INTERACTIONS BETWEEN HEALTH AND AGRICULTURAL OUTPUT ON ECONOMIC GROWTH IN NIGERIA

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ABSTRACT
This paper examines the Interactions between health and agricultural output on economic growth in Nigeria using annual time series dataset spanning 1980 to 2018. Body mass index was proxied for health while the real Gross Domestic Product captures economic growth. The two stage Least Squares approach was adopted in the analysis after testing for unit root and cointegration among variables. Results indicate that the interactive variable was positively signed and statistically significant at a 5 percent level both physical and labour exert a significant positive impact on economic growth in Nigeria. Specifically, body mass index and agricultural output significantly spur economic growth. The paper recommends, amongst others, that government should strive a programme that will not only encourage agricultural output but also enhance the health facilities in the country at all levels. Government should increase allocation to health and agriculture sectors in the country for optimal performance of the economy.
Keywords: Agricultural output, Life expectancy, Economic Growth

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1. INTRODUCTION
In the 21st century, agriculture remains fundamental to economic growth, poverty alleviation, improvement in rural livelihood, and environmental sustainability (World Bank 2007). Three-quarters of the world's poor population live in rural areas, particularly in Asia and Africa (Ravallion, Chen, and Sangraula 2007), and depend on agriculture as their primary livelihood source. The agricultural sector, which has employed over 70% of the Nigerian workforce, grew at a rate of just about 9.6% annually within the same period and contributed less than 22% of the country's GDP (CBN, 2018). Growth in agricultural productivity has also stagnated since 1980 despite the national population's rise (IFPRI, 2015). A trend analysis of the share of agriculture to GDP in Nigeria showed that the share of agriculture has been fluctuating over time. While the share of agriculture to GDP stood at 48.8% in 1970, it however declined to 20.2% in 1980 and slightly increased in 1990 to 31.5%. In 2000 and 2010, it decreased to 26.3% and 23.9% respectively. In 2017, the agriculture share to GDP in Nigeria stood at 21.2% and in 2019, Agriculture contributed around 21.91 percent to Nigeria's GDP (CBN, 2019). As populationincreases demand for food, energy and income increases. Rising population coupled with land degradation aggravates challenges of crop production and consequently, arable land per capita declines while land degradation increases through overuse of land resources.

Diseases have significantly reduced labour productivity in the agricultural sector in developing countries due to the loss of labour and technical know-how of the productive labour force (World Bank, 2016). In Nigeria's case, the loss of labour due to ill-health is more frequent during the rainy season due to the lack of preventive programs, efficient healthcare, and diseases, considerably affecting

farmers' productivity across the country. Health affects Agricultural systems by affecting the health of the producers. Poor health will result in loss of work days or decrease worker capacity, decrease innovative ability and ability to explore diverse farming practices and by such makes farmers to capitalize on farm specific knowledge.

Ugwu (2006), Clifford *et al*. (2006), Donald (2006) and Bradley (2002) opined that health capital is affected by a number of preventable diseases: Malaria, musculoskeletal disorders, HIV/AIDS, farminjuries, yellowfever, typhoidfever, Schistosomiasis, Onchocerciasis, Diarrhoreal diseases respiratory diseases and skin disorders, etc. These diseases according to Ngambeki and Ikpi (1982) makes farmers not to utilize fully all inputs at their disposal and debilitates farmer`s physical performance and equally impacts negatively on the farm profit levels.

The importance of good health summarized in a famous saying, the wealth of a nation is the health of its people. Research focusing on agriculture has revealed the negative impact of ill health, especially on the welfare of agricultural households-which ultimately affect overall economic development. For instance, Iheke and Ukaegbu (2015), Egbetokun, Omonona and Oluyole (2014) reported that the effects of ill health on farm households include three broad impacts: absenteeism from work due to morbidity (and eventual death); diversion of family time to caring for the sick; and the loss of savings and assets in the course of dealing with diseases and its consequences. They reported further that the long-term impacts of ill health include loss of farming knowledge, reduction of land under cultivation, planting of less labor-intensive crops, reduction of a variety of crops planted, and reduction of livestock. The ultimate impact of ill health according to their report is a decline in household income and food insecurity—that is, severe deterioration in household livelihood.

Amidst the alarming report of effects of diseases on farmers, Nigerian subsistent farmers spend as much as 13% of total household expenditure on the treatment of malaria alone Abiobun(2018). This gives enough evidence that the cost of combating diseases and health problems by the farmers is quite enormous, considering the frequency and prevalence of diseases among the Nigerian farmers.Despite the number of studies focusing on the links between health status and economic outcomes, including income and labor productivity, very few studies exist that focus on the interaction between health and agricultural output and economic growth.

While the link can be easily seen in descriptive statistics, disentangling the precise nature of the connection between health and agricultural productivity and whether the connection is causal is another matter altogether. Economists Thomas and Frankenberg (2002) write, ―A positive correlation between health and economic prosperity has been widely documented, but the extent to which this reflects a causal effect of health on economic outcomes is very controversial. They point out that the causality is likely to run in both directions. While Thomas and Frankenberg (2002), wrote about the general variable of economic well-being. A similar observation can be made for the link between health and increase in agricultural productivity. Does better health lead to higher rates of agricultural growth? Possibly yes, and it is also likely that higher levels of agricultural growth lead to higher levels of health. This article analyzed the Interactions between Health and Agricultural output on Economic Growth in Nigeria by constructing a theoretical model where health, agricultural output and other factors that affect economic growth are also introduced. Thus, these questions are pertinent: What is the link between health and economic growth? What is the relationship between the interaction of agricultural output and economic growth? What is the impact of life expectancy on economic growth? This paper seeks to answer these questions, among others, and further investigate how health as a factor in human capital affects economic growth. This paper is structured into five sections. Following the introductory

section are the reviews of literature while the third discusses the methodology adopted. Results obtained were provided in the fourth section while the fifth section concludes the paper.

2. LITERATURE REVIEW

Studies on health human capital have been principally preoccupied with determining the relationship between detailed causal factors and mortality and morbidity in the society. Interestingly, social scientists have used health theories to improve studies on human capital. That is to say inclusion of health as human capital variable every bit has enhanced human capital theory. Human capital theory provided the foundations which have been laid by the seminal works of Schultz (1961), Becker (1964), Grossman (1972), and Mincer (1974). This theory has proven very effective in contributing to the understanding of decisions with respect to education and health. The health - based human capital model has served as the pillar of model in health economics and has contributed immensely to the understanding of a wide range of phenomena in health and healthcare (Van Kippersluis and Galama, 2013). One of the foremost pathways responsible for the link between health, health outcomes and economic conditions is the strong influence health has on labour force participation, wealth, and earnings. Because unhealthy individuals most likely drop out of labour force sooner and lose income as a result (Deaton, 2006; Møller, 2005).The demand for health investment, like the demand for input factors, is a derived demand because individuals invest in health due to the underlying demand for good health. Current health status as observed by Van Kippersluis and Galama (2013) is a function of the initial level of health and histories of prior health investment. Becker (1964), and Mincer (1974), posited that human capital arises out of any activity that would raise individual worker's productivity. It follows that human capital being the aggregate stock of knowledge, skill and vitality,is vital in creating measurable economic value. This theory posits that there are different kinds of investment in human capital which includes training, knowledge, skill and health. Several authors estimate wage equations for developing country data, again including calories (occasionally also protein intake), or the body-mass index (weight-for-height), and height. Alters et al. (1989) use the body-mass index (*BMI*) and height but find neither to be significant; most other authors, however, find that nutritional status positively and statistically significantly influences wages. Behrman and Deolalikar (1988), Croppenstedt and Christophe Muller (2000), highlight seasonal variations in the role of calorie intake and nutritional status as measured by the body-mass index. Haddad and Bouis (1991) include daily calorie intake, height, and the body-mass index in the wage equation, but find only height to be statistically significant.Height has a strong positive effect on wages for both men and women. Calories and protein intake are significantly related to wages of men and women who work in the market sector.

Much of the literature has focused on the impact of overall health, as measured by life expectancy or adult survival rates. Disease-specific analyses have focused mainly on malaria's negative effects on economic growth in sub-Saharan Africa (Gallup and Sachs, 2001; McCarthy, Holger and Wu, 2000). Considering the studies that focus on the impact of general mortality and life expectancy changes, Bloom et al. (2004) find the coefficient on life-expectancy to be 0.01, implying that increasing life expectancy by one year raises output by about 1%. Lorentzen et al. (2005) also show that adult mortality is a robust and statistically significant predictor of economic growth. Chakraborty (2004) also finds a very strong positive relationship between health and income growth. Turning to studies estimating the effect on the income of malaria, Gallup and Sachs' (2001) find that countries with intensive malaria grew 1.3% less per person per year.

Creating a sustainable agricultural development path simply implies improving the quality of life by ensuring enough food for both present and future generations and generating sufficient income (Udemezue and Osegbue, 2018).

Agricultural development within the ambit of the conservative model was capable in many areas of the world of sustained rate of growth in agricultural production around 1.0% per year over relatively long periods. However, this rate is not compatible with modern growth rate of in the demand for agricultural output which typically fall between 3-5% in the developing countries (Udemezue and Osegbue, 2018).

3. METHODOLOGY

In this study, we modeled health, agricultural output and gross domestic capital per income within a simultaneous equation framework. This is because proper analysis of the relationship between, health, agricultural output and income would, at best, be done within a simultaneous equation framework to allow for the expected bi-directional causation amongst the variables. This is a significant departure from related studies that have adopted single-equation models to examine this relationship. The study utilizes three equations: economic growth, agricultural output and health. In the economic growth equation, real GDP per capita is assumed to depend on physical capital, life expectancy at birth,labour participation rate, health and agricultural interaction. In the health equation, life expectancy is assumed to be a function of real GDP per capita per, body mass index, crude death rate. The agricultural output equation is a function of physical capital, labour participation rate, crude death rate, health and agricultural interaction. The study uses annual data from 1980 to 2018 for Nigeria. The data used for the analysis are secondary data as published and freely made available by the National Bureau of Statistics and the Central Bank of Nigeria. Complementary source includes the World Bank Africa Development Indicator. Due to the issue of endogeniety and possibility of reverse causation, we propose to use simultaneous equation techniques: 2SLS. Thus, the 2SLS estimator is used to (i) account for the simultaneity bias between growth and health variables and (ii) control for the probable existence of cross error correlation resulting from the simultaneity between the health and growth variables. The 2SLS is particularly efficient in the presence of endogeneity bias given appropriate instrumentation.

The study employed an endogenous growth model to examine the interactive effect between human health capital, agricultural output on economic growth in Nigeria. This approach is based mainly on the Mankiw-Romer-Weil empirical growth model (Mankiw et al., 1992), which extends the Solow model to include measures of health human capital in addition to physical capital and labour as determinants of economic growth (Knowles and Owen, 1995; McDonald and Roberts, 2002). This framework assumes the existence of a production function that uses physical capital, human capital and labour as inputs in the production of aggregate output. The parameters of the production function are estimated using a times series dataset of country to evaluate whether differences in health indicators impact subsequent on agricultural output and income growth.

Model Specification

Following Asterious and Hall (2007) and Hyndman and Athanasopolous (2013), introducing logarithms help provide stability to the time series data variance. Using the Cobb-Douglas production function, we can construct a Solow model which includes human capital:

The empirically estimable log-linear form of the model with minor modification is stated as:

$$\text{LnGDPPC} = \Phi_0 + \Phi_1 \text{lnLIF} + \Phi_2 \text{lnCAP} + \Phi_3 \text{lnLAB} + \Phi_4 \text{ln BMI*AGR} + \mu t \quad (1)$$

$$\text{LnLIF} = \alpha_0 + \alpha_1 \text{lnGDPPC} + \alpha_2 \text{lnBMI} + \alpha_3 \text{lnCDR} + \mu t \quad (2)$$

$$\text{LnAGR} = \beta_0 + \beta_1 \text{lnCAP} + \beta_2 \text{lnLAB} + \beta_3 \text{lnCDR} + \beta_4 \text{lnAGR*LIF} + \mu t \quad (3)$$

Where:

lnGDPPC_t= the log of real GDP per capita income at time *t*.

lnAGR_t= the log of agricultural output at time *t*.

lnCAP_t= the log of real gross capital formation (CAP) per capita, which measures physical

Capital Accumulation at time *t*.
$lnLAB_t$= the log of the labour force participation at time *t*.
lnBMI =the log of body mass index proxy for health
$lnLIF_t$= the log of health human capital at time *t*.
ln BMI*AGR_t=the log of interaction between agricultural output and health human capital at time
ε_t = Error term

4. RESULTS AND DISCUSSION OF FINDINGS

Correlation Matrix Analysis

In the empirical literature, studies have shown that the correlation among the variables of estimates would make the researchers detect whether the variables have high multicollinearity among themselves. As a result, the parameter estimates could be contradictory with what would be expected because of multicollinearity's unpredictable effect (Agung, 2009; Hamsal, 2006).

However, Iyoha (2004) argued that multicollinearity among variables occurred when the correlation coefficient was above 0.95. In line with this explanation, we conducted a correlation matrix among the variables used in this study. We detected that there was a strong correlation between body mass index, labour and life expectancy. The results of the correlation among other variables were reasonable, as presented in Table 1 below.

Table 1. Correlation Matrix

	AGR	BMI	CAP	CDR	GDPPC	LAB	LIF
AGR	1						
BMI	0.941203	1					
CAP	0.751274	0.683576	1				
CDR	-0.9262	-0.90589	-0.84449	1			
GDPPC	0.834776	0.765071	0.939719	-0.9022	1		
LAB	0.943373	0.938685	0.700517	0.91419	0.777611	1	
LIF	0.927833	0.897903	0.855487	\0.92799	0.913765	0.906841	1

Source: Author, 2021

Time series Properties

To avoid spurious results, the study Augmented Dickey-Fuller Test to test for the unit root problem in the variables. The stationarity test result showed that all the variables were stationary at the first difference using a five percent significant level, as shown in Table 2 below. Having established that the variables were stationary at the first difference, we tested whether the said variables have long-run co-movement using the Johansen cointegration test.

Table 2. Unit-Root Test Result by Philips Perron.

Variables	PP @ level	Critical value @5%	1st Difference	Critical value @5%	Order of integration
LGDPPC	-0.829581	-2.941145	-4.265588	-2.943427	1(1)
LAGR	-0.080581	-2.941145	-5.906347	-2.943427	1(1)
LCAP	-0.983940	-2.941145	-4.821283	-2.943427	1(1)
LBMI	-1.590046	-2.941145	-14.15629	-2.943427	1(1)
LLAB	-1.407509	-2.941145	-3.470689	-2.943427	1(1)
LLIF	-1.04362	-2.941145	-3.223564	-2.943427	1(1)
LCDR	-1.28744	-2.941145	-3.815074	-2.943427	1(1)

Source: Author, 2021

The cointegration test result showed that there were five cointegrating vectors based on the Eigenvalues and Trace statistics since the hypotheses of no cointegration were rejected at a 5% level for both tests using Mackinnon-Haug-Michelis (1999) p-values as shown in table 3.

Table 3. Johansen Cointegration Result (Long-Run Co-Movement Result)

Rank	***Trace Statistic***	***0.05 critical Value***	***Max-Eign Statistic***	***0.05 critical Value***
R= 0	281.2474	125.6154	92.36754	46.23142
R ≤1	188.8798	95.75366	65.10358	40.07757
R ≤2	123.7763	69.81889	49.99543	33.87687
R ≤3	73.78082	47.85613	41.26719	27.58434
R ≤4	32.51363	29.79707	21.26152	21.13162
R ≤5	11.25211	15.49471	11.20698	14.26460
R ≤6	0.045138	3.841466	0.045138	3.841466

Source: Author, 2021

Table 4: Dependent Variable LGDPPC

Method: Two-Stage Least square

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	14.02244	4.182626	3.352545	0.0020
LLAB	1.104442	0.359200	3.074725	0.0042
LCAP	0.245730	0.038670	6.354572	0.0000
LLIF	0.975787	0.534790	1.824617	0.0771
LBMAGR	0.246136	0.075609	3.255380	0.0026

R-squared	0.916657	Mean dependent var	12.45632
Adjusted R-squared	0.862615	S.D. dependent var	0.238313
S.E. of regression	0.046078	Sum squared resid	0.070066
F-statistic	241.9611	Durbin-Watson stat	1.897871
Prob(F-statistic)	0.000000	Second-Stage SSR	0.046409
J-statistic	6.60E-30	Instrument rank	5

Source: Author, 2021

The estimated result above showed that the explanatory variables explained approximately 86 percent of the total variations in the Nigerian economy's growth. This result showed that the model has high goodness of fit. The standard error of regression was less than a unit that indicated that the model's estimators had minimum variance and hence, efficient, sufficient and best linear and unbiased. The fact that labour participation rate carries a large coefficient and statistically significant at 5 percent level of significance may suggest this is more labour intensive less sensitive to capital. Holding other variables constant a unit increase in labour participation rate will increase gross domestic product per capita by 1.104 units. The positive sign of the labour force coefficient is a piece of clear evidence supporting the theory that the larger the labour force, the higher the supply of labour and hence output growth. This also indicates that the rapid growth in the working-age's labour force in the total population stimulates economic growth (McConnell, Brue and Flynn, 1969; Mankiw, Romer and Weil, 1992; Weil, 2005).

The significance of capital (CAP) in the specifications is an indication that high levels of economic growth can be achieved by increasing and improving the stock of modern capital. Thus, a unit of change in capital increases the level of economic growth by 0.25 units.

Life expectancy is positive and significant at 10 percent level of significance implying that increasing life expectancy by one year raises gross domestic product per capita by about 0.97 units. This result corroborate with Bloom et al (2004).

The coefficient of the interactive variable was positively signed and statistically significant at a 5 percent level. The positive relationship exhibited by the interactive agricultural output and heath proxy by body mass index variable showed that a percent increase in the combination of both agricultural and health would lead to an approximately 0.25 percent increase in the gross domestic product per capita growth.

Table: 5 Dependent Variable LLIF

Method: Two-Stage Least square

Variable	Coefficient	Std. Error	t-Statistic	Prob
C	4.587652	0.146728	31.26641	0.0000
BMI	-0.001067	0.001317	-0.810217	0.4235
GDPPC	0.026749	0.008108	3.298895	0.0023
CDR	-0.376417	0.015807	-23.81340	0.0000
R-squared	0.897360	Mean dependent var		3.851040
Adjusted R-squared	0.797127	S.D. dependent var		0.062459
S.E. of regression	0.003348	Sum squared resid		0.000381
F-statistic	4264.894	Durbin-Watson stat		2.016776
Prob(F-statistic)	0.000000	Second-Stage SSR		0.000937
J-statistic	5.75E-30	Instrument rank		4

Source: *Author, 2021*

All coefficients match the logical interpretation of what the relationships should be (positive and negative). As GDP per capita increases by 1%, life expectancy increases by 0.026 years. Also, crude death rate has inverse relationship with life expectancy if other variables hold constant a unit increase in death rate reduced the life expectancy by 0.37 years. It is highly significant at 1 percent level of significance. Meanwhile, body mass index has inverse relationship with life expectancy and not significant. The finding was corroborate with Alters *et al*(1989) who used the body-mass index (*BMI*) and height but find neither to be significant. It was also found out that height is associated with higher wages for both self-employed men and those who work in the market sector. Moreover, being taller and having a higher BMI is compensated most in self-employment. It was noted that, many of the self-employed in urban Brazil work as manual laborers and returns to strength are large in such vocations in which a lot of energy is required.

The F-test gives a better idea of if every explanatory variable should be in the model. The null hypothesis states that $\beta1=\beta2=\beta3=0$; the alternative hypothesis says that the null isn't true and the variables are jointly significant. When performing the F-test, the F-statistic is 4264.88, with a p-value of 0%. Because of this microscopic p-value, the null hypothesis is rejected. The three explanatory variables are jointly significant, so they all must be in the regression equation.

Table: 6 Dependent Variable LAGR

Method: Two-Stage Least square

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	49.85871	10.00206	4.984844	0.0000
CAP	0.035418	0.067915	0.521500	0.6055
LAB	2.840189	0.693981	4.092606	0.0003
CDR	-0.461129	0.395579	-1.165707	0.2521
BMAGR	1.030690	0.141900	7.263481	0.0000
R-squared	0.966949	Mean dependent var		29.49513
Adjusted R-squared	0.955368	S.D. dependent var		0.696355
S.E. of regression	0.084234	Sum squared resid		0.234150
F-statistic	629.6681	Durbin-Watson stat		2.269884
Prob(F-statistic)	0.000000	Second-Stage SSR		0.070599
J-statistic	2.77E-28	Instrument rank		5

Source: *Author, 2021*

Healthiness (BMI proxy for health) interacts positively and highly significant at 1 percent of significance level with agricultural output, a unit increase in interaction of health and agricultural output will increase agricultural output by 1.03 units. Healthy farmer's learn more in the fields and are more likely to stay in farm (Bhargava et al. 2001; Miguel and Kremer 2004). In addition, improved levels of health capital may increase the rate of return on further investments in health capital. This is particularly true of increases in health programme; people who expect to live health earn their returns on agricultural output over a longer period of time. The positive and significant of interaction of health and agricultural output was in line with Behrman and Deolalikar (19888) and Croppenstedt and Muller (2000).

Better health and nutrition, as related to labor productivity or better production organization (since deciders in good health generally have better intellectual capacities), can increase household income and economic growth. Poor health will result in a loss of days worked or in reduced worker capacity, which, when family and hired labor are not perfect substitutes or when there are liquidity constraints, is likely to reduce output (world Bank 2016). The elasticity of labour with respect to agricultural output 2.84 significant at 1 percent level of significance is an indication of the strength of the productivity-nutrition and health relationship. A unit increase in labour participation increase the agricultural output by 2.84 units, In Nigeria governments are increasingly concerned with the basic needs of their populations, and education and health projects account for rising public sector expenditures.

Crude death rate have inverse relationship with agricultural output if other variables hold constant a unit increase in death rate reduced the agricultural output by about 0.46 billion of agriculture value added. One of the most direct ways in which crude death rate affect the sector is through reduced production. This results in direct economic loss to farmers, which can cascade along the entire value chain, affecting agricultural growth and rural livelihoods.

Labour participation exhibit positive relationship with agricultural output and highly significant at 1 percent level of significance. This result confirmed with the theoretical preposition corroborates with Etea and Obodoecchi (2018) work and Aroriade and Ogunbadejo (2014). While the capital is positive but not significance this can be attributed to the fact that most farmers are still used crude methods like cutlasses and hoes for farming.

The coefficient of determination ($R^2 = 0.9669$) suggested that the explanatory power of the independent variable is very high, it means that 96.69 percent variations in agricultural output are accounted for by the changes in explanatory variables. This result showed that the model has high goodness of fit.

5. CONCLUSION AND POLICY RECOMMENDATIONS

There are records of studies that propose the imperative and positive effect of healthy human capital and agricultural output on economic growth. The effect, however, differs significantly among various studies depending on the model, the data and the case country. Studies based on growth calculation methods result in a less potent effect of health capital on the output. Finally, empirical studies of endogenous growth imply the crucial impact of health human capital and agricultural output on economic growth in different countries.

The results of this study which are based on the endogenous model, also confirm the positive and significant interactive effect of health capital components and agricultural output on Nigeria's agriculture and gross domestic per capital growth. According to the results of this study, health capital's interactive effect affects economic growth in Nigeria.

Based on this study's findings, the following recommendations are made that all the stakeholders should invest in capacity building to help translate the interaction into a comprehensive action on ground. Government should strive a programme that will not only encourage agricultural output but also enhance the health facilities in the country and motivate the health personnel with reasonable remuneration to guarantee increased productivity in the sector.

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