



## CAUSALITY BETWEEN INTERNATIONAL TRADE AND EXCHANGE RATE IN SUB-SAHARAN AFRICA: EVIDENCE AND INSIGHTS

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### Abstract:

Motivated by the need to examine the exact nature of causality between international trade correlates and exchange rates, this study explored the directional causality between the two concepts. Panel Granger Causality- Dumitrescu-Hurlin tests and stationarity tests using Augmented Dickey-Fuller (ADF) were applied on data sourced from Sub-Saharan African countries for the period 1990-2018. Results showed bi-directional causality between real exchange rate, export and trade openness, while unidirectional causality was observed between real exchange rate and import. The prevailing contemporaneous causal relationship between real exchange rate, export and trade openness led the study to conclude that lagged values of each of the variables support the growth or behavior of the other. However, there was unidirectional causality which flow from real exchange rate to import. The conclusion here is that while real exchange rate promotes the volume of import, import on the other hand, does not support real exchange rate.

**JEL:** B17; F31; O24

**Keywords:** real exchange rate, export, import, trade openness and Dumitrescu-Hurlin

### 1. Introduction

Given the line of thought that there is a correlation between international trade and exchange rate, attention has been drawn to key sources of foreign exchange for Africa (Schmiege, 2016). The foreign exchange needed to pay for imports is often generated through exports of goods and services, as well as other sources which included home remittances. Fundamentally, that may not be a problem so long as the sources are stable

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and reliable. Raheem (2016) contended that financial integration, trade openness and natural resources are the three channels of foreign currency earnings for Sub-Saharan Africa (SSA).

Irrespective of the exchange rate regime adopted, one of the underlying objectives is to promote international trade and competitiveness. To this end, the real exchange rate (RER) is regarded as one key measure for international trade competitiveness. The nature of any exchange rate misalignment is expected to affect the country's import or export outlook, which is critical to economic transformation. A change in the RER can exert effects on a firm, via different channels, which may include its export sales and its import purchasing power (Papadavid, 2017).

Exchange rate dynamics have generated significant interest after the collapse of Bretton Woods monetary system of fixed exchange rate parities (Serenis & Tsouni, 2014; Sissoko, 2012). This gave rise to the adoption of floating exchange rate regimes by many economies since 1973. It has indeed occasioned wide erratic fluctuations in bilateral exchange rates (Senadza & Diaba, 2017). Dell' Ariccia (1999) asserted that these unpredictable movements have prompted renewed attention in exchange rate movements due to the likely effects on international trade. Accordingly, McKenzie (1999) highlighted the argument of the traditional school of thought that when risk associated with bilateral exchanges is intensified, exchange rate fluctuations may diminish the volume of trade, as it is argued that risk averse traders would ultimately shift away from high-risk trading obligations towards less risky alternatives. However, the risk-return portfolio theory contradicts the traditional school, with a counter argument that higher risk entails higher return. In other words, increase in risk owing to fluctuation in exchange rate could rather increase the trade volume (De Grauwe, 1996).

In recent times, the nature of currency movements among the biggest economies and their apparent disconnect with developing economies due to the mixed evidence of their impact on trade has gained attention (Sokolova, 2017; Kang, 2016). Moreover, the heavily debated question as to whether the uncertainties associated with exchange rate movements do reduce the incentives to trade internationally is seemingly a prime focus of academic interest after the end of the gold exchange standard (Aubion & Ruta, 2011). The study argues that higher exchange rate volatility gives rise to higher cost for risk averse traders and to less foreign trade and finance. This is on the justification that the exchange rate is agreed upon at the time of the trade contract, but payment/finance is not made until the future delivery actually takes place. In the event of unpredictable exchange rate variation, there is no certainty about the profit to be made. As a result, benefits from international trade reduce (Arize, Osang, & Slottje, 2009).

Therefore, in the spate of growing need to understand the direction or flow of relationship between international trade variables and real exchange rate, this study contributes to the discuss using the Sub-Saharan African region as focus and further, in the light of recent data.

## 2. Review of Related Literature

### 2.1 Conceptual Review

The conceptual framework of this study is based on the theoretical relationship between international trade variables such as export, import and trade openness and exchange rate. It draws on the direction of causality between the variables of discourse.

Vijayasri (2013) observed that trade is basically an international transformation of inputs, technology and commodities which promote welfare by extending the market for the outputs of a country beyond national boundaries and may ensure better prices through exports. Through imports, international trade makes inputs, commodities, and technology available in markets where they are either not available or can only be procured at higher prices.

The disintegration of the production chain across national borders and the growing importance among global manufacturers of outsourcing and foreign direct investment highlight the growth of international trade (Xu, 2012). However, a global perspective of cross-border trade has always been characterised by fluctuations, with the outlook for global trade marked by uncertainties (KPMG International Cooperative, 2019).

Trade openness is the ratio of a country's export, plus import, divided by its gross domestic product. Trade openness restricts or fosters international trade. Hence, the higher the trade openness index, the larger the influence of international trade on an economy and the stronger an economy is expected to be (Mputu, 2016). The level of trade openness is an indication of the significance of international trade for an economy.

Although the view that trade openness is influenced by exchange rate variations is not new in literature, the nature of the effect is however vigorously debated. Interactions between domestic and foreign residents arising from the exchange of goods and services potentially reflect on the national and international markets, and consequently, key economic variables. As a result, a good number of studies have explored the linkages between trade openness and exchange rate (Gantman & Dabos, 2018; Calderon, 2004; Nkalu, Urama & Asogwa, 2016). Besides its role in fostering international competitiveness, a country's real exchange rate is crucial for the growth of its cross-border trades (Zakaria & Ghauri, 2011; Kannaiah & Murty, 2017).

### 2.2 Theoretical Review

The theories backing this study are found in established international trade and exchange rate theories which include, but not limited to the following:

- 1) Absolute advantage by Adam Smith: Adam Smith's principle of absolute advantage is generally based on the technological superiority of one nation over another in producing a commodity (Gupta, 1996). Absolute advantage implies a country has a greater (absolute) productivity or lower cost in the production of a commodity compared to another nation. This is a static theory with labour as the

only cost of production and without much monetary influence. Specialisation is needed.

- 2) Comparative advantage theories of David Ricardo: In business, emphasis is often given to competitive advantage, a concept that is closely related to absolute advantage (Seretis & Tsaliki, 2015; Schumacher, 2012). According to economics literature, a nation's standard of living as well as a firm's profit is dependent on competitive advantage. Hence, while it may be appropriate to have an absolute advantage in the production of commodities (especially in a domestic economy), it is the comparative advantage that is crucial in explaining trade patterns in international trade (Acharya, 2008, Seretis & Tsaliki, 2015). This is a dynamic theory with Labour and/or technology as the factor of production without much influence of money. Countries need to specialise partially.
- 3) Factor proportion by Hechsher-Ohlin as quoted by Jhingan, (2009). This theory improved the assumptions and deficiencies of the Absolute advantage and Comparative advantage theories. The motivation of this theory is in the observation that countries produce relatively more of the goods which use more factors of production that are more abundant in those countries (Lerner, 1995; Melitz, 2012; Morrow, 2008). The theory introduced capital as a factor of production/cost in trade and no specialisation is needed (in real terms).
- 4) Exchange rate theory: Bahmani, Harvey and Hegerty (2013) tested the Marshall-Lerner (M-L) condition to confirm the fact that depreciation or devaluation of a currency causes domestic goods to be cheaper and foreign goods to be dearer in the international market. This test was further confirmed by Meniago and Eita (2017a). The theory is of the view that for a depreciation/devaluation to have a positive effect on a country's balance of payments, the sum of elasticity of demand for a country's export ( $e_x$ ) and its elasticity of demand for imports ( $e_m$ ) must be greater than unity ( $>1$  ie elastic). If the sum of these elasticities is less than unity ( $<1$  ie inelastic), then the country can instead improve its trade balance by revaluation (Alege & Osabuohien, 2015). If  $e_x + e_m = 1$ , then devaluation/revaluation has no effect. In other words, it is both the elasticity of imports and exports vis-à-vis changes in exchange rates that determine the overall effect of the depreciation/devaluation or appreciation/ revaluation on the current account balance.

### 2.3 Empirical Review

Odili (2014) contended that under the elasticity approach, the balance of payments, especially the trade (current account) balance, plays significant role as a measure of the forces of demand and supply of foreign exchange in an economy. For example, a surplus in a nation's balance of payments entails that the supply of foreign currency (export) exceeds its demand (import). In the absence of any other transaction in the balance of payment, this balance is expected to put pressure on the price of foreign currencies against the domestic currency which causes their values to depreciate vis-à-vis the local

currency. Although the elasticity model is commonly recognised as Bickerdike-Robinson-Metzler Condition (Ali, Johari, & Alias, 2014), Bickerdike (1920) was actually the one who originally proposed and laid the foundations of this theory by modeling the nominal import and export prices as functions of import and export quantities. Essentially, two vital theories govern the elasticity approach namely the Marshall-Lerner condition and the J-curve.

In a subsequent study, Odili (2015) investigated the effect of exchange rate trends on Nigeria's imports. The study employed the cointegration and Parsimonious Error Correction (ECM) model on annual data spanning the period 1971-2011. The findings showed that exchange rate trends had significant positive effect on imports only in the long-run and that exchange rate volatility weakened imports. It was further found that a unidirectional causality runs from trends of exchange rate to imports.

Umoru and Odjegba (2013) analysed the relationship between exchange rate misalignment and balance of payments adjustment in Nigeria over the period of 1973 to 2012 using the vector error correction econometric technique. The results showed that exchange rate misalignment had a positive effect on Nigerian's balance of payments position. Moreover, the Granger causality test results also showed a unidirectional causality running from exchange rate misalignment to balance of payments adjustment. Nkalu, Urama and Asogwa (2016) investigated the trade openness and exchange rate fluctuations in Nigeria using annual time series data covering the period 1984-2013. The study employed the Ordinary Least Squares method. The findings revealed that trade openness influence the exchange rate fluctuations in Nigeria positively. The causality test conducted using Pairwise Granger causality procedure showed that there exists significant unidirectional causality between trade openness and exchange rate variations.

Twamugize, Xuegongb and Rmadhani (2017) examined the effect of exchange rate fluctuation on international trade in Rwanda employing annually time series data from 1990-2014. The Vector Error Correction model was used to capture both short and long-run relationships. The findings revealed an insignificant relationship between exchange rate and export volume as well as between exchange rate and volume of import. The Granger causality test was employed to ascertain causality. The results showed that a significant bidirectional relationship exists between exchange rate and export. The study found evidence suggesting that exchange rate fluctuation is the key factor that affects the level export and import flows in Rwanda.

Yakub, Sani, Obiezue and Aliyu (2019) investigated the influence of exchange rate volatility on trade flows in Nigeria using monthly data for the period, 1997-2016. A GARCH model was applied to generate the nominal exchange rate volatility series. To determine the nature of long-run relationship among the variables, the ARDL bounds testing methodology was adopted. Also, the pairwise Granger causality test was employed to find out the direction of causality among the variables. The result showed that exchange rate volatility had negative impact on trade flows in the short-run but does not in the long run. The findings further indicated that ignoring exchange rate volatility could exert negative impact on trade flows especially in the short-run.

Nyamrunda and Mbogela (2014) examined the long and short run effects of exchange rate depreciation on imports, exports and national output in Tanzania. The study employed the VECM estimation method. The results revealed that exchange rate depreciation leads to an increase in exports in the long run while imports declined overtime.

Gantman and Dabos (2018) used a group of 101 developing countries over the period, 1960–2011 to examine the relationship between the real exchange rate and trade openness. The study used econometric estimators that treat potential endogeneity problems and cross-sectional dependence that are present in the data, while also allowing for cross-country heterogeneity in the parameters of interest. The findings of the study strongly support the proposition that an increase in trade openness produces a depreciation of the real exchange rate.

Calderon and Kubota (2009) explored the ability of trade and financial openness to intensify or ease real exchange rate volatility. The study used a sample of industrial and developing countries for the period 1975-2005. Results based on instrumental variables techniques showed that high real exchange rate volatility was induced by highly volatile productivity shocks. The study observed that countries that are more integrated with international markets tend to display more stable real exchange rate fluctuations. The findings reveal that financial openness appeared to amplify the fluctuations in real exchange rates. Similarly, Zakaria and Ghauri (2011) examined the nexus between trade openness and real exchange rate in Pakistan using quarterly data for the period 1972-2010. The results suggested a significant positive effect of trade openness on real exchange rate. Floating exchange rate system was found to have depreciated the real exchange rate significantly.

### 3. Data and Methodology

In the course of the study, panel data set were obtained from the World Bank's World Development Indicators (WDI) over the period 1990-2018 for 31 Sub-Saharan African (SSA) countries. Based on available data and dynamic panel function of the variables, the natural logarithm of real exchange rate was regressed against the ratio of total exports, import and trade openness of goods and services relative to GDP. The technical approach employed is the Dumitrescu-Hulin panel Granger causality to test the panel-data models having established that the variables are stationary after first differencing as shown subsequently in table 1.

#### 3.1 Model Specification

##### A. Panel Granger Causality Test: Dumitrescu-Hulin (DH)

The simple idea behind Granger causality is that given two temporal events,  $x_t$  and  $y_t$ ,  $x_t$  is said to Granger cause  $y_t$  if past information in  $x_t$  supports  $y_t$ , or contributes uniquely to future information in  $y_t$ . The classical, time-series (non-panel) Granger causality model as developed by Ganger (1969 & 2003) is expressed as follows:

$$X_t + b_0 Y_t = \sum_{j=1}^m a_j X_{t-j} + \sum_{j=1}^m b_j Y_{t-j} + \varepsilon'_t, \quad (3.1)$$

$$Y_t + c_0 X_t = \sum_{j=1}^m c_j X_{t-j} + \sum_{j=1}^m d_j Y_{t-j} + \varepsilon''_t.$$

Equation (3.1) is regarded as a simple causal model if  $b_0 = c_0 = 0$ . If not, it is viewed as a model with instantaneous causality (Granger, 1969).

According to Granger (1969), the Granger causality entails that the knowledge of past values of one variable ( $X$ ) is essential in improving the forecasts or predictability of another variable ( $Y$ ). Since Granger Causality is computed by estimating bivariate regressions, there are a number of different approaches to testing for Granger Causality in a panel context (Yildirtan & Salihoğlu, 2017). Thus, this study utilised the panel Granger causality approach proposed by Dumitrescu and Hurlin (2012) to test for causality in a panel data framework. With panel datasets, comprising of many cross-sections and many time periods becoming extensively available, empirical analysis on panel data is evidently shifting to macro panel, with large  $N$  and  $T$  (Lopez & Weber, 2017). As a result, test for causality on panel dataset is gaining considerable attention, especially in recent studies (Olanipekun, Güngör & Olasehinde-Williams, 2019; Zhang, Dufour & Galbraith, 2013; Yildirtan & Salihoğlu, 2017; Ojo & Alege, 2014).

Ascertaining whether slope coefficients are heterogeneous or homogeneous is also important in a panel causality analysis in order to impose causality restrictions on estimated coefficients, hence Dumitrescu and Hurlin (2012) suggested an extended test designed to identify causality in panel data. The underlying regression model is as follows:

$$y_{i,t} = \alpha_i \sum_{k=1}^K \beta_{ik} y_{i,t-k} + \sum_{k=1}^K \gamma_{ik} x_{i,t-k} + \varepsilon_{i,t} \quad (3.2)$$

Equation (3.2) can be used to determine whether  $x$  granger causes  $y$ . The basic idea is that if past values of  $x$  are significant in predicting the current value of  $y$  even with the inclusion of past values of  $y$  in the model, then  $x$  exerts a causal influence on  $y$  (Lopez & Weber, 2017). The results of the study are represented in table 2 below.

To determine the causal relationship between exchange rate and each of the international trade variables of export (EXP), import (IMP) and trade openness (TOPN) in the Sub-Saharan Africa, the Pairwise Granger Causality Test was applied and stated below following Granger (1969) thus:

**a. For  $InRER \rightarrow INT'LTR$**

Causality between Exchange Rate and International Trade variables in the Sub-Saharan African countries:

$$InRER_t + b_0INT'LTR_t = \sum_{j=1}^m \beta_1 InRER_{t-j} + \sum_{j=1}^m \beta_2 INT'LTR_{t-j} + \mu_{it} \quad (3.3)$$

**b.** For  $INT'LTR \rightarrow InRER$

$$INT'LTR_t + b_0InRER_t = \sum_{j=1}^m \beta_1 INT'LTR_{t-j} + \sum_{j=1}^m \beta_2 RER_{t-j} + \mu_{it} \quad (3.4)$$

Where;

→ shows the direction of causality: bi-directional or uni-directional depending on significance.

INT'LTR = Individual variables of International Trade represented by Export (EXP), Import (IMP) and Trade openness (TOPN)

InRER = Log of Real exchange rate.

This study expounded direction through the application of the Dumitrescu Hurlin (DH) panel Granger causality test. Unlike the ordinary pairwise causality test, DH accounts for heterogeneity in cross-sections and provides better outlook of the underlying causal relationship between exchange rate and each of the selected variables.

## 4. Hypothesis, Results and Interpretations

### 4.1 Test of Hypothesis

The fundamental hypothesis for this study is stated in the null and alternate forms as follows:

**H<sub>0</sub>:** Each of the international trade variables and exchange rate do not significantly promote each other in selected Sub-Saharan Africa countries

**H<sub>a</sub>:** Each of the international trade variables and exchange rate significantly do promote each other in selected Sub-Saharan Africa countries.

Decision Rules:

The decision rules are subject to 5% probability value. They are stated as follows:

$H_0: \theta = \theta_0$  versus  $H_a: \theta \neq \theta_0$

Reject null hypothesis if p-value < 0.05 and Accept alternate hypothesis

Accept null hypothesis if p-value > 0.05 and Reject alternate hypothesis

### 4.2 Tests for Stationarity

Table 1 below depicts the result of the stationarity tests of the study's variables. It shows the reliable nature of the time series data and its usefulness in prediction purposes. Therefore, the stochastic trend in time series is random, but predictable.



**Table 1:** Results of Panel unit root test

Variable	<sup>a</sup> ADF - Fisher Chi-square	Order of Integration
InRER	251.233***	I(1)
EXP	260.291***	I(1)
IMP	83.7182***	I(1)
BOT	84.4343***	I(1)
BOP	90.9600***	I(1)
RESV	227.263***	I(1)
TOPN	252.083***	I(1)

**Source:** Extracts from E-view output 2020.

<sup>a</sup>Null: Unit root (assumes individual unit root process)

\*\*\*Significant at 1% and 5%

Results of the panel unit root test are presented in Table 1. The stationarity status of the variables was tested using Augmented Dickey-Fuller (ADF). As can be seen ADF - Fisher Chi-square assumes individual unit root process. They are all stationary at order 1(1). Consequently, they do not have unit root and prediction capacity of the study data is better. The criteria confirmed stationarity at 5% significance level.

### 4.3 Panel Causality Test

The study's hypothesis was tested based on the results presented in table 2 below. It presents the Dumitrescu Hurlin Panel causality test results for the dependent variables of export, import, Trade openness and the independent variable (Exchange rate).

**Table 2:** Results of Dumitrescu Hurlin (DH) Panel Causality Tests

Pairwise Dumitrescu Hurlin Panel Causality Tests  
 Sample: 1990 2018  
 Lags: 2

Null Hypothesis:	Zbar-			Inference	Decision
	W-Stat.	Stat.	Prob.		
EXP does not homogeneously cause INRER	3.98490	3.17652	0.0015**	Bidirectional causality	Reject Null
INRER does not homogeneously cause EXP	3.70297	2.65210	0.0080**		
IMP does not homogeneously cause INREER	2.83910	1.04522	0.2959	Unidirectional causality	Reject Null
INRER does not homogeneously cause IMP	3.72477	2.69264	0.0071**		
TOPN does not homogeneously cause INRER	3.41913	2.12414	0.0337**	Bidirectional causality	Reject Null
INRER does not homogeneously cause TOPN	3.70514	2.65613	0.0079**		

\* indicate rejection of null hypothesis at 5% significant levels.

\*\* indicate rejection of null hypothesis at 1% significant levels.

The Granger causality test shows the nature of causality flow between the variables. It shows the extent to which the pair of study variables do promote and/or support

themselves in the growth process. It is bi-directional when the probability of causality of the dependent on independent as well as the independent on dependent are both significant at the chosen significance level. It is a unidirectional causal relationship when the significance is observed in one direction (from dependent to independent or independent to dependent).

The study chose the Dumitrescu Hurlin (DH) panel causality procedure over the stacked (ordinary) pairwise causality test because it takes into account the heterogeneity in the cross-sections. Unlike the stacked pairwise, the DH panel causality generates individual coefficients while the former assumes common coefficients across the individuals or cross-sections.

The first panel in Table 2 indicates that strong bidirectional causal relationships exist between EXP and RER. This implies that lagged value of EXP explains that variation in RER with a feedback response where the lagged value of RER is instrumental in predicting EXP. We therefore reject the null hypothesis and accept the alternative hypothesis of significant causality between export and real exchange rate.

The second panel analysed the nature of causal relationship between IMP and RER. The results revealed that whereas there is no causality from IMP to RER, a unidirectional causal relationship was established and flow from RER to IMP without a feedback effect. This entails that the lagged value of RER is crucial in forecasting IMP but not the other way round. Therefore, both the null and alternative hypothesis cannot be entirely accepted or rejected as it is a mixed result.

The results in the last panel further showed that bidirectional causal relationships exist between real exchange rate (RER) and trade openness (TOPN) in which case, there is a two-way causality which runs from TOPN to RER and from RER to TOPN. This indicates that past information on TOPN is critical in forecasting RER and vice-versa, it further indicates that RER and TOPN re-inforce themselves in the growth process and are symbiotic. The null hypothesis is hereby rejected, and the alternate hypothesis accepted.

## **5. Discussions, Conclusion and Recommendation**

It was found that real exchange rate supports (Granger causes) export, import and trade openness in Sub-Saharan Africa, in line with theoretical expectations. This implies that value of exchange rate is essential in promoting export, import and trade openness. However, while export (EXP) and trade openness (TOPN) have bidirectional causality with real exchange rate (RER), RER also Granger causes/promotes EXP and TOPN, meaning that they support each other. In this sense, they are said to be contemporaneous. This case is different from the causality between Import (IMP) and RER which is unidirectional flowing from RER to IMP (Nkalu, Urama and Asogwa 2016, Umoru & Odjegba, 2013).

The study therefore concludes that exchange rate mechanisms can be used to influence export and trade openness and vice versa, while exchange rate only influences import and not vice versa.

Based on the above, the study recommends that the management of the external sector of Sub-Saharan African economy should target export or import promotion policies in managing the external sector. That is to focus on Export or import in exchange rate mechanisms instead of focusing on Balance of payment (BOP), Balance of trade (BOT) or Reserve (RESV) as exchange rate mechanisms do not support or Granger cause BOP, BOT or RESV.

We further recommend that since RER supports export, import and trade openness, our reasoning of using RER and the lags of the international trade correlates as the independent variable and Export, Import and Trade openness as dependent variables are in order.

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