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The Economic Burden of Malaria: Evidence from Nigeria's Data

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Abstract

In this study, the impact of Malaria as a disease burden is investigated, on national productivity. The study proxy Malaria by both Malaria Death Cases and Malaria prevalent rate. Labour productivity is proxy by Per Capita Income. Annual time series data covering the period 1987-2017 was obtained from World Bank Data base. The stationarity state of the variables was examined using Augmented Dickey Fuller test. At a level, none of the variables were stationary but at first difference they all became stationary, hence they are integrated of order one. The Engel-Granger Co-integration test shows that long-run relationship existed among the variables. The estimated Error Correction Model revealed that malaria constituted drag on labour productivity, Public health expenditure made unimpressive contribution to per capita income and secondary school enrolment rate produced adverse effect on labour productivity. This study recommended that intensive efforts should be made towards curbing malaria burden in Nigeria.

Key words: Malaria, Labour Productivity, Unit Root, ECM, Nigeria

JEL Classification: I15, I16, I17

Paper Classification: Research Paper

Introduction

Malaria remains a major threat to public health despite decades of control efforts. It is a devastating disease that threatens labor productivity and economic performance of endemic countries. According to World Health Organization (2010), there are still over 200 million cases of malaria and approximately one million deaths annually (Okorosobo, Okorosobo, Mwabu & Orem, 2011). Malaria constitutes 10 per cent of Africa's overall disease burden, accounting for 40 per cent of public health expenditure, 30-50 per cent of in-patient hospital admissions and up to 50 per cent of outpatient visits in areas with stable transmission (WHO, 2015). Malaria morbidity and mortality rate vary from region to region in Sub- Sahara Africa. In Nigeria, malaria is the number one public health problem (Onwujekwe, Malikel, Mustafa & Moiznvaa, 2006). It is responsible for about 300,000 deaths every year (Enato, 2014). Approximately 50% of the Nigerian population experience at least one episode per year. However, official estimate suggests as much as four episodes per person per year on the average (WHO, 2012).

In addition to this, malaria imposes substantial socio-economic costs on both individuals and governments (Onwujekwe et al; 2003). For instance, the costs of malaria to individuals and their families include purchase of drugs for treating malaria at home; expenses incurred in travelling to clinics and cost of treatment; lost days of work; absenteeism from school; expenses for preventive measures and expenses for burial in case of deaths. On the other hand, the costs to governments include maintenance, supply and staffing of health facilities; purchase of drugs and supplies; public health interventions against malaria, such as insecticide spraying or distribution of insecticide-treated bed nets and lost opportunities for joint economic ventures and tourism (WHO, 2011). The above facts have serious socio-economic implications on health outcome and welfare with indirect impact on economic growth.

Malaria is responsible for an estimated average annual reduction of 13 per cent in economic growth for those countries with the highest burden, Nigeria inclusive (Ojewumi & Ojewumi, 2012). In Africa, Malaria produces huge negative effect on economic growth and intensifies the vicious circles of poverty because it costs the continent between US$10 billion and US$ 12 billion every year in loss of Gross Domestic Product (Mavis & Humphrey, 2015). The seemingly intractable trend of this ancient scourge has compounded both national and household poverty due to intensive loss of productive time to malaria attack and death (Onwujekwe et al; 2006).

Extensive review of studies in Nigeria show that good number of them are focused on willingness to pay for insecticides treated nets(ITNs)(see Onwujekwe, Hanson & Fox Rusby,2004;Jimoh et al;2004), malaria prevalence and control(see Erhabor et al ;2014;Nwagha et al;2004),catastrophic expenditure associated with malaria treatment(Ichokwu et al;2010). There is handful of studies that examined the socio-economic effects of malaria on Nigerian Economy. A good number of these studies investigated either the impact of health care spending on malaria reductions or the impact of malaria prevalence on health outcomes (Ejezie et al; 1990; Olalekan & Nurudeen, 2013; Nwanosike, 2014; Nwanosike et al; 2015; Sede, 2017). The few studies on economic burden of malaria are community-based studies that utilized self-structured questionnaires in eliciting information from sampled groups. These studies limit the extent to which findings can be generalized (see, Alaba & Alaba, 2009). Bello (2004) utilized time series data for the period 1975-2001 to investigate the economic burden of malaria, in its study. However, the study adopted a comparative analytical method by comparing malaria death rates and malaria cases without relating it to any economic variable.

The present study is set to investigate the economic burden of malaria in Nigeria. Specifically, the study tests the hypothesis: does malaria burden impacts on per capita income in Nigeria? In view of the research objectives, it is hypothesized that malaria burden proxy by both malaria death cases and malaria prevalent rate does not significantly impact on Nigeria's per capita income.

Review of Related Literature

The role health plays in reducing poverty and economic development particularly in developing countries is indisputable in literature (Shephard, Ettling, Brinkman & Saverborn, 1991). The health of the population is a key factor for labor productivity, poverty reduction and overall economic development of a country. Healthier workers are physically and mentally more energetic and productive and tend to earn higher wages. They are also less likely to be absent from work because of illness (or illness in their family) (Bloom & Canning, 2001). Most recently, the links between health and economic productivity have become a significant policy concern.

Good health therefore can increase household income and national economic growth. On the other hand, poor health inflicts pain and suffering which affects the welfare of the individuals and the society at large. Given the stock of physical capital, land and other complementary resources, the productivity of a worker depends on the quantity and quality of various components of human capital embodied in him. Health is an important determinant of labor force participation and productivity besides some other unquantifiable factors like innate ability and motivation. Health is directly affected by nutrition, housing, clothing, personal and medical care etc. The nutritional deficiencies and poor health especially due to Malaria would adversely affect the capacity of an individual to carry on sustained and prolonged physical activity. Thus reducing his level of productivity.

Equally, the link between malaria and productivity has been shown by Gallup & Sachs (2001), Deleire & Manning (2004), Goodman, Coleman & Mill (2000) and Chukwuocha (2002), Okorosobo, Okorosobo, Mwabu & Orem (2011) who assessed this relationship and concluded gains from good health include opportunity to work maximally without being interrupted by illness, greater opportunities to obtain better paying jobs and longer working lives. These factors combine together to increase both short- and long-term productivity of individuals. Generally accepted measure of productivity is earnings, with wages and salaries. All these studies concluded that malaria leads to a reduction in productivity of individuals in a household. Economists have made various attempts to establish links between health status and productivity. Poor health resulting from Malaria episode, directly affects individuals output and income. It however impairs the individuals' productive capacity and the demand to work. This may most probably translate to reduce income and even to extreme poverty, which directly feeds back to poorer health status. Loss of productivity includes inability to work to maximum daily capacity, total absence from work, and reduce hours of work especially at the beginning of the illness.

Malaria directly affects individual's health status. It then impairs ability to withstand demands of work and productive capacity. Actions toward reducing the disease burden and improving quality of life in this part of the world must take into consideration, the dynamic effect of malaria on labor productivity. Besides Malaria can have a debilitating effect on adults, with recurrent bouts of fever that induces increased absenteeism from work and lowers labor productivity (United Nations, 2005; Sachs, 2000).

However, the effect of health on productivity seems to be complex. Efforts have been made to determine the effects of Malaria (health) on individuals and households. This analysis has received great attention in recent years (Frank & Mustard, 1994; Hamoudi & Sachs, 1999; and Bloom & Canning, 2001, Mallaney & Sachs, 2002; Jimoh, 2005).

Theoretical Perspective

Four different models have been utilized in analyzing the economic burden of diseases .They are Cost of Illness Model, Disability Adjusted Life Lost Model, Production Health Function Model and Willingness to Pay Model. Cost of illness Model and Willingness to Pay Model utilized data obtained from household surveys through questionnaires, Key Informant Interview and Focused Group Discussion. Therefore, they are used for micro-based studies (see Onwujekwe et al;2000). Production Health function Model is used in studying the impact of disease burden on macro-economic aggregates (see Gallup & Sachs, 2001). Below a brief review of these models is presented:

Cost of Illness Model

This model assesses the productivity losses due to illness as measured by income foregone due to morbidity, mortality and disability (Shephard, Ettling, Brinkman & Sauerborn, 1991). The model assessed the cost of malaria to the economy in three distinct perspectives: (i) considers the proportion of Gross National Product that must be set aside in the treatment of malaria (ii) Productivity losses associated with absenteeism due to malaria attack (iii) costs that household and governments are willing to bear to avoid the pains and sufferings inflicted by malaria. The Cost of illness model facilitates the aggregation of economic burden of Malaria at the microeconomic level in order to yield the macroeconomic burden.

According to Malaney (2003), The Cost of Illness can be aggregated below:

COI= F (PMC, NPMC, LL) .... (1)

Where:

PMC = Private Medical Cost

NPMC = Non Private Medical Cost

LL = Labour Productivity Loss

Furthermore, within an accounting sense, the model categorized the cost of malaria into direct, indirect and institutional (intangible) costs of Malaria (Shephard et al; 1991). Therefore, the COI can be stated as the function of direct, indirect and intangible costs. The direct cost is the medical expenses incurred in the treatment of Malaria, the indirect cost is the loss of productivity during sick period and the intangible cost is the pain and suffering associated with malaria attack (Sede & Rolle, 2015).

Disability Adjusted Life Years (DALYs) Lost Model

This is a new model used to capture the burden of diseases such as malaria. It captures the amount of time, activity and ability lost due to disease or illness (Loevinson, 1994). It captures as the sum of years of life lost due to premature death and years of life lived with disability. In the DALYs lost model, efforts were made to define disease specific mortality rates (Snow & Guyatt, 2004). The model offers a standardized measurement of disability due to diseases that is comparable across geographical regions, serve as useful tool for resource allocation, cost effectiveness and estimation of disease burden (Clarke et al; 2005).

Willingness to Pay Model

This model is useful in evaluating the economic burden of diseases such as malaria and it entails asking the respondent questions on the maximum amount, they will be willing to pay in order to receive a health service or prevent the occurrence of diseases (Jimoh, Sofola, Petu & Okorosobo, 2007). The model elicits the full personal costs associated with illness. It captures the cost of treatment of diseases, lost time of productivity due to illness and the pain and suffering associated with being sick. The model presumed that an individual's income and circumstances play role in determining the size of the willingness to pay out.

Theoretical Framework

This study is casted within the production Health Model following the interactive variables used in the study. This study adopts a macroeconomic perspective by considering the loss in national output due to malaria attack. Therefore, national productivity is a function of malaria and other controlled variables (McCarthy & Wolf, 2000; Asante & Asenso-okyere, 2003; Okorosobo, Okorosobo, Mwabu & Orem, 2011).

$Q = f(K, L, X, M)$ ....(2)

Where: Q = Productivity, K= Physical Capital, X= Vector of diseases (Malaria), L= labour force and M= controlled variable(s).

The Production Function Health Model is therefore the best preferred in this macro perspective study because of its ability to support covariance structural equations (Rebhan, 2009). The covariance Structural Model explicitly defined the relationship among the assigned explained and unexplained variances. Covariance Structural models allow both confirmatory and exploratory modeling meaning. They are suited to both theory testing and theory development (Long, 1983). Among the strength of Covariance Structure Model is the ability to construct latent variables. This allows the researcher to explicitly capture the reliability of measurements in the models, which in theory allows structural relations between latent variables to be accurately estimated (Pui wa & Qiong, 2007).

Methodology

The primary objective of this study is to investigate the economic burden of malaria on labour productivity for the period 1987 to 2017. The choice of this period is based on data availability. Thus, the empirical model to be estimated is expressed as:

PCY = F (MDC, MPR, PHE, SSER) ………………................…. (3)

Presenting equation 3 in a non- linear Cobb Douglas production function will yield:

$PCY = MDC\ \beta 1\ MPR\ \beta 2\ PHE\ \beta 3 SSER\ \beta 4$ ....(4)

Equation 2 cannot be estimated directly with the use of Ordinary Least Square since it is not in linear form. In order to estimate the model with OLS equation (4) is first linearized using the double log transformation rules. The application of this rules directly transforms the coefficients into elasticity estimates. Taking the natural logarithm of both sides of equation (4):

$\text{Log } PCY = B_0 + B_1 \log SSER + B_2 \log PHE + B_3 \log MDC + B_4 \log MPR + uit$--------------- (5)

Where:

PCY= Per Capita Income

MDC= Malaria Death Cases.

MPR= Malaria prevalent Rate

PHE = Public Health Expenditure

SSER = Secondary school Enrolment Rate

Log= natural logarithm

Bi = elasticity coefficients

U = The random disturbance term

Table 1: Summary of Model

Variables	Expressed as	Proxy for	Source of Data	Expected sign
Per capita Income	PCY	Labor productivity	National Bureau of Statistics	Dependent variable
Malaria Death Cases	MDC	Malaria Burden	WHO Malaria Fact Sheet	Negative
Malaria Prevalent Rate	MPR	Malaria Burden	WHO Malaria fact sheet	Negative
Public Health Expenditure	PHE	Policy variable	Central Bank of Nigeria Bulletin	Positive
Secondary School Enrolment	SSER	Labour force	National Bureau of Statistics	Positive

Source: Author's Expression (2018)

Estimated Results

In this section of the study, estimated model for the study is presented, analyzed thereafter implications for the study are deduced. The results are presented in the order of unit root tests, co-integration results and Error Correction Model.

Unit Root Results

Since the study uses economic time-series data, it is advisable to begin by verifying the time series property of the variables employed. In order to test for the stationarity of the variables used in the study, unit root testing of all the macroeconomic variables was carried out using both the Augmented Dickey-Fuller (ADF) and Phillip- Perron (P-P).

Table 2: Summary of the Unit Root Results at 5%

Variables		Tests		Conclusion
	Order of integration	ADF	PP	
PCY	Level	-1.0603	-2.0824	I (1)
	1st DIFF	-2.1837	-8.8007	
MPR	Level	-0.6371	-1.1194	I (1)
	1st DIFF	-5.5981	-5.6606	
MDC	Level	-3.3892	-0.3017	I (1)
	1st DIFF	-5.4809	-5.5511	
SSER	Level	-2.0217	-2.0912	I (1)
	1st DIFF	-4.6304	-5. 1258	
PHE	Level	-0.1277	-1.6413	I (1)
	1st DIFF	-7. 1739	-7. 3243	

Note: L= Natural logarithms

A summary of the unit roots result is presented in Table 2. The results do not take in to consideration the trend in variables. The reason for this is that an explicit test of the trending pattern of the time series has not been carried out. The results indicate that at levels all the variables have ADF statistics that is less than the Mckinnon critical values at 95 per cent, however, at first difference, the ADF statistics is larger than the critical values, hence the macroeconomic variables used in this study are integrated of order one written as I (1).

Co-Integration Results

In the literature, two or more variables are co-integrated if a linear combination of the variables produces a stationary series regardless of the stationarity state of the variables at levels; hence co-integrated series have common stochastic drift, with long-run equilibrium existing among them. The Enger-Granger Residual based unit root test approach was utilized for the exercise. The results are presented in Table 3.

Table 3: Co-integration Test Results

Variables	ADF Test – Statistic	95% critical value	Remarks
Residual Vector	-5.4428	-3.0522	Stationary

Source: Author's Computation (2017)

Using the Engle and Granger co-integration procedure from Table 3, the null hypothesis of no co-integration among the variables at 5 per cent level cannot be accepted. This is shown from the fact that, in absolute value, the ADF test statistic is greater than the 95% critical value. This again implies that the residual is stationary and thus, the variables are co-integrated and a long-run meaningful relationship exists between the dependent variable and the independent variables. As a result, there are low chances that our regression results yielded spurious regression. In addition, this result indicates that an ECM formulation is most appropriate.

Estimated Error Correction Model

Table 4: Aggregate Production Function

Dependent variable	Regressors	Estimated coefficients	Std. Error	T-Ratio	Prob.
Per capita income	DPCY(-1)	1.0296	0.23878	4.3119	0.002***
	DPCY(-2)	-0.3263	0.3458	-0.9436	0.368
	DPCY(-3)	-0.3263	0.3458	-0.9436	0.440
	DMPR(-1)	-1.0238	0.2121	4.8281	0.000***
	DMPR(-2)	-1560.43	7,736.4	-0.2017	0.8408
	DMDC(-1)	--12.66	2.5783	4.9103	0.0000***
	DMDC(-2)	-24649.3	19,6643.4	1.2535	0.2151
	DSSER(-1)	5535.07	6,124.2	0.9038	0.3699
	DSSER(-2)	-0.0512	0.0759	1.8956	0.087*
	DPHE(-1)	0.0366	0.0678	0.5403	0.601
	DPHE(-2)	0.0549	0.0733	0.7493	0.471
	ECM(-1)	-0.3245	0.1234	-2.6297	0.0324**
	R-square = 0.99679 Adjusted R-squared = 0.99198 S.E. of regression = 0.039287 Mean of dependent variable = F-stat = 18.16 Prob. (F-stat) = 0.0000 D.W. = 1.89				

Source: Authors Computation using E-view 7.0
*Note, ***, ** & * significant @ 1, 5 and 10 %.*

The results for LPCY are presented in Table 4. Note that all the coefficient estimates are elasticities. Examination of the results show that the most important determinants of LPCY are both two-period lagged values of LMPR and LMDC. The elasticity of LPCY with respect to two-period lagged values of LMPR and LMDC are respectively - 1560.43 and -24649.3. The fact that these elasticities are negative reflects the perverse effect of malaria burden on output per man. However, both one-period lagged value of LMPR and LMDC are negative and significant. This shows that malaria constitutes drag on labour productivity with time. In the long–run, the burden of malaria is more felt. The reduction in national productivity can take various forms which include reduced labour performance and school attendance, reduction in the ability to save by households, modification of households' economic decisions in an attempt to prevent malaria and increased government funding on malaria prevention programmes (Okorosobo, Okorosobo, Mwabu & Orem, 2011).

One-period lagged value of LPCY both positively and significantly impacts current value of LPCY. Thus, productivity of the immediate past period will positively influence productivity of the current period. The elasticity of LPCY with respect to one-time lagged value of LPCY is 1.03, showing that if per capita income in previous period rises by one percent then output per man in the current period will rise by 1.03 percent.

Both one-period and two-period lagged value of LPHE has no significant impact on labour productivity. Also, one –period lagged value of LSSER has no significant impact on PCY but two-period lagged value is significant. The elasticity of PCY with respect to LSSER (-2) is -0.0512.The estimated model has impressive goodness of fit as shown by the coefficient of determination of 99.68% and predictive ability as shown by the adjusted coefficient of determination of 99.19%. The F-statistics (18.16) with p-value (0.000) shows that a significant linear relationship exists between LPCY and the included regressors. The Durbin-Watson statistics (1.89) recorded negligible presence of autocorrelation which has no serious effect on the estimated coefficients. The ECM coefficient is negative (-0.3245) and statistically significant at 5 %(p = 0.0324), hence the ECM coefficient can serve as "Error Equilibrium". The coefficient of 0.3245 shows that about 32.45 % of the deviation of LPCY from its long-run equilibrium value will be reconciled per annum. Thus, this speed of adjustment is slow.

Table 5: Estimated long run coefficients using ARDL approach

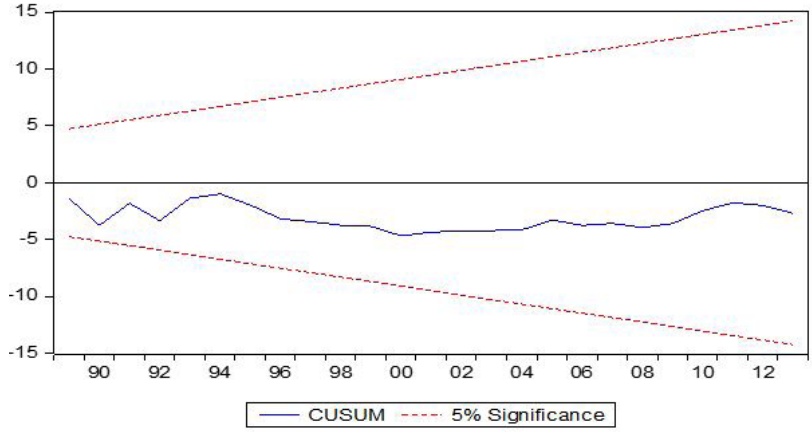
Dependent variable	Regressors	Estimated Coefficients	Std. Error	T ratio	Prob.
Per Capita Income	C	0.4567	0.6653	1.4567	0.6578
	LPHE	3.4567	7.5689	0.4567	0.7868
	LSSER	1.4567	1.6229	0.8976	0.6789
	LMPR	4.9503	1.3456	3.6789	0.0456**
	L MDC	22.0803	2.4567	8.9878	0.0678***
	R-square = 0.82 Adjusted R-squared = 0.78 S.E. of regression = 0.076 Mean of dependent variable = 12.89 F-stat = 28.16 Prob. (F-stat) = 0.0000 D.W. = 2.45				

*Note: *,**,*** respectively represents coefficients that are significant at 1%, 5% and 10%.*

The long run estimates of labour productivity which is presented in Table 5 shows that both malaria prevalent rate and malaria death cases significantly influence labour productivity. The long run estimates are respectively 1.3457 and 2.456, which shows that in the long run, one percent rise in malaria prevalent rate and malaria death cases will respectively result in 1.3457% and 2.456% fall in per capita income. The long run model has both commendable goodness of fit and high predictive ability. The F statistics (F =28.16) and its probability values (0.0000) show that a significant linear relationship exists between per capita income and the included regressors. The Durbin Watson D statistics put at 2.45 which is approximately 2 shows that the serial dependence in the disturbance term is negligible.

Stability Test

The CUSUM test (Brown, Durbin and Evans, 1975) is based on the cumulative sum of the recursive residuals. This option plots the cumulative sum together with the 5% critical lines.



The test finds parameter instability if the cumulative sum goes outside the area between the two critical lines. As observed from the figure, the lines for the cumulative sum lie within the 5% critical lines and hence this suggests that the parameters of the model are stable.

Discussion

The estimated results analyzed in previous sections proffer us the opportunity to deduce policy implications for the study. For once, both malaria death cases and malaria prevalent rate negatively and significant impacted on per capita income. The marginal effects coefficient for malaria measures the loss in per capita income as a result of malaria prevalence. Malaria elasticities in both long and short run have negative and significant values. In the long run, the elasticity of malaria prevalent rate with respect to Per Capita Income is 4.9503, which shows that a 1 % rise in malaria prevalent rate will cause the per capita income to fall by 4.9503%.Thus malaria has a negative impact on Nigeria's economic growth performance on the macro level. The findings from this study confirm those from Gallup & Sachs (2001), Mccarthy et al (2000), Asante & Asenso Okeyere (2003) and Jimoh (2005). However, the impact of malaria prevalence for this study is higher than those of Asante & Asenso-Okeyere (2003) who reported 0.41% for Ghanian economy, Mccarthy et al (2000) reported an average impact of 0.55% for selected SSA countries and Gallups and Sachs (2001) reported 1.3% per year. This confirms the huge economic burden placed on Nigerians by malaria parasite. It therefore follows that malaria not only poses health challenge but development burden to the Nigerian economy. This puts Nigeria policy makers on their toes that policies designed to significantly yield growth dividends must not only consider policy variables but must also consider the prevalence of malaria. This calls to mind the admonition by Malaney & Sachs (2003) that where malaria prospers most human society has prospered less.

Conclusion

In this study, the impact of Malaria on labour productivity was investigated utilizing aggregate data for Nigeria for the period (1987-2017). Secondary data on the variables was obtained from WorldBank and Central Bank of Nigeria Statistical Bulletin. The data was analyzed using Cointegration and Error Correction methodology. Labour productivity was proxy by per capita income and malaria burden by both Malaria Prevalent Rate and malaria Death Cases. The estimated model revealed that both Malaria Prevalent Rate and Death cases negatively and significantly impacted on per capita income. Therefore, Malaria constituted drag on labour productivity in Nigeria for the period reviewed. In the light of this finding, it is pertinent that Nigerian government should intensify its efforts in the fight against malaria. To this end, the government should strengthen the roll back Malaria programme; promote environmental sanitation and creation of awareness among rural dwellers.

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