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A MULTIVARIATE CANONICAL ANALYSIS OF NIGERIAN STOCK MARKET VARIABLES ON THE ECONOMY

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Abstract: *This research is on canonical correlation of multivariate stock market on economic factors in Nigeria. This study aim to analyze the effect of Nigerian macroeconomic factors and also to investigate the relationship between the factors for the period of 1991-2021. Four macroeconomic variables (economic factors) used in this research are Gross Domestic Product (GDP), Currency in Circulation (CIC), Foreign Trade and Inflation. Canonical correlation analysis under Multivariate regression was used for association between the variables. The result showed that there is a significant relationship between GDP and all the variables considered at (0.01) level of significant with the exception of inflation which showed negative and no significant relationship. However, the results also revealed that the economy of Nigeria is been affected by volume of economic factor returns.*

Keywords: *Multivariate stock market; canonical correlation; economy and economic factors.*

INTRODUCTION

Multivariate analysis takes into account several predictive variables simultaneously, and modeling the property of interest with more accuracy. This essentially models the reality that is found in every situation, product and decision which involves more than one variable. It is a process where several macro-economic variables (y's) are measured relative to each set of micro-economic variables (z's.). The multivariate view is central in economics, where set variables are traditionally viewed in the context of relationship to other variables.In forecasting and economics, multivariate models are convenient in modeling interdependencies to achieve a better result within a given data. Canonical correlation is a statistical model which tries to investigate as well as quantify the relationship between two sets of variables. The aim is to determine whether there is relationship between the two sets of variables. The significant of economy in a country are measured using the stock market variables that makes important contribution in the allocation of resources in two directions, of which, are identified a source of funds, determination of organizational value and its borrowing capacity. It provides a credible avenue for investment, capital formation and can act as an indicator and predictor of overall economic condition.

Macro-economic factors include politics and general economic condition to identify how the economy is performing. Consequently, such as demand and supply tend to influence by the

performance of the company through the industry and other players in the industry, Oseni, (2009). In addition, distinguished researchers such as Oaikhenan, (2003); Bolbol et al, (2005); Sharma and Singh, (2006), Sharma, (2011), suggested that share price changes relative to changes in fundamental variables that are relevant for share valuation. There are a lot of argument surrounding the validity and predictability of the stock market returns. The stock market incorporates all public information, so that an average investor and business executives cannot acquire abnormal returns based on trading strategies. Accordingly, it is impossible to consistently outperform the market by using the information that is currently available in the market.

Material and methods

This section focuses on the source of data collection as well as the methods used in collecting the data. The data shall be collected from the Central Bank of Nigeria Statistical bulletinfor the period of thirty years starting from 1991 to 2021. The methods that shall be adopted is a survey technique.

Research Approach

Research approach deals with the test to examine how valuable a research hypothesis is. For this to be exercised, data must be collected, analyze and interpreted. Therefore, the appropriate approach that shall be used to obtain the objectives of this study is deductive research approach.

Methods of Data Collection

The technique that shall be used to collect data is a survey method of data collection. Survey may be carried out by using the existing published data and making observation. This form of data collection is known as a secondary data. The data in this case can be obtained either from Newspaper or magazine or Libraries, Schools, Government publication such as annual abstract of Statistics, State Statistics, Employment gazettes, Books, Journals, Internet and other publications.

Instrument of Data Collection

The instrument for data collection is a tool used to collect data in a research process. But in this research, documentary analysis shall be considered as an instrument for the data collection which is also in line with the statement in section 3.3 above.

Methods of Data Analysis

The techniques that shall be used to analyze the entire research are Canonical Correlation, Multivariate test and Aurgment Dicky Fuller test for stationarity. The breakdown of the methods is shown below:

Canonical Correlation

The emphasis in canonical correlation is to determine the pair of the variable with the highest correlation coefficient. The aim is to determine whether there is relationship the two sets of variables. It also tried to examine whether the dimensionality of the relationship between sets of variables can be explained by just few sets of canonical variable. For the random vectors $u^{(1)}$ and $u^{(2)}$.

$$E(u^{(1)}) = \lambda^{(1)}; \quad Cov(u^{(1)}) = \Sigma_{11}$$
$$E(u^{(2)}) = \lambda^{(2)}; \quad Cov(u^{(2)}) = \Sigma_{12} \qquad (1)$$
$$Cov(u^{(1)}, u^{(2)}) = \Sigma_{12} = \Sigma'_{21}$$

The mean vector

$$\underset{((p+q)\times 1)}{\lambda} = E(u) = \begin{bmatrix} E(u^{(1)}) \\ u^{(2)} \end{bmatrix} = \begin{bmatrix} \lambda^{(1)} \\ \lambda^{(2)} \end{bmatrix} \qquad (2)$$

and covariance matrix

$$\underset{((p+q)\times 1)}{\sum} = E(u-\lambda)(u-\lambda)', \qquad \underset{((p+q)\times 1)}{u} = \begin{bmatrix} u^{(1)} \\ \cdots \\ u^{(2)} \end{bmatrix} \qquad (3)$$

Linear combinations provide simple summary measures of a set for variables set.

$$U = a'u^{(1)}$$
$$V = b^1 u^{(1)} \qquad (4)$$

The covariance is given by;

$$\delta(U,V) = \frac{a'\Sigma_{22}b}{\sqrt{a'\Sigma_{11}a\sqrt{b'\Sigma_{22}b}}} \qquad (5)$$

For coefficient vectors $\underset{(a+1)}{a}$ and $\underset{(a+1)}{b}$ form the linear combinations

then, $\max\limits_{(a,b)} Corr(U,V) = p_1^*$ (6)

attained by the linear combinations (first canonical variate pair)

$$U_1 = \underbrace{e_1'\overline{\Sigma}_{11}^{1/2X^{(1)}}}_{a_1'} \quad and \quad V_1 = \underbrace{f_1\Sigma_{22}^{-1/2}X^{(2)}}_{b_1'} \qquad (7)$$

The kth pair of canonical variates, $k = 2,3,...,p,$

$$U_k = e_k'\Sigma_{11}^{-1/2}X^{(1)} \qquad V_k = f_k'\Sigma_{22}^{-1/2}X^{(2)} \qquad (8)$$

Maximizes

$$Corr(U_k, V_k) = p_k^* \qquad (9)$$

Among those linear combinations uncorrelated with the preceding $1,2...,k-1$ canonical variables. Here $p_1^{*2} \geq p_2^{*2} \geq ... \geq p_p^{*2}$ are the eigen values of $\Sigma_{11}^{-1/2}\Sigma_{12}\Sigma_{22}^{-1}\ \Sigma_{21}\Sigma_{11}^{-1/2}$ and $e', e_{2,...,}e_p$ are the associated $(p\mathrm{X}_1)$ eigenvectors. The quantities $p_1^{*2}, p_2^{*2}, ...p_p^{*2}$ are also the *p* largest eigenvalues of the matrix $\Sigma_{11}^{-1/2}\Sigma_{21}\Sigma_{11}^{-1}\ \Sigma_{12}\Sigma_{22}^{-1/2}$ with corresponding

$(q\mathrm{X}_1)$ eigen vectors $f_1, f_2, ..., f_{p.}$ Each fi is proportional to $\Sigma_{22}^{-1/2}\Sigma_{21}\Sigma_{11}^{-1/2}e_i$

The linear functions that yield the maximum correlation are called canonical variates.

The canonical variates have the properties

$$Var(U_k) = Var(V_k) = 1$$
$$Cov(U_{k,}U_t) = Corr(U_{k,}U_t) = 0 \qquad k\ t\ \ell$$
$$Cov(V_{k,}V_t) = Corr(V_{k,}V_t) = 0 \qquad k\ t\ \ell$$
$$Cov(V_{k,}V_t) = Corr(U_{k,}V_t) = 0 \qquad k\ t\ \ell \qquad (10)$$

For k, ℓ =1, 2 . . . p.

Multivariate tests are:

(a) Wilk's Lambda: $\lambda^* = \dfrac{\left|\hat{\Sigma}\right|}{\left|\hat{\Sigma}\right|}$ (11)

(b) Pillai's trace : $\left[(\hat{\Sigma} - \hat{\Sigma}_0)\hat{\Sigma} - 1\right]$ (12)

(c) Lawley-Hoteling's $\left[(\hat{\Sigma} - \hat{\Sigma}_0)\hat{\Sigma} - 1\right]$ (13)

(d) Roy's Maximum Root test: largest eigenvalue of $\hat{\Sigma}_0\hat{\Sigma} - 1$ (14)

Note that Wilk's Lambda is directly related to the Likelihood Ratio Test. Also $\wedge^* = \prod_{i=1}^{p} (1 + \iota_i)$, where ι_i are the roots of $\left|\hat{\Sigma}_0 - \iota(\hat{\Sigma} - \hat{\Sigma}_0)\right| = 0.$ For $\lambda = \dfrac{|g|}{|g + j|}$ to be positive (15)

Stationarity test (Dickey Fuller Test)

The Dickey and Fuller (1997) can be used to examine the stationarity of a variable. The null hypothesis is that

$\mathrm{H}_0 : \alpha_1 = 1$, and the alternative hypothesis is stated as:

$\mathrm{H}_1 : \alpha_1 < 1$

The test statistic,

t-ratio = $\dfrac{\hat{\alpha}_1 - 1}{Std(\alpha_1)}$ (16)

The null hypothesis is rejected if the calculated value of t is greater than t critical value.

Result

Table 1 shows that, four canonical roots were extracted with the first root accounting for 98.99% of the variation in the data set. Root 2, 3 and 4 accounted for 0.69%, 0.22% and 0.007% respectively. Two of these canonical roots (GDP and CIC) accounted for 99.69% of the variance shared between the variable sets. Hence, the two canonical roots were considered enough to study the variability in the data set. Therefore, canonical roots III and IV were dropped. The reason is that, the one dropped did not make up to 50% of the variation.

Table 1 multivariate Relationship between Economic factors

Root No	Eigen value	% Variance	Cumulative %	Canonical correlation	Square of canonical correlation
1	207.4745	99.0818	99.0818	0.9966	0.9941
2	1.4508	0.6928	99.6923	0.7686	0.5970
3	0.4568	0.2153	99.9923	0.5850	0.3430
4	0.0150	0.0072	100.000	0.1245	0.0147

Table 2 Multivariate test of the significance of the canonical correlation coefficients of the canonical root

Test	Eigen value	Value	Approximate F	Hypothesis DF	Error DF	p-value
Pillais	1.97291	98.9964	6.08298	16.00	100.00	0.00
Hotellings	210.7003	0.7360	269.9597	16.00	82.00	0.00
Wilks	0.0012	0.2600	34.1960	16.00	82.00	0.00
Roys	0.9952	0.0076				

Table 2 presents multivariate test assessing the significant of the four canonical roots. The Wilks statistics was used. The Wilks showed that collectively, the full model across all the four functions was statistically significance, Wilks $\lambda = 0.2600$, F approximation = 34.196, $p = 0.000 (p<0.05)$. the Wilk's λ represents the variance unexplained by the canonical model. Hence, 1-Wilks λ represents the 1- λ is (1-0.2600) = 0.74 = 74%. This indicates that the full model explained 74% of the variance shared between the variable sets. Therefore, the model accounted for substantial portion of the shared variance between the data set.

Table 3 Dimensionality reduction analysis testing the significance of each canonical correlations coefficient of the each canonical root

Root no.	Wilk L.	F	Hypothesis DF	Error DF	Sig. of F	Remarks
1 to 4	0.0019	34.1960	16.00	67.85	0.00	Significant
2 to 4	0.2493	4.7999	9.00	56.13	0.00	Significant
3 to 4	0.6359	3.0489	4.00	48.00	0.026	Significant
4 to 4	0.9842	0.4006	1.0	25.00	0.533	Not significant

In Table 3, result of the dimensionality reduction is represented. Although, the four canonical roots were found to be statistically significant, it was also needful to test the significance of each of the canonical root. Results revealed that the function 1 to 4 were significant (F=34.1960, p=0.00 p=<0.01). Function 2 to 4 were also significant (F=4.7999, p=0.00 p<0.01). It was observed that

function 3 to 4 is also statistically significant (F=3.0489, p=0.026 p<0.05). The only function that was found not to be significant was function 4 (F = 0.401, p = 0.533, p> 0.05).

Table 4 Canonical solution for economic variables in function 1

Variables	Coefficient	ρ_s	ρ_s^2(%)	% Variance
GDP	0.93009	0.9999	99.98	
Inflation	0.00799	-0.2863	8.20	**76.61**
Foreign Trade	0.1199	0.9948	98.96	
Currency in circulation	0.06053	0.9965	99.30	

Table 4 presents the standardize canonical function coefficients and its corresponding structure coefficients for function 1. From the result it can be deduced that the most relevant predictor variable (economic variable) were Gross Domestic Product (ρ = 0.9948) closely followed by currency in circulation (ρ_s = 0.9948) and then foreignρ trade (ρ = 0.9948). Therefore, GDP, currency in circulation and Foreign trade are the major criterion variable.

Table 5 Canonical solution for economic variables for function 2

Variables	Coefficient	ρ_s	ρ_s^2(%)	% Variance
GDP	11.9211	0.0083	0.01	
Inflation	-0.5740	-0.6252	39.09	
Foreign Trade	-6.9296	-0.0519	0.27	
Currency in circulation	-5.2096	-0.0350	0.12	**9.87**

ρ_s = structure coefficient, ρ_s^2 = square structure coefficient

Table 5 presents the result of the standardized coefficient for function 2. Function 2 only explained 9.87% of the variation in the data set. Based on this function, it was observed that, inflation is the major predictor. But because the second function explained less than 10% of the shared variance between the variables, the identification of the most important economic (predictor) variables were based on the result obtained for function 1. In summary, GDP, amount of currency in circulation and amount of foreign trade were the main criterions variables.

Discussion

The study has sought to model some of the major economic factors (variables) (Gross Domestic Product, Currency in Circulation, inflation, foreign Trade) in Nigeria for the period of 1985-2014 using canonical analysis under Multivariate analysis technique. The result shows that gross domestics product (GDP) was significantly related to all the variables at (p< 0.01) exception of inflation which shows a negative and no significant relationship at 5% level. Although the canonical root were extracted and two of the variables accounted for 99.73% of the variance

shared between the data set, which are considered to be best for the study of the variability. Wilks statistics for the four functions were statistically significant and the dimensionality analysis for the four canonical roots were also significant as well. Although the standardized canonical co efficient and it corresponding structure showed that Gross Domestic Product (GDP), Currency in Circulation and Foreign Trade were the major reference point for evaluation. Communality shows that Gross Domestics Product is the most relevant economic variable. Inflation has a significant contribution to foreign trade, likewise currency in circulation.

Conclusion

The micro-economic factors were tested which shows significant influence in the Nigerian economy. It has been revealed that the relationship between microeconomic variables and Nigerian economy are significant. However each factor may significantly affect different sector in different manner. That is microeconomic factors may significantly affect one sector of economy positively, but may significantly affect the other sector of economy negatively. Hence, the monetary policy which affected some of the key variables should be redirected and decision makers should critically look to streamline the investment patterns of the economy with respect to the variables.

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