

Analyses of Foreign Trade Using Gravity-Type Models

*Yakub, M. U., Achua, J. K., Ray, P. M. and Asuzu, O. C.**

Abstract

Despite the increasing importance and overall net gains of international trade, there is growing concern about the potential negative net effects on developing economies. This necessitates the need for an in-depth analysis to better understand the economic principles underlying foreign trade policies and practices. This paper, therefore, employed gravity-type models to estimate long-run trade relationships in developing economies over a period of 38 years' across five continents. All the models showed that gross domestic product (GDP), foreign direct investment (FDI) and trade openness significantly promote multilateral trade. Conversely, real exchange rate volatility inhibited foreign trade significantly. However, migrant remittances and population impacted on cross border trade, insignificantly. The paper, therefore, recommended the need for rebalancing global net trade gains.

Keywords: Gravity-type Models, Foreign Trade, Trade Interdependencies, Rebalancing, Trade Gains

JEL Classification: F47, P45, Q27

I. Introduction

The strategic importance of international trade in the development process of global economies has escalated due, largely, to globalisation and its increasing influence of international dependencies. Fundamentally, international trade is premised on comparative advantage of countries in ensuring efficient allocation of national resources in a free global market system. In order to benefit maximally from international trade, countries and regional blocs are committed to sustainable alternatives to bilateral, regional and the multilateral levels of trade negotiations that provide the necessary guarantees for mutually-beneficial exchanges. Thus, optimisation of mutual benefits underlines the need to ensure that economic principles reflect the framework of foreign trade policies and practices of individual nations and regional blocs, as against subjecting such important decisions on political whims and caprices. The implication is that cost-benefit analysis, based on principles and pragmatism, has become the vogue in shaping and blending the international trading system (World Trade Report, 2003).

Striving for frameworks that are accommodative enough to ensure positive net gains of international trade for an economy, is essential in view of the indispensable role it plays in the global economy. For instance, in 2017, the ratio of trade growth to GDP growth rose to 1.5, buttressing the crucial role of trade in

* The authors are staff of the Research Department, Central Bank of Nigeria. The usual disclaimer applies.

driving economic growth and development, and job creation (World Trade Organisation, 2018). However, the increased importance of trade is not without growing concerns, particularly the potential negative effects, of trade on developing economies, despite overall net gains. The potential opportunities offered by international trade to developing countries are compromised by challenges of inefficiencies (Nicita et al., 2013). International trade will lead to economic growth, only if the policy measures are designed to promote economic benefits in the multilateral trading system. In Nigeria, for example, the long-run relationship between foreign trade and economic growth is predominantly characterised by "own shocks" (Arodoye & Iyoha, 2014). The consequences are imbalance in the global trade configuration (Ekesiobi et al., 2011) which requires urgent solution to douse the growing global tension. This has been explained by inconsistencies in the country's international trade policies (Akanni et al., 2009). All these point to the need for an in-depth analysis of the relationship between foreign trade and economic growth and the need to rebalance the overall trade gains.

Thus, the motivation for this study is to provide insights into the economic principles that are fundamental to foreign trade policies and practices for net gains, by employing more reliable data and robust econometric models. It is incumbent on individual countries, and regional unions, to design a framework of foreign trade policies that provides the necessary economic infrastructure to cope with the changes in global economic order. This is necessary because a well-articulated international trade policy exerts "a profound influence on the economic growth of a country" (Vijayasri, 2013:113). It is essential, therefore, to weigh the political economy of a country's trade policy on the basis of cost-benefit analysis. This behooves on individual countries, and blocs, to apply models that are appropriate in understanding, interpreting and predicting the dynamics of international trading activities. Accomplishing this task entails identifying priority international markets based on the complementary patterns of comparative advantage of foreign trade policy (Alleyne and Lorde, 2014).

The main objective of this paper, therefore, is to employ gravity-type models to analyse the underlying economic principles for equitable optimal trade policy. The significance of the analysis is to provide deeper understanding of foreign policy directions, predicated on economic interests of a country.

II. Literature Review

II.1 International Trade and Gravity Models

Adam Smith, pioneered the importance of international trade (Smith, 1776) and Ricardo (1817) subsequently drew from the principles of division of labour to establish what has come to be known as the law of comparative. Krueger

(1980:289) fostered the position of the classical economists by maintaining that international trade would generate growth “if only policy makers would abstain from unproductive intervention”. The subsequent challenge, therefore, was ascertaining interventions that were productive or otherwise.

Historically, the attempt of Ravenstein (1889) to use the gravity model in explaining migration patterns in the 19th century pioneered the adaption of the model to applications in economic problems in the UK. The gravity model was derived from the Newton's law of gravitation (Newton, 1728). Subsequently, the model was employed by Isard (1954) to make predictions on bilateral trade flows, based on the distance between a couple of countries as well as their respective economic dimensions.

Even though the gravity model had been employed in solving economic problems earlier, Tinbergen (1962) was the first to use the model by applying econometric techniques to explain trade flows. This was a significant introduction that allowed the economic measures and interpretation of the coefficients. The improvements of the model was anchored on the inclusion of the effect of political borders, common language and the likes as supplementary variables, to proxy for trade frictions which enhanced the model's usefulness. Thus, the theory, which initially covered spatiality and geographical factors, was extended to cover pure economics and to play an important role in the prediction of international trade. However, this development also highlighted the need for economic theory that could lay a solid foundation for the model's economic relevance. Anderson (1979) applied Cobb-Douglas and constant elasticity of substitution to derive the gravity model with the aid of properties of linear expenditure systems.

This application has resulted to richer and more accurate estimations and interpretations of the relations described in the model (Salvatici, 2013). Gravity equation has proven to be among the “most stable and robust empirical regularities in economics” over time and across different samples of countries and methodologies (Chaney, 2013). It is in furtherance of this development that several varieties of the model are widely used in international economics (Mitze, 2010), which include system generalised method of moments [GMM] (Nardis et al., 2009).

II.2 Nature and Dynamics of International Trade

II.2.1 Nature of International Trade

International trade is the exchange of products and services from one country to another. Nations engage in trade with one another because no country has the resources or capacity to satisfy all domestic needs of one another. On the other hand, by developing and exploiting their domestic resources, countries can

produce a surplus which is sold abroad through international trade. With international trade, competition ensures that consumers have affordable choices. According to OECD (2000), "the two main data items used in the concept of international trade are imports and exports"(p. 151) While imports of goods measure the value of goods that enter the domestic territory of a country, irrespective of their final destination, exports of goods measures the value of goods, which leave the domestic territory of a country. In international trade system, the definition of the statistical territory of a country coincides with its economic territory (United Nations, 1998). This study adopts the OECD (2000) definition.

The two main theories associated with foreign trade are import and export substitution theories. Import substitution is a trade theory that advocates the need to replace of imports with domestic production so as to reduce a country's foreign dependency through local production of goods and services, especially in areas where it has comparative advantage. The major benefits include self-sufficiency, eventual export-orientated economy, economic wealth and diversification, as well as ensuring less reliance on foreign goods. Another strong argument for this strategy is that all industrialised countries employed the strategy by which investment is directed to export-oriented industries in a bid to replace some imports (Sanderatne, 2011). The strategy is also important for raising revenues, saving foreign reserves, generating positive externalities and learning effects (Jayanthakumaran, 2000). However, the export substitution strategy has been criticised for promoting interventionist economic policies with the consequent misallocation of resources, misalignment of domestic and world prices, as well as rent-seeking opportunities associated with the shielding. Adomanis (2015) argue that the strategy has not been successfully transformed in some developing economies, partly, because of weak regulations and infrastructural deficiencies, as well as general aversion to investment which hindered its effective implementation.

Export substitution is a trade policy that is aimed at speeding up the production process of a country to facilitate exportation of goods and services for which the economy has comparative advantage. Reduced tariff barriers, floating exchange rates, and government support for exporting sectors are the usual policies adopted to promote the strategy. Export substitution trade policy is promoted to motivate export-led growth. It is essential for trade-dependent economies for which international trade makes up a large percentage of their gross domestic product. Trade reforms towards export substitution are targeted at reducing the gap between domestic and border prices by incentivising exports on the lines of comparative advantages in order to attain export-led growth (Jayanthakumaran, 2000).

II.2.2 Dynamics of International Trade

II.2.2.1 Gross Domestic Product

Gross domestic product (GDP) is a measure of economic production and growth. As a proxy for potential market, GDP reflects the attractiveness of a country and its market to foreign trading partners. When GDP growth is strong, the economy is expected to produce enough to export and import inputs to augment the production. In addition, GDP growth leads to more spending by consumers on goods and services; hence, exports are bolstered. Foreign partners also have the confidence to invest more when economic growth is strong, and investment lays the foundation for future exports. Conversely, when economic activities are dampened and GDP growth is very low or the economy goes into a recession, there is less to export and consumption of goods and services is constrained, thereby reducing imports into, and export out of, the economy.

There is overwhelming empirical agreement of the positive influence, running from GDP to Foreign trade. The regression relationship between trade and GDP growth shows overwhelmingly that there is bi-directional causality between trade and GDP growth in Togo, implying that the two variables complement each other in that economy (Gnoufougou, 2013). In the Jordanian economy, however, there is a causal relationship going from the economic growth to foreign trade, and not vice versa; implying that changes in the economic growth essentially explain the changes that occur in international trade (Shihab et al., 2014). Empirical results also indicate growth-led foreign trade pattern in Turkey (Kahya, 2011; Karahasan, 2011). The empirical consensus, therefore, is that there is a strong positive causality running from GDP to trade.

II.2.2.2 Real Exchange Rate

The relative valuations of currencies and their volatility often have important repercussions on international trade, however determined. Even though extant literature shows that exchange rate plays an important role in a country's trade performance, the determination of the direction and extent is yet to be resolved. Disaggregated trade data, for a large number of countries between 1970 and 1997, found strong evidence, supporting the prediction that exchange rate volatility impacts trade in products, differently. According to their degree of differentiation, commodities are less affected by exchange rate volatility than more highly-differentiated products (Broda & Romalis, 2011). This insight necessitates the need to identify the channels of causation in an attempt to structurally address the effects of exchange rate volatility on trade.

An investigation by Auboin & Ruta (2013) indicated that, on average, exchange

rate volatility had a negative impact on trade flows. Furthermore, the findings further revealed that the extent of the effect depended on a number of factors, such as: the prevalence of hedging instruments; the structure of production, such as the existence of small firms; and the degree of economic integration across countries. Dike (2016) identified the channels through which the fluctuation of exchange rate affected international trade. His findings on seven developed and four developing economies, using the GARCH approach showed mixed results. While the result from developing economies unequivocally supported that fluctuation of real exchange rate had negative effect on trade, the relationship was found to be ambiguous among developed countries.

However, Nicita (2013) analysed the impact of exchange rate volatility on trade by estimating fixed effects models on a panel dataset, comprising 100 countries spanning over 10 years, and found no relationship between them. He concluded that since the relative valuation of currencies explained only a small part of global trade, exchange rates adjustment could only supplement other policy actions in order to make an effective impact on the rebalancing of global trade.

II.2.2.3 Foreign Direct Investment

It is yet to be empirically determined as to whether foreign direct investment (FDI) and exports are net substitutes or net complements. Theoretically, horizontal FDI models uphold a substitution relationship between FDI and exports while models of vertical FDI sustain the existence of complementarity (Liu & Graham, 1998). Although, empirical results are mixed due, perhaps, to the fact that studies use different samples, different FDI proxies and levels of analysis, empirical findings indicate that most countries experience complementarity between FDI inflows and trade (Forte, 2004). The explanation for the strong complementarity is hinged on the existence of vertical production relationship between headquarters and hosts FDI's products (Fontagné, 1999). It has been noted that countries that experience substitution effect between FDI and foreign trade have no significant relationship between the two variables (Blonigen, 2001). Turkey is a good example of an economy where there is no causal relationship between FDI and trade (Kiran, 2011). Given the indeterminate nature of the relationship between FDI and trade "a lot of work remains to be done in order to clarify the type of existing relationship between FDI and international trade". (Forte, 2004: 23).

II.2.2.4 Migrant Remittances

International migration is a complex phenomenon involving a multiplicity of international linkages, including trade (International Organisation for Migration, 2018). Migrant remittances have become an important component of inflows into

the economy. For instance, global remittances reached US\$613 billion, while remittance flows to low- and middle-income countries (LMICs) rose to US\$466 billion in 2017 (World Bank Group, 2018). The World Development Indicators (WDI) definition of remittance includes “all current transfers in cash or in kind between residents and nonresident individuals ... independent of the sources of the sender” (World Bank, undated).

Granger causality results from Spanish data between 1975 and 2013 showed that remittances and international trade formed a positive feedback loop (Metelski & Mihi-Ramirez, 2015). However, panel regression analysis of remittances in the trade balance of 11 labor-abundant Middle East and North Africa (MENA) countries showed that the inflow of remittances had had an increasing effect on trade deficits by triggering import-led consumption expenditures (Farzanegan & Hassan, 2016). This finding points to the fact that capturing the use of remittances in an economy is helpful in determining the relationship between migrant remittances and external trade. This is essential because where a significant portion of the remittances is invested in trade and business as well as financing import of capital goods, remittances would serve as a vehicle to boost international trade. This has been the case in Bangladesh (Ferdaous, 2014). It appears that the application of remittances in an economy is fundamental in explaining its relationship with international trade.

II.2.2.5 Trade Openness

Trade-led growth hypothesis holds that trade openness (TOP) can potentially enhance access to goods and services, achieve efficiency in the allocation of resources and improve total factor productivity through technology diffusion and knowledge dissemination in the long-run (Keho & Wang, 2017). It is in view of these expected gains that countries are adopting and consolidating trade liberalisation reforms as alternatives to import-substitution industrialisation strategy. The reforms, which aim at reducing import and export tariffs and non-tariff barriers, have been adopted by many developing countries. However, there are arguments that increase in trade openness may expose developing countries to increasing inflation and lowering exchange rates (Cooke, 2010). It is further argued that trade openness has adverse effects on economies that are characterised by production of low-quality products (Hausmann et al., 2007).

In spite of these conflicting views, the consensus is that openness to international trade is beneficial to developing countries. This is imperative because openness is an indispensable enabler of trade in a global landscape that has devolved production processes internationally into global value chains (GVCs) that offer developing economies enormous global trading opportunities. The GVCs

opportunities have, however, intensified global trade competition. In order to reap the benefits of international trade in a contemporary economy, it is crucial to pursue a twin strategy of trade and competitiveness. The competitiveness of an economy determines how well it can convert the potential that openness offers into opportunities. Coping with the global competitiveness entails reforms which incorporate policies and regulations that ensure conducive business climate, stable macroeconomic conditions, good governance, and infrastructural development. A holistic infrastructure that encompasses “hard” or core physical infrastructure in transport, communications, energy, and logistics as well as “soft” infrastructure, in education and skills is encouraged (Jackson, 2015).

II.2.2.6 Population

There are mixed findings regarding the believe that population size gives a country comparative advantage in international trade, especially in primary goods. The economic rankings of developing countries do not seem to support this theory (Morrison, 1977). The countervailing population size effects listed to explain the deviation include the facts that small domestic markets encourage exports; countries with large population encourage import substitution strategies; the dependence of small countries on export encourage open trade policies; and population is not a perfect proxy for natural resources. Morrison's (1977) conclusion from empirical findings is that country-specific influences in the samples explain the differences recorded in research outcomes. This is further elucidated by subsequent empirical findings. In an extension of the original gravity model of bilateral trade with special emphasis on the influence of the population size on a country's trade flows, Nuroğlu (2010) showed that the impact of population on bilateral trade flows was positive for the exporting country, while it is negative for the importing country. A related study involving time-series cross-section empirical analysis for a large sample of developed and developing countries by Doces (2011) revealed that international trade had a statistically significant inverse effect on the birth rate. It has been observed that though the relationship between trade and population is premised on growth of people, global trade actually benefit multinational corporations, lobbyists, and some government officials, who constitute about one (1) per cent of the global population (UNCTAD, 2018). The take from these reviews is that population may have positive or negative effect on a country's international trade, depending on the prevailing circumstances.

III. Methodology

Traditionally, classical gravity models have been expressed as single equations using cross-sectional data to estimate trade flows between a pair of countries for a particular period. However, the use of structural gravity models, by the application

of panel data techniques, has long been established. Further to this development, several varieties of the model are widely used in international economics (Mitze, 2010). For example, Sevela (2002) and Aliyu & Bawa (2013) employed gravity-type models using panel data approach in the analyses of foreign trade. Afolabi et al., (2017) extensively employed FMOLs, CCR and DOLs as dynamic panel cointegration method as gravity-types models. The use of panel data in gravity model is becoming increasingly popular because it provides for multiple sites with periodical observations over a defined timeframe and could be used with several estimation techniques (Gul & Yasin, 2011).

III.1 Data Characteristics

The panel data for this study has a structure of T>N. There are a total number of 342 observations made up of annual data for 38 years (T), spanning 1980 – 2017, as against seven variables (N) for 9 countries employed in the model. The countries are Brazil, China, Ghana, Japan, Malaysia, Nigeria, South Africa, United Kingdom and USA. The variables employed are international trade, gross domestic product, real exchange rate, trade openness, foreign direct investment, migrant remittances and population. These are chosen on the basis of economic theory and data availability. However, the sample is a good representation of five continents as well as developed and emerging economies. The data were collected from World Bank and IMF sources. Table 1 summarises the theoretical underpinnings of the variables.

Table 1: Variables Description and *Á priori* Expectations

Variable	Description	Expected Effect	Explanation
TRD	Total Trade (US\$)		The two data items used in the concept of international trade are imports and exports (OECD, 2000)
GDP	Gross domestic product (US\$)	+	GDP is a measure of economic production and growth and reflects the attractiveness of a country for foreign trade (Gul, & Yasin, 2011)
EXR	Real Exchange Rate	-	An explanatory variable and a proxy for prices and an adjustment for domestic and foreign inflation (Gul & Yasin, 2011)
FDI	Net Foreign Inflows	+/-	This has substitution and complementary effects between trading partners (Liua et al., 2016)
REM	Net Remittances	+/-	All current transfers, in cash or in kind, between residents and nonresident individuals, independent of the sources of the sender (World Bank, undated)
TOP	Trade Openness	+/-	Ratio of imports to total trade. The more open a country, the greater its involvement in trade (Gul & Yasin, 2011)
POP	Population	+/-	The number of people living in a country at a particular time period may reflect the market size (Tayyab et al., 2012)

III.2 Model Selection

Variety of methods are used in a T>N panel structure. However, the Fully Modified OLS (FMOLS), Canonical Co-integrating Regression (CCR) and Dynamic OLS (DOLS) are more commonly employed (Priyankara, 2018). These models are usually preferred to the OLS estimator because they take care of small samples and endogeneity bias by adding the leads and lags of the first-differenced regressors. As a result, panel co-integration regression procedures have become the vogue for cross-sectional data analysis (Yorucu & Kirikkaleli, 2017).

Preliminary examination of stationarity of the sample data, using Augmented Dickey-Fuller (ADF), showed that all the variables are stationary at first level $I(1)$. In addition, Pedroni Residual co-integration test and Kao Residual co-integration test also revealed that all the variables were stationary, at first differencing $I(1)$. However, due to the fact that Pedroni and Kao co-integration tests are one-way co-integration, the Johansen (1988) testing, which has the advantage of a system-based co-integration test for the whole panel set instead of single equation based, was included for robustness. In the Johansen System Co-integration Test results, the summary of all the sets of Johansen System Co-integration model results (Table 2) indicated that both Trace and Max-Eigen values had two (2) equations at 0.05 significant levels.

Table 2: Summary of All Sets of Johansen System Co-integration

Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
Trace	2	2	2	2	2
Max-Eig	2	2	2	2	2

*Critical values based on MacKinnon-Haug-Michelis (1999)

More tests were carried out to further strengthen the reliability of the sample data. Tables 3 and 4 showed that the Engle-Granger and Phillips-Ouliaris Co-integration, each with the null hypothesis that the series are not co-integrated, were rejected while in Table 5, the null hypothesis of Park Added Variables that series are co-integrated was accepted.

Table 3: Engle-Granger Co-integration Test

	Value	Prob.*
Engle-Granger tau-statistic	-4.295102	0.2381
Engle-Granger z-statistic	-36.08790	0.2017

*MacKinnon (1996) p-values.

Table 4: Phillips-Ouliaris Co-integration Test

	Value	Prob.*
Phillips-Ouliaris tau-statistic	-4.452866	0.1801
Phillips-Ouliaris z-statistic	-35.90026	0.2063

*MacKinnon (1996) p-values.

Table 5: Park Added Variables Co-integration Test

	Value	df	Probability
Chi-square	23.32381	1	0.0000

The outcomes of all the tests indicated that the variables were co-integrated. This translates that there is long-run relationships among the variables. Therefore, confirming the reliability of the sample data for the co-integration models. The convergence implies that the collective outcomes of the tests signify the appropriateness of FMOLS, CCR and DOLS models for panel regression estimations.

These co-integrating equation estimations seek to appraise the long-run relationships among the variables.

III.3 Specifications of Models

Having satisfied the conditions for co-integration regressions, the explicit specifications for general equation for all the FMOLS, CRR and DOLS models comprise of time-variant variables. Thus, specification of gravity model of multilateral trade in a cross-sectional way was specified as in Afolabi et al. (2017):

$$\ln TRD_{ij}^t = b_i + \beta_2 EXR_{ij}^t + \beta_3 TOP_{ij}^t + \beta_4 \ln FDI_{ij}^t + \beta_5 \ln REM_{ij}^t + \beta_6 \ln POP_{ij}^t + \varepsilon_{ij}^t \quad (1)$$

where i refers to the cross-section, t refers to the time, α refers to the constant term, β refers to the constant term, $\ln TRD$ stood for total trade, $\ln GDP$ referred to real gross domestic product, EXR represented to real exchange rate, TOP was the trade openness index, $\ln FDI$ referred to foreign direct investment, $\ln REM$ proxied to the remittances, $\ln POP$ represented population and ε referred to the error or residual term. Variables with symbols starting with \ln underwent natural logarithm transformation to control for scale differences and obtain regression results of elasticity. TOP was not transformed because it is an index. Since the paper sought to investigate the long-run relationship between trade and the identified independent variables, $\ln TRD$ was the dependent variable, assuming normalisation. Furthermore, the model included $\ln GDP$, $\ln EXR$, TOP and $\ln FDI$ as core explanatory variables or variables of interest to capture their isolated effect on foreign trade. $\ln REM$ and $\ln POP$ were included as control variables to separate their effects from those of the explanatory variable of interest.

III.3.1 The Fully Modified (FMOLS) Estimator

The FMOLS technique provides optimal estimates of co-integration consistent with the parameters, even when the sample size is small, and overcomes the problems of endogeneity, serial correlation, omitted variable bias and measurement errors. It also allows for the heterogeneity in the long-run parameters. The long-run correlation between the cointegrating equation and stochastic regressors innovations. The resulting Fully Modified OLS (FMOLS) estimator is asymptotically unbiased and has fully efficient mixture normal asymptotics allowing for standard Wald tests using asymptotic Chi-square statistical inference.

The FMOLS estimator employs long-run covariance matrices of the residuals. It may be estimated directly from the difference regressions.

$$\Delta X = \hat{\Gamma}'_{21} \Delta D_{1t} + \hat{\Gamma}'_{22} \Delta D_{2t} + \hat{v}_{2t} \quad (2)$$

If $\hat{\Omega}$ $\hat{\Lambda}$ are the long-run covariance matrices computed using the residuals, then

define the modified data

$$Y_t^+ = Y_t - \hat{\omega}_{12} \hat{\Omega}_{22}^{-1} \hat{v}_2 \quad (3)$$

and an estimated bias correction term

$$\hat{\alpha}_{12}^+ = \hat{\lambda}_{12} - \hat{\omega}_{12} \hat{\Omega}_{22}^{-1} \hat{\Lambda}_2 \quad (4)$$

Then, in line with Adom et al. (2015), the FMOLS estimator can be obtained as in equation (2):

$$\hat{\theta}_{FME} = (\sum_{t=1}^T Z_t Z_t')^{-1} \left(\sum_{t=1}^T Z_t Y_t^+ - \begin{bmatrix} \hat{\alpha}_{12}^+ \\ 0 \end{bmatrix} \right) \quad (5)$$

where $Z_t = (X_t', D_t')'$. Construction of long-run covariance matrix estimators $\hat{\Omega}$ and $\hat{\Lambda}$ is the key to FMOLS estimation.

III.3.2 The Canonical Co-integrating Regression (CCR) Estimator

The CCR estimator is used for testing co-integration with the integrated process of $I(1)$. The technique is based on a transformation of the variables that removes the second-order bias of the OLS estimator. The major difference of CCR from FMOLS is that CCR concentrates on only data transformation, while FMOLS focuses on the transformation of both data and parameters. In addition, CCR applies multivariate regression without modification and loss of efficiency (Park, 1992). CCR estimator according to Adom et al., 2015, is obtained as:

$$\hat{\theta}_{CCR} = (\sum_{t=1}^T Z_t^* Z_t^{*'})^{-1} (\sum_{t=1}^T Z_t^* Y_t^*) \quad (6)$$

where $Z_t^* = (X_t', D_t')'$. The equation assumes that adding the lags and leads of the differenced regressors soaks up all of the long-run correlation of the long-run covariance matrices of the residuals and that the least-squares estimates have the same asymptotic distribution as those obtained from FMOLS and CCR.

III.3.3 The Dynamic OLS (DOLS) Estimator

The dynamic OLS method augments the co-integrating regression with lags and leads, such that the resulting co-integrating equation error term is orthogonal to the entire history of the stochastic regressor innovations. The DOLS model assumes that the introduction of lags and leads of the differenced regressors takes care of all the long-run correlation between the error terms, that make the model to have the same asymptotic distribution (Kurozumi & Hayakawa, 2009) as those obtained from FMOLS and CCR. Masih & Masih (1996) also argue that DOLS does not impose additional requirements that all variables should be integrated of the same order $[I(1)]$ and that the regressors themselves should be co-integrated. The advantage of this technique is that, in the event of an error in stationarity determination, the

DOLS model makes up for the shortcoming. The specification for the DOLS' estimator is given in Equation (4) following Stock & Watson (1993):

$$y_t = \alpha + bX_t + \sum_{i=-k}^{i=k} \phi_i \Delta X_{t+i} + \varepsilon_t \quad (7)$$

This model assumes that adding the lags and leads of the differenced regressors soaks up all of the long-run correlation covariance matrices of the residuals and that the least-squares estimates have the same asymptotic distribution as those obtained from FMOLS and CCR.

IV. Empirical Results and Discussion

The results of FMOLS, CCR and DOLS estimations are presented in Table 6. All the models were estimated with a lag and a constant. The findings showed that the models were stable, robust and consistent with theory. The adjusted R-squared indicated that all the estimators explained over 98 per cent of the effects on regressand. The results indicated a positive and significant relationship at 1 per cent, for *lnGDP*, *lnFDI* and *TOP* while each of the estimators had a negative but significant relationship for at 1 per cent level of significance. The models' results also revealed that *lnREM* and *lnPOP*, were insignificant at 1 per cent level of significance.

Table 6: Results of Estimation of Co-integration Models

Variable	FMOLS	CCR	DOLS
lnGDP	[0.871] 0.000	[0.792] 0.000	[0.865] 0.000
lnEXR	[-0.209] 0.002	[-0.372] 0.002	[-0.246] 0.005
lnFDI	[0.043] 0.000	[0.082] 0.000	[0.047] 0.001
lnREM	[0.010] 0.242	[0.010] 0.495	[0.008] 0.384
TOP	[1.230] 0.000	[1.102] 0.000	[1.232] 0.000
lnPOP	[-0.026] 0.424	[-0.040] 0.495	[-0.023] 0.487
Constant	[1.024] 0.182	[2.414] 0.078	[1.157] 0.1709
R-Squared	0.986	0.981	0.988
Adjusted R-Squared	0.986	0.981	0.987
Long-run Variance	0.256	0.810	0.252

Note: The figures in brackets [] denotes coefficients, while the figures below them are p-values.

Since the variables, except openness (TOP) which is an index, had undergone transformation to natural logarithms, the coefficients could, therefore, be treated as elasticity coefficients, which indicated the percentage change of *lnTRD* when any of them changes by 1 per cent. The outcomes of all the three models indicated statistical evidence that GDP had positive impact on international trade. The implication is that a buoyant economy would boost foreign trade, and vice versa. This is in congruence with extant literature that rising real exchange rate constrains foreign trade, which agrees with extant literature.

The findings agreed with Auboin & Ruta's (2013) observations that the extent of the adverse effects is subject to several factors, including the prevalence of hedging instruments, the structure of production, and the existence of small firms. In view of country-specific peculiarities, it is important to give consideration to Dike's (2016) position that conscious efforts should be made to identify the channels through which the fluctuation of exchange rate affects international trade and put in place appropriate strategies to curtail its adverse effects on trade. However, Nicita's (2013) conclusion that the relative valuation of currencies explained only a small part of global trade suggested that exchange rates adjustment could only supplement other policy actions in effecting global trade rebalancing. The inference is that a holistic approach to attaining optimal trade benefits is essential.

All the estimations found strong positive effect of FDI on cross-border trade. This supported the theoretical postulation that FDI is either a substitute or supplement to international trade, depending on whether the FDI is horizontal or vertical (Liu & Graham, 1998). The import of this is that countries may invoke the horizontal FDI strategy to promote import substitution by reducing the volume of trade, while enhancing GDP growth through improved balance of payment (Blonigen, 2001). The strong trading relation of vertical FDIs with the parent country may offset the gains of international trade to the host country.

The findings of strong positive impact of trade openness on international trade are in consonance with existing literature (Keho & Wang, 2017). It is important to note, though, in an open trade environment, countries that mainly export primary products are vulnerable to trade shocks (Haussmann et al., 2007). It is imperative, therefore, that, for a country to beneficially engage in trade openness, it has to invigorate the global competitiveness of its economy, so as to be able to convert the potential that openness offers into opportunities. This entails reforms that incorporate policies and regulations that ensure conducive business climate, stable macroeconomic conditions, good governance, and infrastructural development (Jackson, 2015). It is, therefore, important to note that unguarded trade openness may expose developing countries to pass-through currency devaluation to inflation (Cooke, 2010).

The study also revealed that migrant remittance and population are statistically insignificant. This may be largely attributed to country-specific characteristics and influences (Morrison, 1977). However, it is gainful to note that the impact of population on bilateral trade flows is positive for the exporting country, as against the importing country (Nuroğlu, 2010). The significance of this is that all international trade theories are predicated on optimising the gains inherent in free trade based on comparative advantage.

V. Conclusion

The strategic importance of international trade in the development process of global economies underlines the need for its in-depth analysis to unravel the growing concerns about the potential negative effects, particularly, the unbalanced benefits prevalent in developing economies, despite overall net gains. It has become imperative to optimise mutual trade benefits of individual nations by analysing trade policies and practices with reliable data and robust models, as against risking such important decisions on political whims and caprices.

This paper employs the FMOLS, CCR and DOLS co-integration panel models to estimate the long-run trade relationships with data spanning 38 years for countries across five continents. The aim is to test extant research findings and add empirical support to existing literature in this direction. The empirical findings revealed that GDP, FDI and trade openness had a positive and significant relationship with international trade. Conversely, all the models showed that real exchange rate volatility hindered foreign trade significantly. The models also revealed that migrant remittances and population had no significant relationship with cross border trade. These findings provide the guiding principles in formulating foreign policy to rebalance the net gains from global trade.

References

- Adom, P. K., Amakye, K., Barnor, C., & Quartey, G. (2015). The Long-Run Impact of Idiosyncratic and Common Shocks on Industry Output in Ghana. *OPEC Energy Review*, 39(1), 17-52.
- Adomanis, M. (2015). Russia's 'Import Substitution' Isn't Working. *Forbes*, October 15.
- Afolabi, L. O., Aznin, A. B. N., & Izraf, A. A. M. (2017). ECOWAS Regional Integration and Trade Effect: A Dynamic Panel Cointegration Method Using the Gravity Model, *International Journal of Economic Perspectives*, 11 (1), 165-172.
- Akanni, K. A., Akinleye, S. O. & Oyebanjo, O. (2009). Free Trade Policy and the Market Prices of the Nigerian Cash Crops. *Journal of Social Sciences*, 18(2), 75-79.
- Alleyne, A. & Lorde, T. (2014). A Gravity Model Approach to Analysing the Trade Performance of CARICOM Member States. *Applied Econometrics and International Development*, 14(2), 145-160.
- Aliyu, S. U. R. & Bawa, S. (2013). Gravity Model by Panel Data Approach: Empirical Evidence from Nigeria, MPRA Paper 52549, University Library of Munich, Germany.
- Anderson, J. E. (1979). A Theoretical Foundation for the Gravity Equation. *The American Economic Review*, 69, 106-116.
- Arodoye, N. L. & Iyoha, M. A. (2014). Foreign Trade-Economic Growth Nexus: Evidence from Nigeria. *CBN Journal of Applied Statistics*, 5(1), 21-141.
- Auboin, M. & Ruta, M. (2013). The Relationship between Exchange Rates and International Trade: A Literature Review. *World Trade Review*, 12(3), 577-605.
- Blonigen, B. (2001). In Search of Substitution between Foreign Production and Exports. *Journal of International Economics*, 53(1), 81-104.
- Broda, C. & Romalis, J. (2011). Identifying the Relationship between Trade and Exchange Rate Volatility, NBER Chapters in: *Commodity Prices and Markets, East Asia Seminar on Economics*, Vol. 20, pp. 79-110.
- Chaney, T. (2013). The Gravity Equation in International Trade: An Explanation. *NBER Working Paper Series* 19285.
- Cooke, D. (2010). Openness and Inflation. *Journal of Money, Credit and Banking*, 42, 267-287.
- Deardorff, A. (1998). Determinants of Bilateral Trade: Does Gravity Work in a Neoclassical World? In: *The Regionalisation of the World Economy*. Jeffrey A. Frankel (ed.), pp. 7-32. Chicago: University of Chicago Press.
- Dike, C. K. (2016). Exchange Rate Fluctuations and International Trade Transactions. *International Journal of Social Sciences and Humanity Review*, 6(3), 209-217.
- Doces, J. A. (2011). Globalisation and Population: International Trade and the Demographic Transition. *International Interactions*, 37(2):127-146.

- Ekesiobi, C. S., Ifebi, O. E., Ibekilo, B. C. & Onochie, J. D. (2011). Dynamics of Foreign Trade and Trade Relation Problems: Policy Options for Nigeria. *African Research Review: An International Multi-Disciplinary Journal*, Ethiopia, 5(1), Serial No. 18, 40-56.
- Farzanegan, M. R. & Hassan, S. M. (2016). How Does the Flow of Remittances Affect the Trade Balance of the Middle East and North Africa? *Marburg Centre for Institutional Economics (MACIE)*, Nr. 2016/13,
- Ferdaous, J. (2014). Impact of International Trade, Remittances and Industrialisation on the Economic Growth of Bangladesh. *Chinese Business Review*, 13(8), 485-495.
- Fontagné, L. (1999). Foreign Direct Investment and International Trade: Complements or Substitutes? *OECD Science, Technology and Industry Working Papers*, 03, OECD Publishing, Paris.
- Forte, R. (2004). The Relationship between Foreign Direct Investment and International Trade Substitution or Complementarity? A Survey. *Working Paper No. 140*, CETE – Centro de Estudos de Economia Industrial, do Trabalho e da Empresa.
- Gnoufougou, D. (2013). A Causal Relationship between Trade and GDP Growth in Togo. *International Journal of Trends and Economics, Management & Technology*, 2(4), 66-71.
- Gul, N. & Yasin, H. M. (2011). The Trade Potential of Pakistan: An Application of the Gravity Model. *The Lahore Journal of Economics*, 16(1), 23-62.
- Hausmann, R., Hwang, J., & Rodrik, D. (2007). What You Export Matters. *Journal of Economic Growth*, 12, 1-25.
- International Organisation for Migration (2018). *World Migration Report 2018*, Geneva: International Organisation for Migration (IOM).
- Isard, W. (1954). Location Theory and Trade Theory: Short-Run Analysis. *Quarterly Journal of Economics*, 68(2), 305-322.
- Jackson, S. (2015). Growth and Development: Why Openness to Trade is Necessary but not Sufficient. *World Economic Forum*.
- Jayanthakumaran, K. (2000). Industrialisation: Import Substitution to Export Promotion, University of Wollongong Department of Economics, WP 00-09, *Working Paper Series*.
- Johansen, S. (1988). Statistical Analysis of Co-integration Vectors. *Journal of Economic Dynamics and Control*, 12, 231-254.
- Kahya, M. (2011). An Analysis of the Relationship between Foreign Trade and Economic Growth in Turkey over the period 1980-2009, Master thesis, *School of Economics and Management*, Lund University, Turkey.
- Karahasan, B. C. (2011). Causal Links between Trade and Economic Growth Evidence from Turkey and European Union Countries. *MPRA Paper No. 29809*.
- Keho, Y. & Wang, M. G. (2017). The Impact of Trade Openness on Economic

- Growth: The Case of Cote D'Ivoire, *Cogent Economics & Finance*, 5(1), 1-14.
- Kiran, B. (2011). Causal Links between Foreign Direct Investment and Trade in Turkey, *International Journal of Economics and Finance*, 3(2), 150-158.
- Krueger, A. O. (1980). Trade Policy as an Input to Development. *American Economic Review*, Papers and Proceedings, 76, pp. 288-290.
- Kurozumi, E. & Hayakawa, K. (2009). Asymptotic Properties of the Efficient Estimators for Co-integrating Regression Models with Serially Dependent Errors. *Journal of Econometrics*, 149(2), 118-135.
- Liu, L. & Graham, E. M. (1998). The Relationship between Trade and Foreign Investment: Empirical Results for Taiwan and South Korea. Working Paper 98-7, Institute for International Economics.
- Liu, Z., Xub, Y., Wang, P. & Akamavid, R. (2016). A Pendulum Gravity Model of Outward FDI and Export, *International Business Review*, 25, 1356–1371.
- MacKinnon, J. G. (1996). Numerical Distribution Functions for Unit Root and Co-integration Tests. *Journal of Applied Econometrics*, 11, 601–618.
- MacKinnon, J. G., Haug, A. A. & Michelis, L. (1999). Numerical Distribution Functions of Likelihood Ratio Tests for Co-integration. *Journal of Applied Econometrics*, 14, 563–577.
- Masih, R. & Masih, A. M. (1996). Stock–Watson Dynamic OLS (DOLS) and Error-Correction Modeling Approaches to Estimating Long- and Short-run Elasticities in a Demand Function: New Evidence and Methodological Implications from an Application to the Demand for Coal in Mainland China. *Energy Economics*, 18, 315–334.
- Metelski, D. & Mihi-Ramirez, A. (2015). The Economic Impact of Remittances and Foreign Trade on Migration. Granger Causality Approach, *Inzinerine Ekonomika-Engineering Economics*, 26(4), 364–372.
- Mitze, T. (2010). Estimating Gravity Models of International Trade with Correlated Time-Fixed Regressors: To IV or not IV? *MPRA Paper No. 23540*.
- Morrison, T. K. (1977). The Effects of Population Size and Population Density on the Manufactured Exports of Developing Countries. *Southern Economic Journal*, 43(3), 1368-1371.
- Nardis, S., Santis, R. & Vicarelli, C. (2009). The Euro's Effects on Trade in a Dynamic Setting. *The European Journal of Comparative Economics*, 5(1), 73-85.
- Newton, I. (1728), *Philosophiæ Naturalis Principia Mathematica*, translated by Benjamin Motte, London: Benjamin Motte.
- Nicita, A., Ognitsev, V. & Shirotori, M. (2013). *Global Supply Chains: Trade and Economic Policies for Developing Countries*. Policy Issues in International Trade and Commodities Study Series No. 55, UNCTAD, Geneva.
- Nicita, A. (2013). *Exchange Rates, International Trade and Trade Policies*, United Nations Conference on Trade and Development Policy Issues. In: *International Trade and Commodities Study, Series No. 56*, UNCTAD, Geneva.

- Nuroğlu, E. (2010). The Impact of Population on Bilateral Trade Flows in the Case of OIC, Conference: *2nd International Conference on Islamic Economic Integration*.
- OECD, (2000). Glossary of Statistical Terms: International Trade, Measuring the ICT Sector: Data Item Definitions, Data Sources and Methodologies, page 151, Information Society, OECD.
- Park, J. Y. (1992). Canonical Co-integrating Regressions, *Econometrica*, 60(1), 119-143.
- Priyankara, E. (2018). The Long-run Effect of Services Exports on Total Factor Productivity Growth in Sri Lanka: Based on ARDL, FMOLS, CCR, and DOLS Approaches. *International Journal of Academic Research in Business and Social Sciences*, 8(6),
- Ravenstein, E. G. (1889). The Laws of Migration. *Journal of the Royal Statistical Society*, 52(2), 241-305.
- Ricardo, D. (1817). *Principles of Political Economy and Taxation*, Reprinted by J.M. Dent, London, in Everyman's Library, 1911.
- Salvatici, L. (2013). The Gravity Model in International Trade Version 2. AGRODEP Technical Note TN-04.
- Sanderatne, N. (2011). Import Substitution: Is it a Pragmatic Economic Policy? *Sunday Times*, November 6th.
- Sevela, M. (2002). Gravity-Type Model of Czech Agricultural Export, *Agricultural Economics*, (10), 463-466.
- Shihab, R. A., Soufan, T. & Abdul-Khaliq, S. (2014). The Causal Relationship between Exports and Economic Growth in Jordan. *Global Journal of Management and Business Research*, 14(3), 17-22.
- Smith, A. (1776). *An Inquiry into the Nature and Causes of the Wealth of Nations*, edited by Edwin Cannan, London: Methuen & Co., Ltd.
- Stock, J. H., & Watson, M. W. (1993). A Simple Estimator of Co-integrating Vectors in Higher Order Integrated Systems. *Econometrica*, 61(4), 783-820.
- Tayyab, M., Tarar, A. & Riaz, M. (2012). Review of Gravity Model Derivations, *Mathematical Theory and Modeling*, 1.2(9), 82-95.
- Tinbergen, J. (1962). *An Analysis of World Trade Flows, in Shaping the World Economy*, edited by Jan Tinbergen. New York, NY: Twentieth Century Fund.
- United Nations (1998). International Merchandise Trade Statistics – Concepts and Definitions, United Nations, Series F, No. 52, Rev. 2, para. 111- 13.
- Vijayasri, G. V. (2013). The Importance of International Trade in the World. *International Journal of Marketing, Financial Services & Management Research*, 1.2(9), 111-119.
- World Bank (undated). How do you Define Remittances? Retrieved on 9/1/2019 at <https://datahelpdesk.worldbank.org/knowledgebase/articles/114950-how-do-you-define-remittances>
- World Bank Group (2018). Migration and Remittances: Recent Developments and Outlook, Migration and Development Brief 29.

World Trade Organisation (2018). *World Trade Statistical Review 2018*.
World Trade Report (2003). Trade and Development Chapter 2.
Yorucu, V., & Kirikkaleli, D. (2017). Empirical Modeling of Education Expenditures for
Balkans: Evidence from Panel FMOLS and DOLS Estimations. *Revista de
Cercetare si Interventie Sociala*, 56, 88-101.