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DYNAMIC IMPACT OF MONETARY POLICY INSTRUMENTS ON RESOURCE SUSTAINABILITY IN NIGERIA

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Abstract

This research analyzed the dynamic impact of monetary policy instruments on sustainability of resources in Nigeria for the period 1980-2018. The instantaneous and compound growth rate of exchange rate policy instruments, sustainability indicators and the impact of exchange and interest rates policy instruments on resource sustainability were analysed. Data were obtained from secondary sources. From the findings, exchange rate policy instrument significantly impacted the utilization of resources by -0.22%.There was little evidence that interest rate as a monetary policy instrument has direct impact on resource sustainability. In contrast poor agricultural practices, such as the cultivation of unsuitable land among others lead to the over-exploitation of resources driven by increased demands for natural resources in soil, forest resources as well human capital depletion among others. Thus, monetary policies should be reassessed in terms of their long run impact on the environment. Sustainable farming that support our planet should be encouraged. Water reserves, fisheries stocks, forests and soil should be protected through effective coordination of policy instruments against over exploitation for improved agricultural growth and resource sustainability in Nigeria.

Keywords: policy instruments, exchange rate, interest rate, sustainability and resources

Introduction

Sustainable practices are a deliberate attempt to improve intergenerational equity. This covers preservation of the Agro ecosystems, forest ecosystems, grassland ecosystems and aquatic ecosystems. According to Sanya and Babu (2010) natural resource depletion is an unsustainable way of development and growth.The benefits resulting from sustainable agriculture are often integral to the provisioning of clean drinking water, the decomposition of wastes, and the natural pollination of crops and other plants thereby critical for agricultural growth.To attain agricultural sector goals, several policies were formulated and implemented after independence. According to Dayo, Ephraim, John and Omobowale (2009) some macroeconomic and sectoral policies implemented from 1970 to 1985 promoted growth with some shortcomings. For instance, misapplication of exchange rate policy instruments led to large deviation between them and their market-determined equivalents. The exchange rates policy instrument cheapened imports, hurt exports, implicitly taxed farmers' incomes, and subsidized consumers. Government policies however led to the provision of many farm inputs and services which helped in the production, processing, and marketing of farm commodities (Chimobi and Uche, 2010). The need to correct some shortcomings of policy outcomes in Nigeria led to adoption of the Structural Adjustment Programme (SAP) of 1986. Dayo etal. (2009) further stated that after SAP was introduced, there was general improvement in agricultural production and external trade from 1986 to 1989. Thereafter, growth indices of agricultural production fluctuated between stagnation and decline, a situation blamed mainly on three policy reversals and inconsistencies. First, the devaluation of the naira led to higher domestic prices of imported goods, including farm inputs. Thus, some subsidies were retained on fertilizers and agrochemicals, the benefit of which never got to their target. Second, neither the interest-rate nor the exchange-rate liberalization was implemented to its logical conclusion. As a result agriculture could not sustainably derive the inflow of the required revenue for the government. Third, the agricultural trade reforms were interrupted by import and export restrictions or outright bans or both. All these unfavorable macroeconomic policy instruments utilization affected long-term private-investment decisions in agriculture.

Preliminary observations showed that monetary policy instruments in Nigeria have become defective over time with its attendant consequences: The value of the Naira against the Dollar keeps depreciating, the interest rate is unstable, and incomes are on the decline despite the rise in inflation and Nigeria has become a net import nation (Agu, Idike, Okwor, and Ugwunta, 2014; Ugwu and Kanu, 2012). These have dire implications for the economy as a whole and the agricultural sector in particular resulting to unsustainable exploitation of resources- forest trees are felled indiscriminately, arable land resources degraded, water resources over utilized, even the sovereign national fund keeps decreasing among others (Blejer and Khan, 1984; Oluwatobi and Ogunrinola, 2011).Sustainable development means the development that "meets the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development, 1987). Sustainability in broad term is the endurance of systems and processes. It is the prospects of biological systems to remain diverse and productive indefinitely (Hussein, 2005). According to Norton (2012) long-lived and healthy wetlands and forests are examples of sustainable biological systems. Hussein (2005) described sustainability as non-declining natural capital. Sustainability of resources is necessary for the survival of humans, other organisms as well as agricultural growth. This is because agricultural growth revolves around resources and humans derive benefits from the natural resources and from properly-functioning ecosystems. However, the possibility that human societies will achieve resource and environmental sustainability has been, and continues to be questioned—in the light of environmental degradation, climate change, overconsumption, population growth and the pursuit of economic growth.

In Nigeria, the occurrence of natural hazards such as periodic drought and flooding, as well as other environmental issues such as urban air and water pollution, desertification in the northern part, oil spills in the Niger-Delta, loss of arable land to erosions, urbanization and rural-urban migration remain a major challenge for sustainable development (FMEN, 2001). Again, land degradation emanating from the removal of top soils, trees and vegetation has deprived soil of its nutrients and rendered it infertile for agricultural purposes (Ako et al., 2014). Consequently few arable lands are left for farming activities. Sloman and Wride (2009) opined that as population and waste grow, resource depletion is also likely to grow at a faster rate ceteris paribus. Nigerian population is increasing and requires higher levels of material consumption, which in turn generate increased demands for natural resources in soil, forest resources etc. However, the prospect of policy instruments to allow for inter-temporal resource exploitation is uncertain raising question as to the effectiveness of exchange rate and interest rate policy instruments on agricultural resources sustainability. Furthermore, If food output per head is to remain constant, let alone increase, land must be made to yield more and more but increased use of say fertilizer results in emissions (from fertilizer use, rice production emissions, and emissions from agriculture as a sector etc) into the environment. Nigeria has continued to experience agricultural land degradation and rapid deforestation have occurred, reducing agricultural productivity and threatening long-term agricultural growth (Agu, et. al. 2014). In the absence of suitable macroeconomic policies to rebuild incentives for agricultural production, the sector may face the unfortunate prospect of being neglected, with dire consequences for the survival and food security of the nation that may arise from poor agricultural output and growth. However, the conceptualization of macroeconomic policies on agricultural growth and sustainable use of resources is still scarce.Misalignment in these macro policy instruments could generate macroeconomic instability and distort production activities that may lead to unsustainable use of resources hence the need for this study.

2.1 Sustainability Indicators-Capital Approach

According to UN (2008) the Joint United Nation Economic Commission for Europe/ European Statistical Office/Organization for Economic Corporation and Development (UNECE/Eurostat/OECD) working Group on Statistics for Sustainable Development was established in 2005 to identify good concepts and practices to assist national governments and international organizations in the design of sustainable development indicator sets. The mandate of the group was to develop a broad conceptual framework for measuring sustainable development with the concept of capital at its centre, and to identify a small set of indicators that might become the core set for international comparisons.Table 1. shows the measurement alternatives for sustainability: for human capital, the fundamental flow indicator is net investment. This would be the value of the increase in human capital during a period less its depreciation (UN, 2008). Depreciation of human capital results from the obsolescence of skills (for example, as workers age and fail to keep their skills up-to-date) and the loss of workers from the labor force as a result of retirement, unemployment or other factors. Investment in human capital occurs through education and training and through improvements to health status.

Table 1: A Proposed Small Set of Sustainable Development Indicators for Measuring Sustainability

Indicator domain	Stock Indicators	Flow Indicators
Foundational well-being	Health-adjusted life expectancy	Index of changes in age specific mortality and morbidity (place holder)
	Percentage of population with post-secondary education	Enrolment in post-secondary Education
	Temperature deviations from Normal	Greenhouse gas emissions
	Ground-level ozone and fine particulate concentrations	Smog-forming pollutant Emissions
	Quality-adjusted water Availability	Nutrient loadings to water bodies
	Fragmentation of natural habitats	Conversion of natural habitats to other uses
Economic well-being	Real *per capita* net foreign financial asset holdings	Real *per capita* investment in foreign financial assets
	Real *per capita* produced capita	Real *per capita* net investment inproduced capital
	Real *per capita* human capital	Real *per capita* net investment inhuman capital
	Real *per capita* natural capital	Real *per capita* net depletion of natural capital
	Reserves of energy resources	Depletion of energy resources
	Reserves of mineral resources	Depletion of mineral resources
	Timber resource stocks	Depletion of timber resources
	Marine resource stocks	Depletion of marine resources

Source: United Nation, 2008

For financial capital, the fundamental flow variable is net investment in foreign financial assets. For produced capital, the fundamental flow indicator is net investment. This is the value of new investment in produced capital during a period net of the depreciation of the existing produced capital stock. As can be seen in the Table above, the proposed small set has been divided into two indicator domains. The first is labeled foundational well-being to reflect the fact that the indicators measure stocks and flows that are essential to the well-being of society. The seconddomain is labeled economic well-being. The indicators within it are more narrowly related to the well-being derived from market activity. An indicator had to be both consistent with the capital approach and identifiable with an indicator found among the most common indicators from policy-based sets (UN, 2008).

The focus of countries in establishing indicators sets has been generally to meet theinformation needs of a national sustainable development strategy.Their establishment has been for many countries and institutions a key opportunity to moveenvironmental issues higher up the policy agenda alongside economic and social issues. Thesustainable development indicators have also been instrumental in promoting the concept ofsustainable development in a much clearer way than can be achieved through national sustainabledevelopment strategies alone.In many cases the relationship between indicators and policy is very strong – with the policyframework in effect determining the indicators. While there may be concerns about havingindicators closely aligned with policy and hence potentially biased towards particular policypriorities at the expense of other aspects of sustainable development, this is also one of theirstrengths. Policy makers see them as being directly relevant to the policies they have establishedand effective for communication.That is, market prices of a number of assets reflect their well-being effects. This includes cases where the assets are, *inter alia*, bought and sold in free markets where full information is available to all players, where no single player has undue market power, where the external effects of the assets are negligible. While these conditions seldom are perfectly fulfilled, market prices probably serve as good estimates of accounting prices in cases where the assets in question are frequently and openly traded (UN, 2008).

Modeling Sustainability: Theory of Resource Sustainability

According to Hanley, Shogren and White (2007) economic views of what defines a sustainable development path for the economy over time may be divided into two broad groups. The first is the outcome approach which is concerned with how the economic process directly affects human well being. 'Well being' is synonymous with the standard economic concept of utility or welfare of an individual. Hence sustainability can be defined as the utility of a representative agent in any period t, U(t)- taken to represent society's interests-to be non-declining for the rest of the time from time t* onwards (Pezzey, Hanley, Tinch, & Tuner (2003).

$$\partial U(t)/\partial t \geq 0 \qquad \text{all } t > t^* \ldots\ldots(1)$$

Or that in any period t, the utility of that representative agent does not exceed the maximum sustainable level of utility, depending on the economy's potential at time t (Pezzey and Toman, 2002):

$$U(t) \leq U_m(t) \ldots\ldots (2)$$

Where for the time periods s following on from the time periods t:

$$U_m(t) = \max U \qquad \text{given } U(s) \geq U_m(t) \qquad \text{for all } s \geq t \ldots\ldots(3)$$

Equation (1) says that sustainable development occurs when utility per capita is not falling over time. This means that constant utility equals sustainability as well as rising utility (Hanley, et al., 2007). A variant on the outcome based approach is to define sustainable development in terms of the observable determinants of utility. In other words, if we know what factors affect utility- for example, the level of consumption and the level of environmental quality- then by examining changes in these factors we can infer whether a sustainable path is being followed (Hanley et al., 2007). These have several applications – on forest, human resource and arable land in the case of this study, According to Pezzey's definition. A time path of consumption over time which is rising and then falling might be consistent with maximizing the present value of social well-being, according to utilitarian view, but would not be a sustainable path (Hanley, et al., 2007). There is thus a trade off here between sustainability and present value maximising optimality. The outcome definition of sustainable development implies that it is the absolute level of consumption and environmental quality per capita that matters for well-being, not one's consumption/environmental quality relative to one's neighbours; implying that rising real incomes result in higher utility.

Furthermore, following Hanley, et al. 2007 consider an economy with representative agent who derives utility from consumption of both produced goods and environmental amenities, given by a vector C_t, where t indexes time. Production is determined by the aggregate (man-made + natural + human) capital stock, a vector K, and technological progress which depends on solely the passage of time. An economy is deemed to be sustainable at time t if utility is less than or equal to maximum sustainable utility at this time. Where sustainable here means consistent with non-declining value of utility over infinite time, at a constant discount rate p:

$\underbrace{Max}_{c,k} \int_0^{\infty} U[C_t]\, e^{-pt} dt$……………………………………………………………………(4)

Pezzey, Hanley, Tinch & Tuner (2006). show that for this economy to be sustainable, green net national product Y^t, defined by

$Y^t = P(t).C(t) + V(t)K(t)$……………………………………………………………………(5)

Where K is the rate of change in K per unit of time subject to production possibilities given by K(t) and t and where P is the relative price for the consumption goods and environmental amenities and V is the price for each element of the capital stock, must be non-declining at a time t, that is

$Y(t) \leq 0 \Rightarrow U(t) > U_m(t)$……………………………………………………………………(6)

That is if the green net national product is declining at a time t, then utility must exceed the maximum sustainable level.

In equation (5) both the K and C terms are augmented, which means they include a value of time: this is the discounted value of future exogenous technological improvements and resource price appreciation in a resource exporting country together with the capital gains on net foreign capital. The 'value of time' is shown in equation (6) but one can think of it intuitively as the discounted value of 'time passing' to the economy, in terms of its capital gains from both held overseas and from its natural resource net exports. Since consuming or utilizing more resources now than in the near future means attaching more utility to the present implying discounting the future, it is reasonable to argue that diminishing resources- forest, land and labor in quantity and value among other resources, simply is not sustainability but unsustainable development path.

Methodology

The study utilized secondary source of data on policy instruments, agricultural growth and sustainability indicators. Data on Gross Domestic Product (GDP), exchange rate, interest rate, were obtained from CBN Statistics Data Base (Finance and real sector).while information on arable land, forest area and agricultural land area were obtained from Food and Agriculture Organization Statistical data (FAOSTATS).Data on taxes, general tariff, Government expenditures, and education expenditures were obtained from, World Bank. Following the Joint UNECE/Eurostat/OECD Working Group of the UN (2008) on Statistics for Sustainable Development which was established in 2005 to identify good concepts and practices to assist national governments and international organizations in the design of sustainability indicator sets, three (3) resource sustainability indicators were considered among others. There are human capital resource, forest resource and arable land. These sustainability indicators cover both natural and human resources, by so doing the three predominant perspectives namely ecological, Hart-Wick Solow and the Safe minimum approaches to sustainability were appropriately captured. Thus the index of sustainability was computed using the weighted average index as shown in Appendix.

Data for the study were analyzed through the application of both descriptive and inferential statistical tools. The study adopts a longitudinal survey design.. Unitroot Test, and Granger Causality Pre-estimation tests were carried out to avoid spurious parameters. After the estimation, a diagnostic test of misspecification, robustness/heteroscedasticity, autocorrelation and multicollinearity were carried out to assess the validity of the empirical model. Objective I was achieved using Trend analysis, Objective II was achieved firstly through the use of distributed lag model, Two Stage least Squares (2SLS) and through the use of Difference-in Differences Estimation Model (DID). Endogeneity test was carried out to ascertain the presence of endogeneity. Although the choice of what variable is regarded as endogenous depends on the researcher's intuition and economic theory, a statistical test is required to confirm it (Ochalibe, Mgbebu & Onyia, 2016). The essence of the test is to avoid using 2SLS which is less efficient than OLS when the explanatory variable is actually exogenous

1. **Trend Analysis of Agricultural Growth and sustainability Indicators over the Period**

Growth trend Model

$Yt = Y_0 (1 + r) t$ .... (8)

Where Y_t= rate of agricultural growth; Y_0 = rate of agricultural growth in a base year; r = compound rate of growth of Y; t = time in chronological years in natural log form we have

$InY_t = lnY_0 + tln(1 + r)$ .... (9)

Substituting InY_0 with β_1 and $Ln(1 + r)$ with β_2, we re-write equation as

$InY_t = \beta_1 + \beta_2 t$ .... (10)

Adding the disturbance term to equation we obtain

$InY_t = \beta_1 + \beta_2 t + \mu t$ ....(11)

Equation (11) is a growth rate model developed for this study. A semi-log growth model was developed for this study instead of a linear trend model because the point of interest in this study is both absolute and relative change in the parameters of interest. The most important parameter in equation (11) is the $coefficient \beta 2$. This is the coefficient of the slope which measures the constant proportional or relative change in Y for a given absolute change in the value of the regressor, t. Multiplying $\beta 2$ by 100 gives the instantaneous growth rate at a point in time.

GR=β_2 x 100……………………………………………………………………… (12)

Where: IGR= Instantaneous growth rate

According to Gujarati (2009) β_2 is the least-square estimate of the coefficient of the slope $\beta 2$, then taking the anti-log of β_2 and subtracting 1 from it and then multiplying the difference by 100 give the compound growth rate (CGR) over a period of time:

CGR = [antilog β_2 – 1] x 100 ………………………… …………………………(13)

If the coefficient β_2 is positive and statistically significant or negative and statistically significant there is acceleration or deceleration in growth process respectively. If β_2 is not statistically significant there is stagnation in the growth process.

2. **Causality Test: There is no causality between policy instruments θ and resource sustainability**

$$InRsus_{tij} = \alpha_0 + \sum_{i=1}^{p} \theta_i Rsus_{t-i} + \sum_{i=1}^{p} \alpha_i pcnstr_{t-j} + \varepsilon_{1t} \quad \ldots\ldots (14)$$

$$pcnstr_t = \beta_0 + \sum_{i=1}^{p} \nexists_i pcnstr_{t-j} + \sum_{i=1}^{p} \exists_i Rsus_{t-i} + \varepsilon_{2t} \quad \ldots\ldots (15)$$

Explicitly:

$$InRsus_{tij} = \alpha_0 + \sum_{i=1}^{p} \theta_i Rsus_{t-1ij} + \sum_{i=1}^{p} \alpha_i forex_{t-1} + \varepsilon_{1t} \quad \ldots\ldots (16)$$

$$forex_t = \beta_0 + \sum_{i=1}^{p} \nexists_i forex_{t-1} + \sum_{i=1}^{p} \exists_i Rsus_{t-1ij} + \varepsilon_{2t} \quad \ldots\ldots (17)$$

$$InRsus_{tij} = \alpha_0 + \sum_{i=1}^{p} \lambda_i Rsus_{t-1ij} + \sum_{i=1}^{p} \Delta_i i\_rate_{t-1} + \mu_{1t} \quad \ldots\ldots (18)$$

$$i\_rate = \alpha_0 + \sum_{i=1}^{p} \delta_i i\_rate_{t-1} + \sum_{i=1}^{p} \gamma_i Rsus_{t-1ij} + \mu_{2t} \ldots\ldots\ldots\ldots\ldots\ldots \quad (19)$$

$$InRsus_{tij} = \alpha_0 + \sum_{i=1}^{p} \eta_i Rsus_{t-1ij} + \sum_{i=1}^{p} \psi_i expn\_agr_{t-1} + v_{1t} \ldots\ldots\ldots\ldots \quad (20)$$

$$expn\_agr_t = \alpha_0 + \sum_{i=1}^{p} \varphi_i Agr_{t-1} + \sum_{i=1}^{p} \sigma_i Rsus_{t-1ij} + v_{2t} \ldots\ldots\ldots\ldots\ldots\ldots \quad (21)$$

The variables are as defined, for the purposes of illustration assume that *Rsus* and *forex* are to be tested for causality. In this dynamic regression if the $\exists_i$ in equation 17 is not significant and α_i in equation 16 is significant then there exist a unidirectional causality running from *forex* to *Rsus*. The opposite is also true when α_i in equation 16 is not significant but $\exists_i$ in equation 17is significant then there is a unidirectional relationship running from *Rsus to forex*. In the case where α_i and $\exists_i$ in equation 16 and 17respectively are significant then there exists a bi-directional causation. However if the two coefficients in the two equations are insignificant then existence of ~~any~~ causation between the variables is rejected. The procedure highlighted is applicable to the other pairs in equations above.

3. Dynamic Model: Finite Distributed Model (Monetary and Fiscal policy instruments)

$$\begin{aligned} InAgth_t = b_0 + b_1 Inforex_t + b_2 Ini\_rate_t + b_3 Ininf_t + b_4 lnmss_t \\ + b_5 Inexpn\_agr_t \\ + b_6 Inexpn\_edu_t + b_7 Indebt_t + b_8 Inwagrate_t \\ + b_9 pcnstr_{t-1} + e_t \end{aligned}$$

Where *In* = natural logarithm; b_o - b_9= parameters to be estimated; *Agrth* = is the annual aggregate agricultural contribution to GDP in millions of naira; *forex* = exchange rate measured as annual average exchange rate of Nigeria naira to one US dollars; *i_rate*= interest rate measured as weighted average of prime lending rate of commercial banks (%);*expn_agric* = expenditure on agriculture measured as share of agriculture in the government expenditure outlay in millons of naira; *edu_exp* = expenditure on education measured as share of education in annual budget in millions of naira; *debt* = external debt measured as the external debt stocks, total (current US$) to gross domestic product. It is the sum of public, publicly guaranteed, and private non guaranteed long-term debt, short-term debt, and use of IMF credit; wagered= wage rate, control variable approximated by per capita income; *infl* = inflation rate measured as the percentage change in the general price of all goods and services(%); mss = money supply measured as the total money in circulation broad money (M2 in ₦) $Pcnstrt\text{-}_1$ =$_{et}$= is a stochastic error term that satisfies the normal classical regression assumptions. It is expected that increased in public expenditures and wage rate will yield aggregate agricultural growth ceteris paribus. government expenditure in human resource for accessible and quality education is required for skillful labor force while lack it may warrant depletion of skills and hence unsustainable development. Still, higher expenditure and growth in agriculture may warrant cutting down of trees (deforestation) if government intends to construct roads dams etc, low government expenditure may also lead to depletion of resources e.g. logging (indiscriminate cutting down forest trees).

Results and Discussion

Pre-estimation test: unit root test

Table 2 reports the Unit root test results for Value Gross capital formation in current US (*c_stock;)*,Arable land area and Permanent crops (1000ha) (*arable*); Forest products in million tonnes (*forest_prd),*Primary forest land area in 1000ha (*forest_land*); human capital (*human_cap*) proxied by education expenditure US$) (*expn_edu*) and Expenditure on Agriculture (current US$) (*expn_agric*)

Table 2: Results of Aurgumented Dickfuller Unit root test

Variable	ADF Z(t)	Statistics	Mackinnon critical value@5%	differenced level	P-value Z(t)	Remarks
Agrth	-3.668		-1.688	1(0)	0.003***	Stationary
expn_agric	-2.503		-1.688	1(0)	0.008***	Stationary
ext_debt	-3.668		-1.688	1(1)	0.001***	Stationary
Arable	-3.668		-1.688	1(0)	0.040**	Stationary
human_cap	-1.342		-1.688	1(1)	0.094*	Stationary
forest_prd	-4.410		-1.688	1(1)	0.000***	Stationary
forest_land	2.966		-1.688	1(0)	0.042**	Stationary
c_stock	-2.664		-1.688	1(0)	0.006***	Stationary

Source: Computed from secondary data, 2018

Note: *** significant at 1%; ** significant at 5% and * significant at 10%.

From the table, most the variables are stationary at order I (0) respectively except external debt, and forest product(*forest_prd*) which are stationary at first difference. Therefore the null hypothesis of non-stationarity is rejected at 5% level of significance.

Granger Causality Test between policy instruments and resource sustainability

The result of the pair wise granger causality test between policy instruments and resource sustainability is presented in table 3.

Table 3: Granger pair wise causality test between policy instruments and resource sustainability

Null Hypothesis	Df	Chi2- Statistics	Probability	Decision
forex does not granger cause *indexstk*	3	17.598	0.000***	Rejected
ndexstk does not granger cause *forex*	3	3.195	0.362	Not rejected
i_rate does not granger cause *ndexstk*	3	30.426	0.000***	Rejected
ndexstk does not granger cause *i_rate*	3	4.008	0.261	Not rejected
exp_agric does not granger cause *ndexstk*	3	33.734	0.000***	Rejected
ndexstk does not granger cause *exp_agric*	3	4.144	0.246	Not rejected

Source: Computed from secondary data, 2018

Note: *** significant at 1%; ** significant at 5% and * significant at 10%.

The result of the causality test in table 2 revealed that at least a unidirectional causality exists between f*orex* (P=0.000<0.01), *i_rate* (P=0.000<0.01)*, exp_agric*(P=0.000<0.01) and sustainability index (*indexstk)* (P=0.000<0.01). This indicates that all the variables granger cause sustainability indicators in Nigeria. Therefore the null hypothesis should be rejected while the alternate hypothesis should be accepted. The implication is that general policy instruments are relevant determinants of sustainability in Nigeria.

Instantaneous and Compound Growth Rate of Policy Instruments, Agricultural growth Rate and Sustainability Indicators

The result fromexponential trendregression of agriculture output (*agrth*); Expenditure on Agriculture (current US$) (*expn_agric*); Primary forest land area in 1000ha (*forest_land*); Arable land area and Permanent crops(1000ha)(*arable*); human capital (*human_cap*) proxied by education expenditure (US$) (*expn_edu*);and resource sustainability index(*Rsus_index*) are presented in Table 4. From the table the trend of policy instrument showed that there was acceleration in the growth in most of the policy instruments but deceleration in resource sustainability index (*Rsus_index*) and money supply (mss) with no reorded stagnation during the period under review. The instantaneous growth rate (at a point in time) for agriculture

(P=0.000<0.01) was 5.9%. This means that the relative change in agricultural output with respect to absolute change in the variableover timewas 5.9% while the compound (over the period under review) rate of growth amounted to 6.08%. The implication is that there was a general improvement in the agricultural growth process in Nigeria during this period even though the growth may not be as expected. The result showed further that there was a deceleration in the index resource sustainability (P=0.068<0.1) during the period of study with instantaneous growth rate and compound growth rate of -2.81% and -2.84% respectively. However, there was a deceleration in the index of resource sustainability during the period of study with instantaneous growth rate and compound growth rate of -2.81% and -2.84% respectively. There was acceleration in growth for with instantaneous and compound growth rate of expenditure to agriculture (P=0.000<0.01), external debt (P=0.082<0.1), with instantaneous and compound growth rate of 7.62%, 7.92%; 1.23%, 1.24%; respectively. Although efforts were made through the use of monetary and fiscal policies to improve macro-economic stability and stimulate growth (Oluwatobi and Ogunrinola 2011) the growth rate of exchange rate and interest rate may well suggest failure of policy instruments application in this regard. The implication of the empirical results is that the targets sets by the government of Nigeria are not achievable since government has not utilized macroeconomic policy instruments such that revenue generation is increased through the productivity of resources to meet national objective for agricultural growth and resource sustainability given the pressure on natural resources.

Table 4: Instantaneous and Compound Growth Rate

	Instantaneous growth rate%	Compound growth rate%	P-value
Agrth	5.90	6.08	0.000***
lnexpn_agric	7.62	7.92	0.000***
Inexdebt	1.23	1.24	0.082*
forest_land	-1.57	-1.58	0.008***
Arable	0.33	3.38	0.470
human_cap	-1.93	-1.95	0.005***
Rsus_index	-2.81	-2.84	0.068*

Source: Computed from secondary data, 2018

Note: *** significant at 1%; ** significant at 5% and * significant at 10%.

The instantaneous growth rate for forest resources (P=0.008<0.01), arable land (P=0.47>0.01) and human capital (P=0.005<0.01) were 1.57%, 0.33% and 1.93% with a compound rate of growth of -1.58%, 0.34% and -1.95% respectively. This means that the relative change in forest resources, arable land and human capital with respect to absolute change in the trend variable were -1.57%, 0.333% and 1.93% respectively. Therefore there was a deceleration in forest resources and human capital while arable land was stagnant. The implication is that agricultural resources are not on a sustainable path and more effort may be required to enhance sustainability of this resources however this cannot concluded without further analysis.

Long-Run Relationship BetweenPolicy Instruments and Resource Sustainability in Nigeria: Results Lag in VECM

Cointegration of two or more time series suggests that there is a long-run, or equilibrium, relationship. According to Neaime (2009) if variables indicator series are non-stationary, then it means that it is growing without bound over time, which means that subsequent resource in this instance will also grow without bound rendering resources unsustainable. A stationary resources series means that the series is reverting to a certain mean overtime and is not growing without bounds. To test for cointegration or fit cointegrating VECMs, it is required to specify how many lags to include as shown in Table 5.

Table 5 Results of number of lag in VECM of long-run relationship between policy instruments and resource sustainability in Nigeria

.	LL	LR	Df	P	FPE	AIC	HQIC	SBIC
0.0000	-18.2170				43.0000	1.3069	1.3681	1.4865
1.0000	117.1690	270.7700	16.0000	0.0000	0.0000	-5.7158	-5.4096	-4.81794*
2.0000	129.0380	23.7380	16.0000	0.0950	0.0000	-5.4728	-4.9217	-3.8567
3.0000	163.7810	69.4850	16.0000	0.0000	0.0000	-6.5753	-5.7792	-4.2409
4.0000	195.4440	63.328*	16.0000	0.0000	9.7e-09*	-7.49673*	-6.45566*	-4.4440

Source: Computed from secondary data, 2018

Note: *** significant at 1%; ** significant at 5% and * significant at 10%.

From Table 5. The order of the corresponding VECM is always one less than the VAR. VEC makes this adjustment automatically. The output lag order of the VAR of the average policy instruments: Exchange rate in percent (*forex*); interest rate (*i_rate*); government expenditure on Agriculture (*expn_agric*) and Index of resource sustainability covering arable land area(*arable*); human capital (*human_cap*) as well as forest land area in 1000ha (*forest_land*). The result indicate that four (4) lags are required for this model because the Hannan–Quinn information criterion (HQIC) method and sequential likelihood-ratio (LR) test all chose four lags, except the Schwarz Bayesian information criterion (SBIC) method, as indicated by the "*" in the outputwhich chose (1) lag.

Estimation of cointergration equation

Additionally, the result of cointergrating equation between policy instruments and resource sustainability in Nigeria is presented in Table 6.The tests for cointegration are based on Johansen's method. If the loglikelihood of the unconstrained model that includes the cointegrating equations is significantly different from the log likelihood of the constrained model that does not include the cointegrating equations, we reject the null hypothesis of no cointegration.

Table 6: Result of cointergration equation between policy instruments and resource sustainability in Nigeria

Maximum Rank	Parms	LL	Eigen value	Trace Statistics	5%critical Value
0.0000	20.0000	-216.3034	.	47.7326	47.2100
1.0000	27.0000	-203.3161	0.5140	21.7579*	29.6800
2.0000	32.0000	-196.8806	0.3006	8.8869	15.4100
3.0000	35.0000	-192.4633	0.2176	0.0522	3.7600
4.0000	36.0000	-192.4372	0.0015		
Lags	4				
Trends	Yes				
Constant	Yes				
Number of observation	36				

Source: Computed from secondary data, 2018
Note: *** significant at 1%; ** significant at 5% and * significant at 10%.

Besides presenting information about the sample size and time span, the header indicates that test statistics are based on a model with four lags and a constant trend. The body of the table presents test statistics and their critical values of the null hypotheses of no cointegration (line 1) and one or fewer cointegrating equations (line 2). The eigenvalue shown on the last line, column 4 is used to compute the trace statistic in the line above it. Johansen's testing procedure starts with the test for zero cointegrating equations (a maximum rank of zero) and then accepts the first null hypothesis that is not rejected. In the output above, we strongly reject the null hypothesis of no cointegration and fail to reject the null hypothesis of at most one cointegrating equation. Thus we accept the null hypothesis that there is one cointegrating equation in the model. So, four (4) lags were utilized in the estimation of long-run relationship between policy instruments and resource sustainability in Nigeria using the VECM model.

Long run relationship between policy instruments and resource sustainability in Nigeria

Having established the stationarity of the variables and that there is a cointegrating equation between the policy instruments and resource sustainability indicator; the parameters of a multivariate cointegrating VECM for these four series were estimated. The result in Table 6 contains information about the sample, the fit of each equation, and overall model fit statistics as well as the long-run, or equilibrium, sustainability functions.

Table 6: Result of long-run cointegrating equations relationships between policy instruments and resource sustainability in Nigeria

Beta	Coef.	Std. Err.	Z	P>z
_ce1				
Rsus_index	1.0000	.	.	.
Lnforex	26079	1.8531	14.100	0.000
i_rate	-0.0041	0.6168	-0.0100	0.0950
Lnexpn	-22105	2.9742	-7.400	0.007
_cons	-52.8427	.	.	.
Parms	3.0000			
Chi2	44.254			
P>chi2	0.0000			

Variables	B-Coefficient	Standard error	T-value	P-value
D_lnforex _ce1 L1.	-0.0064	0.0032	-1.9700	0.0490**
Rsus_index LD.	0.0035	0.0020	1.7100	0.0880
Lnforex LD.	0.4175	0.1571	2.6600	0.0080
I_rate LD.	-0.0205	0.0107	-1.9200	0.0550
lnexpn LD.	-0.0071	0.2187	-0.0300	0.9740
_cons	0.1585	0.0486	3.2600	0.0010
D_i_rate_ce1 L1.	-0.0568	0.0566	-1.0000	0.3160
Rsus_index LD.	0.0114	0.0355	0.3200	0.7490
lnforexLD.	-0.9940	2.7494	-0.3600	0.7180
i_rate LD.	-0.2188	0.1871	-1.1700	0.2420
lnexpn LD.	0.9790	3.8258	0.2600	0.7980
_cons	0.7311	0.8504	0.8600	0.3900
D_lnexpn _ce1 L1.	0.0110	0.0039	2.8000	0.0050***
Rsus_index LD.	-0.0040	0.0025	-1.6000	0.1090
lnforex LD.	0.2800	0.1911	1.4700	0.1430
i_rateLD.	-0.0055	0.0130	-0.4200	0.6750
lnexpnLD.	-0.3352	0.2659	-1.2600	0.2070
_cons	-0.0612	0.0591	-1.0400	0.3000

Source: Computed from secondary data, 2018
Note: *** significant at 1%; ** significant at 5% and * significant at 10%.

There are four types of parameters of interest: The parameters in the cointegrating equations ; the adjustment coefficients β and α t have useful interpretations .. The four coefficients on *L. ce1* in Table 6 are the parameters in the adjustment matrix _ for this model. *Vecrank* implements Johansen's multiple trace test procedure, the maximum eigenvalue test, and a method based on minimizing either of two different information criteria. The coefficient on*lnexpn* and*lnforex* in the cointegrating equation are statistically significant, as are the adjustment parameters. The adjustment parameters of estimates have the correct signs and imply rapid adjustment toward equilibrium. According to the United Nations World Committee on Environment and Development (UNWECD) (1991), after two centuries, it became apparent that the methods used to exploit the natural resources were not sustainable as most of these resources are non-renewable and under threat of depletion and their persistent rate of consumption could compromise the ability of future generations to meet their own needs.Overall, the output indicates that the model fits well (P=0.000<0.01).

The table also contains the estimated parameters of the cointegrating vector for this model, along with their standard errors, z statistics, and confidence intervals. When the predictions from the cointegrating equation are positive, resources sustainability indicator is above its equilibrium value because the coefficient on exchange rate in the cointegrating equation is positive. The estimate of the coefficient (ln*forex) L._cel*; (*i_rate) L._cel*and (ln*expn*) *L._cel* were -0.0064,-0.0568 and0.0110 respectively. Thus in the long run when average interest rate continue to rise associated with devalued currency the resources will be utilized in an unsustainable manner but increase government expenditure in the long run will impact resources positively with the tendency of enhancing sustainability of resources. The estimated coefficient (ln*expn*) *L._cel* was 0.0110 implies that when government increases expenditure by 10%, resource sustainability indicator will increase by 11%. The implication is that measures aimed at restoring macroeconomic stability also will generally yield economic, social and environmental benefits. This finding is in agreement with (NBS, 2016) who opined that for the 1990-2005 interval, Nigeria lost 39.2% of its forest and woodland habitat. Sustainable development does not prohibit the use of natural resources but restricts their use in such a way that enough, or as much as possible, is left for the future generations. It can be achieved by increasing efficiency or cutting down on waste or by adopting policy instruments such as imposing a tax on environmental use. This is in alignment with the work of (IFPRI, 2016) that posits that attaining sustainability of resources requires policy coherence and cooperation at all levels of government and across sectors, recognizing that all the goals must be addressed in an integrated manner. Each dimension requires a mixture of skill and disciplines.

Conclusion and recommendations

The empirical result showed that resource sustainability index was quite sensitive to the influence of policy instruments. An increase in exchange rate decreased sustainability index by -0.22% ceteris paribus. There is little evidence that interest rate as a monetary policy instrument has direct impact on resource sustainability however, there was a deceleration in the index of resource sustainability during the period of study with instantaneous growth rate and compound growth rate of -2.81% and -2.84% respectively. Unfavorable policy instruments driven by increased demands for natural resources in soil, forest resources as well as human capital depletion, poor agricultural practices among others impacted negatively onsustainability of resources.While increased investment and research directed toward the solution of forest, human capital and land related problems are now widely advocated, the special contribution of this paper and the underlying research is in computation of resource sustainability index and identifying how policy instruments can be utilized to reduce the wastage of resources without sacrificing other economic policy objectives and effectiveness.Additionally, it brings to the fore the inter-connectedness that exist between macroeconomic policy instruments and sustainability of resources and the understanding that growth revolves around services provided by the natural resource and humans derive benefits from properly-functioning ecosystems is further deepened. The study further contributed to the growing demand for sustainability theory by establishing the existence of long-run relationship between policy instruments and agricultural resource sustainability implying that value should be placed on resources today, tomorrow and in the future which will help Nigerian quest for food sufficiency, economic diversification and sustainable development. It is recommended that exchange rate as a policy instrument needs to be stabilized to narrow the foreign exchange gap, since its relative price influences other prices and the devaluation of the naira led to higher domestic prices which resulted in utilization/ over exploitation of resources in an unsustainable manner. Furthermore, more attention should be given to resource sustainability because as more emphasis is placed on agricultural growth and economic development, food production faces increasing competition for available resources with other sectors of the economy.

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