https://doi.org/10.51483/IJMRE.3.2.2023.65-84
ISSN: 2710-141X

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Publisher's Home Page: https://www.svedbergopen.com/

Research Paper
Open Access

Econometric Analysis of Exchange Rate on Current Account Adjustment in Rwanda

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Article Info

Volume 3, Issue 2, July 2023
Received : 10 January 2023
Accepted : 19 May 2023
Published : 05 July 2023
doi: 10.51483/IJMRE.3.2.2023.65-84

Abstract

In this paper, we use BNR quarterly macroeconomic time series data from 2000 Q1 to 2020 Q4 used in this study. The trade balance is the dependent variable, and the real effective exchange rate, GDP per capita, trade openness, trade conditions and foreign direct investment are the explanatory factors. In this study, VAR and VAR impulse responses were used for Rwanda. According to our findings, all variables at I(1) are stationary, which means that there is a long-run relationship between the cointegrating variables. The results of the linear model show that the real effective exchange rate has no impact on the trade balance in the short run, but improves the trade balance in the long run. In addition, Granger causality and impulse response analyzes are used to study the dynamics of exchange rate and current account adjustments. We also provide evidence of spillover effects from Rwandan demand shocks and central interest rate policy shocks. This study recommends to policymakers that a devaluation of the Rwandan franc improves the trade balance in the long term. However, increasing the volume of foreign direct investment in Rwanda also increases import and profit repatriation.

Keywords: *Current account, Exchange rate, Macroeconomic shocks, VAR*

1.Introduction

1.1. Background of the Study

Current account is one of the components of the balance of payments among others components such as the capital account, the financial account, Reserve account and Net error and omission account. Balance of payments records all the financial transaction that a country makes with other countries in a year. These transactions allow the transfer of ownership of anything that has economic value and can be measured in monetary terms for citizens of one country to citizens of the other country. International dealings are documented in the balance of payments on the reasons for the double-entry principle used in company bookkeeping, in which each transaction gives increase to two offsetting records of equivalent value so that, in concept, the causing the both sides entries are always same (Lima, 2013). Transactions are usually respected at market costs and are, to the level possible, recorded when a modification of a possession happens. Transaction related to products, services and unilateral transfers are recorded in the current account and the transaction related to liabilities and financial assets are recorded in the capital accounts.

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In theory, policymakers have two options for improving the country's trade balance and changing the country's competitiveness. The internal approach is based on supply-side policies, such as influencing labor productivity or wages by lowering inflation, lowering taxes, or loosening labor market conditions. The external approach, on the other hand, consists of depreciating the currency (Stucka, 2004).

The relationship between REER and trade balance adjustment was examined in a number of empirical research, with varying degrees of success. There is a consistent relationship between REER and trade balance, according to one line of research. According to Bahmani Oskoee's (1985) empirical model, the trade balance initially worsens after a currency depreciation as a result of the lag structure of exchange rates, but eventually improves with time. Schaling and Kabundi (2014) examined this pattern and found that real depreciation ultimately improves the trade balance between South Africa and the US, supporting the J-curve phenomenon.

Exchange rate is then value of one currency in terms of another. For example, the current exchange rate of pound in terms of dollar is 1 pound = 1.6 US dollars. It means that it takes 1 pound to purchase good of worth 1.6 dollars. And from the dollar perspective it means that 1.6 dollars can buy goods and services worth of 1 pound.

Devaluation of a currency means that the value of the currency decreases in terms of another currency. This means that the country will have to pay more to buy goods and services that it buys from other countries. And if the currency value appreciates, this means that the country will have to now pay less to buy the same amount of goods and services. Devaluation leads to decrease in the purchasing power of the currency and appreciation lead to the increasing purchasing power of the currency (Laffer, 1974). The Current account records transaction of products, services and unilateral transfers between residents of one country and the other. It is one of the measures to calculate the country's foreign trade.

The current account consists of thee following four components such as Goods: Being portable and physical in characteristics, products are often exchanged by nations all over the world. When a deal of certain good's possession from a nation to overseas occurs, this is called an "export." (Tribedy, 1986)

Services: When an intangible service (e.g. tourism) is used by a foreigner in a regional area and the regional citizen gets the cash from a foreigner, this is also mentioned as a trade, thus a credit score.

Income: A credit score of earnings happens when a personal or an organization of household nationality gets cash from an organization or personal with international identification. An international organization's investment upon a household organization or a municipality is considered as a credit score (Mussa, 1985). Formula to calculate the current account balance: Current account = (X – M) + NY + NCT.

X = Exports, M = Imports, NY = Net income abroad, NCT = Net current transfer

Rwanda had a significant and persistent current account deficit during the study period, which was primarily driven by the merchandise trade deficit.

This goods trade deficit is the result of higher imports versus stagnant and less diverse exports.

Despite this persistent trade deficit, the size of Rwanda's trade elasticities has received little attention. Nuwagira and Muvunyi (2016) investigated the presence of the Marshall-Lerner condition, i.e., the need for depreciation to improve trade balance, and discovered that the conditi on exists.

1.2. Nexus Between Current Account Movements, and Exchange Rate in Rwanda

The relationship between exchange rates and current account balance is strong. The balance of payments is heavily influenced by exchange rates. When a country's exchange rate falls, the value of its currency in terms of another country falls, making its exports cheaper and imports more expensive. This can result in a current account deficit and a negative balance of payments. On the other hand, an increase in one currency's exchange rate will help the country improve its current account and thus its balance of payment (Chang, 1992). At broader scale level, the evolution of Rwanda's trade deficit and real effective exchange rates. Based on the consumer price index, the real effective exchange rate is determined for Rwanda's 10 trading partners (CPI). Depreciation is indicated by an increase in the exchange rate and vice versa. Over the past two decades, Rwanda has maintained a current account deficit that is primarily caused by the trade deficit and outpaces significant inflows from official and private transfers. Strong imports required to meet domestic demand for consumption and investment, combined with sluggish and less diverse exports, have contributed to the rising trade deficit. However, Rwanda has recently implemented a number of initiatives targeted know as Made in Rwanda at diversifying its export base, particularly value addition for its conventional commodities, and strengthening Rwanda's manufacturing base.

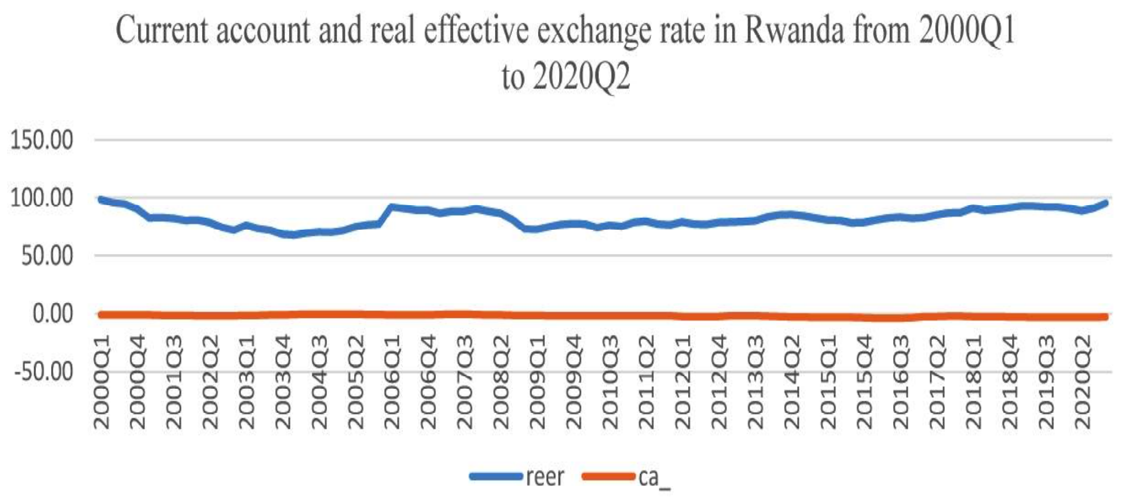

Figure 1: Current Account and Real Effective Exchange Rate in Rwanda from 2000Q1 to 2020Q2

Source: Authors‘ Computation

Over the years 2000-2020, real effective exchange rates increased in 2000, 2006, 2019 and 2020 on average and current account reduce from 2018 due to unfavorable trade between Uganda and Rwanda, and 2020 due to covid 2019 outbreak, Kharroubi (2011) stated that when a country is vertically specialized, its exports depend greatly on the number of imports (Figure 1). As a result, the trade balance responds to a change in the real exchange rate less quickly when imports and exports move together more closely.

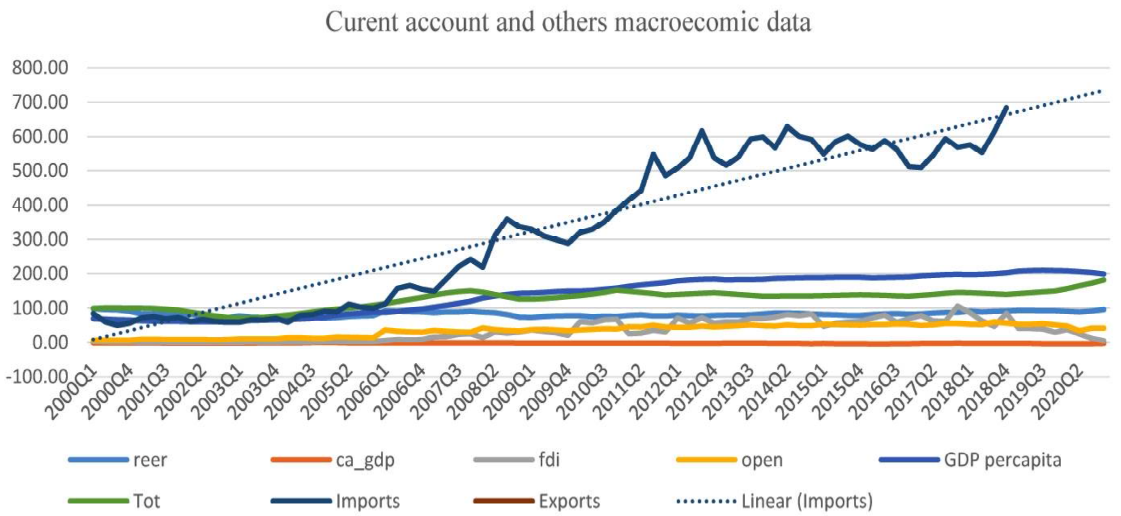

Figure 2: Current Account and Others Macroeconomic Indicator

Source: Authors‘ Computation

Over 20years from 2000, the evolution of Rwanda's trade deficit is mainly caused by the trade deficit and outpaces significant inflows from official and private transfers. Strong imports required to meet domestic demand for consumption and investment, combined with sluggish and less diverse exports, have contributed to the rising trade deficit.

1.3. Research Paper Key Motive

The primary goal of this research is to contribute Econometric analysis of exchange rate on current account adjustment in Rwanda. The country of Rwanda was chosen for two reasons. First, there are only a few empirical studies that have examined the relationship between Rwanda's exchange rate and trade balance. Apart from the three previous studies, which examined the impact of the exchange rate on exports and imports separately, no study on the real exchange rate and trade balance relationship has been conducted to the best of our knowledge. Second, prior research on Rwanda's trade elasticities relied on linear models that assumed an asymmetric effect of the real exchange rate on trade flows. Therefore, this working paper is to answer the questions such as what are effect of the real effective exchange rate on effect on trade balance? To investigate spillover effect on demand and supply shocks, to determine the effect of the orthogonality (independent) variable such as the real effective exchange rate (REER), GDP per capita (GDP _Ca) trade openness (TR), Terms of Trade (TOT) and Foreign Direct Investment (FDI) on current account of Rwanda.

1.4. Conceptual Framework

This conceptual framework of our study in Figure 3 gives blue print that taking into account dependent variable such as the real effective exchange rate (REER), GDP per capita (GDP _Ca) trade openness (TR), Terms of Trade (TOT) and FDI and dependent variable such as trade balance and finally intervening variables such as Foreign policy and Domestic policy in form of Inflation shock, Financial shocks, Monetary policy shocks and Demand shocks.

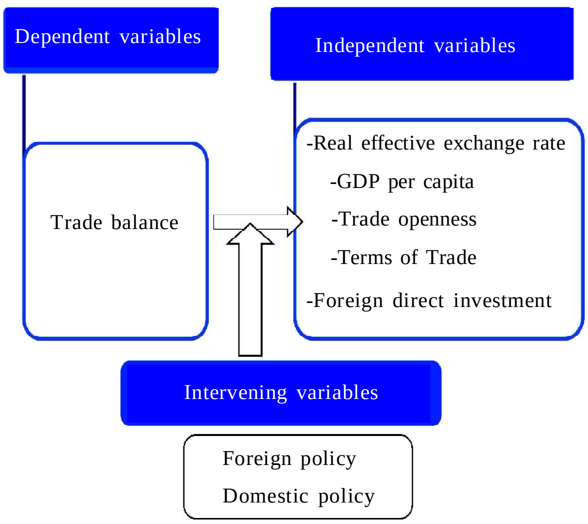

Figure 3: Conceptual Framework

Source: Authors' Computation

2. Related Literature

2.1. Theoretical Literature

Several empirical research has examined the causes and effects of current account adjustment. Milesi-Ferretti and Razin (2000) were the first to do so methodically, applying Eichengreen *et al.* (1995) methodology from currency crises to current account adjustments. The Asian crisis of 1997-98 inspired Milesi-Ferretti and Razin to focus on low- and middle-income countries. Using a set of empirical criteria, the authors identify multiple adjustment episodes ("reversals") and discover that somewhat more than half of them are connected with an economic slowdown. Using a probit analysis, they find that adjustments are more likely in countries with large current account deficits, lower reserves, higher GDP per capita, worsening terms of trade, an increasing investment rate and floating exchange rate. Two external variables, namely BNR growth and the US interest rate, also turn out to be robust predictors of adjustment.

This approach was extended to industrial countries by Freund (2005). Using a dataset of 25 adjustment episodes during 1980-1997, she finds that average adjustments start when the current account deficit reaches 5% of GDP. Slowing income growth and a real depreciation of about 10 to 20% are the major drivers of adjustment. Strengthening real export growth, decreasing investment growth and a levelling off in the budget deficit are also part of the adjustment process. These findings suggest that current account adjustments in industrial countries are largely manifestations of the business cycle. Freund's probit analysis fails to identify good predictors of current account reversals, leading the author to conclude that the exact timing of an adjustment is very difficult to forecast.

Historical Studies: Adalet and Eichengreen's (2006) samples goes back to the gold standard of the late-19th century. They find that adjustments were more frequent in recent history (post-Bretton Woods era) than in earlier historical episodes. Also de Haan *et al*. (2006) and IMF (2007) use somewhat longer samples than the rest of the literature, starting in 1960. In this paper, we will restrict the sample to the post-Bretton Woods era, starting in 1973.

Role of financial variables and sudden stops. Several authors have sought to bridge the literature on current account adjustments with that on sudden stops. Sudden stops refer to abrupt and large reductions in capital inflows and have been studied inter alia by Calvo *et al.* (2004); Calvo and Talvi (2006). Edwards (2005c) finds that sudden stops, in the presence of large current account deficits, increase the likelihood of a current account adjustment. De Haan *et al.* (2006) show that a higher degree of financial openness lowers the probability of current account adjustment in BNR countries. Freund and Warnock (2006) study the composition of financial flows but do not find a systematic relation with current account adjustments. Also Debelle and Galati (2005) examine the role of financial flows, highlighting thatfinancial account variables help explain why countries run a large current account deficit, but not why they go through a current account adjustment.

Adjustment in developing and emerging market economies. A number of papers focus mainly on developing and emerging market economies, including the seminal work of Milesi-Ferretti and Razin (2000), the comparison of Asia's and Latin America's experience by Guidotti *et al.* (2003), and the studies of transition economies by Aristovnik (2005), Benhima and Havrylchyk (2006); Komárek *et al.* (2005). In this paper, we focus on industrial economies and the most advanced emerging market economies.

2.2. Empirical Literature

The diversity across adjustment episodes is generally acknowledged in the literature. Only few authors, however, have explicitly addressed it by distinguishing subgroups of adjustment. Distinction between low-growth and high-growth adjustment. Croke *et al.* (2005); and IMF (2007) selected among their industrial country episodes the top and the bottom performers in terms of real GDP growth. Croke, Kamin and Leduc find that the low-growth cases are not characterized by significantly higher volatility in exchange rates, interest rates or share prices. The IMF finds that lowgrowth cases tend to exhibit a relatively modest degree of real effective depreciation, whereas highgrowth cases were associated with above-average real depreciation.

Distinction between export-led and import-driven adjustment. Guidotti *et al.* (2003) investigate differences in export and import performance during adjustments in emerging market and developing economies. They conclude that stronger export growth was the main driver of adjustment in emerging Asia while slowing import growth was the main driver in Latin America. The authors attribute this difference to structural factors, highlighting that more closed economies and economies with a higher degree of liability dollarization are more likely to adjust through import contraction.

Distinction between large and small countries. Edwards (2005c) finds that the harmful effects of current account adjustment on economic growth tend to be more significant for larger countries. Distinction in terms of adjustment threshold. Clarida *et al.* (2006) identify country-specific thresholds for current account adjustment, i.e., levels of the current account to output ratio above which the current account tends to revert to equilibrium. Applying their methodology to G7 countries, they find that thresholds differ significantly across countries, ranging on the deficit side from 0.18% in Japan to 4.05% in Canada.

These papers highlight that adjustments have different implications for macroeconomic and financial stability. The central contribution of this paper is to assess the diversity across episodes in a systematic way, in terms of both the adjustment dynamics and the developments before the start of the adjustment. Before presenting the results, the following section reviews the data and the episode selection.

3. Data and Methods

3.1 Stationary Time Series

If the mean and auto covariance of the series do not vary on time, the series is considered to be (weakly or covariance) stationary.

The random walk is an illustration of a non-stationary series that is as follows:

$$Y_t = Y_{t-1} + \varepsilon_t \quad ...(1)$$

where, ε_t is a stationary random disturbance term; the series Y_t has a constant forecast value, conditional on t; and the variance is increasing over time. Augmented Dickey-Fuller (ADF) (Dickey and Fuller, 1979), Phillips-Perron test (PP) (Phillips and Perron, 1998), GLS detrended Dickey-Fuller (ERS) (Elliott *et al.*, 1996), KPSS (Kwiatkowski *et al.*, 1992), and Ng- Perron tests (NP) (Ng and Perron, 2001) are recognized as unit root tests for a time series to be stationary or not. The random walk is a difference stationary series, since the first difference of Y_t is stationary:

$$Y_t - Y_{t-1} = (1 - L)Y_t + \varepsilon_t \quad ...(2)$$

A difference stationary series is said to be integrated and is denoted as I(d), where d is the order of integration. The order of integration is the number of unit roots contained in the series or the number of differencing operations taken to make the series stationary. For the random walk above, there is one unit root, so it is an I(1) series. Similarly, a stationary series is I(0). Bierens (1997) anticipated that anticipated regression model involving unit root process may provide spurious regression, because time series data often tend to move in the same direction. Consequently, this may show a higher R^2 and lower Durbin Watson statistic, which may not indicate the true degree of association among the study variables. For a non-stationary time, series y_t, if one would fit the model $y_t = y_{t-1} + \beta_t$ and test the null hypothesis $H_0 : \beta = 1$ in the AR (1) model, the null distribution is non-normal and it follows the Dickey- Fuller distribution. In short, if a time series is generated by a unit root process, the conventional test procedures remain no longer valid. So, it is important to check whether a time series is stationary or not.

3.2. Johansen Co-Integration Test

The Johansen co-integration test process entails estimating a vector autoregressive (VAR) model that contains the difference as well as the levels of non-stationary variables.

3.3. Model Specification

We start our specification with a reduced form trade balance equation described as follows, following Bahmani-Oskooee and Gelan (2019). This is how the model can be displayed:

$$\text{Ln}TB_t = \pi_0 + \pi_1\text{Ln}REER_t + \pi_2\,\text{Ln}GDP\_Ca_t + \pi_3T0_t + \pi_4TOT_t + \pi_5\,FDI_t + \varepsilon_t \quad ...(3)$$

The explanatory variables in this model are the GDP (Y), and the real effective exchange rate ($REER$),$T0$ is trade openness, TOT is Terms of Trade and FDI is foreign direct investment. The trade balance is the dependent variable and ε_t, is stochastic error term we hold others factor constant even if we know that trade balance has numerous indicators, including trade liberalization, the elimination of anti-export bias, and import liberalization

The Gauss-Markov conditions for the linear regression model given by:

$$TB_i = x'_i\, b + \varepsilon_i \quad ...(4)$$

Tb is trade balance as dependent variable, b is vector of the regression coefficients and ε_i, is disturbance term in matrix notation where,

$$b = (X'X)^{-1}X'y \quad ...(5)$$

Gauss-Markov conditions should satisfy the following conditions:

A1 $E\{\varepsilon_i\} = 0, i = 1, ..., N$ ...(6)

A2 $\{\varepsilon_1, ..., \varepsilon_N\}$ and $\{x_1, ..., x_N\}$ are independent ...(7)

A3 V $\{\varepsilon_i\} = \sigma^2, i = 1, ..., N$ ...(8)

A4 $\text{cov}\{\varepsilon_i, \varepsilon_j\} = 0, i, j = 1, ..., N, i\, 6 = j$ ...(9)

spurious regressions which may arise as a result of carrying out regressions on time series data which are not stationary are suspected therefore OLS Estimators is not relevant to our study, we use.

3.4. VAR Model Estimation Approach

Since the contributions in Eichenbaum and Evans (1995); Clarida and Gal1 (1994), VAR methods have been largely used in the study of the current account and exchange rate. Following this approach, a five-variable structural VAR model of, real effective exchange rate, GDP per capita, trade openness, Terms of Trade, foreign direct investment. This specification incorporates the major insight of intertemporal models, namely that the current account is influenced by common rather than idiosyncratic (country-specific) shocks. This comes at the cost of identifying common 'relative' shocks without distinguishing whether shocks originate in the national or the foreign economy. The long run, which is not consistent with models like the one presented here. The following is account the following reduced form VAR model.

$$TB_t = c + \sum_{j=1}^{p} A_j X_{t-j} + \varepsilon_t \quad \text{where } E[\varepsilon_t] = 0 \text{ and } E[\varepsilon_t \varepsilon_t^r] = \Sigma_E \qquad ...(10)$$

X_t is the vector of n endogenous variables and c is a $n \times 1$ vector of intercepts. A_j is a $n \times n$ matrix comprising the AR-coefficients at lag $j = 1, ..., P$ and ε_t is a vector of residuals with covariance matrix

$\Sigma_\varepsilon = E[\varepsilon_t \varepsilon_t{}^r]$, and X_t comprises the following n endogenous variables

$$TB_t = [\, GDP\_Ca_t, REER_t, TR_t, TO_t, FDI_t] \qquad ...(11)$$

GDP_t denotes the log level of the real gross domestic product, real effective exchange rate t, trade openness t, Terms of Trade t, foreign direct investment t.

To capture spillover effects from foreign country shocks to domestic aggregates, we include the same set of variables for the foreign country in the VAR, which are denoted with an asterisk. Hence, we define:

$$TB^*t = [\, GDP\_Ca_t, REER_t, TR_t, TO_t, FDI_t] \qquad ...(12)$$

The total set of variables included in the open-economy VAR framework are summarized a follows:

$$TB_t' = \begin{bmatrix} TBt^x \\ TB_t \end{bmatrix} \qquad ...(13)$$

Statistic $M(i)$ or the Akaike Information Criterion (AIC) have been used to identify the order, then estimate the specified model by using the least squares method (if there are statistically insignificant parameters, the model should be re-estimated by removing these parameters), and finally use the Qk(m) statistic of the residuals to check the adequacy of a fitted model. Other characteristics of the residual series, such as conditional heteroscedasticity and outliers, can also be checked.

The time series Y_t follows a VAR(p) model, if it satisfies

$$Y_t = \Phi_0 + \Phi_1 Y_{t-1} + ... + \Phi_p Y_{t-p} + \alpha_t,\ p > 0 \qquad ...(14)$$

where, Y_t is a vector of the dependent variable; Φ_0 is a k-dimensional vector; and α_t is a sequence of serially uncorrelated random vectors with mean zero and covariance matrix Σ. Covariance matrix Σ must be positive definite; otherwise, the dimension of Y_t can be reduced. The error term, α_t is a multivariate normal and Φ_j are $k \times k$ matrices. Using the back-shift operator B, the VAR(p) model can be written as:

$$1 - \Phi_1 B - ...\ \Phi_p B^p Y_t = \Phi_t + \alpha_t \qquad ...(15)$$

where, I will be the $k \times k$ identity matrix. In a compact form, it is as follows:

$$\Phi(B) Y_t + \Phi_0 + \alpha_t \qquad ...(16)$$

where, $\Phi(B) = 1 - \Phi_I B - ... - \Phi_\pi B^p$ is a matrix polynomial, if Y_t is weakly stationary, then it reduces to:

$$\mu = E(Y_t) = (1 - \Phi_1 B - ... - \Phi_p)^{-1} \Phi_0 = [\phi(1)]^{-1} \Phi_0 \qquad ...(17)$$

Provided that the inverse exists, since determinant of $[\Phi(1)]$ is different from zero.

Let $\bar{Y}_t = Y_t - \mu$, then the VAR(p) model becomes:

$$\bar{Y}_t = \Phi_1 Y_{t-1} + ... + \Phi_p Y_{t-p} + \alpha_t \qquad ...(18)$$

The results can be obtained as:

Cov(Y_t, α_t) = Σ the covariance matrix of α_t;

Cov(Y_{t-1}, α_t) = 0, for l > 0

$$\Gamma_1 = \Phi_1\Gamma_{1-1} + \ldots + \Phi_p\Gamma_{1-p}, \text{ for } 1 > 0 \quad \ldots(19)$$

The Equation (5) is a multivariate version of Yule-Walker equation and it called the moment equation of a VAR(p) model. The concept of partial autocorrelation function of a is univariate series can be generalized to specify the order p of a vector series. Consider the following consecutive VAR models:

$$Y_t = \Phi_0 + \Phi_1 Y_{t-1} + \alpha_t$$

$$Y_t = \Phi_0 + \Phi_1 Y_{t-1} + \Phi_2 Y_{t-2} + \alpha_t$$

$$\ldots = \ldots$$

$$Y_t = \Phi_0 + \Phi_1 Y_{t-1} + \ldots + \Phi_p Y_{t-p} + \alpha_t$$

$$\ldots = \ldots \quad \ldots(20)$$

The Ordinary Least Squares (OLS) method is used for estimating parameters of these models. This is called the multivariate linear regression estimation in multivariate statistical analysis (Tsay, 2001). For the equation in Equation (5), let, $\hat{\Phi}_j^{(i)}$ be the OLS estimate of Φ_j and $\hat{\Phi}_j^{(i)}$ be the estimate of Φ_0, where the superscript (i) is used to denote that the estimates are for a VAR(i) model. Then, the residual is:

$$\hat{\alpha}_t^{(i)} = Y_t - \hat{\Phi}_1^{(i)} Y_{t-1} - \ldots - \hat{\Phi}_1^{(i)} Y_{t-I} \quad \ldots(21)$$

For $i = 0$, the residual is defined as $\hat{Y}_t^{(0)} = Y_t - \overline{Y}$, where $\overline{Y}$ is the sample mean of Y_t.

The residual covariance matrix is defined as:

$$\hat{\Sigma}_i = \frac{1}{T-2i-1}\sum_{t=i+1}^{T} \hat{\alpha}_t^{(i)}\left(\hat{\alpha}_t^{(i)}\right)^T \quad \ldots(22)$$

To specify the order p, the i^{th}, and $(i-1)^{th}$ in Equation (6) is to test a VAR(i) model versus a VAR($i-1$) model and test the hypothesis $H_0 : \Phi_l = 0$ versus the alternative hypothesis $H_a : \Phi_l \; G \; 0$ sequentially for $i = 1, 2, \ldots, I$. The test statistic is:

$$M(i) = -\left(T - K - i - \frac{3}{2}\right)\ln\left(\frac{|\hat{\Sigma}_i|}{|\hat{\Sigma}_i - 1|}\right) \quad \ldots(23)$$

The distribution of $M(i)$ is a chi-squared distribution with k^2 degrees of freedom. Alternatively AIC can be used to select the order p. Assume that α_t is multivariate normal and consider the i^{th} equation, one can estimate the model by the Maximum Likelihood (ML) method. For AR models, the OLS estimates Φ_0 and Φ_j are equivalent to the (conditional) ML estimates. However, there are differences between the estimates of Σ and the ML estimates of Σ (Tsay, 2001).

$$\hat{\Sigma}_i = \frac{1}{T}\sum_{t=i+1}^{T} \hat{\alpha}_t^{(i)}\left(\hat{\alpha}_t^{(i)}\right)^T \quad \ldots(24)$$

The AIC of a VAR(i) model under the normality assumption is definied as:

$$AIC(i) = \ln\left(|\tilde{\Sigma}_i|\right) + \frac{2K^2 i}{T} \quad \ldots(25)$$

For a given vector time series, one selects the AR order p such that AIC(p) = min $\{1 \le i \le p, \text{AIC}(i)\}$, where p is positive integer. Estimation and model checking both of the OLS method or the ij maximum likelihood method can be used to estimate parameters of VAR model, since the two methods are asymptotically equivalent. The estimates are asymptotically normal under some regularity conditions, after constructing the model, adequacy of the model should then be checked. The $Q_k(m)$ statistic can be applied to the residual series to check the assumption that there are no serial or crosscorrelations in the residuals. For a fitted VAR(p) model, the $Q_k(m)$ statistic of the residuals is asymptotically a chi-square distribution with $K^2(m\text{-}g)$ degrees of freedom, where g is the number of estimated parameters in the AR coefficient matrices (Tsay, 2001).

3.5. Structural Analysis by Impulse Response Functions

The general form VAR(*p*) model also has a Wold representation as follows:

$$Y_t = \mu + \theta_i \alpha_{i-1} + \theta_2 \alpha_{t-1} + \ldots \qquad \ldots(26)$$

where, θ_s are the *n* x *n* matrices. To interpret the $(i, j)^{th}$ element θ^{s}, element of the matrix θ_s as the dynamic multiplier or impulse response:

$$\frac{\delta y_{i,t+s}}{\delta \alpha_{j,t}} = \frac{\delta y_{i,t}}{\delta \alpha_{j,t-s}} = \theta_{ij}^{s} \quad i, j = 1,2,\ldots n \qquad \ldots(27)$$

The condition for the variance of a_t equal to Σ is a diagonal matrix. If Σ is diagonal, it shows that the elements of Σ and α_t are uncorrelated. One way to make the errors uncorrelated is to estimate the triangular structural VAR(*p*) model:

$$y_{1t} = c_1 + \alpha'_{11} Y_{t-1} + \ldots + \alpha'_{1p} Y_{t-p} + \eta_{1t} y_{2t} = c_1 + \beta_{21} Y_{1t} + \alpha'_{21} Y_{t-1} \ldots + \alpha'_{2p} Y_{t-p} + \eta_{2t} \qquad \ldots(28)$$

... = ...

$$y_{nt} = c_1 + \beta_{n1} Y_{1t} + \ldots + \beta_{n,n-1} Y_{n-1,t} + \alpha'_{n1} Y_{t-1} \ldots + \alpha'_{np} Y_{t-p} + \eta_{nt} \qquad \ldots(29)$$

The estimated covariance matrix of the error vector 5_t is diagonal. The uncorrelated errors 5_t are referred to as structural errors.

The Wold representation of Y_t is based on the orthogonal errors 5_t:

$$Y_t = \mu + \theta_0 \eta_t + \theta_1 \eta_{t-1} + \theta_2 \eta_{t-2} + \ldots \qquad \ldots(30)$$

where $Q_0 = B^{-1}$

B is the lower triangular matrix of β_{ij} in Equation (11). The diagonal elements of the *B* are 1.

The impulse responses to the orthogonal shocks 5_{jt} are:

$$\frac{\partial y_{i,t+s}}{\partial^{\eta}{}_{j,t}} = \frac{\partial y_{i,t}}{\partial^{\eta}{}_{j,t-s}} = \theta_{ij}^{s} \quad i, j = 1,2,\ldots,n \qquad \ldots(31)$$

where θ_{ij}^{s} is the $(i,j)^{th}$ element of θ_s.The plot of θ_{ij}^{s} against s is called the orthogonal impulse response function of y_i with respect to η_j.

3.6. Structural Analysis by Granger Causality

In order to investigate the causal relationship among the variables of the system, the linear Granger causality tests should be applied by using the following strategy. Compare the unrestricted models:

$$\Delta Y_t = a_1 + \sum_{i=1}^{m_1} \beta_{1i} \Delta Y_{t-i} + \sum_{j=1}^{m_2} \theta_{1j} \Delta X_{j-1} + e_{1t} \qquad \ldots(32)$$

$$\Delta X_t = a_2 + \sum_{i=1}^{m_1} \beta_{2i} \Delta Y_{t-i} + \sum_{j=1}^{m_2} \theta_{2j} \Delta X_{j-1} + e_{2t}$$

with the restricted models:

$$\Delta Y_t = a_1 + \sum_{i=1}^{m_1} \beta_{1i} \Delta Y_{t-1} \qquad \ldots(33)$$

$$\Delta X_t = a_2 + \sum_{i=1}^{m_1} \beta_{2i} \Delta Y_{t-1} \qquad \ldots(34)$$

where ΔY_t and ΔX_t first order forward differences of the variables; α, β, and θ are the parameters to be estimated; and e_1 and e_2 are standard random errors. The lag *m* are the optimal lag orders chosen by information criteria. The equations described above are convenient tools for analyzing linear causality relationship among the variables. If θ_1 is statistically significant and θ_2 is not, it can be said that changes in variable *y* Granger cause changes in variable *x* or vice versa. If both of them are statistically significant, there is a bivariate causal relationship among the variables; if both of them are statistically insignificant, neither the changes in variable *y* nor the changes in variable *x* have any effect over other variables.

3.7. Forecasting

If the fitted model is adequate, then it can be used to obtain forecasts. For forecasting, same techniques in the univariate analysis can be applied. To produce forecasts and standard deviations of the associated forecast, errors can be done as following. For a VAR(*p*) model, the 1-step ahead forecast at the time origin *h* is:

$$Y_h(1) = \varphi_0 \sum_{i=1}^{p} \varphi_0 Y_{h+1-i} \qquad ...(35)$$

The associated forecast error is $e_h = a_{h+1}$. The covariance matrix of the forecast error is Σ. If Y_t is weakly stationary, then the l-step ahead forecast Y_h(l) converges to its mean vector μ is the forecast horizon increases.

3.8. Data

The paper uses BNR quarterly macroeconomic data over the period 2000 Q1 to 2020Q4. The time series include Trade balance as dependent variable and explanatory variables the real effective exchange rate (REER), GDP per capita (GDP _Ca) trade openness (TR), Terms of Trade (TOT) and Foreign Direct Investment (FDI) are converted into natural logarithms and come from the National Bank of Rwanda (NBR). The empirical study is based on quarterly data from 2000Q1 to 2020Q4.

3.9. Variables Definition

Trade Balance (TB) is the difference between a country's exports and imports in terms of money over a given time period is known as (Export-Import), sometimes known as net exports.

The Real Effective Exchange Rate (REER) is the weighted average of a country's currency in respect to an index or basket of other important currencies. By comparing a country's currency's relative trade balance to those of every other country in the index, the weights are determined.

A Country's Gross Domestic Product (GDP) per capita is calculated by dividing its GDP by its total population.

Trade Openness is the term used to describe how a country's economy is structured in relation to international trade. The size of an economy's recorded imports and exports serves as a proxy for the degree of openness.

The terms of trade are defined as Trade openness is given by exports plus imports divided by GDP. It can be understood as the number of importable commodities an economy can buy for each unit of exportable goods.

A foreign direct investment is a financial commitment made by a company with its headquarters in another nation to control a company in another country.

4. Empirical Econometric Results

4.1 Data Descriptive as Individual Sample

The features of the variables seen in the short-, medium-, and long-term data from BNR are shown in Table 1. The variability in cross-sectional observations, which is supported by standard deviation statistics, is a characteristic shared by all the variables. Both the explanatory and the dependent variables are expressed in logarithmic form as follows: TB, Ln*REER*, Ln*GDP* per capita, Ln*To*, Ln*TOT*, and Ln*FDI*, respectively.

4.2. Unit Root Test (Test for Stationarity)

The pre-test of the order of integration of the variables serves as the analysis's first step. In order to obtain the ordering of integration, we test for unit root to avoid this fruitless effort. Using the Augmented Dickey-Fuller (ADF) test, the test for stationarity is used to avoid spurious regressions which may arise as a result of carrying out regressions on time series data which are not stationary. Stationarity of time series was tested using the ADF tests. Professor Noman Arshed (2017) commented about OLS and cointegration as such: If all variables are I(0), no integration tests are required and OLS

Tabale 1: Data Descriptive as Individual Sample

	CA	*REER*	*GDP_PERCAPITA*	*TO*	*TOT*	*FDI*
Mean	-1.871095	82.12537	140.5376	34.96631	125.5582	34.37700
Median	-1.717797	81.10288	152.7378	38.46799	135.7985	30.19320
Maximum	-0.362297	98.40000	209.5449	59.40694	181.6496	105.9381
Minimum	-3.948398	67.82000	60.21290	6.424578	70.98898	0.480466
Std. Dev.	0.943754	7.244767	54.69618	17.16445	25.42189	29.48384
Skewness	-0.304700	0.124433	-0.321111	-0.516629	-0.664958	0.338412
Kurtosis	2.171058	2.137015	1.460049	1.738809	2.603907	1.800031
Jarque-Bera	3.704799	2.823370	9.743640	9.303780	6.739491	6.643051
Probability	0.156860	0.243732	0.007659	0.009544	0.034398	0.036098
Sum	-157.1720	6898.531	11805.16	2937.170	10546.89	2887.668
Sum Sq. Dev.	73.92571	4356.392	248308.8	24453.32	53640.63	72151.62
Observations	84	84	84	84	84	84

Source: Author's Computation

Table 2: Unit Roots Test for Non-Stationary Data (Sample: 2000Q1-2020Q4)

Variables	**Level**		**First Difference**		**Order of Integration**
	Intercept	**Trend**	**Intercept**	**Trend**	
TB	-4.49***	5.59***	-10.54***	-10.13***	I(1)
Ln*GDP* per capita	-2.28	-2.89	-7.86***	-7.63***	I(1)
Ln*reer*	-0.89	-3.88**	-9.01*	-8.79*	I(1)
Ln*To*	-0.29	-1.23	-6.62*	-6.39*	I(1)
Ln*TOT*	-0.79	-3.88**	-9.11*	-8.39*	I(1)
Ln*FDI*	-0.16	-1.23	-5.62*	-6.38	* I(1)

Note: *, **, ***: denote rejection of null hypothesis at 10%, 5% and 1% significance level respectively.

Source: Author's Computation

can be used. However, the regression of a non-stationary time series to another non non-stable time series may produce spurious to a non-sense regression.

4.3. Test for Co-integration

Since all variables are non-stationary at levels, but became stationary at first difference. we performed a co-integration test using Johnsen cointegration tests based on unit root tests of regression residuals. Table 6 shows the results of the Johansen Cointegration test used to investigate whether there exists long-run relationship among the cointegrating variables which are are Trade balance as dependent variable and such as explanatory variables GDP (Y), and the real effective exchange rate (reer), trade openness(TR), Terms of Trade (TOT) and foreign direct investment (FDI).

Table 3: Test for Co-integration

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None*	0.451885	119.1654	95.75366	0.0005
At most 1*	0.275031	70.46255	69.81889	0.0444
At most 2	0.238718	44.41077	47.85613	0.1016
At most 3	0.163479	22.31793	29.79707	0.2812
At most 4	0.066546	7.859179	15.49471	0.4806
At most 5	0.027770	2.281203	3.841466	0.1309

Note: Trace test indicates 2 cointegrating eqn(s) at the 0.05 level; * denotes rejection of the hypothesis at the 0.05 level; ***MacKinnon-Haug-Michelis (1999)* *p*-values.

Source: Author's Computation

4.4. VAR MODEL Estimates

Table 4 shows the computed VAR coefficients results show that the real effective exchange rate has no effect on trade balance in the short run but improves trade balance in the long run. Because there are so many criteria, presenting them all is time-consuming. Furthermore, they are underestimated: with the exception of the first personal lag, they are all minor. As a result, it is common to provide functions of the VAR coefficients discussed above that condense information, have some economic relevance, and are, ideally, more properly assessed. Among the numerous functions available, three are commonly used: impulse responses, variance, and historical decompositions. The impulse responses trace out the system's Moving average, describing how it responds to a shock; the variance decomposition measures the contribution to the variability of the real effective exchange rate; and the historical decomposition describes the contribution of Rwanda's current account shock to deviations from its baseline forecasted path from 200Q1 to 2020Q4. Since we don't use ARDL in our study, we fail to estimate short run speed of adjustment coefficient and Long run speed of adjustment coefficient

4.5. Granger Causality Tests

Granger causality test is use a statistical test to see if one-time series may predict another. The hypothesis would be rejected at that level if the probability value was less than 0.05. in our case we fail to reject H_0 which means that the long-run coefficient indicated that a 1% real effective exchange rate would lead to improvement in Rwanda's trade balance.

4.6. Impulsive Response for Rwanda

Base on VAR impulsive response in our variables which are Trade balance as dependent variable and explanatory variables the real effective exchange rate (REER), GDP per capita (GDP_Ca), trade openness (TR), Terms of Trade (TOT) and Foreign Direct Investment (FDI). VAR impulse responses react to the identified spillover effect on demand and supply shocks and evidence for spillover effects from Rwanda demand shocks and Central interest rate policy shocks as follows:

1. VAR impulsive response shows that in the foreign exchange markets, a rising current account deficit in Rwanda causes a rise in the supply of Rwandan francs. There will be an outward movement in supply on the market for Rwandan francs as a result. *Ceteris paribus,* this could result in a decline in the Rwandan franc's external value.
2. VAR impulse response demonstrates that in the short-run, there is a poor correlation between changes in the current account deficit and per-capita GDP.
3. VAR Impulse response show the favorable impact of trade openness on the current account suggests that an economy can improve the current account more quickly with fewer trade barriers and greater exposure.
4. VAR Impulse response indicate When the value of imports rises faster than the value of exports, the trade balance in Rwanda deteriorates, which causes shocks to the terms of trade in Rwanda.

Table 4: VAR Model

	CA	GDP_ PERCAPITA	REER	TO	TOT	FDI
CA(-1)	1.293997	0.930493	0.471692	0.229308	0.395743	0.620574
	(0.10621)	(0.78250)	(1.59639)	(2.32690)	(1.13239)	(7.60122)
	[12.1832]	[1.18912]	[0.29547]	[0.09855]	[0.34947]	[0.08164]
CA(-2)	-0.483717	-0.516878	0.007810	0.308642	0.017735	2.372929
	(0.10474)	(0.77166)	(1.57427)	(2.29466)	(1.11670)	(7.49589)
	[-4.61829]	[-0.66983]	[0.00496]	[0.13450]	[0.01588]	[0.31656]
GDP_PERCAPITA(-1)	0.012639	1.451722	0.042716	0.246905	-0.073444	-0.885763
	(0.01362)	(0.10032)	(0.20466)	(0.29831)	(0.14518)	(0.97449)
	[0.92825]	[14.4711]	[0.20871]	[0.82767]	[-0.50590]	[-0.90895]
GDP_PERCAPITA(-2)	-0.016468	-0.512902	-0.003388	-0.209747	0.117930	0.840846
	(0.01290)	(0.09507)	(0.19394)	(0.28269)	(0.13757)	(0.92346)
	[-1.27628]	[-5.39527]	[-0.01747]	[-0.74196]	[0.85722]	[0.91054]
REER(-1)	-0.003223	0.084850	0.940626	0.027631	-0.067005	-0.558808
	(0.00906)	(0.06674)	(0.13616)	(0.19846)	(0.09658)	(0.64831)
	[-0.35577]	[1.27135]	[6.90837]	[0.13923]	[-0.69376]	[-0.86194]
REER(-2)	0.000430	-0.116657	-0.071810	-0.090993	0.050547	0.189657
	(0.00867)	(0.06387)	(0.13029)	(0.18992)	(0.09242)	(0.62040)
	[0.04957]	[-1.82657]	[-0.55114]	[-0.47912]	[0.54691]	[0.30570]
TO(-1)	0.003818	0.045626	0.008665	0.564563	0.046584	0.941083
	(0.00596)	(0.04394)	(0.08965)	(0.13067)	(0.06359)	(0.42685)
	[0.64015]	[1.03832]	[0.09666]	[4.32058]	[0.73257]	[2.20471]
TO(-2)	-0.001001	0.106809	-0.082135	0.086334	0.056262	0.011346
	(0.00626)	(0.04610)	(0.09405)	(0.13708)	(0.06671)	(0.44780)
	[-0.15996]	[2.31699]	[-0.87336]	[0.62981]	[0.84338]	[0.02534]
TOT(-1)	0.012921	-0.004945	0.240972	0.106129	1.812866	-0.551939
	(0.00641)	(0.04721)	(0.09631)	(0.14038)	(0.06832)	(0.45858)
	[2.01641]	[-0.10474]	[2.50204]	[0.75600]	[26.5360]	[-1.20358]
TOT(-2)	-0.012126	0.033739	-0.242566	-0.039852	-0.898504	0.459439
	(0.00672)	(0.04948)	(0.10095)	(0.14714)	(0.07161)	(0.48066)
	[-1.80554]	[0.68186]	[-2.40291]	[-0.27084]	[-12.5478]	[0.95585]
FDI(-1)	-0.000836	0.017722	-0.004005	0.004400	-0.033810	0.471624
	(0.00169)	(0.01247)	(0.02544)	(0.03708)	(0.01805)	(0.12113)
	[-0.49369]	[1.42123]	[-0.15744]	[0.11866]	[-1.87361]	[3.89355]

Table 4(Cont.)

	CA	GDP_ PERCAPITA	REER	TO	TOT	FDI
FDI(-2)	0.000888	-0.006644	0.010489	0.084534	-0.037668	0.163607
	(0.00172)	(0.01268)	(0.02586)	(0.03770)	(0.01835)	(0.12316)
	[0.51586]	[-0.52406]	[0.40553]	[2.24225]	[-2.05307]	[1.32846]
C	0.163110	3.482958	8.391647	1.932112	5.858460	34.70804
	(0.27654)	(2.03742)	(4.15655)	(6.05860)	(2.94844)	(19.7914)
	[0.58981]	[1.70950]	[2.01890]	[0.31890]	[1.98697]	[1.75369]
R-squared	0.969311	0.999489	0.870418	0.952919	0.995137	0.836526
Adj. *R*-squared	0.963974	0.999400	0.847882	0.944731	0.994291	0.808095
Sum sq. resids	2.235907	121.3627	505.1171	1073.172	254.1609	11451.97
S.E. equation	0.180012	1.326228	2.705649	3.943757	1.919242	12.88296
F-statistic	181.6157	11246.53	38.62358	116.3789	1176.579	29.42373
Log likelihood	31.33201	-132.4276	-190.8939	-221.7908	-162.7341	-318.8601
Akaike AIC	-0.447122	3.547015	4.973021	5.726605	4.286199	8.094148
Schwarz SC	-0.065569	3.928568	5.354574	6.108158	4.667752	8.475701
Mean dependent	-1.888704	142.3093	81.76209	35.66043	126.1909	35.15736
S.D. dependent	0.948409	54.14852	6.937162	16.77519	25.40078	29.40850
Determinant resid covariance (dof adj.)			2674.530			
Determinant resid covariance			949.4212			
Log likelihood			-979.2077			
Akaike information criterion			25.78555			
Schwarz criterion			28.07487			

Source: Author's Computation

Table 5: Granger Causality Tests

Pairwise Granger Causality Tests

Date: 09/29/22 Time: 12:22

Sample: 2000Q1 2020Q4

Lags: 2

Null Hypothesis:	**Obs.**	***F*-Statistic**	**Prob.**
REER does not Granger Cause CA	82	0.30880	0.7352
CA does not Granger Cause REER		0.78386	0.4602

5. VAR Impulse response show that Increased foreign direct investment(FDI) into Rwanda could lead to increased economic investment of Rwanda, which would improve Rwanda current account.

However, increase the volume of Foreign direct investment in Rwanda also increases the sizes of import and profit repatriation.

5. Conclusion and Policy Implication

The paper uses BNR quarterly macroeconomic data over the period 2000 Q1 to 2020Q4. The time series include Trade balance as dependent variable and explanatory variables, the real effective exchange rate, GDP per capita, trade openness, Terms of Trade and foreign direct investment.

Several research has since attempted to prove this connection. According to some theories, a nation's trade balance will worsen when its currency depreciates or devalues before turning around in the long run. This phenomenon is known as the J-curve effect in the literature. These studies made the assumption that the trade balance and exchange rate movements were linearly related.

Our research shows that Rwanda's export growth has typically lagged behind its import growth, causing the trade deficit to widen to the point where it may potentially trigger a financial crisis. The data have been transformed in natural logarithm. According to our findings all variable is stationary at I (1) with means there exists long-run relationship among the cointegrating variables. Granger causality test results show that long-run coefficient indicated that a 1% real effective exchange rate would lead to improvement in Rwanda's trade balance. AR impulse responses react to the identified spillover effect on demand and supply shocks and evidence for spillover effects from Rwanda demand shocks and Central interest rate policy shocks

This study recommends Policymakers that depreciation of Rwandan francs improves the trade balance in long run, ceteris paribus and Increasing Foreign Direct Investment (FDI) into Rwanda could lead to increased economic investment of Rwanda, which would improve Rwanda current account. However, increase the volume of Foreign Direct Investment in Rwanda also increases the sizes of import and profit repatriation.

Declaration of Competing Interests

None.

Acknowledgment

We acknowledge the National Bank of Rwanda's team for grant me the right to get data.

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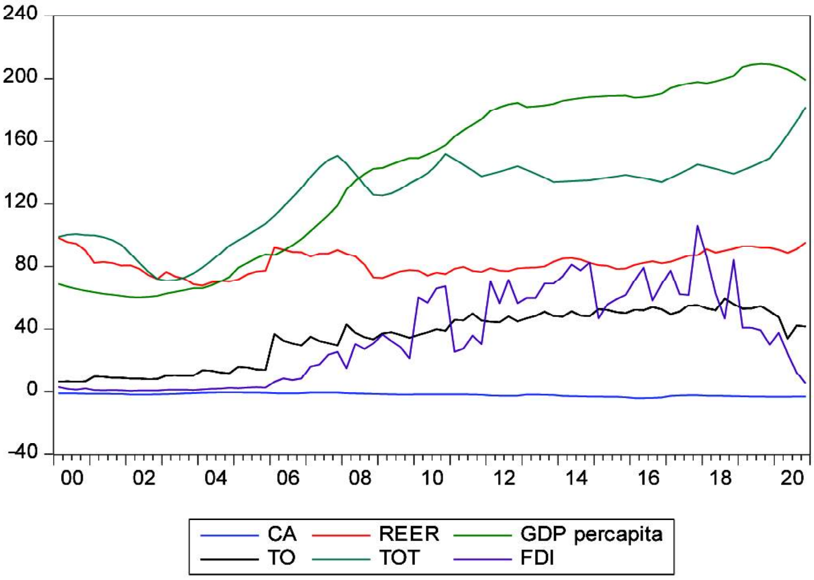
Appendix

Data Used								
obs	**reer**	**ca_gdp**	**fdi**	**open**	**GDP percapita**	**Tot**	**Exports**	**Imports**
2000Q1	98.40	-1.16	2.97	6.42	68.6689	98.9	83.6	10.1
2000Q2	95.64	-1.14	1.79	6.59	67.1264	100.3	59.4	20.3
2000Q3	94.52	-1.14	1.28	6.43	65.7425	100.7	49.5	16.3
2000Q4	90.16	-1.16	2.06	6.62	64.5173	100.0	56.2	8.4
2001Q1	82.43	-1.20	1.01	9.68	63.4507	99.9	71.7	25.9
2001Q2	82.91	-1.26	0.90	9.58	62.5428	98.8	75.1	29.2
2001Q3	82.19	-1.33	1.02	8.78	61.7935	96.8	68.6	20.4
2001Q4	80.53	-1.42	0.88	8.77	61.2030	93.8	72.2	10.0
2002Q1	80.72	-1.72	0.48	8.46	60.2963	88.2	60.7	15.2
2002Q2	78.53	-1.77	0.73	8.40	60.2129	82.3	66.5	28.5
2002Q3	74.55	-1.76	0.68	7.95	60.4781	76.7	60.4	14.1
2002Q4	71.99	-1.69	0.71	8.17	61.0918	72.1	58.4	7.9
2003Q1	76.39	-1.46	1.18	10.19	62.7393	71.0	58.5	14.8
2003Q2	73.51	-1.32	1.30	10.38	63.7760	71.3	65.5	18.5
2003Q3	72.14	-1.16	1.25	10.04	64.8871	72.9	64.8	18.0
2003Q4	68.57	-0.98	0.98	10.22	66.0726	75.5	70.0	11.1
2004Q1	67.82	-0.61	1.41	13.59	66.0884	79.3	58.5	16.6
2004Q2	69.71	-0.48	1.86	13.31	67.9204	83.7	78.5	30.0
2004Q3	70.69	-0.39	2.00	12.23	70.3245	88.5	81.1	29.5
2004Q4	70.34	-0.36	2.42	11.81	73.3007	93.3	90.7	21.8
2005Q1	71.79	-0.46	2.25	15.89	79.1649	96.6	88.4	18.2
2005Q2	74.93	-0.51	2.69	15.41	82.3590	99.9	111.1	41.7
2005Q3	76.74	-0.58	2.86	14.20	85.1988	103.4	102.6	35.2
2005Q4	77.22	-0.68	2.69	13.87	87.6843	107.2	99.2	29.7
2006Q1	91.98	-1.02	6.32	36.86	87.3860	112.5	112.0	20.0
2006Q2	90.72	-1.08	8.47	32.70	90.1350	118.2	156.8	48.2
2006Q3	89.29	-1.08	7.41	30.74	93.5015	124.2	165.2	35.7
2006Q4	89.07	-1.01	8.44	29.43	97.4855	130.1	154.0	38.4
2007Q1	86.41	-0.54	16.00	35.11	102.4818	137.1	148.2	31.2
2007Q2	88.31	-0.48	17.37	32.37	107.5432	143.3	184.3	44.9
2007Q3	88.26	-0.50	23.60	31.01	113.0645	148.0	220.0	52.9
2007Q4	90.43	-0.58	25.31	29.52	119.0455	150.5	242.0	47.8
2008Q1	88.19	-0.95	14.84	42.77	129.1188	145.5	218.2	50.1
2008Q2	86.36	-1.10	30.40	37.79	134.5664	138.9	311.2	72.9
2008Q3	81.26	-1.25	27.19	34.84	139.0208	131.9	358.5	70.4
2008Q4	72.98	-1.38	30.92	33.48	142.4821	125.8	336.0	75.1
2009Q1	72.68	-1.57	36.62	37.30	142.9404	125.4	329.2	44.3
2009Q2	74.83	-1.66	32.41	37.97	145.2191	126.7	309.8	41.3
2009Q3	76.80	-1.71	28.36	36.43	147.3086	129.4	299.6	57.9
2009Q4	77.62	-1.74	21.28	34.50	149.2089	133.1	288.4	49.4
2010Q1	77.32	-1.62	60.25	36.33	149.0705	135.8	320.2	57.3
2010Q2	74.08	-1.62	56.87	37.97	151.3319	139.5	329.0	67.7
2010Q3	76.10	-1.63	65.98	40.01	154.1437	144.7	350.8	92.8
2010Q4	75.13	-1.65	67.40	38.96	157.5059	151.6	384.4	79.5
2011Q1	78.57	-1.60	25.41	45.91	163.1303	148.4	415.0	97.3
2011Q2	79.77	-1.67	27.42	45.57	166.9087	144.9	442.1	92.6
2011Q3	77.17	-1.76	35.99	49.89	170.5530	141.3	548.0	145.4

Appendix (Cont.)

obs	reer	ca_gdp	fdi	open	GDP percapita	Tot	Exports	Imports
2011Q4	76.40	-1.90	30.29	45.48	174.0630	137.4	485.5	129.7
2012Q1	78.91	-2.36	70.54	44.66	179.1430	138.9	507.4	132.9
2012Q2	77.28	-2.45	56.49	44.36	181.7029	140.5	537.4	119.3
2012Q3	76.98	-2.47	71.49	48.11	183.4470	142.2	617.1	168.7
2012Q4	78.84	-2.41	56.44	44.90	184.3752	144.1	537.3	169.8
2013Q1	79.20	-1.84	59.84	46.88	181.8125	141.7	516.1	163.6
2013Q2	79.33	-1.80	59.84	48.31	182.1789	139.2	539.2	192.5
2013Q3	79.98	-1.85	68.97	50.91	182.7995	136.6	592.9	186.8
2013Q4	83.08	-2.00	68.99	48.36	183.6741	133.8	599.2	160.1
2014Q1	85.08	-2.57	73.64	47.93	185.8535	134.1	566.1	160.8
2014Q2	85.45	-2.78	81.22	51.30	186.8161	134.4	628.9	196.4
2014Q3	84.43	-2.94	77.36	48.65	187.6125	134.7	600.9	187.9
2014Q4	82.39	-3.06	82.52	48.27	188.2428	135.0	591.0	178.0
2015Q1	80.88	-3.00	46.78	52.58	188.5900	135.8	548.5	174.7
2015Q2	80.45	-3.10	55.72	52.13	188.9348	136.6	585.6	171.1
2015Q3	78.33	-3.22	59.16	50.75	189.1601	137.5	601.4	172.2
2015Q4	78.69	-3.37	61.67	50.16	189.2661	138.4	575.7	166.0
2016Q1	80.94	-3.92	71.13	52.24	187.8365	137.4	562.1	164.9
2016Q2	82.41	-3.95	79.15	51.91	188.2703	136.3	588.1	183.3
2016Q3	83.27	-3.84	58.26	53.93	189.1511	135.1	561.0	194.4
2016Q4	82.05	-3.60	68.70	52.45	190.4791	133.9	512.1	194.7
2017Q1	83.03	-2.62	77.32	49.47	193.9863	136.5	509.1	189.3
2017Q2	84.93	-2.36	62.32	51.16	195.5156	139.2	544.7	236.2
2017Q3	86.86	-2.19	61.77	55.09	196.7992	142.1	593.6	282.5
2017Q4	87.25	-2.14	105.94	55.27	197.8370	145.2	568.0	342.2
2018Q1	90.98	-2.41	86.26	52.99	197.0106	143.8	575.0	253.2
2018Q2	88.81	-2.48	62.61	51.94	198.2043	142.4	552.5	285.9
2018Q3	90.06	-2.57	46.75	59.41	199.7996	140.8	614.5	295.2
2018Q4	91.31	-2.68	84.12	55.99	201.7965	139.1	683.1	291.6
2019Q1	92.83	-2.91	40.90	52.93	207.4544	141.4		
2019Q2	92.81	-3.01	40.80	52.98	208.9508	143.8		
2019Q3	92.01	-3.07	39.30	54.51	209.5449	146.3		
2019Q4	91.94	-3.11	30.10	51.23	209.2369	149.0		
2020Q1	90.59	-3.12	37.80	47.65451	208.0267	156.5		
2020Q2	88.65	-3.10	24.30	34.04221	205.9144	164.4		
2020Q3	91.07	-3.05	12.10	42.19223	202.8998	172.7		
2020Q4	95.26	-2.97	5.40	41.59542	198.9831	181.6		

Appendix (Cont.)



Graph for Variables

Variance Decomposition

Period	S.E.	CA	GDP_PER CAPITA	REER	TO	TOT	FDI
1	0.180012	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000
2	0.299325	98.64906	0.556814	0.000895	0.117702	0.555245	0.120282
3	0.380047	96.32660	1.131327	0.001661	0.267461	2.134861	0.138093
4	0.430497	93.19359	1.478891	0.002403	0.704498	4.392411	0.228203
5	0.461068	89.67864	1.613612	0.002171	1.409507	6.776825	0.519249
6	0.479509	86.37469	1.613966	0.009591	2.151049	8.788052	1.062652
7	0.490489	83.74463	1.565470	0.041305	2.708205	10.11849	1.821903
8	0.496783	81.93792	1.526138	0.110081	2.997718	10.73762	2.690526
9	0.500310	80.81698	1.522735	0.216857	3.071405	10.84383	3.528187
10	0.502617	80.08393	1.563661	0.351316	3.048923	10.74963	4.202539

Appendix (Cont.)

Spurious Regression				
Dependent Variable: CA				
Method: Fully Modified Least Squares (FMOLS)				
Date: 09/29/22 Time: 15:42				
Sample (adjusted): 2000Q2 2020Q4				
Included observations: 83 after adjustments				
Cointegrating equation deterministics: C				
Long-run covariance estimate (Bartlett kernel, Newey-West fixed bandwidth = 4.0000)				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
REER	-0.023032	0.014522	-1.586044	0.1168
GDP_PERCAPITA	-0.028792	0.005654	-5.092826	0.0000
TO	0.015468	0.017713	0.873292	0.3852
TOT	0.024904	0.007587	3.282544	0.0015
FDI	0.001633	0.005702	0.286456	0.7753
C	0.271858	1.039238	0.261594	0.7943
R-squared	0.758751	Mean dependent var	-1.879701	
Adjusted *R*-squared	0.743085	S.D. dependent var	0.946169	
S.E. of regression	0.479582	Sum squared resid	17.70995	
Durbin-Watson stat	0.217265	Long-run variance	0.592368	

Note: The goal of OLS estimation at the level is to detect spurious regression. If the results are proven to be erroneous, they will be unable to process or use them further. Such outcomes, if employed incorrectly, will lead the formulation of economic policy. The calculated result indicates that R-square is bigger than the DW statistics, which is the primary criterion for spurious regression.

Cite this article as: Nzabirida Etienne (2023). Econometric Analysis of Exchange Rate on Current Account Adjustment in Rwanda. *International Journal of Management Research and Economics.* 3(2), 65-84. doi: 10.51483/IJMRE.3.2.2023.65-84.