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Cointegration and Error Correction Model of Sectoral Contributions To Nigerian Gross Domestic Product

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Abstract

The value of Nigerian Gross Domestic Product (GDP) has been on a steady increase. It becomes pertinent to study how Agriculture, Industry and services sectors of the economy contribute to GDP based on their huge budgetary allocation by the government. The normalized cointegrating result showed that sectoral contribution to GDP by Agriculture is negatively related to GDP, while the sign of sectoral contribution to GDP by industry and services sectors indicated a positive relationship with GDP. This lead to the estimation of the parameters of the vector error correction model. In conclusion, the Nigerian government should declare a state of emergence in the Agricultural sector considering its negative relationship with GDP. Also, the service sector of the economy has a potential of becoming the driving force of the economy if proper reforms are made in sector.

Keywords: Unit root, Cointegration, Vector Error Correction Model and sectoral contribution

1.0 Introduction

Information on the current state of economic activity is a crucial ingredient for policy making, as choice of the appropriate policy stance relies on the updated knowledge of the macroeconomic framework [1]. The development of the Nigerian economy is one that emanated from a monoculture economy being based purely on the agricultural sector of the economy, therefore making the sector the main stay of the economy. The discovery, in Nigeria of the crude oil in commercial quantity has however nullified this assertion, since it has relegated the hitherto main stay of the economy to the background. It is however important to note that the various sectors of any economy has a contribution to the development of that economy, this is to say that no matter how small the contribution of any sector, to the national income of that economy is, it adds up to the aggregate income of the economy and thus contributing directly or indirectly to the gross domestic earnings of such economy [2]. The contribution of the various activity sectors to GDP can never be over emphasized. The value of Nigerian GDP has been on a steady increase, it becomes pertinent to study how Agriculture, Industry and Services sectors contribute to GDP based on the huge amount of budgetary allocation by the government to these key sectors of the economy in line with the transformation agenda of the present Federal government. Also, the vision of making Nigeria one of the top twenty economies of the world by the year 2020 can only be possible if the Nigerian economy is diversified. This work therefore seeks to determine how diversified the Nigerian economy is at present using VAR approach to model sectoral contributions to GDP and the growth process of the economy.

2.0 Literature Review

Vijay and Michael [3] estimated an econometric model that incorporates the linkages among agriculture, manufacturing, service and trade sectors using a vector error correction model for Poland and Romania. They found three cointegrating vectors for Poland and one for Romania to confirm that the different sectors in the Poland and Romania moved together over the sample period, and for this reason their growth rates are interdependent.

Haroon and Anastasios [4] studied an econometric model that incorporates the linkages among Agriculture, Manufacturing and non- manufacturing, transport storage and telecommunication, and service sectors using a Vector Error Correction model for Palestine. One cointegrating vector confirmed that the different sectors in the Palestine economy moved together over the sample period, and for this reason their growth rates are inter-dependent. But in the short-run, Agriculture in Palestine seems to have a partial role as a driving force in the growth of other non-agricultural sectors.

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Ragoobur [5] examined the long run and short run impact of service sector on economic growth of Mauritius. The result showed that the services sector contributes positively to economic growth of Mauritius with a larger growth impact from wholesale and retail trade, followed by transport, communication and financial sector. Her findings further confirm the stability of the relationship between the services sector and economic growth for a small Island like Mauritius.

Norbert and Dorte [6] analyses sectoral growth in Ecuador using multivariate cointegration analysis. They found significant relationships between the agricultural, industrial and services sectors. The linkage between the sectors suggests that attention should be directed towards the interdependencies in sectoral growth, since an improved understanding of sectoral growth dynamics may facilitate policy implementation aimed at increasing economic growth in Ecuador.

3.0 Methodology

The data for the study work was collected from Central Bank of Nigeria [7]. The data was arranged on quarterly basis and was collected for a period of thirty years (1981-2010). The data showed Nigerian GDP, contributions to GDP from Agriculture, Industry, and Services all expressed in millions of naira. The Vector Autoregressive (VAR) model was used in this study, according to Gujarati and Porter [8] for us to model a set of variable using the VAR model; we must first find out if the economic variables are stationary individually

Test of Stationarity

A unit root is a feature of process that evolves through time that can cause problem in statistical inference. A linear stochastic process has a unit root if one is a root of the process characteristic equation. Such process is non stationary and if the other roots of the characteristic equation lie inside the unit circle that is have modulus (absolute value) less than one, the first difference will be stationary. Consider eqn. (1)

$Y_t = \Phi Y_{t-1} + u_t$ $\quad -1 \leq \Phi \leq 1$ (1)

If $\Phi = 1$ we have unit root which means that the series is non stationary.

The Unit Root Test

A test of stationarity or non stationarity that has become popular over the past several years is the unit root test [8]. This is estimated using the Augmented Dickey Fuller (ADF) test

$\Delta Y_t = m + dt + gY_t + \sum_{i=1}^{n} \alpha_i \Delta Y_{t-i} + u_t$ (2)

Cointegration

A time series Y_t is called integrated of order 1 denoted by $Y_t \sim$I(1) if the stochastic trend can be removed by differencing the variable once and a stochastic trend still remains after no differencing. A vector of I(1) variable Y_t is said to be cointegrated if there exist a vector β_i such that $\beta^I Y_t$ is trend stationary. If there exist r such linearly independent vectors β_i, i = 1,- - -, r then Y_t is said to be cointegrated with cointegrating rank r. The matrix $\beta = (\beta_1, \beta_2, - - -, \beta_r)$ is called the cointegrating matrix. β_i vectors are individually identified only up to scale since $\beta^I Y_t$ stationary implies that $C\beta_i Y_t$ is stationary. This of course implies that one can normalize one of the coefficients to one, but only in the case where one is willing to impose the a priori restriction that the coefficient is not zero. As far as the identification of the matrix β is concerned it is also clear that if β is a cointegrating matrix then βF^I is also a cointegrating matrix for any non- singular matrix F. Test of cointegration is done with Johansen system of maximum likelihood using trace statistic and maximum eigenvalue statistic.

The trace statistic is $\lambda_{trace} = -T \sum_{i=r+1}^{p} ln\,(1 - \hat{\lambda}_i)$ (3)

Where $\hat{\lambda}_{r+1}, \ldots, \hat{\lambda}_n$ are the smallest characteristic roots. If the statistic is bigger than the critical value, the null hypothesis of at most r cointegrating vector is rejected.

The Maximum Eigenvalue statistic $\lambda_{max} = -Tln(1 - \hat{\lambda}_{r+1})$ (4)

The Vector Error Correction Model (VECM) representation

If $Y_t \sim$ I(1) and the variables are potentially cointegrated, we obtain

$\Delta X_t = \Pi X_{t-1} + \Gamma_j \Delta X_{t-1} + - - - + \Gamma_{p-1} \Delta X_{t-p+1} + u_t$ (5)

Here $\Pi = -(I_k - A_1 - \ldots - A_p)$ and $\Gamma_j = (A_{j+1} + - - - + A_p)$ for j = 1, - - -, p-1

This representation is known as VECM form. Notice that ΔX_t does not contain stochastic trend because $X_t \sim$ I(1) by assumption. Thus the term ΠX_{t-1} is the only one which includes I(1) variable and consequently ΠX_{t-1} must also be I(0). Here it must contain the cointegrating relations. The term ΠX_{t-1} is often referred to as the long run part or error correction term of the model. On the other hand, the short-run movements of the variables are determined by the Γ_j's (j = 1, - - -, p-1) which are sometimes called short-term parameters.

4.0 Results and Discussion

Table 1: ADF Test – Levels

Null hypothesis: Variable has unit root

Variable:	LGDP	LAGRICULURE	LINDUSTRY	LSERVICES
ADF test statistic	1.220624	0.357791	-0.731498	1.977873
Test critical value:1% level	-3.488063	-3.488063	-3.488063	-3.488063
5% level	-2886732	-2.886732	-2.886732	-2.886732
10% level	-2.580281	-2.580281	-2.580281	-2.580281
MacKinnon prob-value	0.9982	0.9803	0.8337	0.9999

From Table 1 the tests on the levels of the variables show that the null hypothesis of a unit root cannot be rejected for LGDP, LAGRICULTURE, LINDUSTRY, and LSERVICES at either the 1%, 5% or 10% levels; From the unit root test, we conclude that the four series are non stationary, so we make these four non stationary series, stationary by taking first difference as D(LGDP), D(LAGRICULTURE), D(LINDUSTRY) and D(LSERVICES).

Table 2: ADF Test – First Difference

Variable:	D(LGDP)	D(LAGRICULURE)	D(LINDUSTRY)	D(LSERVICES)
ADF test statistic	-3.963922	-4.386384	-5.116884	-5.633371
Test critical value:1% level	-3.488063	-3.488063	-3.488063	-3.488063
5% level	-2.886732	-2.886732	-2.886732	-2.886732
10% level	-2.580281	-2.580281	-2.580281	-2.580281
MacKinnon prob-value	0.0023	0.0005	0.0000	0.000

As shown in Table 2, taking first differences renders each series stationary, with the absolute value of ADF statistics exceeding the critical values at the 1%, 5% or 10% levels. This confirms that the series are I(1). The asymptotic critical values are provided by the econometric software, Eviews Version 7 [9]. Having confirmed that all the variables are I(1) then check whether there exist any long-run relationship between the variables under consideration estimating equation (3) and equation (4).

The results of Johansen system of maximum likelihood approach to cointegration analysis are presented below. The Johansen's trace test aimed at determining whether a long-term relation exist between the four series starts with the null hypothesis that there is no cointegrating relation, and if the hypothesis cannot be accepted, we test the hypothesis that there is at most one cointegrating equation. Since there only four variables in the model, we test whether the number of cointegrating equations is zero, one, two, three or four.

Series: LGDP LAGRICULTURE LINDUSTRY LSERVICES

Lags interval (in first differences): 1 to 4

Table 3 : COINTEGRATION RANK TEST(TRACE)

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.235260	55.52480	47.85613	0.0081
At most 1	0.129930	24.67958	29.79707	0.1732
At most 2	0.071103	8.673629	15.49471	0.3964
At most 3	0.001664	0.191543	3.841466	0.6616

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level

TABLE 4 : COINTEGRATION RANK TEST(MAXIMUM EIGENVALUE)
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.235260	30.84522	27.58434	0.0184
At most 1	0.129930	16.00595	21.13162	0.2245
At most 2	0.071103	8.482086	14.26460	0.3318
At most 3	0.001664	0.191543	3.841466	0.6616

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level

From Table 3, considering the first row, the null hypothesis of no cointegration (None) is rejected since the calculate trace statistic (55.52480) is greater than the tabulated trace statistic (47.85613) at 5 percent significance level with a probability (Prob.**) of 0.0081 which is significant. In the second, third and fourth rows respectively the null hypothesis of (Atmost 1, Atmost 2 and Atmost 3 respectively) were not rejected since their computed trace statistic (24.67958, 8.673629 and 0.191543) were respectively less than the tabulated trace statistic (29.79707, 15.49471 and 3.841466) at 5 percent significance level with Prob.** of 0.1732, 0.3964 and 0.6616 that were all insignificant. The trace statistic indicates one cointegrating equation at 5 percent significance level for the sample period.

From Table 4, considering the first row, the null hypothesis of no cointegration (None) is rejected since the calculate Max-Eigen statistic (30.84522) is greater than the tabulated trace statistic (27.58434) at 5 percent significance level with a probability (Prob.**) of 0.0084 which is significant. In the second, third and fourth rows respectively the null hypothesis of (Atmost 1, Atmost 2 and Atmost 3 respectively) were not rejected since their computed Max-Eigen statistic (16.00595, 8.482086 and 0.191543) were respectively less than the tabulated trace statistic (21.13162, 14.26460 and 3.841466) at 5 percent significance level with Prob.** of 0.2245, 0.3318 and 0.6616 that are insignificant. The Maximum Eigenvalue statistic indicates one cointegrating equation at 5 percent significance level for the sample period.

Given the evidence of one cointegrating relation among the four variables, we normalize the cointegrating vector on the natural log of GDP. This also means that the hypothesis that r = 0 is rejected against the alternative r = 1, but the hypothesis that r =1 cannot be rejected against r =2 and so on.

Table 5: Normalized cointegrating Coefficients (standard error in parentheses)

LGDP =	LAGRICULTURE	LINDUSTRY	LSERVICES
1.000000	-9.552678	0.232149	6.341312
	(1.84161)	(1.51154)	(1.55522)

Considering the estimate of normalized coefficients shown in Table 5, the cointegrating vector with standard error reported in parenthesis. The normalized cointegrating result showed that Agriculture is negatively related to GDP, while the sign of industry and services sectors indicated a positive relationship. The coefficients are significant at 5 percent level.

This result is in agreement with Usman and Ijaiya [10] and Abdulrasheed [2] that showed a negative effect of Agriculture to the GDP. This result is, however, contradictory to Norbert and Dorte [6] that showed a positive relationship between Agriculture and GDP in Ecuador. The results also differed with Haroon and Anastasios [4] that found that different

sectors of Palestine economy moved together and their growth was interdependent but agreed in the area of Palestine economy having one cointegrating relationship. This is however, not surprising as there have been inconsistencies in government policies toward agriculture and lack of political will to implement government policies in the past in Nigeria.

The positive effect of sectoral contribution of industry correlates the fact that Nigerian economy has been dependent on this sector. Also, the positive effect of the services sector contribution may not be unconnected to the reforms in this sector especially in the telecommunication sector.

Table 6:Vector Error Correction Estimates

Sample (adjusted): 1982Q2 2010Q4

Included observations: 115 after adjustments

Standard errors in round bracket & t-statistics in square bracket.

Cointegrating Eq:	CointEq1
LGDP(-1)	1.000000
LAGRICULTURE(-1)	-9.552678
	(1.84161)
	[-5.18715]
LINDUSTRY(-1)	0.232149
	(1.51154)
	[0.15358]
LSERVICES(-1)	6.341312
	(1.55522)
	[4.07745]
C	26.19081

Error Correction:	D(LGDP)	D(LAGRICULTURE)	D(LINDUSTRY)	D(LSERVICES)
CointEq1	-0.001747	0.022266	-0.011956	-0.003886
	(0.00527)	(0.00876)	(0.00808)	(0.00955)
	[-0.33169]	[2.54280]	[-1.48050]	[-0.40675]
D(LGDP(-1))	0.390021	1.702278	-0.304226	2.133021
	(0.30028)	(0.49920)	(0.46038)	(0.54459)
	[1.29886]	[3.41003]	[-0.66081]	[3.91673]
D(LGDP(-2))	-0.370299	0.860826	-1.219175	0.648098
	(0.33001)	(0.54862)	(0.50597)	(0.59851)
	[-1.12208]	[1.56906]	[-2.40959]	[1.08285]

D(LGDP(-3))	-0.436700	0.765363	-0.805580	-1.106364
	(0.35399)	(0.58849)	(0.54273)	(0.64200)
	[-1.23366]	[1.30056]	[-1.48431]	[-1.72330]
D(LGDP(-4))	0.993269	0.678768	0.391740	1.311321
	(0.35771)	(0.59468)	(0.54844)	(0.64876)
	[2.77671]	[1.14140]	[0.71428]	[2.02128]
D(LAGRICULTURE(-1))	-0.124427	-0.552640	0.114095	-0.813397
	(0.10646)	(0.17699)	(0.16323)	(0.19309)
	[-1.16871]	[-3.12239]	[0.69898]	[-4.21258]
D(LAGRICULTURE(-2))	-0.057401	-0.701666	0.430857	-0.441352
	(0.12185)	(0.20257)	(0.18682)	(0.22099)
	[-0.47109]	[-3.46389]	[2.30632]	[-1.99719]
D(LAGRICULTURE(-3))	-0.015193	-0.460899	0.043875	0.393629
	(0.13417)	(0.22306)	(0.20571)	(0.24334)
	[-0.11323]	[-2.06628]	[0.21328]	[1.61760]
D(LAGRICULTURE(-4))	-0.113539	0.159514	0.259762	-0.444609
	(0.13709)	(0.22791)	(0.21019)	(0.24864)
	[-0.82819]	[0.69989]	[1.23584]	[-1.78819]
D(LINDUSTRY(-1))	-0.361583	-0.836657	-0.164914	-0.629588
	(0.12372)	(0.20568)	(0.18969)	(0.22438)
	[-2.92260]	[-4.06781]	[-0.86941]	[-2.80589]
D(LINDUSTRY(-2))	0.072476	-0.233076	0.250108	-0.243262
	(0.12869)	(0.21395)	(0.19731)	(0.23340)
	[0.56317]	[-1.08942]	[1.26759]	[-1.04225]
D(LINDUSTRY(-3))	0.078331	-0.246363	0.040192	0.395123
	(0.13295)	(0.22102)	(0.20383)	(0.24112)
	[0.58919]	[-1.11467]	[0.19718]	[1.63872]
D(LINDUSTRY(-4))	-0.231105	-0.092425	0.017035	-0.145835
	(0.13977)	(0.23236)	(0.21430)	(0.25349)
	[-1.65344]	[-0.39776]	[0.07949]	[-0.57530]

D(LSERVICES(-1))	-0.012464	-0.188990	0.067968	-0.524259
	(0.07848)	(0.13047)	(0.12033)	(0.14234)
	[-0.15881]	[-1.44849]	[0.56485]	[-3.68317]
D(LSERVICES(-2))	0.070991	-0.024502	0.110256	-0.250627
	(0.08702)	(0.14466)	(0.13341)	(0.15781)
	[0.81584]	[-0.16938]	[0.82643]	[-1.58811]
D(LSERVICES(-3))	0.102507	-0.066253	0.215661	0.035200
	(0.08330)	(0.13848)	(0.12771)	(0.15107)
	[1.23063]	[-0.47844]	[1.68868]	[0.23301]
D(LSERVICES(-4))	0.052720	0.059414	0.035391	-0.052346
	(0.07101)	(0.11805)	(0.10887)	(0.12878)
	[0.74243]	[0.50330]	[0.32507]	[-0.40647]
C	0.008926	0.002203	0.008270	0.018171
	(0.00465)	(0.00773)	(0.00713)	(0.00844)
	[1.91849]	[0.28480]	[1.15935]	[2.15348]
R-squared	0.872102	0.901448	0.860679	0.880523
Adj. R-squared	0.849687	0.884176	0.836262	0.859584
Sum sq. resids	0.104114	0.287744	0.244738	0.342456
S.E. equation	0.032762	0.054465	0.050230	0.059418
F-statistic	38.90699	52.19143	35.24895	42.05139
Log likelihood	239.7360	181.2825	190.5907	171.2733
Akaike AIC	-3.856278	-2.839695	-3.001578	-2.665623
Schwarz SC	-3.426636	-2.410053	-2.571937	-2.235981
Mean dependent	0.013047	0.016782	0.007711	0.016508
S.D. dependent	0.084503	0.160036	0.124134	0.158565

Determinant resid covariance (dof adj.)	1.37E-12
Determinant resid covariance	6.94E-13
Log likelihood	957.0804
Akaike information criterion	-15.32314
Schwarz criterion	-13.50910

Conclusion

The federal government of Nigeria should declare a state of emergence in the Agricultural sector considering its negative relationship with GDP. Agriculture should be restored to its glory days by government formulating a strategic road map of Agricultural development in Nigeria which will be pursued by all levels of government. The service sector of the economy

has a potential of becoming the driving force of the economy if the reforms in the area of telecommunication sector is extended to other areas in this sector like education, health and tourism. There should be strategic master plan for the development of the Nigerian economy which successive government should vigorously pursue since policy inconsistency has been the bane of Nigerian development. All hands must therefore be on deck to make sure that the different sectors of Nigerian GDP contribute significantly to the economy.

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