HEALTH AND LABOUR PRODUCTIVITY IN NIGERIA: A MACROECONOMIC APPROACH

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Abstract

This study empirically examined the effects of health status on labour productivity for the period 2000Q1 to 2018Q4. In addition, the study examined the effect of macroeconomic variables on Nigerian labour productivity. Finally, the nature of relationship that exists among health status, macroeconomic variables and labour productivity was examined. The study proceeded by first testing for stationarity and co-integration of the variables used in the estimation process. Health status in this study is proxy by malaria cases, the proportion of undernourished Nigerians and life expectancy rate at birth. The macroeconomic variables considered in this study were secondary school enrolment rate and gross fixed capital formation. The vector auto-regression and the granger causality were used for the analysis. The empirical results attained showed that output per man has self-cumulative effect. Malaria cases constituted drag to labour productivity during the study period. Secondary school enrolment rate, the proportion of malnourished Nigerians and life expectancy rate at birth had no significant effect on output per worker. The study recommended that policies should be formulated to combat malaria in Nigeria, secondary school curriculum should be reviewed and efforts should be made to improve the life expectancy rate for Nigerians.

Keywords: Health, Labour productivity and Nigerian economy.

1.0 Introduction

There has been growing attention on improving the health of the population among developing countries due to its implications on enhancing labour productivity and improvement in overall economic performance (Laplagne, Glover and Shomos, 2007). The World Health Organization (1996) defines health as a "state of complete physical, mental and social well-being and not merely the absence of disease or infirmity". According to Anyanwu, Oyefusi, Oaikhena and Dimowo (1997), health is the ability of an individual to live a socially and economically productive life. The first approach based on the Grossman (1972) health capital model assumes that an individual is born with a stock of health that diminishes over time, but can be replenished through the act of health investment. The available health stock of a person produces a stream of healthy time payoffs that determines the individual market (investment) and non-market (consumption) participation in the economy. When this stock diminishes below a certain point, death occurs. In this model, individuals use medicare and their own time to produce "good health". Thus, the health of the individual depends on the amount of time the individual spends and on the investment he or she makes.

Health status is the general wellbeing of a person at a point in time. The health status of a people transcends the mere absence of infirmity or diseases and often it is summarized by life expectancy or self-assessed health status. Life expectancy is the number of years an individual will live at a point in time. There are various categories of life expectancy rate and they are life expectancy rate at birth, healthy life expectancy at 60 years, and healthy life expectancy at birth. Self-assessed health is a subjective assessment of health which comprises physical, emotional, mental health and well-being.

Globally, there are five dimensions of health that can affect labour productivity. These include: disease burden, malnutrition, bodily injuries, life style habits (such as smoking and drinking) and barriers to healthcare utilization. Malnutrition is a situation where people do not eat the food required by the body to be healthy so that they are dietarily deficient. Body injuries include broken bones, fractures and burns which may cause infection and consequently reduce the quality of life of an individual. Diseases are abnormal conditions that negatively affect the functioning of the body, and are not due to external injury. As medical conditions, diseases are associated with symptoms and signs. There are non-communicable diseases (e.g. cancer, lung diseases, diabetes) and communicable diseases (HIV/AIDS, tuberculosis). The United Nations Programme on HIV/AIDS (UNAIDS,2005) statistics revealed that HIV continues to be a global public health challenge with 36.9 million people globally living with HIV and 25.3 million people who died of HIV/AIDS-related illness since the year 2000. African continues to be plagued by HIV/AIDS. Evidence from the WHO (2016) statistics showed that sub-Saharan Africa (SSA) has the highest number of total new infection of HIV/AIDS, and it accounts for over 70% of it globally. In 2017, 75% of deaths and 65% of new infections occurred in SSA and 71% of people with HIV/AIDS resided in SSA (Dwyer-Lindgren, Cork, Slogar, Stenben, Wilson et al; 2019). According to UNAIDS (2019), Nigeria recorded an adult HIV/AIDS prevalent rate of 1.5%, that is, approximately 1.9 million people were living with HIV in 2018. Over 90% of global malaria cases occur in Africa. In 2017, there were 219 million malaria cases that occurred worldwide. In Nigeria, there are over 100 million malaria cases every year with 300,000 deaths per year (Nigeria Malaria Fact Sheet, 2018). Life expectancy rate in SSA was estimated to be 61 years in 2017, which was below that of developed nations -70 years (World Development Indicators, 2018).

The effect of health on labour productivity has been the subject of various studies in Nigeria. A good number of the studies adopted microeconomic perspectives by examining the effect of self-assessed health on labour productivity for a set of individuals (see Omonona, Egbetokun and Omiolele, 2012; Ajani and Ugwu, 2008). While most of these studies validated the pivotal place of health capital on labour productivity findings from the studies cannot be generalized given their limited scope. In addition, the use of subjective assessment of health cannot be validated given that responses cannot be validated.

There are only few studies that examined the effect of health on labour productivity using aggregate time series data for Nigeria (see Jimoh, 2005; Umoru and Yaqub, 2013; Ahuru and Iseghohi, 2018; Onyema and Nyenke, 2019). Beside Umoru and Yaqub (2013), all of these studies utilized a single equation technique such as ordinary least square. A single equation technique does not address possible reverse causality from economic progress to health status. The findings of the studies could not address endogeneity bias hence simultaneous equation technique that addresses such endogeneity bias should be utilized. In this present study, the versatile tool of vector Auto regression model, which addresses possible reverse causality from labour productivity to health will be examined. Also, the method will allow us examine the short-run dynamics and long-run equilibrium relationship between health status and labour productivity in Nigeria.

2.1 Empirical Review of Literature

Bloom and Canning (2000) identified four pathways by which health can affect productivity namely; healthy labour force may be more productive because workers have more physical and mental energy and are absent from work less often; individuals with a longer life expectancy may choose to invest more in education and receive greater returns from their investments ; with longer life expectancy, individual may be motivated to save more for retirement , resulting in a greater accumulation of physical capital; and improvement in the survival and health of young children which may in turn provide incentives for reduced fertility and result in an increase in labour force participation leading to increase in per capita income if these individuals are accommodated by the labour market.

In a study by Cai and Caleb (2004) for Australia, they controlled for endogeneity of self-assessed health in labour force equation by applying only full information maximum likelihood criterion. The study observed that better health increases the probability of labour force participation for age group 15-64 across gender. On the reverse, it was reported that labour force participation had a negative impact on older females' health and negative impact on younger males' health. For younger females and older males, the impact of labour force participation on health was not significant.

Kalwij and Vermeulen (2005) who studied labour force participation of elderly for eleven countries in Europe found that different health indicators had different significant impact on the decision of the elderly to participate in the labour force and that health effects differ between countries. The study utilized both subjective measures of health (self-assessed health) and objective health measures (body mass index and bad mental health) for individuals aged 50-64. Using descriptive analysis, they observed improved health conditions may yield 10 percentage points higher for men than women in some European countries under study, while in other countries studied, participation would be higher for females with improved health than males.

Thomas and Thierry (2006) analyzed disability and labour force participation of older workers using latent variable model. In a preliminary step they estimated an equation of participation by directly introducing the self-reported disability, but the ‘’ true’’ disability status was unobserved. In a second step following Bound (1991) methodology, they used estimations of self-reported disability and observed that using a self-reported health measure leads to a downward bias in the impact of disability status on labour force participation.

Cai (2007) examined the relationship between health and labour force participation in Australia. The study adopts the method of simultaneous equation panel model using full information maximum likelihood criterion and two-stage least square to observe the relationship between self-assessed health and labour force participation for both males and females. Drawing upon data from HILDA data, it was observed that health had a significant positive effect on labour productivity.

Omonona, Egbetokun and Omidele (2012) investigated the effects of health on labour productivity for 120 farmers in Osun State, using multi-stage sampling technique. The effect of ill-health labour productivity was examined using ordinary least square. Adverse health status was measured by average days lost to incapacitation due to ill-health has negative effect on labour productivity. The longer the period of the illness, the lower the productivity. The study concluded that community extension workers should collaborate with farmers in the prevention of human diseases and improvement in general health.

Eneyi, Juliana and Onabe (2013) in their study were interested in examining the relationship among healthcare expenditure, health status and national productivity. They utilized annual time series data for the period (1999-2012) and utilized ordinary least square techniques. The study reported strong positive and significant relationship between poverty, unemployment, nutrition, health status and national productivity in Nigeria. The study concluded that improvement in healthcare expenditure is a necessary condition for enhancing human capital development in most economies.

Umoru and Yaqub (2013) also chronicled their findings on the impact of health capital on labour productivity for Nigeria. According to the researchers, health capital is both a result and a determinant of labour and hence income level. The study examined the impact of health capital on labour productivity. The mechanism is that richer nations have on average healthier workforce. The healthiness of the country’s labour force determines importantly her level of productivity and hence economic growth (Weil, 2004). Labour productivity being the ratio of the volume of input, uses hour worked, labour force jobs and number of individual employment as measures of inputs.

In their paper titled, “Health expenditures and economic growth’’, Ozturk and Topcu (2014) used panel co-integration method of estimation for annual data for the period of 1995-2012 for G8 countries. Their findings from panel error correction model (ECM) revealed that the existence of growth hypotheses is confirmed in the long run. The study therefore, recommended that governments of developing countries have to invest in their services now, if they are to benefit from it in the long run just as the developed countries are reaping their benefits to day.

Dogrul (2015) examined the effect of health status on labour force participation in Turkey utilizing a two-stage estimation technique for a cross-sectional data and found out that health status significantly affects labour force participation for all age-gender groups. Also, a reverse causality noted flowing from labour force participation to health, showing there is psychic utility in being engaged economically. However, its findings that labour force participation positively influenced health contradicts that of Cai's(2007) findings that labour force participation had negative effect on health status of men.

Nwosu and Woolard (2015) applied the bivariate problems and Instrumental Variables (IV) models on a cross-sectional data to show the exogeneity of self-assessed health in labour force participation in South Africa. The study found a positive and significant association between better health and labour participation for both males and females, where the effect was more pronounced among males.

Novignon, Novignon and Arthur (2015) used an objective health indicator –life expectancy as a proxy for health status to examine the relationship health status and labour force participation in SSA by employing a dynamic panel model using generalized method of moments. The result shows a significant effect of health status on female labour force participation across SSA countries.

Onyema and Nyenke (2019) examined the nexus among healthcare, health status and labour productivity for Nigeria for the period 1990-2017. The ordinary least square method was used for the analysis. Undernourishment and life expectancy rate did not yield significant impact on labour productivity. The authors attributed this to institutional weakness and corruption. However, prevalence of HIV/AIDS and risk of catastrophic expenditure on surgical care are consistent with apriori expectations.

3.1 Theoretical Framework

The endogenous growth model explains that balanced growth is positively influenced by knowledge spillover, human capital (in the form of health and education), research and development (R & D), through their influence on technical progress. Technological progress in this model is therefore endogenized and can be explained by some factors. Based on this model, Lucas (1988) put forward an endogenous growth model where human capital is a major driver of output growth. Lucas (1988) theorized that economic growth Y is a function of capital stock (K), Labour (L) and technological progress (A). The production function may be of the form:

$$Y_t = K_t^{\alpha} A\, L_t^{(1-\alpha)} \qquad \textbf{(1)}$$

Where A (t) L is effective labour with α and 1-α as shares of K and AL respectively in output. Now with the technical progress or labour productivity (A) being entirely explained by the stock of human capital, say, H, that is, human capital increases labour productivity.

$$A=H \qquad (2)$$

Consider an economy where the population does not grow, that is n = 0 (where n is the growth rate of the population), there are constants returns to scale to the produced inputs in both goods and research sectors. Furthermore, Research and Development (R & D) uses labour and the existing stock of human capital, but not physical capital, whereas goods production uses labour, human and physical capital. The production function for labour productivity is given by:

$A_{(t)} = \beta a_1 L A_{(t)}$ (3)

And since all physical capital is used to produce goods, goods production is

$Y(t) = K(t)^{\alpha}[(1 - a1)LA(t)]^{1-\alpha}$ (4)

Where A (t) denotes a derivative of labour productivity with respect to time (that is, A(t) is a shorthand for $\frac{dA(t)}{dt}$; β is a shift parameter (which accounts for all other factors affecting rate of change of labour productivity other than labour and labour productivity), a_1 and 1-a_1 denote the fraction of labour used in labour productivity and goods production, respectively; and α represents the elasticity of output with respect to capital stock, while L, A, K and Y are labour force, labour productivity, capital stock and output respectively. Notice that time (t) enters the model continuously in line with (the prescription of) the endogenous growth theory. The saving rate is assumed to be constant, so that:

$K_{(t)} = sY_{(t)}$ (5)

Equation (4) is important to this study because it introduced capital stock, labour and labour productivity as (macroeconomics) determinants of output. Since model (4) is a mathematical model, it has to be changed to an econometric model by exponentially introducing the error term as thus:

$Y(t) = K(t)^{\alpha}[(1\text{-}a1)LA_{(t)}]^{1-\alpha} \; e^{u(t)}$ (6)

Where μt is error term, which entered the model exponentially for two reasons: First, for the model's error term after transformation to follow a normal distribution with zero mean and homoscedastic variance, that is μ~(0,δ), as it is required for valid statistical inference. If μ (t) had entered model (6) multiplicatively such as in $Y(t) = K_t\,[(1\text{-}a_1)LA(t)^{1-a}\mu(t)$, it is then the model's log-error that will follow normal distribution, that is in $\mu \sim N(0,\delta^2)$, in which case μ must follow the log-normal distribution with mean $e^{\frac{\delta 2}{2}}$ and variance $e^{\delta 2}$ ($e^{\delta 2}$-1), which has implications to the statistical inference of the model's findings. Second, $\mu_{(t)}$ entered model (6) exponentially for it to be intrinsically linear (in parameter) regression model because if it had entered additively such as in $Y(t) = K(t)^{a}[(1\text{-}a1)LA(t)]^{1-a} + \mu(t)$, there is no way to transform the model so that the transformed model becomes linear in the parameters (Gujarati & Porter,2009). Thus, to show that model (6) is a suitable growth model for this study and to enable the use of linear regression estimation technique such as Vector Auto regression rather than "trial-and-error" or 'iterative' methods of nonlinear regressions, we log-transform model (6) as thus:

$1nY(t) = 1n[K(t)^{\alpha}$ [(1-a$_1$)LA$_{(t)}$]$^{1-\alpha}$ $e^{u(t)}$ (7)

So,

$1nY(t) = \alpha 1\text{nK}(t) + (1-\alpha)\ln(1-\text{a}1) + (1-\alpha)1\text{nL} + A_{(t)} + \mu(t)1\text{ne}$ (8)

then,

$1nY(t) = \alpha 0 + \alpha 1\text{nK}(t) + (1-\alpha)1\text{nL} + A_{(t)} + \mu\,(t)\,1\text{ne}$ (9)

$where\ \alpha 0 = (1 - \text{a}1)\ln(1-\alpha) = a\ constant,$ And Lne = 1.

Then again, to measure output per man, a measure of labour productivity, we will use per capita income derived in growth model by dividing model (4) by labour, L, as thus:

$\frac{Y(t)}{L(t)} = \frac{K(t)^{\alpha}[(1-\alpha 1)LA(t)]^{(1-\alpha)}}{L(t)} = \frac{Y(t)}{L(t)} = K(t)^{\alpha}{}_{[(1\text{-}\alpha 1)\ LA\ (t)]}{}^{1\text{-}\alpha}\ [L\ (t)]^{-1}$ (10)

Then, $\frac{Y(t)}{L(t)} = k(t)^{\alpha}\ (1-\alpha 1)^{1-\alpha}A(t)^{1-\alpha}L(t)^{1-\alpha-1}$ **(11)**

i.e. $\frac{Y(t)}{L(t)} = k(t)^{\alpha}\ (1-\alpha 1)^{1-\alpha}A(t)^{1-\alpha}L(t)^{-\alpha}$ (12)

y(t) $= k(t)^{\alpha}\ (1-\alpha 1)^{1-\alpha}A(t)^{1-\alpha}L(t)^{-\alpha}e^{\varpi t}$ (13)

Where: y(t) denotes output per man (a proxy for labour productivity), and where ϖt is the error term introduced exponentially into the model for the same reason as in model (6)

We divided output by labour as our measure of productivity because output per man or per capita means per head/population. The population of interest here is the population of the working-age and precisely the labour force because Blanchard (1997) opines that people who are not working and are not looking for employment are not regarded as unemployed, hence they are not counted among the labour force. Blanchard (1997) calls these people discouraged workers. Thus, our derivative of the per capita output as a measure of labour productivity in the model (13) is quite a reasonable approximation.

Log-transformation of model (13) yields:

Ln y (t) =$\ln [\ k(t)^{\alpha}(1-\alpha 1)^{(1-\alpha)}A(t)^{(1-\alpha)}L(t)^{(-\alpha)}e^{\varpi t}\ ]$ (14)

Ln y(t) = α$\ln K(t)$ + (1-α) lnA(t) +$(1-\alpha 1)$ 1n (($(1-\alpha)$ -αlnL(t) +ϖt - - - (15)Thus, lny (t) = $\alpha 1$+ (1-α) 1nA (t) +α 1nK (t) + -α1n L (t) +ϖt - - - - - - - - - (16)

Where $\alpha 1 = (1 - \alpha 1)$1n (1- α) = a constant, and 1ne = 1

Now, assumes the growth rate of labour to be equal to zero, that is, $\frac{dlnL(t)}{dt} = \frac{dL(t)}{dt}$/L(t) = n= 0, Then the two most interesting models for this study-model (9) and (16)- will reduce respectively to:

$lny(t) = \alpha 0 + (1 - \alpha)$LnA (t)+$\alpha lnK + \mu_t$ (17)

And, $lny(t) = \alpha 1 + (1 - \alpha)$lnA(t)+$\alpha lnK + \varpi$t (18)

Note that transformations that yielded equations (17) and (18) were done also to justify the rationale behind the logging of some variables in this study. Finally, substituting equation 2 or 3 into either 17 or 18, so that human capital H and by consequence, health enters the model, we have:

$lny(t) = \alpha 0 + (1 - \alpha)$LnH (t)+$\alpha lnK + \mu_t$(19)

And, $lny(t) = \alpha 0 + (1 - \alpha)$lnH(t)+$\alpha lnK$ +ϖt (20)

Thus the equations 19 or 20 will serve as the fundamental equation adopted for this study. It simply shows that human capital in the form of health is an important determinant of labour productivity.

3.2 Model Standard, Data and Econometrics Results

Lately, researchers have begun to examine the interrelationship among macroeconomic variables using the powerful and versatile techniques known as Vector Auto regression (VAR), which was pioneered by Sim (1980a &b) (Iyoha, 2015; Sede and Ahuru, et al; 2017). VAR is attractive as it deals with the interrelationship among macroeconomic variables treating all the variables as endogenous. It has been proved that VAR is a powerful tool for the analysis of time series data, and evaluation of short and long-run dynamics. This research therefore, explored the powerful tools to explicate the intricate links between health and labour productivity. The study utilized unit root tests, cointegration tests and forecasting error variance decomposition to explore the complex interrelationship among health status, macroeconomic variables and labour productivity in Nigeria. This study posits a six variable-VAR model which includes output per worker (**OUT_L**), secondary school enrolment rate (SSER), Gross Fixed Capital Formation (GFCF), Malaria Cases(MC), Life Expectancy Rate at birth (LER), and the proportion of people under nourished (UN).

3.4 Data and its Sources

Quarterly data covering the period 2000Q1 to 2018 Q4 were utilized and they were output per worker (**OUT_L**), secondary school enrolment rate (SSER), Gross Fixed Capital Formation (GFCF), Malaria Cases(MC), Life Expectancy Rate at birth (LER), and the proportion of people under nourished (UN). Table 1 shows the various sources of the data and brief description for them.

Table 1: Variables Description and Sources

Variables	**Description**	**Sources**
Output per worker (OUT_L)	It is total output divided by the number of labour force.	International labour organization (ILO, 2018)
Gross fixed capital formation (GFCF)	Gross capital formation (formerly gross domestic investment) consists of outlays on additions to the fixed assets of the economy plus net changes in the level of inventories.	Central Bank Statistical Bulletin (CBN, 2018)
Secondary s school enrolment rate (SSER)	Secondary school enrollment is the proportion of the population of the official age for secondary education according to national regulations who are actually enrolled in secondary schools.	World Development Indicators (WDI)
Malaria cases (MCs)	Measure the prevalence of malaria	World Health Organization Website (WHO)
Life expectancy rate at birth (LER)	Life expectancy at birth indicates the number of years a newborn infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life.	World Development Indicators (WDI)
Proportion of under nourished people (UN)	It shows the proportion of Nigerians that are undernourished	World Development Indicators (WDI)

Source: Authors Computation (2021).

3.5 Econometric Estimations Results

In This section of the study the results of the estimated models are present. The results presented in the order of descriptive statistics, unit root, co-integration tests, the VAR estimates, Forecasting error variance decomposition and Impulse Response Functions.

Table 2: Descriptive statistics

	OUT_L	SSER	GFCF	UN	MC	LER
Mean	15176.95	37.29263	5356.777	8.268421	3296756.	50.21579
Median	14971.00	35.09000	3050.580	7.800000	3183072.	50.40000
Maximum	19728.00	46.76000	16908.13	13.80000	6757961.	54.00000
Minimum	9429.000	24.46000	331.0600	6.000000	0.000000	46.30000
Std. Dev.	3504.828	6.785831	5648.431	2.345390	2442151.	2.534090
Skewness	-0.047501	-0.302003	0.933486	1.143817	-0.102645	-0.100640
Kurtosis	1.671370	1.738497	2.245928	3.359045	1.604674	1.647916
Jarque-Bera	5.618567	6.194671	12.83834	16.98025	6.298753	5.917376
Probability	0.060248	0.045169	0.001630	0.000205	0.042879	0.051887
Sum	1153448.	2834.240	407115.0	628.4000	2.51E+08	3816.400
Sum Sq. Dev.	9.21E+08	3453.563	2.39E+09	412.5642	4.47E+14	481.6211
Observations	76	76	76	76	76	76

Source: Authors Computation (2021).

The descriptive statistics of the data employed in this study is presented in Table 1. The average output per worker is 15176.95, which is relatively high given that its maximum value is 19728.00. Output per man has a standard deviation of 3504.828, which shows wide dispersion around its mean value. The mean value of secondary school enrolment rate is 35.09000, which is low and its standard deviation of 6.785831 shows that the series is tightly clustered around its mean value. The mean value of the proportion of under nourished persons (8.268421), and life expectancy rate (50.21579), shows that an infinitesimal proportion of Nigerians are malnourished, while the life expectancy rate for Nigeria is low. With the exemption of gross fixed capital formation and the proportion of malnourished Nigerians, all other macroeconomic variables are negatively skewed. Only the proportion of malnourished Nigerians has normal kurtosis. The jarque Statistics showed that all the variables are normally distributed.

3.6 Unit root tests

Since the study uses economic time series data, it is advisable to begin by verifying the time series properties of the variables employed. In order to test for the stationarity of the variables used in this study, unit root testing of all the macroeconomic variables was conducted using both Augmented Dickey-Fuller and Phillip-Perron approaches. Both approaches were considered the most reliable tests of stationarity for economic time series variables. The unit root tests were conducted using eview 7.0. The results are presented in Table 3.

Table 3: Unit Root Test using Augmented Dickey Fuller and Philip-Perron

	Unit Root Test using Augmented Dickey Fuller				Unit Root Test using Philip-Perron			
Variables	Test statistic for variables in levels		Test statistics for variables in first difference		Test statistic for variables in levels		Test statistics for variables in first difference	
	Without trend	With trend	Without trend	With trend	Without trend	With trend	Without trend	With trend
NOUT_L	-2.41 (-2.90)	-1.12(3.49)	-21.49(-2.90)*	-21.39(-3.47)*	-2.32(-2.90)	0.84(-3.41)	-10.11(-2.90)*	-13.50(-3.47)*
NGFCF	-0.66(-3.08)	-2.48(-3.69)	-4.53(-3.05)*	-4.36(-3.71)*	0.52(-3.04)	-2.51(3.69)	-4.72(-3.05)*	-4.52(-3.71)*
NLER	18.12(-3.08)*	0.525(-3.759)	-91.49(-3.09)*	79.60(-3.76)*	1.28(-3.04)	-2.26(-3.47)	-12.34(-2.90)*	-11.71(-3.47)*
NMC	-1.26(-2.90)	-1.799(-3.494)	-7.38(-2.92)*	-7.34(-3.49)*	-1.26(-2.92)	-1.84(-3.49)	-27.80(-2.92)*	-7.34(-3.49)*
NUN	-0.92(-2.90)	-1.228(3.474)	-18.55(-2.90)*	-4.88(-3.48)*	-2.01(-2.90)	-2.16(-3.47)	-8.74(-2.90)*	-8.89(-3.47)*
NSSER	-2.00 (-2.90)	-2.164(-3.471)	-7.16(-2.91)*	-8.87(-3.47)*	0.85(-2.90)	-0.12(-3.47)	-8.63(-2.90)*	-10.16(-3.47)*

Source: Authors Computation (2021).N: natural logarithms; *Variables that are stationary

- Values outside the bracket are ADF statistics, while those in parenthesis are the critical values

The unit root analysis was conducted with the use of ADF and P-P both with trend and without trend. Also, analyses were conducted both at levels and first difference. Concerning ADF results, for level and without trend only LER was stationary, but none of the variables was stationary at levels with trend. However, when the variables were differenced, all the variables became stationary, both with trend and without trend. Analysis of the P-P result revealed that none of the variables was stationary at levels both without trend and with trend analyses. However, at first difference, all the variables became stationary. The variables used for the analysis can be said to be integrated of order one.

3.7 Co-integration Test

Table 4 : Cointegration test results of : NOUT_L NGFCF NLER NMC NSSER NUN

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.827934	0.0609
Test critical values:	1% level	-3.555023	
	5% level	-2.915522	
	10% level	-2.595565	

*MacKinnon (1996) one-sided p-values.

Source: Authors Computation (2021).

The Engel -Granger cointegration tests result is presented in Table 4, and it showed that there is at least one long-run relationship (determined at the point where the test statistics is greater than the 90% critical value) between the dependent variable and the independent variables. The evidence of long-run cointegration relationship rules out spurious correlations and it implies that at least one direction of influence can be established among the variables (Ighodaro, 2015).

3.8VAR Lags Selection Criteria

In the specification of an optimal lag length, one of the challenges faced is that if the chosen lag length is too small, it may be possible that the model is wrongly specified due to omission of relevant variables and if too large the model may be over parameterized resulting in the loss of degrees of freedom. In the literature, a model with relatively large number of parameters will generate residuals that approach the white noise process, but might not be parsimonious on the other hand. A model with over restricted parameters may likely be parsimonious, but may not produce residuals that are random enough to approach white noise process. The above problem implies that there is the need to select an optimal lag length. The Ackaike Information criteria (AIC), Schwartz Bayesian Information criteria (SIC), Hannan Quinn (HQ) are identified in the literature as appropriate optimal lag selection criteria. The lag selection result is presented in table 5. The AIC and SC revealed that the optimal lag length is two.

Table 5: VAR lag Selection Criteria

Endogenous variables: NOUT_L NGFCF NLER NMC NSSER NUN

Lag	LogL	LR	FPE	AIC	SC	HQ
0	369.3070	NA	1.97e-14	-14.53228	-14.30284	-14.44491
1	637.2748	460.9046	1.86e-18	-23.81099	-22.20489	-23.19938
2	647.4349	15.03698	5.56e-18	-22.77740*	-19.79464*	-21.64155
3	668.4336	26.03841	1.20e-17	-22.17734	-17.81793	-20.51726
4	894.7749	226.3412	8.40e-21	-29.79099	-24.05493	-27.60667
5	969.3474	56.67511*	3.50e-21*	-31.33390	-24.22117	-28.62533*
6	984.0817	7.661827	2.91e-20	-30.48327	-21.99388	-27.25046

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akahike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Source: Authors Computation (2021).

Table 6: VAR Estimates Result

Variables	NOUT_L	NGFCF	LER	MC	SSER	UN
NOUT_L(-1)	0.852 (2.053)**	0.026 (0.008)	0.004 (2.055)**	0.200 (0.118)	-0.066 (-0.087)	-0.221 (2.398)**
NOUT_L(-2)	0.150 (0.351)	2.647 (0.784)	0.005 (0.073)	0.033 (0.019)	0.396 (0.505)	-0.629 (-1.096)
NGFCF(-1)	-0.007 (-0.249)	0.746 (3.574)	0.000 (0.000)	0.015 (0.135)	-0.012 (-0.244)	-0.002 (-0.049)
NGFCF(-2)	-0.009 (-0.328)	-0.284 (-1.234)	0.000 (0.000)	-0.013 (-0.113)	0.011 (0.218)	-0.006 (-0.176)
LER(-1)	-0.617 (-0.303)	-2.427 (-0.151)	0.673 (2.069)	- 1.932 (-0.232)	0.477 (0.128)	-0.896 (-0.328)
LER(-2)	1.217 (0.593)	7.419 (0.459)	0.259 (0.793)	1.528 (0.182)	0.296 (0.079)	3.271 (1.189)
MC(-1)	-0.003 (-2.051)	0.056 (0.127)	0.000 (-0.039)	0.764 (3.365)**	-0.017 (-0.166)	-0.002 (-0.023)
MC(-2)	-0.017 (-2.299)	-0.182 (-0.415)	0.001 (0.099)	- 0.072 (-0.317)	-0.079 (-0.782)	-0.004 (-0.007)
SSER(-1)	-0.015 (-0.102)	-0.872 (-0.073)	0.005 (-0.014)	0.267 (-0.244)	-0.217 (3.054)**	0.074 (-0.124)
SSER(-2)	-0.021 (-0.147)	-0.872 (-0.763)	0.005 (0.211)	0.267 (0.452)	-0.217 (-0.818)	0.074 (0.382)
UN(-1)	0.015 (0.100)	0.128 (0.107)	0.000 (0.000)	-0.053 (-0.086)	0.049 (0.176)	0.713 (3.516)**
UN(-2)	-0.029 (-0.198)	-0.045 (-0.038)	-0.005 (-0.229)	-0.439 (-0.714)	-0.119 (-0.431)	0.276 (1.369)
R2	0.984	0.962	0.990	0.940	0.937	0.950
ADJ R2	0.979	0.950	0.987	0.923	0.918	0.935
F-stat	207.307	85.486	349.276	53.736	50.49	64.959

( ) standscalculated values
***, **, *** respectively represents significant coefficient at 1%, 5%, and 10%.**

( ) stands for t calculated values
***, **, *** respectively represents significant coefficient at 1%, 5%, and 10%.**

Source: Authors Computation (2021).

The VAR estimates are presented in Table 6. Remember that all the coefficients are elasticities given that the logs of the variables were used. The result revealed that one time lagged value of all the variables have significant effect on its own current value. The coefficients of determination range from 0.937 to 0.984, which shows that the entire estimated models have impressive goodness-of-fit and high explanatory power. The adjusted coefficient of determination ranges from 0.918 to 0.987, which reflects a set of models that have high predictive ability. The F-statistics for the six estimated models show that a significant linear relationship exists between the dependent variable and the included regressors for each model. One time lagged value of output per worker has significant positive effect on current value of output per worker, showing that output per worker has self-feeding effect. Both one time and two times lagged value of secondary school enrolment has positive coefficients in output per man equation, but it is not significant. One and two time lagged values of malaria cases have significant negative effect on output per man. One time lagged value of output per worker has significant positive effect on life expectancy rate at birth. On the other hand, two time lagged value of output per man has significant negative effect on the proportion of the population that is undernourished.

3.9 Forecasting Error Variance Decomposition (FEVD)

The variance decomposition estimates are used to determine the contribution of each sector to the changes in other sectors. From the variance decomposition result, it can be seen that a large proportion of the variance decomposition in each of the variables is due to own shock.

In Appendix I, the variance decomposition for output per worker shows that it accounted for 100% of its own shock in period one. By the tenth period, contribution to own shock stood at 87.8%. Life expectancy rate made modest contribution to the variance of output per worker. Its contribution increases consistently until it peaked at 8.38% by the tenth period.

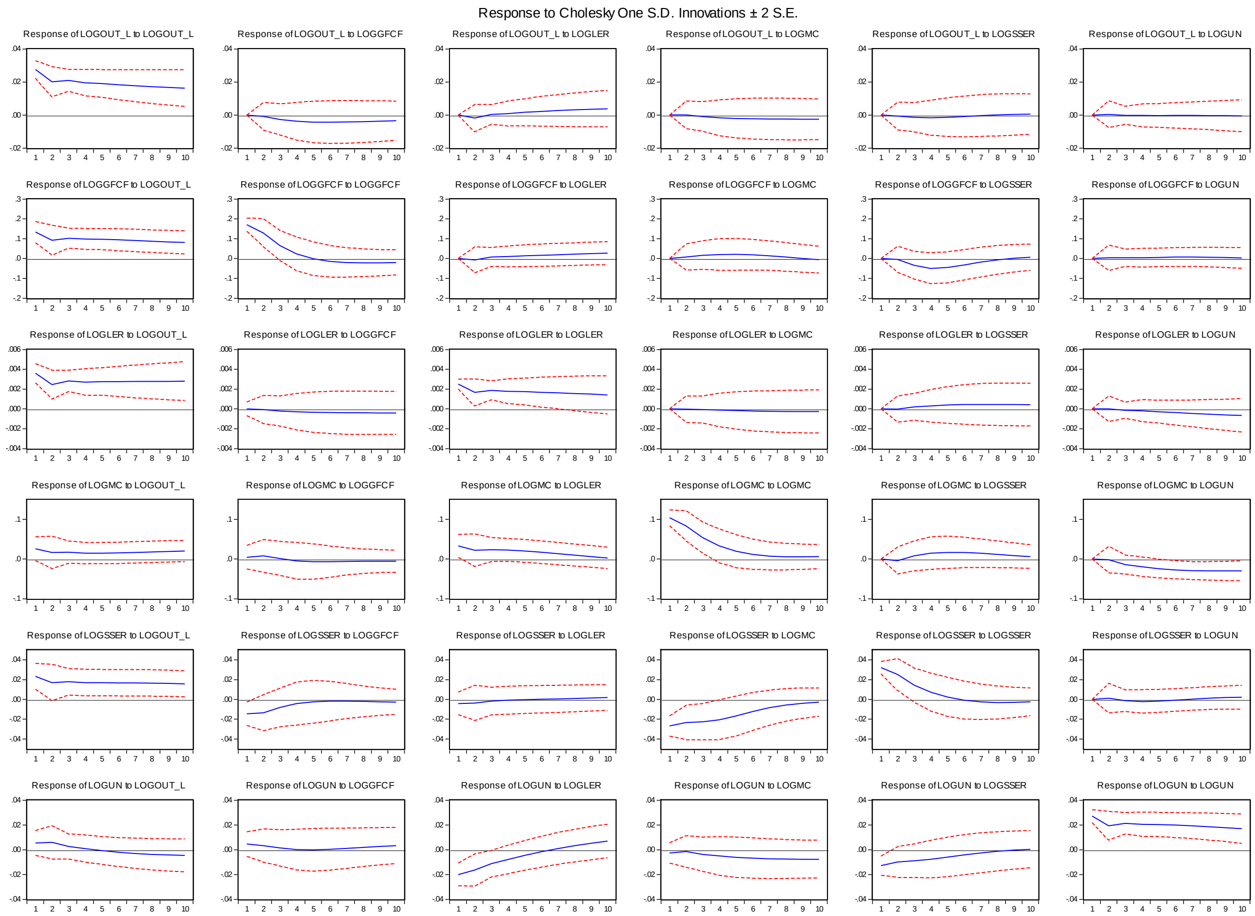
In Appendix II, the variance decomposition of gross fixed capital formation shows that it contributed 62.12% to its own shock by the first period. However, its own contribution decreases consistently throughout the period until it stood at 33.16%. Secondary school enrolment rate made a modest contribution to the variance of gross fixed capital formation. By the third period its contribution was 1.35% and rose to 4.51% by the tenth period. Output per worker made an impressive contribution to the variance of gross fixed capital formation. Its contribution started with 37.88% by the first period and rose to 59.19% by the tenth period.

In Appendix III, the variance decomposition of life expectancy rate at birth is presented. The variance of life expectancy rate at birth is predominantly influenced by output per worker. By the tenth period, the contribution of output per man to the variance of life expectancy rate at birth stood at 69.65%, while contribution to own shock stood at 26.72%. Both secondary school enrolment rate and the proportion of malnourished people made an insignificant contribution to the variance of life expectancy rate at birth. Their contributions respectively stood at 1.10% and 1.34% by the tenth period.

In Appendix IV, the variance decomposition for malaria cases is presented. Malaria accounts for the lion share of its own shock. However, its contribution to its shock decreases consistently until it stood at 61.44% by the tenth period. Both output per worker and life expectancy rate at birth made impressive contribution to the variance of malaria cases. Their contributions were respectively 9.07% and 10.10% by the tenth period. Secondary school enrolment rate and the proportion of undernourished also made modest contributions, with their contributions that respectively stood at 3.62% and 14.87% by the tenth period.

In Appendix V, we present the variance decomposition of secondary school enrolment rate. The variance decomposition of secondary school enrolment rate is predominantly influenced by itself, output per worker and malaria cases. The contribution of secondary school enrolment to its own shock was 40.97% by the first period, but decreases consistently and stood at 23.58% by the tenth period. The contribution of output per worker by the first period was 21.57% but increases consistently until it peaked at 36.63% by the tenth period. The contribution of malaria cases was 28.54% by the first period and rose consistently until it peaked at 36.22% by the seventh period and thereafter it declined to 33.02% by the tenth period.

In Appendix VI, we present the variance decomposition of the proportion of undernourished persons. The variance of the proportion of undernourished persons was predominantly influenced by life expectancy rate at birth and itself. The contribution of the proportion of undernourished persons to its own shock increased consistently throughout the period from 54.08% to 67.27% by the tenth period. Life expectancy rate at birth started with 29.45% by the first period but declined to 15.96% by the tenth period. Malaria cases and secondary school enrolment respectively contributed 5.94% and 7.63% by the tenth period.



Source: Authors Computation (2021).

Figure 1: Impulse Response Functions

Figure 1 shows the outcome of the impulse response functions result that helps to trace out the responsiveness of the dependent variables in the VAR shocks to each of the variables. It is a response to Cholesky one standard deviation innovations. The blue line which is the reaction function which indicates a positive relationship when above the line, while below the line shows a negative relationship. The impulse response graph of figure 1 shows for individual responses only. In figure 1, a positive shock of one standard deviation to output per man has a positive but downward effect on itself in the first tenth quarters. It was noticed that the longer the period, the impact on itself decreased but it was never negative throughout the period. The response of output per man to a positive shock from gross fixed capital formation was negative and downward trending throughout the tenth quarters. This shows that gross fixed capital formation in Nigeria has a downward trending effect on output per man. The response of output per worker to a positive shock of one standard deviation from life expectancy rate at birth was negative during the first and second quarters, then became zero from the third to the fifth quarters and there after become positive through the tenth quarters. Thus, output per worker responds in a relatively high magnitude to life expectancy rate at birth. Also, the response of output per worker to a one standard deviation shock in secondary school enrolment rate and the proportion of undernourished Nigerians were non-existent throughout the period, for it is equal zero though out ten quarters. Furthermore, the responses of all the variables (gross fixed capital formation, secondary school enrolment, malaria cases, life expectancy rate at birth) except the proportion of undernourished Nigerians to a one standard deviation shock in output per man are positive all through the period. However, the response of the proportion of undernourished Nigerians to a one standard deviation shock in output per man was initially positive but became zero and there after decreases consistently throughout the period.

4.0 Discussion of Results

In this study we examined the effect of health and macroeconomic variables on labour productivity for Nigeria utilizing secondary quarterly time series data for the period 2000Q1 to 2018Q4.Findings from the result showed that several of the variables that caninfluence economic performance for other countries do not have the potentials for improving Nigerian labour productivity. Specifically, life expectancy rate at birth, the proportion of malnourished Nigerians, secondary school enrolment rate and gross fixed capital formationhave no significant impact on Nigerian labour productivity. Hence, improving these economic variables to yield gain for Nigeria is pertinent.

Life expectancy rate at birth has no significant effect on labour productivity for a number of reasons. The life expectancy rate does not give true picture of the healthy years of Nigerians. In addition to the fact that the life expectancy rate is low health life expectancy rate is even lower showing that several Nigerians live in poor health making it difficult for them to yield the economic benefits of good health. Also, health can only result in higher productivity if one is gainfully employed. Barro and Canning (2000) hinted that good health can only influence labour productivity through the channels of savings, education, capital investment and fertility regulation. There is need for Nigerian government to improve its health policy, particularly in the area of health funds, efficient utilization of health resources, ensuring prompt investment in medical equipment and health service delivery. Nigerian government owes it a responsibility to improve the provision of health infrastructure, training of health personnel, immunization and other inoculation services.

The result revealed that malaria constitutes a drag to labour productivity. This finding is in harmony with reports made by Jimoh (2005), Ahuru and Iseghohi (2018) and Osakede and Lawanson (2016). This is not surprising given the wide spread and frequent bouts of malaria attack on Nigerians. In Nigeria, malaria accounts for absenteeism from work and school among school children. Both victims of malaria and their care givers often forego days of work due to illness associated with malaria attack. Evidence from Alaba and Alaba (2011) reported that the average days lost from malaria attack ranges from 7-11 days and the loss of work hours expressed in monetary terms was put at between $28 and $34 which is lost to every bout of malaria attack. Jimoh (2005) reported that malaria incidence constituted drags on Agricultural productivity for Nigeria. Several Nigerian studies estimated the indirect cost of malaria.

Onwujekwe et al (2000) estimated that the cost of treating malaria depletes 2.91% of household monthly income, hence concluded that malaria is a big contributor to the economic burden of diseases in malaria holo-endemic communities. Osakede and Lawanson (2016) estimated that 50% of Nigerian adult population experienced loss in labour contribution due to malaria attack with the indirect cost of about N5, 532.59 ($37.16) and N4, 828.73($ 32.43) per person per day for patient and caregiver respectively.

5.0 Conclusion

The study examined the role of health status and selected macroeconomic variables on labour productivity for the period 2000Q1 to 2018Q4. The result showed that malaria cases constituted drag to labour productivity. Neither secondary school enrolment rate nor gross fixed capital formation has significant effect on labour productivity. Among other things, the study concluded that Nigerian government should formulate policies and programmes that can effectively combat malaria in Nigeria. Also, there is need for secondary school education system curriculum to be improved to impart skills that will make labour force more productive. Finally, there is need to enhance life expectancy rate in Nigeria.

6.0 Recommendations

Arising from the findings in this study, the followings are suggested policy recommendations that would help enhance labour productivity in Nigeria:

- Intensification of policies and programmes to combat malaria. Incidence of malaria remains one of the greatest disease burdens plaguing Nigeria; this is what Sachs calls ‘’the curse of the tropics ‘’. In Nigeria the cost of malaria treatment is well beyond the means of the poorest households and given the reality of repeated bouts of malaria and its contributions to low labour productivity, there is an urgent need for the formulation and implementation of policies that will enhance access to effective treatment of malaria, particularly to the most vulnerable groups. This is particularly urgent with the deployment of the more expensive artemisinin-based combination therapies (ACT) in Nigeria. Hence, increased efforts should be made to combat malaria in Nigeria.
- Effort should be made to increase life expectancy rate in Nigeria. Nigeria’s low expectancy rate at birth happens to be very low, and low life expectancy rate is due to economic hardship and political, religious and civil unrest. Nigerian government should commit policy efforts in reducing cost of living, improving living standard and quelling all kinds of unrest, particularly the Boko Haram insurgency. Macroeconomic policies should be used to redress high inflation rate, consistent exchange rate depreciation and chronic unemployment.

7.0 Suggestion for further Areas of Research

The variables examined as determinants of labour productivity are in-exhaustive. There are several non-health variables that can influence labour productivity that were not considered in this study. The omission of these variables may introduce bias in the estimated coefficients. Hence, we suggest that further study be conducted to examine the effects of electricity generation rate (in watts), political stability, environmental quality and climate change such as the rain water fall per month on labour productivity.

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Appendix I: FEVD for NOUT_L

Period	S.E.	NOUT_L	NGFCF	NLER	NMC	NSSER	NUN
1	0.025940	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000
2	0.031435	97.24716	0.036406	2.386506	0.086062	0.068246	0.175620
			0.099610				
3	0.034643	92.37745		6.626319	0.237973	0.186392	0.472260
4	0.039703	92.50093	0.158645	6.264920	0.281356	0.328341	0.465812
5	0.044063	92.05255	0.241578	6.354514	0.354256	0.526224	0.470876
6	0.047385	90.51919	0.348602	7.369264	0.473577	0.773427	0.515936
7	0.050940	89.78919	0.445309	7.671972	0.560492	1.005271	0.527769
8	0.054457	89.27339	0.538739	7.788478	0.637024	1.232800	0.529568
9	0.057599	88.48374	0.638811	8.138024	0.726360	1.474092	0.538973
10	0.060666	87.82525	0.733224	8.386983	0.807017	1.703490	0.544035

Appendix II: FEVD for NGFCF

Period	S.E.	NOUT_L	NGFCF	NLER	NMC	NSSER	NUN
1	0.216839	37.87591	62.12409	0.000000	0.000000	0.000000	0.000000
2	0.268931	36.25452	63.56400	0.057733	0.081567	0.025583	0.016599
3	0.297524	41.40972	56.71835	0.111231	0.386426	1.345847	0.028426
4	0.318955	45.56959	49.87452	0.196168	0.741418	3.581244	0.037061
5	0.337527	49.03881	44.53841	0.348060	1.038988	4.981183	0.054553
6	0.353174	51.90148	40.84184	0.537635	1.237305	5.390548	0.091194
7	0.366564	54.31268	38.21507	0.775674	1.303091	5.262083	0.131399
8	0.378258	56.30564	36.22554	1.068050	1.265571	4.976929	0.158267
9	0.388809	57.91731	34.59145	1.415154	1.198016	4.711525	0.166546
10	0.398602	59.19978	33.16149	1.806272	1.160730	4.509340	0.162385

Appendix III: FEVD for NLER

Period	S.E.	NOUT_L	NGFCF	NLER	NMC	NSSER	NUN
1	0.004384	67.37250	0.000477	32.62702	0.000000	0.000000	0.000000
2	0.005291	67.62724	0.016039	32.35294	0.002975	0.000641	0.000163
3	0.006297	67.97382	0.123581	31.72811	0.014369	0.111052	0.049063
4	0.007096	68.14276	0.265359	31.17296	0.036125	0.277833	0.104960
5	0.007834	68.31679	0.404939	30.50566	0.073319	0.479978	0.219312
6	0.008503	68.48449	0.524914	29.81377	0.125615	0.674933	0.376275
7	0.009122	68.69187	0.626332	29.08030	0.183242	0.841133	0.577124
8	0.009698	68.95454	0.713518	28.31688	0.236625	0.967779	0.810655
9	0.010238	69.27750	0.791777	27.52838	0.279266	1.055156	1.067921
10	0.010746	69.65382	0.865668	26.72313	0.308860	1.109027	1.339496

Appendix IV: FEVD for NMC

Period	S.E.	NOUT_L	NGFCF	NLER	NMC	NSSER	NUN
1	0.112353	5.357848	0.172298	8.624477	85.84538	0.000000	0.000000
2	0.142977	4.676429	0.408766	7.696188	87.13279	0.075693	0.010135
3	0.156445	5.141136	0.348071	8.715302	84.65066	0.325022	0.819811
4	0.164061	5.485395	0.390844	9.842579	81.02240	1.104133	2.154651
5	0.169944	5.899132	0.523961	10.61770	76.89490	2.019405	4.044901
6	0.175018	6.361555	0.642383	10.98496	72.97511	2.790105	6.245877
7	0.179609	6.907388	0.723469	11.01370	69.47937	3.308874	8.567203
8	0.183818	7.546170	0.780444	10.81148	66.43949	3.577703	10.84471
9	0.187731	8.273582	0.830020	10.47973	63.78917	3.657850	12.96965
10	0.191430	9.068920	0.884758	10.10117	61.44958	3.622680	14.87290

Appendix V: FEVD for NSSER

Perio d	S.E.	NOUT_L	NGFCF	NLER	NMC	NSSER	NUN
1	0.050277	21.57128	8.260602	0.653031	28.54254	40.97254	0.000000
2	0.064758	19.80352	9.302888	0.701843	30.30918	39.84113	0.041438
3	0.072826	21.72398	8.623998	0.608464	33.54237	35.43842	0.062771
4	0.078059	23.61143	7.806273	0.541663	36.18493	31.72896	0.126739
5	0.081690	25.83109	7.216793	0.495110	37.22980	29.06887	0.158338
6	0.084328	28.21849	6.816684	0.464867	37.05957	27.28527	0.155123
7	0.086443	30.60478	6.527409	0.445411	36.22494	26.04818	0.149285
8	0.088274	32.83851	6.310715	0.437625	35.14528	25.10510	0.162773
9	0.089926	34.85187	6.149363	0.447347	34.04640	24.30461	0.200402
10	0.091439	36.62732	6.031026	0.482900	33.02395	23.57975	0.255049

Appendix VI: FEVD for NUN

Period	S.E.	NOUT_L	NGFCF	NLER	NMC	NSSER	NUN
1	0.036855	2.178087	1.526809	29.45902	0.510178	12.24605	54.07985
2	0.046356	2.996335	1.464012	31.22748	0.415734	12.35517	51.54128
3	0.053244	2.503173	1.177128	28.22274	0.806443	12.21894	55.07158
4	0.058332	2.110136	0.980747	25.36592	1.425268	11.90218	58.21575
5	0.062513	1.849690	0.854278	22.61962	2.205877	11.25816	61.21237
6	0.066123	1.742734	0.766385	20.28229	3.042482	10.45293	63.71318
7	0.069394	1.767985	0.721140	18.43253	3.874573	9.627959	65.57582
8	0.072448	1.890366	0.731616	17.10702	4.656838	8.866518	66.74764
9	0.075347	2.070136	0.802670	16.29781	5.353571	8.199576	67.27624
10	0.078115	2.271398	0.928617	15.96406	5.939584	7.630854	67.26548