PRINCIPAL COMPONENT ANALYSIS OF NIGERIAN ECONOMY FROM 2006 – 2017

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ABSTRACT:

The economy of a developing country like Nigeria depends mainly on crude oil exploration, currently other economic factors such as Agriculture, other available mineral resources, industrialization e.t.c. are not properly harnessed to improve the country's GDP. A detailed study of the effect of ten economic factors on Nigeria's economy was investigated and Principal Component Analysis was employed to explain the relationship, distribution and effect of the factors among the various sectors of Nigeria. It was discovered that a strong positive significant association existed between building and manufacturing, construction, wholesale and retail, transportation, communication, utilities, real estate and community social services, while a negative relationship existed between cruel oil and Agriculture. The component with the highest effect on the Nigerian economy was Agriculture, followed by crude oil and manufacturing/industrialization. The PCA has suggested retaining two components i.e. Agriculture and cruel oil. It was recommended that Nigeria Government should consider Agriculture first as the major economic factor before cruel oil and natural Gas.

Keywords: Agriculture, Crude-oil and Natural gas, Eigenvalues, Eigenvectors, Gross Domestic Product and Principal Component Analysis.

1.0 Introduction

The best means of measuring a country's economy is through Gross Domestic Product (GDP), it is a macroeconomic aggregate that is globally accepted as an economic indicator used in measuring the performance and strength of an economy. Movement of economic aggregates such as the GDP and their associated Price and Volume measures are used to evaluate the overall performance of the economy and hence judge the relative success or failure of economic policies pursued by governments. Nigeria is a middle income mixed economy and emerging market with expanding manufacturing, financing service, communications and technology entertainment sectors. It is ranked as the 21st –largest economy in the world in terms of nominal GDP and the

20th largest in terms of purchasing power panty. It is the largest economy in Africa, its re-emergent manufacturing sector became the largest on the continent in 2013, and it produces large proportion of goods & services for the West African sub-continent. Oil is a major source of energy in Nigeria and the world in general. Oil being the mainstay of the Nigerian economy plays a vital role in shaping the economic and political destiny of the country. Although Nigeria's oil industry was founded at the beginning of the century, it was not until the end of the Nigeria civil war (1967 – 1970) that the oil industry began to play a prominent role in the economic life of the country. Nigeria can be categorized as a country that is primarily rural, which depends on primary product exports (especially oil products). Since the attainment of independence in 1960 it has experienced ethnic, regional and religious tensions, magnified by the significant disparities in economic, educational and environmental development in the south and the north. These could be partly attributed to the major discovery of oil in the country which affects and is affected by economic and social components. Crude oil discovery has had certain impacts on the Nigeria economy both positively and adversely. On the negative side, this can be considered with respect to the surrounding communities within which the oil wells are exploited. Some of these communities still suffer environmental degradation, which leads to deprivation of means of livelihood and other economic and social factors. Although large proceeds are obtained from the domestic sales and export of petroleum products, its effect on the growth of the Nigerian economy as regards returns and productivity is still questionable [1].

Agricultural sector is seen as an engine that contributes to the growth of the overall economy of Nigeria, despite these efforts the sector is still characterized with low yields, low level of inputs and limited areas under cultivation due to government dependence on mono-cultural economy based on oil. Agriculture has been the backbone of the economy in Nigeria providing employment

And source of livelihood for the increasing population it accounts for over half of the GDP of the Nigerian economy as at independence in 1960. However, the role it plays in the regional and economic development of the country has diminished over the years due to the dominant role of the crude oil sector in the economy. With the increasing food demand in Nigeria, the country has Available natural resources and potential for increasing the volume of crop production towards meeting the food and nutritional requirement of the rapidly increasing population and guarantee

food security in the country. Therefore, the source of national wealth is essentially agriculture [2].

In 2014, Nigeria changed its economic analysis to account for rapidly growing contributors to its GDP such as telecoms, banking and its film industry. There are so many factors that affect Nigeria's GDP, they include; agriculture, crude petrol, natural gas, manufacturing, building and construction, wholesale and retail, transportation, communication, utilities, real estate, community social services, interest rate, foreign private investment, foreign exchange rate, inflation rate, Oil revenue, Federal government expenditure, Leisure preference, non-marketed activities, environmental quality and resource depletion, underground economy; quality of life etc. This study tends

The main objective of this paper is to employ the Principal Component Analysis (PCA) to investigate the relationship between the ten (10) Nigeria economic factors, to extract the important information regarding the factors that affect Nigeria GDP and to reduce the ten major Nigeria economy indicators in to a two Principal components with the highest effect on the economy over the period of eleven (11) years (i.e. 2006 – 2017). The review of related Literatures are discussed in section 2. Section 3 presents the material and methods of the study. Section 4 presents the Analysis and results generated via Principal Component Analysis, and finally, the conclusion and recommendations are presented in section 5.

2.0 Literature Review

There are vast Literatures on Principal Component Analysis of different country's economies, they include; [3] examines the relationship between financial sector development and economic growth of Pakistan for a period from 1981 to 2015, an econometric model is developed on the basis of theoretical frame work in line with previous research to capture various dimensions of financial development an index is constructed by PCA technique through utilizing relevant proxies of financial sector development. Findings of the econometric estimation reveal that a significant long run association exists among the variables while financial depth and rate of investment have positive significant effect on economic performance of the country. [4] Examines the relationship among Financial Development, Export and Economic growth in Nigeria. The ADF and PP test are used in checking the order of integration of the variables and Johasen co-integration methodology is employed to investigate the long run relationship among

the variables. Time series data were collected between 1994 and 2013. Evidence from the study found that exports and transportation development has a positive significant effect and influence in economic growth. While financial development, international trade structure and energy sector has a negative effect on economic growth. [5] Investigate whether energy use in buildings from simulation could be correlated with a new composite climatic index, which would account for the influences of major climatic variables such as temperature, humidity and solar radiation. Principal component analysis of prevailing weather conditions in sub-tropical Hong Kong was conducted, and a new climatic index Z determined. Multi-year (1979–2007) building energy simulations were carried out for a generic office building. It was found that Z exhibited daily and seasonal variations similar to the simulated cooling load and building energy use [6] measured the financial development of India, the study proposes an Index for Financial development (IFD)-a multidimensional measure developed in line with well-known development indexes such as HDI, GDI, IFI, HPI and GEM, using two separate indexes for financial depth in case of India during 1980 to 2011 and through Principal Components Analysis method it was discovered that financial development is the sole cause for economic development in India [7] assessed growth determinants in Brazil, Russia, India, China, South Africa, Mexico, Indonesia, Nigeria and Turkey fast-developing nations for the period 2001-2011. Particular emphasis is laid on the bundling and unbundling of ten governance dynamics, using PCA method, and findings indicated that Governance is more positively significant in non-contemporary specifications as opposed to contemporary regressions, there is some interesting evidence on the heterogeneity of political governance as a driver. Political governance and its constituents (political stability and voice & accountability) are significantly positive in GDP growth but insignificant in real GDP output regressions.

[8] Examined the long run and casual relationship between financial development and economic growth for ten countries in sub-Saharan Africa (Central African Republic, Chad, Congo Republic, Gabon, Kenya, Nigeria, Sierra Leone, South Africa, Swaziland and Zambia) for the period 1980-2005. The result shows that there is a long run relationship between financial development and economic growth in the selected ten countries in sub-Saharan Africa. Again it shows that financial development Granger causes economic growth in Central African Republic, Congo Republic, Gabon and Nigeria while economic growth Granger causes financial development in Zambia. [9] examined how financial development impacted growth in the

MENA (Egypt, Jordan, Morocco, Tunisia and Turkey) region during 1981 to 2008. The study analyzed the relationship between economic and financial developments in presence of the threshold effect. This study concerns six MENA countries over the period 1981-2008. It was observed that the relationship between financial development and economic growth is clearer when threshold effect is introduced, financial indicators are insignificant in the absence of the threshold effect. However they are positive and significant when introduced to the threshold effect.

3.0 Material and Methods

3.1 Source of Data

The yearly economic indicators of the Nigeria GDP (2006 – 2017) data used in this study and was collected from the National Bureau of Statistics (2017).

3.2 Principal Component Analysis

Principal component analysis (PCA) is a statistical procedure that uses an orthogonal transformation to convert a set of observations of possibly correlated variables into a set of values of linearly uncorrelated variables called principal components. The number of principal components is less than or equal to the number of original variables. This transformation is defined in such a way that the first principal component has the largest possible variance (that is, accounts for as much of the variability in the data as possible), and each succeeding component in turn has the highest variance possible under the constraint that it is orthogonal to (i.e., uncorrelated with) the preceding components. Principal components are guaranteed to be independent if the data set is jointly normally distributed. PCA is sensitive to the relative scaling of the original variables. (Wikipedia). Since there is no single aggregate index, this paper constructs an index of financial development which measures the overall development in the financial sector.

Principal component analysis (PCA) is one of the most frequently used multivariate data analysis and it can be consider as a projection method which project observations from a p-dimensional space with p-variable to a k-dimensional space (where K<P) so as to conserve the maximum amount of information (information is measured here through the total variance of the scatter plots) from the initial dimensions. This method transforms a set of highly correlated variable into the new sets which are uncorrelated but contain almost all information in the original data. The

new set of variables are often fewer in number than original variables. The features of PCA are; it incorporate no error terms in its structure and hence it is a mathematical procedure. It transforms a set of variable into a new set of uncorrelated variables, It is appropriate when variables are on equal footing.

3.3 Derivation of PCA

Given a P dimensional random vector $X_i = (X_1, X_2, ..., X_p)$ with mean vector $\mu_i = (\mu_1, \mu_2, ..., \mu_p)$ and dispersion matrix $\sum$, PCA seeks a new set variable $Z_1, Z_2, ..., Z_p$ (P' often fewer than P) so that:

$$Z_j = a_{1j}X_1 + a_{2j}X_2 + ... + a_{pj}X_p = a_{ij}X$$

(3.1)

Where; $j = 1, 2, ..., p$ and $a_{ij} = (a_{1j}, a_{2j}, ..., a_{pj})$ are coefficients; Thus; Z_j's are linear combination with coefficient $a_{1j}, a_{2j}, ..., a_{pj}$ and

$$Z_{ij} = (a_{1j}, a_{2j}, ..., a_{pj}) \begin{bmatrix} X_1 \\ X_2 \\ . \\ . \\ X_p \end{bmatrix}$$

(3.2)

And $Z_1 = a_{i1}X$, $Z_2 = a_{i2}X$, ..., $Z_p = a_{ip}X$

(3.3)

The procedures try to obtain a_{ij} so that Z_j, the jth PC of X will have the following properties
(i)The Z's are orthogonal
(ii)Each Z capture the maximum variable remaining in X, hence we maximize the variation in Z subject to the constraint $a_i a = 1$
For instance if Z, is the first PC we seek for a', such that

$$(i) Var(Z_i) = Var(Z_i X) = a_i Var(X)a_1 = a_{i1}, \sum a_1 \text{ is a maximum}$$

$$(ii) a_{1i1} a_i = \sum a^2_1 = 1$$

If Z_2 is the second PC after determining Z_1, and it's uncorrelated with Z_1, we seek for a_2 such that;

$$(i) Var(Z_2) = a_{i2} Var(X)a_2 = a_{i2} \sum a_2 \text{ is a maximum}$$

$(ii) a_{i1} a_2 = \sum a^2 2 = 1$

$(iii) a_{i1} a_2 = 0$, that is, Z_1 and Z_2 are orthogonal

The procedure continue in this way to select the jth PC such that;

$(i) Var\ (Z_j) = Var\ (a^1{}_j X) = a_{ij} \sum a_j$ is a maximum

$(ii) a_{ij} a_j = \sum a^2{}_j = 1$

$(iii) a_{ij} a_m = 0,\ j \neq m$ i.e., Z_j's are orthogonal

3.4 The procedure of finding the first pc

To find the first PC, we seek for a_1, such that

$Z_i = a_{11} X_1 + a_{21} X_2 + ... + a_{p1} X_p = a_{i1} X$

(3.4)

is the PC of X subjected to the constant.

$(i) Var\ (Z_i) = Var\ (a^1{}_1 X) = a_1{}^1 \sum a, is\ a\ \max\ imum$

$(ii) a^1{}_1 a = 1$

To maximize var (Z_1) subject to $a^1{}_1 a_1$, we define the langrangian function.

$L(a_1) = a^1{}_1 \sum a_1 - \lambda (a_{i1} a_1 - 1)$

(3.5)

λ is the Langrangian multiplier.

To maximize $L(a_1)$ we differentiate $L(a_1)$ partially with respect to a_1 and equate the result to zero

Thus,

$\dfrac{\partial L(a_1)}{\partial a_1} = 2 a_1 \sum - 2 \lambda a_1 = 0$

(3.6)

And $(\sum - \lambda I) a_1 = 0$

(3.7)

Where: λ = Eigen vector of $\sum a_1$ is the corresponding Eigen vector of λ

The solution $a_1 = 0$ is a trivial solution and since a_1 cannot be zero (i.e. $a_1 \neq 0$) to have non-trivial

solution then $(\sum - \lambda I) = 0$

(3.8)

and implies that $\sum = \lambda I$

(3.9)

If (3.7) have non-trivial solution, then because of (3.8), λ must be the characteristics root of $\sum$.

Hence we will have P characteristic root and P a_i's which are vector since $\sum$ is a P x P dimensional matrix lets $\lambda_1, \lambda_2 \ldots, \lambda_p$ be the characteristic roots of $\sum$, then var$(Z_1) = a'_1 \lambda a_1 = \lambda$ hencemax var (Z_1), is equivalent to max (λ). That is, if we have Pλ's we choose the maximum and Var $(Z_1) = \lambda_i$.

3.5 The Procedure for Finding the Second PC

Let Z_2 be the second PC of X, then $Z_2 = a_{2i} X$.

We seek a_2 such that;

$(i) Var\ (Z_2) = a_{2i} \sum a_2\ is\ a\ \max\ imum$

$(ii) a_{2i} a_2 = 1$

$(iii) a_{1i} a_2 = 0$

The langrangian function is

$$L(a_2) = a_{2i} \sum a_2 - \lambda(a_{2i} a_2 - 1) - \theta a_2^{\ 1} a_1 \qquad (3.10)$$

Thus;

$$\frac{\partial L(a_2)}{\partial a_2} = 2 a_2 \sum - 2\lambda a_2 - \theta_{a1} = 0$$

$$= 2\left(\sum - \lambda I\right) a_2 - \theta_{a1} = 0 \qquad (3.11)$$

Multiply by a_i to get;

$$2 a_{1i} \sum a_2 - 2 a_{1i} \lambda a_2 - a_{1i} \theta_{a1} = 0$$

$$2 a_{1i} \sum a_2 - \theta = 0$$

$2a_1'' \lambda a_2 - \Theta = 0$

$$2 a_{1i} \lambda a_2 - \theta = 0$$

$$2(\sum - \lambda I) a_2 = 0$$

$$(\sum - \lambda I) a_2 = 0 \qquad (3.12)$$

$$\sum a_2 = \lambda a_2$$

3.6 Interpretation of the Principal Components

The *loading* or the eigenvector $\alpha_j = \alpha_1, \alpha_2, \ldots, \alpha_p$, is the measure of the importance of a measured variable for a given PC. When all elements are positive, the first component is a weighted average of the variables and is sometimes referred to as measure of *overall crime rate*. Likewise, the positive and negative coefficients in subsequent components may be regarded as factor of the Nigeria economy components. The plot of the first two or three loadings against each other enhances visual interpretation.

The *score* is a measure of the importance of a PC for an observation. The new PC observations Y_{ij} are obtained simply by substituting the original variables X_{ij} into the set of the first PCs. This gives

$$Y_{ij} = \alpha'_{j1} X_{i1} + \alpha'_{j2} X_{i2} + \ldots + \alpha'_{jp} X_{ip} \qquad (3.13)$$

$$i = 1, 2, \ldots, n, \quad j = 1, 2, \ldots, p$$

3.7 The Proportion of Variance

The proportion of variance tells us the PC that best explained the original variables. A measure of how well the first q PCs of Z explain the variation is given by:

$$\psi_p = \frac{\sum_{j=1}^{q} \lambda_j}{P} = \frac{\sum_{j=1}^{q} Var(z_j)}{P}$$

A cumulative proportion of explained variance is a useful criterion for determining the number of components to be retained in the analysis. A Scree plot provides a good graphical representation of the ability of the PCs to explain the variation in the data.

4.0 Analysis and Results

In this section, the results of the analysis on the data of the factor that affects Nigeria economy from 2006 through 2017.

Table 1 summarizes the results of correlation between all the components. Agriculture had the weak positive relationship with all the other economic factors, except with crude oil and Community/Social Service, crude oils had a strong negative relationship with the other economic factors and the other economic factors have strong positive relationships with each other. The correlation are well above 0.3 (a good indication that we will obtain a result), about 62.2% of the correlation coefficients among the variables are over 0.8 while about 33.3% of the correlation coefficient are negative.

Table 1: Correlation Matrix of the ten Nigeria Economic factors

Compone	Agric	Crude	Manu.	Build	Whole	Trans.	Comm.	Utility	Real	SCS
Agric	1									
crude	-0.038	1								
manu	0.149	-0.874	1							
Build	0.167	-0.848	0.991	1						
Wholes	0.271	-0.817	0.95	0.979	1					
Trans	0.285	-0.733	0.898	0.945	0.979	1				
Comm	0.312	-0.723	0.905	0.948	0.986	0.99	1			
Utility	0.256	-0.781	0.963	0.955	0.919	0.867	0.885	1		
Real	0.276	-0.83	0.959	0.982	0.997	0.973	0.983	0.926	1	
scs	-0.003	-0.892	0.975	0.97	0.929	0.861	0.869	0.914	0.928	1

The null hypothesis that the correlation matrix is an identity matrix was rejected at 5% level of significance (Bartlett's test of Sphericity; χ^2 = 204.443, p-value =.000), this implies that the correlation in the dataset are appropriate for factor analysis. Also, "Kaiser-Meyer-Olkin statistic = 0.618" revealed that adequate sampling is being used for this analysis.

Table 2: KMO and Bartlett's Test of the factor affecting Nigeria's GDP

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.618
Bartlett's Test of Sphericity	Approx. Chi-Square	204.443
	d.f.	64
	Sig.	.000

Table 3 summarizes the ten principal components for the PCA. Each eigen-value measures the variance accounted for by the corresponding principal component, and calculation of all possible Eigen-values permits all the variance of the original variables to be quantified. Principal components can be ranked according to their ability to explain variance in the original data set. A common approach is to select only those with Eigen-values equal to or greater than one or with at least 80% cumulative variance. The result shows that the Eigenvalues for Agriculture and Crude/Petrol i.e. 8.377 and 1.086 respectively have cumulative variance 84% and 95% respectively, which implies that; the most effective component of the Nigeria's economy is Agriculture then crude oil exploration.

**Table 3: Extraction method: principal component analysis**

Economic Factors	Eigen values	Proportion (%)	Cumulative (%)
Agriculture	**8.377**	**83.768**	**83.768**
Crude Oil	**1.086**	**10.858**	**94.626**
Manufacture	.314	3.138	97.764
Building	.171	1.708	99.472
Whole/Retail	.028	.284	99.756
Transportation	.016	.158	99.914
Communication	.008	.084	99.997
Utility	.000	.002	99.999
Real Estate	9.663E-5	.001	100.000
Community/Social	-3.912E-17	-3.912E-16	100.000
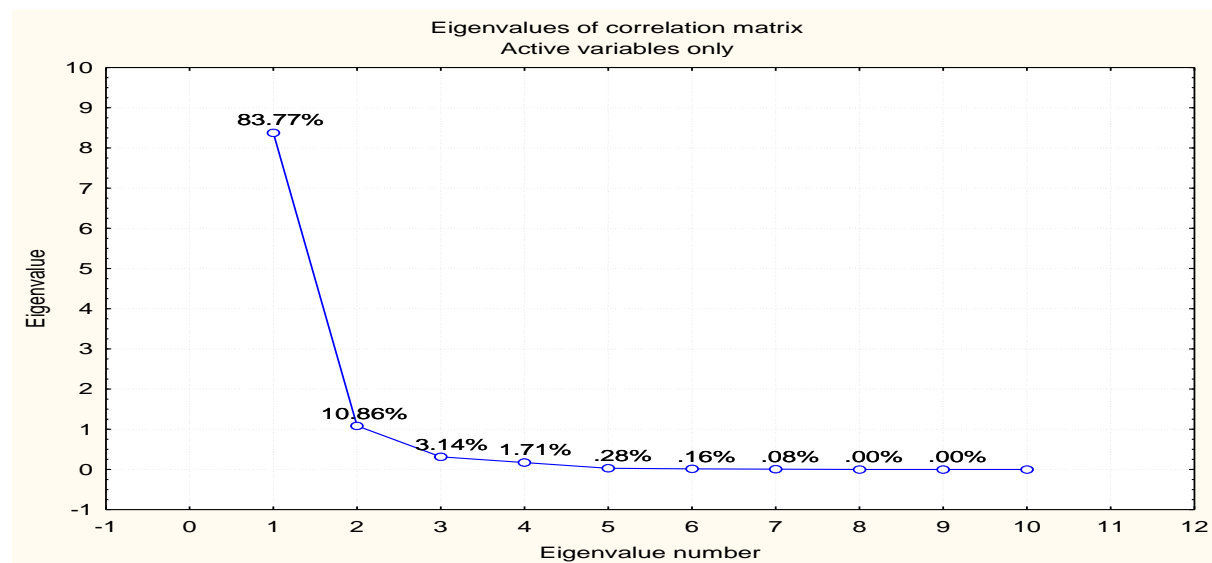
Fig 1: Scree Plot of the economic factors

The scree plot above present the graphical eigenvalue of the Principal components; the first component has the highest eigenvalue of up to 8.37 and a variability of 83.77% is Agriculture followed by the Crude oil exploration with an eigenvalue of 1.09 and a 10.89% variability.

Table 4: Component Matrix of the economic factors

Economic Factors	Component	
	1	2
Agriculture	.231	.954
Crude Oil	.859	.245
Manufacture	.982	-.098
Building	.995	-.062
Whole/Retail	.991	.060
Transportation	.957	.112
Communication	.962	.138
Utility	.951	.028
Real Estate	.994	.061
Community/Social	.957	-.250
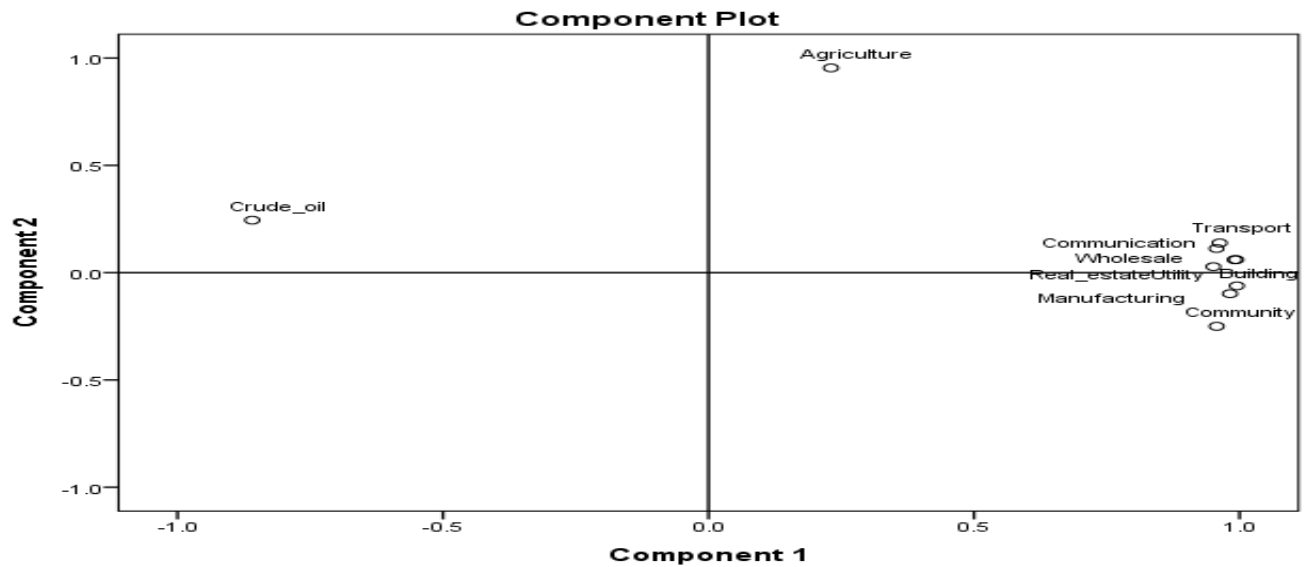
Fig 2: Component Plot of the economic factors

The result and chart above show the expected pattern with high positive and high negative loadings on the first factor. Agriculture and Crude oil have a low and negative loading in the first factor but high and positive in the second factor. This implies the Agriculture and crude oil will both lead to an improvement in the Nigeria's economy (both had positive coefficients in

components 1 and 2), all the other economic factors also had positive coefficients at the both components except manufacturing, social and community that had negative coefficients at the second components.

Table 5: Communalities of the economic factors

Economic Factors	Initial	Extraction
Agriculture	1.000	.963
Crude Oil	1.000	.798
Manufacture	1.000	.974
Building	1.000	.994
Whole/Retail	1.000	.986
Transportation	1.000	.928
Communication	1.000	.945
Utility	1.000	.905
Real Estate	1.000	.991
Community/Social	1.000	.978

The communalities result shows the proportion of each economic factor's variance that can be explained by the principal components, most of the economic factor communalities are closer to one indicating high percentage of variability is attributed to the model.

5.0 Conclusion and recommendations

The study employed the Principal Component Analysis (PCA) to investigate the relationship between the ten (10) Nigeria economic factors, extract the important information regarding the factors that affect Nigeria's economy and to reduce the ten major Nigeria economy indicators in to a two Principal components with the highest effect on the economy over the period of eleven (11) years (i.e. 2006 – 2017). This study has shown that Agriculture had the weak positive relationship with the other economic factors, except with crude oil and community/Social Service, crude oils had a strong negative relationship with the other economic factors and the other economic factors have strong positive relationships with each other. The economic factor correlation matrix result was confirmed to be appropriate and adequate for factor analysis by the (Bartlett's test of Sphericity; χ^2 = 204.443, p-value =.000) and (Kaiser-Meyer-Olkin statistic =

0.618). The study also shows that the Eigenvalues for Agriculture and Crude/Petrol are 8.377 and 1.086 respectively with cumulative variance of 84% and 95% respectively, which implies that; the most effective component of the Nigeria's economy is Agriculture then crude oil exploration, these components form the bulk of the Nigeria GDP and hence are the most influential and effective in the Nigeria GDP. According to the coefficient of each variable in the combination, Agriculture, crude oil, building and construction, wholesale and retails, transportation, communication, utility and real estate would cause Nigeria's economic to improve while increase in manufacturing and community/social life would lead to decline in Nigeria's economy. The finding of this study, therefore shows that the component with the highest effect on the Nigerian economy is Agriculture, followed by crude oil and manufacturing/industrialization. The results is consistent with previous studies in this area of research [2]

It is recommended that Nigeria Government should consider Agriculture as a major source of national revenue and economic growth before cruel oil and manufacturing/industrialization. In-view of this, Government should encourage the use of modern mechanized farm tools, and subsidize the prices of agro-chemical and fertilizer for farmers. Government should also encourage farmer by formulating stable policy guideline to enable the commercial banks disburse loans to farmers at a very lower interest rate, in order to help them expand their production capacity. This study has a positive contribution to the growth and development of Nigeria economy in its quest to diversify Nigeria economy from mono-economy (crude-oil and Natural gas) to a productive developmental sector like Agriculture.

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