International Journal of Science and Research (IJSR)
ISSN: 2319-7064
Index Copernicus Value (2016): 79.57 | Impact Factor (2017): 7.296

Effects of Exports and Imports on the Balance of Foreign Trade in Rwanda Using Principal Component Analysis (2010-2017)

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Abstract: ***Rwanda's BOT deficit has continued to widen overtime despite the measures taken by the government to reduce importation and encourage exportation. The purpose of this research project is to apply principal component analysis technique to determine the effects of major export and import commodities on Rwanda's balance of trade. Specifically the study aimed at determining the principal components of the various groups of exports and imports using PCA, testing for the stationarity of BOT and investigating the effects of key export and import components on the BOT in Rwanda. Time series secondary data from NISR and BNR for the period 2010 to 2017 was processed and analyzed using SPSS and Eviews. The results indicated that there were 2 principal components 1st and 2nd per group. Food and drinks e.g. tea, coffee, wheat and vegetables and minerals were the major exports while electrical and motor vehicle appliances e.g. transformers, motors for goods, passengers and special purpose motors and medical instruments were the major imports. BOT was stationary at first difference. Major exports had significant positive effects whereas major imports had significant negative effects on BOT. The study recommends the use of PCA as data reduction technique by NISR and BNR. The study further recommends various export promotion strategies and imports reduction strategies to be adopted by the government in order to reduce the BOT deficit.***

1. Background of the Study

In Rwanda's Vision 2020 plan, the country set ambitious goals for growth that required an almost seven-fold increase in the economy. Because of the progress made in the last decade, the economy now needs to expand by just 250% between 2010 and 2020 in order to increase its per capita GDP from US$550 to at least US$900. But this growth in the decade ahead will be more challenging, and thus far, Rwanda's scorecard in terms of meeting its export growth of 15% per annum is mixed. (Rwanda National Export Strategy, 2011)

In order to achieve its goal of US$900 GDP per capita, Rwanda now requires a 4.6% annual growth rate, a rate which has been surpassed in the last five years (assuming the population grows at a rate of 2.5-3%). Exports are central to achieve the economic goals of Rwanda's Vision 2020 and EDPRS. In Vision 2020, export growth is targeted at 15% per annum and is marked as a crucial component to achieving balance of trade and balance of payments improvements. Thus far, this effort has contributed to the balance of payments deficit reduction from 17% of GDP in 2001 to 9% in 2010. (Rwanda National Export Strategy, 2011)

Rwanda's exports show robust growth and so do imports. Rwanda's exports, including tourism, have increased significantly over the past decade, rising to US$454 million in 2010. This marks an impressive trend in nominal export revenue growth since 2003. Export growth was led by tourism, tea, coffee and mining sectors, as well as strong growth of re-exports. At the same time as this impressive growth in exports, imports to Rwanda have grown more rapidly, from US$ 282 million in 2003 to US$1.3 billion in 2010. Efforts to both expand exports and reduce or substitute targeted imports through competitive measures can reduce the trade deficit, as donor aid and international transfers, which currently subsidize this deficit, are being reduced.

Although the export sector is growing, Rwanda lags other African nations in terms of exports as a percentage of GDP. Closing this gap will require expansion of production and the creation of niche products and services that respond to the specific needs of target markets.

Rwanda depends on volatile commodity products within its tea, coffee, and minerals industries, for the vast majority of its export revenues. Over-dependence on commodities for exports can contribute to lower long-term growth. While Rwanda's coffee, tea and tourism strategies focus on moving towards more targeted, high-end market niches, progress is not complete and a global downturn may impact these specialty markets as well. Rwanda can escape the "commodity trap" by diversifying its exports into targeted products and services, innovating, increasing productivity and serving higher margin, niche markets. The global market is becoming increasingly complex, with value chains stretching across continents. By moving downstream, closer to end consumers, Rwandan firms can capture larger product margins and learn better from customers.

2. Statement of the Problem

As a rapidly growing economy, Rwanda imports more than it exports leading to a growing trade deficit. Between 2008 and 2012 export growth averaged 26% compared with growth in imports of 18%. The latest trade data indicate that in 2012 merchandise exports grew by 28.13%, over 2011, compared to 11.40% growth in merchandise imports. The government targets to grow exports by 28 per cent annually under the second Economic Development and Poverty Reduction Strategy (EDPRS II). However, the country's exports were at 16.5 per cent in August 2016 while trade

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deficit rose by 2.2 per cent during the first eight months of the year.

According to central bank figures, total exports dropped in value by 2.4 per cent in the first half of 2016, to $268.57 million from $ 275.12 million on the back of a 6.3 per cent decline in the same period last year. However, exports volume rose by 16.5 per cent, driven by a 10.9 per cent growth in coffee exports and 54.1 per cent increase in re-exports. A review of the factors underpinning the poor performance of the economy suggests that the needed growth to support economic development could be achieved if Rwanda develops a strong and vibrant export sector that is efficient, expanded and diversified. Identifying and addressing supply side constraints that impede the development and expansion of the export sector would be a key to achieving this goal.

A deficit in the balance of trade may likely affect the position of the current account leading to unfavorable balance of payments. Balance of trade, also known as net exports, is the sum of the money gained by a given economy by selling exports, minus the cost of buying imports. These form part of the balance of payment, which also includes other transactions such as the international investment position.

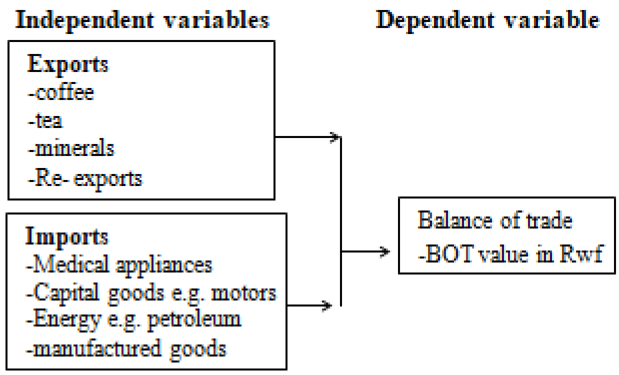
Most people do (not) believe that trade deficits are inherently good or bad, some even believe that trade deficits are generally harmful when countries engage in currency controls, such as fixed or pegged exchange rates. Economists like Milton Friedman point out that a large trade deficit (importation of goods) signals that the currency of this country is strong and desirable. Citizens of such countries also receive the benefit of having the ability to choose between many competing consumables and low prices than they would otherwise experience if the currency was weaker and the country was enjoying a trade surplus. Trade deficit simply means that consumers get to purchase and enjoy more goods at lower prices, conversely, a trade surplus implies that a country's exports that its owns, its citizens do not get to consume and while paying high price for the goods that were consumed (Either, 1992).

In the light of all these macroeconomic indicators, there is a need to apply principal component analysis to determine which exports and imports commodities have important major effects on the Rwanda's balance of trade and quantify such effects thereafter. This leads to the purpose of this research.

3. Objectives of the Study

1) To determine using Principal Component Analysis technique the principal components of the various groups of the export and import commodities in Rwanda.
2) To test for the stationarity of balance of trade in Rwanda
3) To investigate the effects of key components of imports and exports on the balance of foreign trade in Rwanda.

4. Conceptual Framework



5. Research Design

A research design is the set of methods and procedures used in collecting and analysing measures of the variables specified in the research problem. The design of a study defines the study type (descriptive, correlation, semi-experimental, experimental, review, meta-analytic) and sub-type (e.g., descriptive-longitudinal and if applicable, data collection methods and a statistical analysis plan. Research design is the framework that has been created to find answers to research questions. (Andrew B Kirumbi, 2018). This study involves analysis of the effects of exports and imports on balance of trade using numerical data. Therefore the study adopted descriptive quantitative research design.

6. Data Processing and Analysis

Statistical Software SPSS and Eviews were used in data processing and analysis. Inferential and descriptive statistics were computed from the software. The findings were presented in form of tables and graphs. Data was first categorised into 4 groups and the principal components determined using Principal Component Analysis. The effects of balance of imports and exports on balance of foreign trade were analysed using multiple and stepwise regression techniques.

6.1 Principal Component Analysis

Principal component analysis is a multivariate technique that analyses a data table in which observations are described by several inter-correlated quantitative dependent variables. The goals of PCA are to find and extract the most important information from the data and compress the size while at the same time keeping the important information and simplify the description of data, and then the structure of the observations and variables can be analysed. (Abdi and Williams 2010). The PCA computes new variables called principal components (PCs) as linear combinations of the original variables. The first principal component is required to have the largest possible variance (in other words inertia and therefore explain the largest part of the inertia of the data table). The second has to be orthogonal to the first and have the second largest possible inertia.

The rest of the components are computed likewise. The values of these new variables for the observations are called

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factor scores, which can be interpreted geometrically as the projections of the observations onto the principal components. (Abdi and Williams 2010)

The strengths of the principal component analysis are that a large amount of variables can be used without adding much to the complexity of the model.

The goals of PCA are to:
1) Extract the most important information from the data table;
2) compress the size of the data set by keeping only this important information;
3) Simplify the description of the data set; and
4) Analyse the structure of the observations and the variables.

The researcher employed Principal Component Analysis (PCA) to determine which of the major commodities have significant effects on export and import on balance of foreign trade in Rwanda.

A PCA is concerned with elucidating the covariance structure of a set of variables. It is a method that projects a dataset to a new coordinate system by determining the eigenvectors and eigen values of a matrix. It involves a calculation of a covariance matrix of a dataset to minimize the redundancy and maximize the variance.

Given a data matrix with p variables and n samples, the data are first centred on the means of each variable to ensure the cloud of data is centre on the origin of the principal components without affecting the spatial relationships of the data or the variances among the variables. The first principal component (Y_1) is given by the linear combination of the variables $X_1, X_2, \ldots, X_p$.

$Y1 = a_{11}X_1 + a_{12} X_2 + \ldots + a_{1p}X_p$

The first principal component is calculated such that it accounts for the greatest possible variance in the data set. One could make the variance of Y_1 as large as possible by choosing large values for the weights a_{11}, $a_{12} \ldots a_{1p}$ so to prevent this weights are calculated with the constraint that their sum of squares is 1.

$a_{11}^2 + a_{12}^2 + \ldots + a_{1p}$

The second principal component is calculated in the same way, with the condition that it is uncorrelated with (i.e. perpendicular to) the first principal component and that it accounts for the next highest variance. This continues until a total of p principal components have been calculated, equal to the original number of variables. The weights a_{ij} are the elements of an eigenvector of the covariance matrix of the original data (also called factor loadings). The eigenvalues are the variance explained by each principal component and are constrained to decrease from the first principal component to the last.

According to Alvin (2002), in Principal Component Analysis, we intend to maximize the variance of a linear combination of the variables. The first PCA is the linear combination with maximal variance in which we are searching for a dimension along which the observation are maximally separated or spread out. The second PC is the linear combination with maximal variance in a direction orthogonal to the first PC, and so on.

We seek a linear combination with maximal variance. The sample variance of $Z = a' y$ is $a' Sa$

Since $a'Sa$ has no maximum if a is unrestricted, we seek the maximum of

$$\lambda = \frac{a' Sa}{a' a} \qquad (1)$$

By this argument, the maximum value of λ is given by the largest eigenvalue in the expression

$$(S - \lambda I)a = 0 \qquad (2)$$

Hence the characteristic equation

$$|S - \lambda I| = 0 \qquad (3)$$

The eigenvector a_1 corresponding to the largest eigenvalue λ_1 is the coefficient vector in $Z_1 = a_1' y$. Therefore, S can be singular, in which case some of the eigen values are zero and can be ignored. A singular S would arise, for example, when $n < p$ that is when the sample size is less than the number of variables.

Logarithm Transformation

Koutsoyiannis (1977), theory of econometrics, if the relationship is of the form

$$Y = b_0 X_1^{b_1} X_2^{b_2} \mu \qquad (4)$$

Then the error term is multiplication, instead we write the constant relationship in the continent form

$$Y = b_0 X_1^{b_1} X_2^{b_2} \ell^{\mu} \qquad (5)$$

Where $X_1, t(\mu_1) = 0$ the base of natural logarithms, The appropriate transformation for all estimation of constant variables form is to work with logarithms of the variables to the base e.

$$log_\ell Y = log_\ell b_0 + b_1 \; log_\ell X_1 + log_\ell X_2 \qquad (6)$$

Setting $Y^* = log_e Y, X_1^* = log_e X_1, X_2^* + log_2 X_2$

We shall apply OLS to the linear transformation.

$$Y^* = b_0^* + b_1 X_1^* + b_2 X_2^* + \mu \qquad (7)$$

The estimate $\widehat{b_1}$ and $\widehat{b_2}$ are unbiased, however, although $\widehat{b_0}$* intercept b_0^1 unbiased, the logarithmic transformation yields a biased, but consistent, estimate of the intercept b_0^1.

6.2 Assumption

1) The random variables μ has a zero-mean value for each X_k (zero mean)
2) Homoscedasticity; the variance of each μ_1 is the same for all X_1 values $E(\mu_1^2) = \sigma_\mu^2$ constant
3) (Normality of u) the values of each μ_1 are normally distributed. $\mu \rightarrow N(0, \sigma_{\mu 1}^2)$

6.3 Stationarity test

6.3.1 Philips Peron test (unit root test)

Philips Peron test provides a formal test for non-stationarity in the time series data. This test is used to test for the presence of unit root in the coefficient of lagged variables. If the coefficient of a lagged variable shows a value of one, then the equation show that there exists unit root in the series. To test for the presence of a unit root in the balance

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of trade, PP of the form given below is carried out, where Y represent the series for the balance of trade.

$$\Delta Y_t = \alpha_o + \gamma Y_{t-1} + \beta_2 \Delta Y_{t-1} + \beta_3 \Delta Y_{t-2} + \cdots + \varepsilon_t$$

The null hypothesis for the test is given below

$H_o: \gamma = 0$, there exists a unit root problem.

6.4 Decision rule

1) If t-statistic > PP critical value. We don't reject the null hypothesis. Unit root exists in this case.
2) If t-statistic < PP critical value. We reject the null hypothesis. Unit root doesn't exist in this case.
3) The test statistic is the statistic used in the PP test.
4) If the null hypothesis is accepted, we assume that there is a unit root in the series and before applying the model we should to take the first difference of the series.
5) If the null hypothesis is rejected, the data of the series is stationary and can be used for modeling without taking any difference of the series.

6.5 Stepwise Regression

In the stepwise regression, there is one dependent variable and 'p' potential independent variables (Bob, 2002). Stepwise regression uses t-statistics to determine the significance of the independent variables in various regression models. The t-statistic indicates that the independent variable is significant at α-level if and only if the related p-value is less than α.

The stepwise procedure continues by adding independent variables one at a time of the model. After each step one independent variable is added to the model if it has the larger t-statistic of the independent variables not in the model and if its t-statistic indicates that it is significant at the α-level.

It removes an independent variable if it has the small as t-statistic of independent variables already included in the model. This removal procedure is sequentially continued, and only after the necessary removals are made, does the stepwise procedure attempt to add another independent variable to the model. The stepwise procedure terminates when all the independent variables not in the model are insignificant at α level.

6.6 Multiple linear regressions

Secondly, multiple linear regressions are applied to find the effect of exports and imports on balance of trade. After applying the regression on exports and imports variables, the insignificant variables are excluded from the data and again checked for the effects of all significant variables of exports and imports on balance of trade. The lag variables of explanatory variables are also included in the model.

7. Results of Major Findings

Table 1: Total variance of food and drinks components

Total Variance Explained						
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.839	63.987	73.987	3.839	63.987	63.987
2	1.258	20.972	84.959	1.258	20.972	84.959
3	0.492	8.194	93.154			
4	0.331	5.522	98.676			
5	0.053	0.885	99.561			
6	0.026	0.439	100			
Extraction Method: Principal Component Analysis						

Table 2: Component Matrix (Food and drinks components

Component Matrix[a]		
	Component	
	1	2
Tea	0.951	0.122
Wheat	0.928	0.017
Coffee	0.884	-0.402
Vegetables	0.874	0.169
Cereals	0.639	0.579
Beer	-0.346	0.847
Extraction Method: Principal Component Analysis.		
a. 2 components extracted.		

Table 3: KMO and Bartlett's Test (Food and drinks components)

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.538
Bartlett's Test of Sphericity	Approx. Chi-Square	28.381
	df	15
	Sig.	0.019

7.1 Principal Components for electrical and Motor Vehicle appliances

The findings revealed 2 principal components in this group. There were six component numbers but only the 1st and 2nd had Eigenvalues of magnitude greater than one hence qualifying as principal components. However the 1st component in ranking was considered. The variation in the electrical and motor vehicle appliances commodities is given below where X_7, X_8, X_9, X_{10}, X_{11} and X_{12} are Goods Motors, Electrical transformers, Cables, Passenger Motors, Electrical Apparatus and Special Motors respectively. All these were import commodities.

$Z_2=0.985X_7+0.975X_8+0.943X_9+0.906X_{10}+0.844X_{11}-0.322X_{12}+\varepsilon$.

This component accounted for 81.08% of the variation in this group as shown in Table 4. The magnitude of slope between component 1 and 2 is the highest as shown in Figure 3. The model is significant as shown by KMO results in Table 5. Kaiser-Meyer-Olkin Measure of Sampling Adequacy is 0.678 which is above 0.5 and a significance level of 0.000 which is less than 0.05.

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Table 4: Total Variance of Electrical and Motor Vehicle appliances

Total Variance Explained						
Comp-onent	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.445	74.083	81.083	4.445	74.083	74.083
2	1.025	17.078	91.162	1.025	17.078	91.162
3	0.307	5.125	96.286			
4	0.188	3.13	99.417			
5	0.029	0.476	99.892			
6	0.006	0.108	100			
Extraction Method: Principal Component Analysis.						

Table 5: Component Matrix (electrical and motor vehicle appliances)

Component Matrix[a]		
	Component	
	1	2
Goods motors	0.985	0.065
Electrical transformers	0.975	0.144
Cables	0.943	0.007
Passenger motor	0.906	0.299
Electrical apparatus	0.844	-0.216
Special motors	-0.322	0.929
Extraction Method: Principal Component Analysis.		
a. 2 components extracted.		

Table 6: KMO and Bartlett's Test (electrical and motor vehicle appliances

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.678
Bartlett's Test of Sphericity	Approx. Chi-Square	41.396
	df	15
	Sig.	0

7.2 Principal Components for Minerals

The findings revealed 2 principal components in this group. There were six component numbers but only the 1st and 2nd had Eigenvalues of magnitude greater than one hence qualifying as principal components. However the 1st component in ranking was considered.

The variation in the minerals commodities is given below where X_{13}, X_{14}, X_{15}, X_{16}, X_{17} and X_{18} are petroleum, other minerals, tungsten, Cement, Mineral water and Tin respectively. All these were export commodities except petroleum.

$$Z_3=0.921X_{13}+0.848X_{14}+0.757X_{15}+0.624X_{16}-0.342X_{17}+0.095X_{18}+\varepsilon.$$

This component accounted for 78.27% of the variation in this group as shown in Table 7. The magnitude of slope between component 1 and 2 is the highest as shown in Figure 4. The model is significant as shown by KMO results in Table 9. Kaiser-Meyer-Olkin Measure of Sampling Adequacy is 0.576 which is above 0.5 and a significance level of 0.049 which is less than 0.05.

Table 7: Total variance for mineral commodities

Total Variance Explained						
Comp-onent	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.656	44.269	78.269	2.656	44.269	44.269
2	1.951	32.509	76.778	1.951	32.509	76.778
3	0.936	15.606	92.384			
4	0.358	5.959	98.343			
5	0.055	0.921	99.264			
6	0.044	0.736	100			
Extraction Method: Principal Component Analysis.						

Table 8: Component matrix for Minerals

Component Matrix[a]		
	Component	
	1	2
Petroleum	0.921	-0.293
Others	0.848	0.498
Tungsten	0.757	0.599
Cement	0.624	-0.561
Mineral Water	-0.342	0.87
Tin	0.095	0.431
Extraction Method: Principal Component Analysis.		
a. 2 components extracted.		

Table 9: KMO and Bartlett's Test for Minerals

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.576
Bartlett's Test of Sphericity	Approx. Chi-Square	22.771
	df	15
	Sig.	0.049

7.3 Principal Components for Miscellaneous commodities

The findings revealed 2 principal components in this group. There were five component numbers but only the 1st and 2nd had Eigenvalues of magnitude greater than one hence qualifying as principal components. However the 1st component in ranking was considered.

The variation in the miscellaneous commodities is given below where X_{19}, X_{20}, X_{21}, X_{22} and X_{23} are medical instruments, seeds, beddings, second clothes and furniture respectively. All these were export commodities except petroleum.

$$Z_4=0.921X_{19}-0.654X_{20}-0.590X_{21}-0.296X_{22}+0.637X_{23}+\varepsilon.$$

This component accounted for 82.35% of the variation in this group as shown in table 10. The magnitude of slope between component 1 and 2 is the highest as shown in Figure 5. The model is significant as shown by KMO results in Table 12. Kaiser-Meyer-Olkin Measure of Sampling Adequacy is 0.620 which is above 0.5 and a significance level of 0.006 which is less than 0.05.

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Table 10: Total variance for miscellaneous commodities

Total Variance Explained					
Initial Eigenvalues			Extraction Sums of Squared Loadings		
Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
2.118	42.35	82.35	2.118	42.35	42.35
1.139	22.784	65.134	1.139	22.784	65.134
0.858	17.16	82.294			
0.716	14.322	96.616			
0.169	3.384	100			
Extraction Method: Principal Component Analysis.					

Table 11: Component matrix for miscellaneous commodities

	Component	
	1	2
Medical instruments	0.921	0.162
Seeds	-0.654	0.225
Beddings	-0.59	0.359
Second clothes	-0.296	0.708
Furniture	0.637	0.657
Extraction Method: Principal Component Analysis.		
a. 2 components extracted.		

Table 12: KMO and Bartlett's Test for miscellaneous commodities

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.62
Bartlett's Test of Sphericity	Approx. Chi-Square	6.225
	df	10
	Sig.	0.006

8. Stationarity test results of balance of trade

The second objective of the study was to test for the stationarity of balance of trade. This was achieved by carrying out unit root test on the data set using the Philips Peron test method. The existence of unit root on the data set signifies absence of stationarity and vice versa. The stationarity test was carried out at level and at first difference.

8.1 Stationarity test at level

The null hypothesis was that BOT has a unit root. The Philips Perron absolute value of 1.805017 is less than the critical values of 6.29, 4.45 and 3.7 at 1%, 5% and 10% respectively. The probability value of 0.6133 is greater than 0.6133 which is less than 0.05 implying that BOT is not significant. The null hypothesis was therefore accepted signifying presence of unit root hence absence of stationarity in BOT. Therefore BOT is not stationary at level.

Table 13: Unit root at level

Null Hypothesis: (BOT) has a unit root			
Exogenous: Constant, Linear Trend			
Bandwidth: 1 (Newey-West automatic) using Bartlett kernel			
		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.805017	0.6133
Test critical values:	1% level	-6.292057	
	5% level	-4.450425	
	10% level	-3.701534	

8.2 Stationarity test at first difference

From table 14, the Philips Perron absolute value of 6.474963 is greater than the critical values of 4.77 and 3.88 at 5% and 10% respectively. The probability value of 0.0146 is less than 0.05 implying that BOT is not significant. The null hypothesis was therefore rejected signifying absence of unit root hence presence of stationarity in BOT. Therefore BOT is stationary at first difference.

Table 14: Unit root at first difference

Null Hypothesis: D(BOT) has a unit root			
Exogenous: Constant, Linear Trend			
Bandwidth: 5 (Newey-West automatic) using Bartlett kernel			
		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-6.474963	0.0146
Test critical values:	1% level	-7.006336	
	5% level	-4.773194	
	10% level	-3.877714	

The regression coefficients of two components, food and drinks and minerals have positive signs, whereas for the principal component corresponding to electrical and motor vehicle appliances and miscellaneous commodities have positive signs. The principal components corresponding to all the four groups are significant.

The AdjR^2=0.7660 is obtained by applying the model. Adjusted $\mathbf{R^2}$ indicate that 76.6% of variations in balance of trade are explained by these principal components. In the groups, electrical and motor vehicle appliances and miscellaneous dominated imports, whereas food and drinks and miscellaneous commodities dominated exports. Electrical and motor vehicle appliances and miscellaneous commodities have relatively high propensity towards imports from Table 15.

Table 15: Multiple regressions of principal components

Dependent Variable: BOT				
Method: Least Squares				
Date: 06/29/18 Time: 02:06				
Sample: 2010 2017				
Included observations: 8				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-234.5659	275.6058	-0.851092	0.0043
Z1	0.009227	0.004194	-2.200026	0.0012
Z2	-0.021807	0.002430	0.331990	0.0447
Z3	0.002793	0.000437	-6.391509	0.0048
Z4	-0.029905	0.005117	-1.935704	0.0133
R-squared	0.835703	Mean dependent var	-1777.000	
Adjusted R-squared	0.766300	S.D. dependent var	474.1865	
S.E. of regression	106.2009	Akaike info criterion	12.43771	
Sum squared resid	33835.91	Schwarz criterion	12.48736	
Log likelihood	-44.75085	Hannan-Quinn criter.	12.10284	
F-statistic	34.13830	Durbin-Watson stat	1.626560	
Prob(F-statistic)	0.007778			

9. Stepwise Regression

In order to determine the effects of key export and imports components on balance of trade, the researcher carried out

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stepwise regression. The balance of trade was regressed on each of the components per group.

9.1 Effect of food and drinks on balance of trade

This group constituted key exports which included tea, wheat, coffee, cereals, vegetables and beer. All these commodities have positive effects on balance of trade. The commodities are significant except cereals and beer. Tea, coffee, wheat and vegetables were significant since they had a probability value less than 0.05. Cereals and beer had insignificant effects on balance of trade since there probabilities were greater than 0.05. R squared value is 0.8001 implying that these commodities explain 80% of the variations in BOT in Rwanda. The results of positive effects indicate that exports earn foreign exchange hence bringing favourable balance of trade.

Table 16: Effect of food and drinks on balance of trade

Dependent Variable: BOT				
Method: Least Squares				
Date: 06/29/18 Time: 03:10				
Sample: 2010 2017				
Included observations: 8				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1794.633	2103.129	-0.853316	0.5503
Tea	0.051472	0.021081	-0.069830	0.0006
Wheat	0.045047	0.055427	-0.812712	0.0005
Coffee	0.018683	0.058775	0.317869	0.0401
Cereals	0.005734	0.086609	-1.220827	0.0529
Vegetables	0.031750	0.402214	-0.078938	0.0019
Beer	0.042588	0.045567	0.934629	0.0615
R-squared	0.800128	Mean dependent var		-1777.000
Adjusted R-squared	0.711873	S.D. dependent var		474.1865
S.E. of regression	254.5313	Akaike info criterion		13.58728
Sum squared resid	64786.18	Schwarz criterion		13.65679
Log likelihood	-47.34913	Hannan-Quinn criter.		13.11846
F-statistic	3.882474	Durbin-Watson stat		2.706948
Prob(F-statistic)	0.370094			

9.2 Effects of electrical and motor vehicle appliances on BOT

This group constituted key imports which included cables, electrical apparatus, electrical transformers, goods motors, passenger motors and special motors. All these commodities have negative effects on balance of trade except cables which had positive effect. The commodities are significant except cereals and beer. Electrical transformers, electrical apparatus, goods motor and passenger motor had significant effects since they had a probability value less than 0.05. Cables and special motors had insignificant effects on balance of trade since there probabilities were greater than 0.05. R squared value was 0.8601 implying that these commodities explain 86% of the variations in BOT in Rwanda. The results of negative effects indicate that imports are expenses hence there is an outflow of currency bringing unfavourable balance of trade.

Table 17: Effects of electrical and motor vehicle on BOT

Dependent Variable: BOT				
Method: Least Squares				
Date: 06/29/18 Time: 03:22				
Sample: 2010 2017				
Included observations: 8				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1136.554	372.9744	-3.047271	0.0349
Cables	0.018708	0.018948	0.987293	0.0651
Electrical_Apparatus	-0.016323	0.002220	-7.352267	0.0001
Electrical_Transformers	-0.029132	0.023302	-1.250212	0.0295
Goods_Motors	-0.004331	0.023514	-0.184189	0.0040
Passenger_Motors	-0.006786	0.013384	0.506981	0.0413
Special_Motors	-0.068885	0.004272	0.207073	0.0550
R-squared	0.864954	Mean dependent var		-1777.000
Adjusted R-squared	0.754679	S.D. dependent var		474.1865
S.E. of regression	89.11814	Akaike info criterion		11.48836
Sum squared resid	7942.042	Schwarz criterion		11.55787
Log likelihood	-38.95345	Hannan-Quinn criter.		11.01954
F-statistic	32.86367	Durbin-Watson stat		3.159817
Prob(F-statistic)	0.132742			

9.3 Effects of mineral components on BOT

This group constituted key exports which included mineral water, Tin, Tungsten and other minerals and imports which included cement and petroleum. Key exports had positive effects on balance of trade while imports had negative effects on balance of trade. Petroleum had the greatest magnitude change in BOT while Tin had the least magnitude change in BOT. All the commodities were significant with probabilities less than 0.05 except mineral water whose probability was greater than 0.05. Imports had negative effects on BOT whereas exports had positive effects on BOT.R-squared value of 0.758 imply that these minerals account for 75.88% variations in BOT.

Table 18: Effects of mineral components on BOT

Dependent Variable: BOT				
Method: Least Squares				
Date: 06/29/18 Time: 03:28				
Sample: 2010 2017				
Included observations: 8				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1147.114	35.82714	-32.01802	0.0199
Cement	-0.056403	0.003080	-18.31228	0.0347
Mineral Water	0.007048	0.018340	5.291539	0.1189
Others	0.007746	0.000950	8.149892	0.0777
Petroleum	-0.092124	0.000152	-13.93878	0.0356
Tin	0.003028	0.000593	5.102602	0.0032
Tungsten	0.045260	0.004336	-10.43841	0.0408
R-squared	0.758821	Mean dependent var		-1777.000
Adjusted R-squared	0.668745	S.D. dependent var		474.1865
S.E. of regression	16.80126	Akaike info criterion		8.151344
Sum squared resid	282.2824	Schwarz criterion		8.220855
Log likelihood	-25.60537	Hannan-Quinn criter.		7.682517
F-statistic	929.1450	Durbin-Watson stat		3.310029
Prob(F-statistic)	0.025107			

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9.4 Effects of Miscellaneous Components on BOT

This group constituted key imports which included medical instruments, furniture, second hand clothes and seeds and export beddings. Beddings had positive effects on balance of trade while the rest had negative effects on balance of trade. This implies that exports positively affect BOT while imports negatively affect BOT. All the commodities were significant since there probabilities were less than 0.05. Medical instruments had the greatest effect on BOT while seeds had the least effects. The R-squared value of 83.25% shows that these commodities are very influential and account for a greater percentage of BOT variation.

Table 19: Effect of miscellaneous components on BOT

Dependent Variable: BOT				
Method: Least Squares				
Date: 06/29/18 Time: 03:31				
Sample: 2010 2017				
Included observations: 8				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1338.710	333.8735	-4.009632	0.0569
Beddings	0.007957	0.043604	-1.558501	0.0034
Furniture	-0.026005	0.022755	1.142818	0.0505
Medical Instruments	-0.501058	0.014040	-0.787569	0.0435
Second Clothes	-0.086065	0.106369	0.809115	0.0044
Seeds	-0.004682	0.136804	-2.519538	0.0050
R-squared	0.832542	Mean dependent var	-1777.000	
Adjusted R-squared	0.772588	S.D. dependent var	474.1865	
S.E. of regression	310.0077	Akaike info criterion	14.42478	
Sum squared resid	192209.5	Schwarz criterion	14.48436	
Log likelihood	-51.69911	Hannan-Quinn criter.	14.02293	
F-statistic	2.875529	Durbin-Watson stat	2.422924	
Prob(F-statistic)	0.277911			

10. Conclusion

From the findings above the researcher came up with the following conclusions:

There were two principal components for each group. These were the 1st and the 2nd component numbers for each group since they had eigenvalues greater than 1. Food and drinks e.g. tea, coffee, wheat and vegetables and minerals were the major exports of Rwanda while electrical and motor vehicle appliances and medical instruments formed the bulk of Rwandan imports. Imports had fairly greater effect on balance of trade than exports.

Balance of trade data was not stationary at level but became stationary at first difference. This was supported by the fact that there was presence of unit root at level an indication of non-stationary of the data set and absence of unit root at first difference indicating presence of stationarity.

The key exports had a positive effect on balance of trade while the key imports had negative effects on balance of trade.

11. Recommendations

Principal component analysis proves superior technique of data reduction. It should be adopted by NISR and BNR in identifying the key exports and imports that are to be targeted to achieve a favourable balance of trade through coming up with sound decisions on how to encourage the exportation of the key exports and discourage or control the importation of key imports which greatly affects BOT.

Food and drinks majorly tea, coffee, wheat and vegetables forms major exports of Rwanda. The government of Rwanda should therefore focus on encouraging or increasing the export volume of these commodities in order to achieve favourable balance of trade. Value addition is paramount in this regard in order to improve the competitiveness of these commodities. In addition small scale farmers of these commodities should be encouraged to increase their production by giving them incentives such as fertilizers, offering better prices for their commodities, insecticides and pesticides not forgetting sourcing for more and better markets for the products from other countries in order to increase the volume and value of exports.

Electrical and motor vehicle appliances and medical instruments form the bulk of imports and greatly widen the BOT deficit. The government should embark on coming up with strategies to curb or reduce these major imports. This can be achieved by imposing import quotas for some of these commodities or raising imports tariffs in order to reduce dumping or excess importation. Furthermore the government should focus on widening the industrial sector and creating a pool of professionals who are able to manufacture some of these products within in order to reduce the quantity imported. There should be negotiations with the importing countries to reduce the price of essential imported commodities such as medical instruments. The government should also stress on the safety of the environment and food stuffs in order to reduce the rate at which people suffer from various diseases which attracts increased volume of imported drugs and medical machines needed to test various diseases

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