the country-trade pair under consideration.

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Appendix

Table 1: ARCH Models, Distance (km) between Trade Partners and Language Dummies

Trade Partners	Sub-Saharan Developing Country								
	Ghana			Mozambique			Tanzania		
	Volatility Model	$Dist_{ij}$	$D1_{ij}$	Volatility Model	$Dist_{ij}$	$D1_{ij}$	Volatility Model	$Dist_{ij}$	$D1_{ij}$
China	MA(1)-EGARCH(1,1)	19,038	0	NA	NA	NA	MA(1)-EGARCH(1,1)	10,984	0
EU-12	AR(1)-GARCH(1,1)	7,213	0	AR(1)-GARCH(1,1)	10,958	0	AR(1)-GARCH(1,1)	10,216	0
India	AR(1)-EGARCH(1,1)	13,296	1	AR(1)-EGARCH(1,1)	5,159	0	AR(1)-EGARCH(1,1)	4,630	1
Japan	MA(1)-EGARCH(1,1)	20,266	0	MA(1)-EGARCH(1,1)	NA	NA	MA(1)-EGARCH(1,1)	12,694	0
Nigeria	AR(1)-ARCH(1)	420	1	NA	NA	NA	NA	NA	NA
UK	AR(1)-ARCH(1)	7,252	1	AR(1)-ARCH(1)	12,556	0	AR(1)-ARCH(1)	11,845	1
US	ARMA(1,1)-ARCH(1)	8,622	1	ARMA(3,3)-EGARCH(1,1)	18,319	0	AR(1)-ARCH(1)	18,374	1

Table 2: Results from Estimated Gravity Trade Models for Ghana and Trade Partners: Dependent Variable: Logarithm of Bilateral Trade

Explanatory Variables	Coefficients					
	ARCH		EWMA		AMV	
	STSCS	FETSCS	STSCS	FETSCS	STSCS	FETSCS
α_0	32.066 (3.023***)	-520.842 (-5.989***)	31.083 (2.904***)	-528.286 (-5.907***)	24.119 (2.210**)	-535.635 (-6.339***)
$LogGDP_{ijt}$	0.702 (9.182***)	3.476 (2.595**)	0.699 (9.241***)	3.296 (2.450**)	0.782 (9.729***)	3.525 (2.733***)
$LogPOP_{ijt}$	-0.617 (-2.345**)	10.804 (4.794***)	-0.590 (-2.206**)	11.196 (4.798***)	-0.510 (-1.938*)	11.107 (4.904***)
$LogDIST_{ijt}$	-0.798 (-2.882***)	-0.536 (-1.526)	-0.752 (-2.911***)	-0.593 (-2.101*)	-0.699 (-2.967***)	-0.578 (-1.678)
$\log VOL_{ijt}$	-0.185 (-1.141)	0.212 (1.206)	-0.147 (-0.795)	-0.087 (-0.481)	-0.061 (-2.879***)	-0.112 (-0.752)
$D1_{ij}$	-2.919 (-6.161***)	6.970 (0.525)	-3.008 (-6.396***)	7.801 (0.766)	-2.862 (-6.135***)	7.567 (0.723)
Fit of Model						
	ARCH		EWMA		AMV	
	STSCS	FETSCS	STSCS	FETSCS	STSCS	FETSCS
R-Square	0.474	0.846	0.474	0.844	0.498	0.849
AIC	4.824	3.919	4.825	3.934	4.797	3.921
DW Statistics	0.451	1.161	0.459	1.137	0.547	1.169
Observations	26	26	26	26	26	26

T-statistics in (); ***, **and * respectively represents significance at 1%, 5% and 10% levels

Table 3: Ghana and Each Trading Partner Fixed Effects Cross-Sectional Intercepts.

Fixed Effects (Cross-Sectional)	ARCH	EWMA	AMV
CHINA-- β_{0ij}	2.654	0.706	2.175
EU-12-- β_{0ij}	-5.368	-5.116	-5.738
INDIA-- β_{0ij}	-15.671	-16.610	-16.333
JAPAN-- β_{0ij}	-7.217	-6.949	-7.338
NIGERIA-- β_{0ij}	18.299	19.003	19.317
UK-- β_{0ij}	15.720	16.291	15.911
USA-- β_{0ij}	-8.417	-7.325	-7.994

Table 4: Results from Estimated Gravity Trade Models for Mozambique and Trade Partners: Dependent Variable: Logarithm of Bilateral Trade

Explanatory Variables	Coefficients					
	ARCH		EWMA		AMV	
	STSCS	FETSCS	STSCS	FETSCS	STSCS	FETSCS
α_0	4.603 (0.234)	-588.747 (-4.301***)	0.734 (0.044)	-595.326 (-4.352***)	-18.465 (-1.486)	-530.780 (-3.206***)
$LogGDP_{ijt}$	0.877 (1.977**)	23.854 (6.740***)	0.801 (1.956*)	23.558 (6.490***)	0.653 (1.691*)	25.364 (6.439***)
$LogPOP_{ijt}$	-0.136 (-0.304)	-16.074 (-2.456**)	-0.041 (-0.103)	-15.473 (-2.299**)	0.312 (0.861)	-19.835 (-2.238**)
$LogDIST_{ijt}$	-0.715 (-0.373)	0.608 (0.239)	-0.343 (-0.206)	0.603 (0.243)	0.848 (0.664)	0.627 (0.217)
$\log VOL_{ijt}$	0.475 (1.190)	0.127 (0.366)	0.367 (1.241)	0.133 (0.513)	-0.061 (-0.945)	0.042 (0.644)
$D1_{ij}$	3.480 (5.149***)	-21.319 (-1.248)	3.513 (5.242***)	-29.195 (-1.263)	3.452 (4.990***)	-30.997 (-1.156)
Fit of Model						
	ARCH		EWMA		AMV	
	STSCS	FETSCS	STSCS	FETSCS	STSCS	FETSCS
R-Square	0.656	0.872	0.656	0.871	0.654	0.872
AIC	3.99	3.547	3.99	3.544	3.99	3.542
DW Statistics	0.785	1.243	0.758	1.238	0.790	1.222
Observations	25	25	25	25	25	25

T-statistics in (); ***, **and * respectively represents significance at 1%, 5% and 10% levels

Table 5: Mozambique and Each Trading Partner Fixed Effects Cross-Sectional Intercepts

Fixed Effects (Cross-Sectional)	ARCH	EWMA	AMV
EU12-- β_{0ij}	-23.859	-23.586	-25.165
INDIA-- β_{0ij}	63.241	61.946	70.676
UK-- β_{0ij}	-10.312	-9.619	-14.824
USA-- β_{0ij}	-29.070	-28.741	-30.687

Table 6: Results from Estimated Gravity Trade Models for Tanzania and Trade Partners: Dependent Variable: Logarithm of Bilateral Trade

Explanatory Variables	Coefficients					
	ARCH		EWMA		AMV	
	STSCS	FETSCS	STSCS	FETSCS	STSCS	FETSCS
α_0	48.549 (6.130***)	-249.750 (-2.897***)	54.048 (7.088***)	-247.506 (-2.929***)	-66.980 (9.156***)	-268.344 (-3.574***)
$LogGDP_{ijt}$	1.267 (9.653***)	2.515 (4.518***)	1.161 (8.766***)	2.446 (4.412***)	1.083 (7.549***)	1.999 (3.357***)
$LogPOP_{ijt}$	-1.303 (-11.327***)	4.232 (1.549)	-1.230 (-10.526***)	4.330 (1.631)	-1.309 (-11.318***)	5.538 (2.258**)
$LogDIST_{ijt}$	-3.908 (-8.889***)	-0.239 (-0.685)	-3.863 (-7.878***)	-0.242 (-0.481)	-4.206 (9.683***)	-0.261 (-0.413)
$\log VOL_{ijt}$	-0.816 (-3.459***)	-0.362 (-1.574)	-0.413 (-2.082**)	-0.034 (-0.169)	0.009 (0.674)	0.017 (1.396)
$D1_{ij}$	0.371 (1.497)	3.711 (1.418)	0.341 (1.355)	3.762 (0.621)	0.409 (1.664*)	4.142 (0.547)
Fit of Model						
	ARCH		EWMA		AMV	
	STSCS	FETSCS	STSCS	FETSCS	STSCS	FETSCS
R-Square	0.671	0.829	0.653	0.820	0.672	0.845
AIC	3.356	3.124	3.386	3.151	3.332	3.007
DW Statistics	0.925	1.205	0.861	1.155	0.872	1.331
Observations	26	26	26	26	26	26

T-statistics in (); ***, **and * respectively represents significance at 1%, 5% and 10% levels

Table 7: Tanzania and Each Trading Partner Fixed Effects Cross-Sectional Intercepts.

Fixed Effects (Cross-Sectional)	ARCH	EWMA	AMV
CHINA-- β_{0ij}	-0.668	-6.767	-8.771
INDIA-- β_{0ij}	-0.643	-0.657	-2.707
JAPAN-- β_{0ij}	2.134	2.172	3.549
UK-- β_{0ij}	9.098	9.252	11.182
USA-- β_{0ij}	-3.922	-4.001	-3.252

Table 8: Time Specifics Intercepts for the Three Sub-Saharan Developing Countries and their Bilateral Trade Partners

Year	Ghana			Mozambique			Tanzania		
	ARCH	EWMA	AMV	ARCH	EWMA	AMV	ARCH	EWMA	AMV
1980-- α_t	8.4289	8.771	8.459	-	-	-	5.481	5.700	5.222
1981-- α_t	7.615	7.827	7.852	15.446	15.346	15.939	4.964	5.167	4.884
1982-- α_t	7.202	7.338	7.397	17.421	17.286	18.128	4.481	4.535	4.225
1983-- α_t	4.379	4.508	4.564	20.261	20.094	21.234	2.244	2.259	1.953
1984-- α_t	3.746	3.887	3.935	20.089	19.927	21.109	2.940	2.895	2.537
1985-- α_t	3.794	3.931	3.968	18.934	18.827	19.953	1.894	1.875	1.516
1986-- α_t	2.915	3.215	3.215	18.083	17.926	19.147	1.488	1.410	1.016
1987-- α_t	2.682	2.900	2.768	13.923	13.783	14.664	0.874	0.918	0.745
1988-- α_t	1.154	1.342	1.231	11.434	11.346	11.807	0.149	0.218	0.043
1989-- α_t	0.792	0.988	0.957	9.517	9.442	9.803	0.161	0.232	-0.185
1990-- α_t	0.966	1.061	1.017	9.312	9.234	9.621	-0.499	-0.458	-0.867
1991-- α_t	-1.840	-1.694	-1.739	8.444	8.356	8.713	0.001	0.063	-0.387
1992-- α_t	-0.882	-0.667	-0.717	9.751	9.606	10.212	0.194	0.202	-0.252
1993-- α_t	-0.150	-0.037	-0.088	8.125	7.982	8.567	-0.233	-0.227	-0.717
1994-- α_t	-0.382	-0.357	-0.562	7.144	6.969	7.821	-0.198	0.006	-0.481
1995-- α_t	-0.924	-0.966	-1.061	5.791	5.615	6.521	-0.395	-0.061	-0.592
1996-- α_t	-1.517	-1.510	-1.622	4.718	4.550	5.477	-0.630	-0.452	-0.954
1997-- α_t	-2.225	-2.174	-2.267	1.271	1.152	1.976	-1.372	-1.276	-1.764
1998-- α_t	-2.764	-2.698	-2.822	-1.873	-1.953	-1.309	-1.616	-1.536	-2.021
1999-- α_t	-3.605	-3.340	-3.487	-4.361	-4.401	-3.817	-1.631	-1.577	-2.067
2000-- α_t	-4.323	-4.242	-4.393	-5.527	-5.587	-5.072	-2.464	-2.383	-2.850
2001-- α_t	-4.756	-4.703	-4.874	-8.292	-8.338	-7.9053	-2.730	-2.645	-3.108
2002-- α_t	-5.215	-5.195	-5.320	-9.448	-9.476	-9.0745	-3.059	-2.960	-2.964
2003-- α_t	-5.459	-5.431	-5.564	-11.330	-11.323	-10.988	-2.690	-2.596	-3.491
2004-- α_t	-5.563	-5.549	-5.698	-13.846	-13.809	-13.624	-2.705	-2.612	-3.590
2005-- α_t	-6.136	-6.141	-6.298	-15.450	-15.444	-15.283	-2.813	-2.698	-3.123