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NIGERIAN REAL GROSS DOMESTIC PRODUCT ANALYSIS BY PRINCIPAL COMPONENT METHOD

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ABSTRACT
The real (inflation adjusted) gross domestic product of Nigeria is studied here by Principal Component Method. A realization of the series from the first quarter of 2018 to the third quarter of 2019 is analyzed using minitab 17 software. Both the correlation matrix and the covariance matrix are used. Eigen analysis of both matrices suggest that the first three principal components are enough to explain variation in the data set. The correlation principal components involved all the items. The covariance principal components did not involve all the items which is a deficiency. For example, livestock, forestry, fishing, solid minerals, construction, transport, utilities, accommodation and food services, finance and insurance, professional scientific & technical services, administrative and support services and business services, public administration, human health and social services and arts, entertainment and recreation are not involved. This makes the method inferior.
Keywords: Nigeria, gross domestic product, correlation, covariance

INTRODUCTION
The gross domestic product (GDP) is a measure of national income and output for the given economy of the nation. The Central Bank of Nigeria (CBN) has been publishing real GDP of Nigeria under the following sectors:

Sector	**Sub-Sectors**
Agriculture	Crop production, Livestock, forestry, Fishing
Industry	Crude Petroleum & Natural Gas, Solid Minerals,
Manufacturing	
Construction	
Trade	
Services	transport, Information & Communication, Utilities, Accommodation and food services, Finance & Insurance, Real Estate, Professional Scientific & Technical services, Administrative and Support Services & Business Services, Public Administration, Education, Human Health & Social Services, Arts, Entertainment & Recreation, Other services.

This study is a further analysis of the GDP of Nigeria by the use of Principal Components.

MATERIALS AND METHODS

Data

The data used in this work are quarterly Real Gross Domestic Product values from the first quarter of 2018 to the third quarter of 2019 having 22 variables. They are from the website of the Central Bank of Nigeria cbn.gov.ng and are given in the appendix.

Methods

The Principal Component Analysis (PCA) is a technique whereby the variance of a linear combination of a set of variables is maximized (Rencher, 2002). Let $\mathbf{X} = [X_1\ X_2\ \dots\ X_p]'$ be multivariate normal with mean $\boldsymbol{\mu}_p$ and covariance matrix $\boldsymbol{\Sigma}_p$. Solution of the determinantal equation $|\Sigma-\lambda I| = 0$ is called an eigenvalue of Σ. Let $\lambda_1, \lambda_2, \dots, \lambda_p$ be the eigenvalues of Σ in descending order of magnitude with the respective eigenvectors as $e_1, e_2, \dots, e_p$. Suppose $e_i' = (e_{i1}, e_{i2}, \dots, e_{ip})$ a vector of constants.

Consider the linear combinations

$Y_i = e_{i1}X_1 + e_{i2}X_2 + \dots + e_{ip}X_p,\ i = 1, 2, \dots, p$

Then the first principal component is

$Y_1 = e_{11}X_1 + e_{12}X_2 + \dots + e_{1p}X_p$

chosen such that its variance $V(Y_1) = e_1'\Sigma e_1$ is maximum, $\Sigma e_1'e_1 = 1$, the second principal component is such that

$Y_2 = e_{21}X_1 + e_{22}X_2 + \dots + e_{2p}X_p$

chosen such that its variance is the maximum of the remaining variance of the data and $\Sigma e_2'e_2 = 1$ and Y_2 and Y_1 are uncorrelated. Higher principal components are similarly defined.

The same argument may be applied by replacing Σ with the matrix of correlations.

Computer Software: Minitab 17 was used for all computations.

RESULTS

The two approaches of use of the correlation matrix and the covariance matrix were used. The eigen analysis of the correlation matrix yields Table 1 summary:

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Table 1: Correlation Eigen analysis

Eigen value	Proportion	Cumulative proportion
9.9566	0.453	0.453
5.8425	0.266	0.718
5.0505	0.230	0.948
.8751	0.040	0.987
.2313	0.011	0.998
.0440	0.002	1.000

The principal components are summarized in table 2.

Table 2: Correlation principal components

Activity sector	Principal component 1	Principal component 2	Principal component 3
Crop production	0.273	-0.046	-0.218
Livestock	0.183	-0.266	0.220
Forestry	0.186	0.183	0.288
Fishing	-0.161	-0.317	0.174
Crude petroleum & natural gas	0.020	0.018	-0.420
Solid minerals	0.292	0.128	0.082
Manufacturing	0.160	-0.354	0.039
Construction	-0.115	0.186	0.361
Trade	0.241	-0.228	0.140
Transport	0.002	-0.331	0.099
Information & communication	0.046	0.124	0.363
Utilities	0.256	0.187	0.158
Accommodation and food services	0.000	-0.408	-0.069
Finance & insurance	-0.201	0.033	0.310
Real estate	0.306	0.091	0.032
Professional Scientific & Technical services	0.308	-0.078	-0.049
Administrative and support services Business services	0.278	-0.122	-0.159
Public administration	0.250	0.038	0.181
Education	0.226	-0.288	0.016
Human health & social services	0.275	0.112	0.179

Arts, entertainment & recreation	-0.270	-0.180	0.122
Other services	-0.111	-0.280	0.285

The adoption of the covariance matrix yielded the following eigenvalues as summarized in Table 3.

Table 3: Covariance Eigen analysis

Eigenvalues	Proportion	Cumulative proportion
754235000000	0.887	0.887
60886287740	0.072	0.959
26243864684	0.031	0.990
7888173238	0.009	0.999
568511351	0.001	1.000
155401199	0	1.000

The resultant principal components are summarized in Table 4 below.

Table 4: Covariance principal components

Activity sector	Principal component 1	Principal component 2	Principal component 3
Crop production	0.972	-0.034	0.040
Livestock	0.007	-0.057	-0.077
Forestry	0.001	-0.012	0.010
Fishing	-0.010	-0.007	-0.075
Crude petroleum & natural gas	0.097	0.485	0.234
Solid minerals	0.006	-0.019	0.013
Manufacturing	0.029	-0.067	-0.234
Construction	-0.072	-0.175	0.181
Trade	0.093	-0.380	-0.489
Transport	0.001	-0.032	-0.084
Information & communication	-0.065	-0.664	0.510
Utilities	0.014	-0.073	0.065
Accommodation and food services	0.007	0.017	-0.180
Finance & Insurance	-0.046	-0.042	-0.028
Real estate	0.116	-0.281	0.165
Professional Scientific & Technical Services	0.058	-0.086	-0.046

Administrative and support services Business services	0.000	-0.000	-0.000
Public administration	0.018	-0.095	-0.010
Education	0.048	-0.095	-0.239
Human health & Social services	0.002	-0.013	0.007
Arts, entertainment & recreation	-0.006	0.004	-0.016
Other services	-0.067	-0.163	-0.461

DISCUSSION

Eigen analysis of the correlation matrix in Table 1 reveals that the first three eigenvalues account for more than 94% of the total variation in the data. On this basis, it is enough to consider the first three principal components. In table 2, with a benchmark of 0.23, the first principal component is a function of crop production, solid minerals, trade, utilities, real estate, professional scientific and technical services, administrative and support services and business services, public administration, human health and social services and negatively arts, entertainment and recreation. The second principal component is a negative function of livestock, fishing, manufacturing, transport, accommodation and food services, education and other services. The third principal component involves forestry, construction, information and communication, finance & insurance and other services, and negatively, crude petroleum and natural gas. Some corroborative publications include Aderemi Ojekunle (2019), Oluwadamilare (2010), Vanguard (2020), Nigerian Bureau of Statistics (2019) and Njekwe Henry (2019).

The covariance eigen analysis of table 3 shows that the first three eigenvalue account for 99% of the total variation in the data. That means that the first three principal components are enough to explain the data. According to table 4, the first principal component has just crop production as the component. The second has just crude petroleum & natural gas as the positive component. The negative ones are trade, information and communication and real estate. The third has as the only positive component crude petroleum and natural gas and information and communication. The negatives are manufacturing, trade, education and other services.

CONCLUSION

A summary of the results is as follows: The correlation analysis results in the involvement of crop production, solid minerals, trade, utilities, real estate, professional scientific & technical services, administrative and support services and business services, public administration, human health services and arts, entertainment and recreation; livestock, fishing, manufacturing, transportation, accommodation and food services, education and other services; forestry, crude production, construction, information and communication, finance and other services. The covariance analysis involves crop production, crude petroleum, trade, information and communication, real estate, manufacturing, trade, information and communication, education and other services. The correlation method is the more inclusive and therefore the better.

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APPENDIX
DATA: NIGERIA'S REAL GDP

Activity Sector	Quarter 1 2018	Quarter 2 2018	Quarter 3 2018	Quarter 4 2018	Quarter 1 2019	Quarter 2 2019	Quarter 3 2019
Crop production	3045163.11	3378030.03	4877078.38	4486166.16	3144587.69	3443607.45	4994729.88
Livestock	292386.84	283577.69	291160.54	341002.97	294971.65	283559.35	291218.38
Forestry	41360.26	48008.51	43341.10	50038.06	42265.37	499559.78	44980.39
Fishing	108402.70	80103.89	76759.20	101568.29	116091.37	80979.01	78050.27
Crude petroleum & natural gas	1537038.44	1418073.13	1696606.69	1344156.80	1514641.29	1519802.94	1806746.96
Solid minerals	11186.87	25620.64	27270.56	32523.95	12421.19	24969.86	23764.98
Manufacturing	1595563.65	1539566.75	1599043.51	1686416.37	1608461.83	1537522.17	1616584.64
construction	650767.19	747860.30	544228.74	662431.53	671448.37	752833.66	557147.53
Trade	2747170.57	2728125.96	2857370.77	3141123.70	2770454.69	2721316.70	2815887.74
transport	241534.71	216351.50	221416.44	277338.67	288637.00	233705.81	261809.92
Information & Communication	1999209.11	2259564.73	1907885.53	2360999.95	2188810.43	2463113.02	2096318.89
utilities	61027.25	111806.01	104510.68	127728.46	64825.41	117091.44	94995.15
Accommodation and food services	176498.55	105401.85	157259.25	181031.20	183831.29	108482.91	160848.58
Finance & insurance	571134.17	549432.14	456182.57	517927.07	527749.58	537150.37	461049.43
Real estate	907593.68	1131763.57	1175656.69	1256847.82	916064.55	1088267.52	1148470.43
Professional Scientific & Technical Services	564694.65	594967.30	677860.50	706613.23	574481.80	602156.45	660127.24
Administrative and Support Services Business Services	3307.92	3324.81	3870.51	3937.63	3355.32	3392.34	3988.47
Public administration	358496.20	380006.76	365540.65	427,538.21	307550.32	367112.43	367755.38
Education	345537.77	297293.69	386568.22	478161.40	346165.27	300161.48	391169.57
Human health & Social services	112685.85	118790.00	117455.89	123769.86	112506.18	120126.87	118468.79
Arts, entertainment & Recreation	47132.89	38366.32	33646.20	37338.61	50489.39	38677.98	34619.58
Other services	678761.98	524471.99	460629.46	696777.64	694742.66	537845.35	465381.99