ECONOMIC BURDEN OF A NEGLECTED TROPICAL DIS-EASE IN AFRICA: THE CASE OF HUMAN AFRICAN TRYP-ANOSOMIASIS

1 Joseph Afolabi Ibikunle, Department of Economics, Ajayi Crowther University, Oyo, Nigeria
*Corresponding author E-mail: toy4kuns@yahoo.com
ORCID ID: 0000-0001-9865-4202

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A B S T R A C T

Neglected Tropical Diseases (NTDs) are a category of diseases that cause severe infection to over one billion people worldwide. They impact the world's poorest people, decrease the quality of life and productivity of employees, hinder physical and cognitive growth, contribute to maternal and child disease and even death. Despite the risks, they are overshadowed by the efforts to fight HIV/AIDS, malaria and tuberculosis, and considered to be "other diseases" that are not really catered for. Hence, this paper analyzed the economic burden of neglected tropical diseases in Africa from 2000 to 2018. Data used were Gross Domestic Product (GDP), human African trypanosomiasis reported cases, current health spending, net official development assistance, consumer price index and exchange rate. The second-generation econometric methods were employed: cross sectional dependence, slope homogeneity, Westerlund cointegration, Pesaran and Smith MG, Pesaran CCEMG and Eberhardt and Teal AMG estimation. Findings confirm the following: first, cross-sectional dependence and slope heterogeneity exist among African countries; second, there is a long run relationship between GDP and NTDs; third, NTDs impacted negatively and significantly GDP, therefore, they stand as a serious detriment to economic growth in Africa. The study suggested that governments in Africa should raise funds to eradicate NTDs and provide an improvement of the environmental conditions that lead to their spread, such as clean water, enhanced sanitation initiatives and vector control.

1. INTRODUCTION

Neglected tropical diseases (NTDs) are a complex category of infections defined by the World Health Organization (WHO) as diseases primarily infecting low-income communities in tropical countries, causing a substantial burden of morbidity and some mortality, and thus perpetuating the cycle of poverty. They are an ever-growing list of tropical predominant infections that are ignored compared to the "big three": malaria, tuberculosis (TB), and HIV/AIDS (Norris, Adelman, Spantchak&Marano, 2012; Mwiinde *et al*, 2017;). These diseases are called "neglected" because they affect the poorest, the most vulnerable and the most neglected populations, and because they have been relatively unknown and overlooked for decades.As of 2017, the World Health Organization categorizes the following communicable diseases as neglected tropical diseases (NTDs):Buruli Ulcer, Chagas disease, Chromoblastomycosis, Cysticercosis, Dengue fever, Dracunculiasis (Guinea Worm Disease), Echinococcosis, Fascioliasis, Human African Trypanosomiasis (African Sleeping Sickness), Leishmaniasis, leprosy (Hansen's disease), Lymphatic Filariasis, Mycetoma, Onchocerciasis, Rabies, Schistosomiasis, Soil – transmitted Helminths (STH) (Ascaris, Hookworm and Whipworm, Trachoma and Yaw) (Centre for Disease Control, 2020; WHO, 2020). These diseases pose a huge threat to the world and currently affect more than one billion people worldwide (Aerts, Sunyoto, Tediasi&Sicuri, 2017; Engels & Zhou, 2020; WHO, 2020).

Recognizing the importance of good health as a key to sustainable development and the challenge of neglected tropical diseases on the 2030 agenda for improving well-being, it was included as a part of the United Nations' Sustainable Development Agenda in 2015.Goal 3.3 of the agenda is tracked with the predictor: "By 2030, AIDS epidemics ends, as well as tuberculosis, malaria and neglected tropical diseases and battle against hepatitis, waterborne diseases and other communicable diseases." It is frustrating that less than 10 years to the completion of the Sustainable Development Goals, neglected tropical diseases (NTDs) continue to cause serious infection for over a billion people worldwide, affecting the world's poorest people, often impairing physical and cognitive growth, leading to maternal and child disease and death, making it difficult to farm or earn a living and

reducing workforce productivity (United Nations, 2015; CDC, 2020; WHO, 2020).

Human African trypanosomiasis (HAT) also known as sleeping sickness is one of the 17 neglected tropical diseases reported by the World Health Organization (WHO), and has also been targeted for elimination by 2020 (WHO, 2017). Depending on the parasite involved, the disease takes 2 forms: first, Trypanosoma brucei gambiense found in 24 countries in western and central Africa. At present, this type accounts for 98 percent of recorded cases of sleeping sickness and causes a chronic infection, and the second is Trypanosoma brucei rhodesiense found in 13 countries in eastern and southern Africa. This form now accounts for fewer than 2 per cent of recorded cases and causes acute infection (Bukachi, Wandabba&Nyamongo, 2017; WHO, 2020).

African countries currently bear approximately 40 percent of the global NTD burden. However, progress has been made over the years in resolving NTDs in the continents. For instance, in February 2018 Kenya became the 41st country in the African region out of 47 Member States to be certified free of Guinea worm disease. Ghana also removed trachoma in May 2018 and Togo prevented lymphatic filariasis in 2019. Leprosy is now eliminated as a public health issue, and human African trypanosomiasis identified by the World Health Organization (WHO) is still moving towards elimination by 2020 (WHO, 2020; CDC, 2020). While the confirmed number of new cases of human African trypanosomiasis chronic type (T. b. gambiense) decreased by 97 percent between 1999 and 2018, from 27,862 to 953, over the same period, the number of newly recorded cases of acute human African trypanosomiasis (T.b. rhodesiense) decreased by 96 per cent from 619 to 24 (Gryapong, Nartey, Oti& Page, 2016; WHO, 2020).

Nonetheless, the period of less than 8 months before the end of 2020 was marked by the elimination of the disease and the huge amount given to African countries to reduce the threat. However, it is disheartening that, according to WHO (2020), more than 70% of the confirmed cases have occurred in the Democratic Republic of Congo in the last 10 years. Angola, Central African Republic, Chad, Congo, Gabon, Mali, Malawi and South Sudan have announced between 10 and 100 new cases in 2018. Cameroon, Côte d'Ivoire, Equatorial Guinea, Mali, Kenya, Uganda, United Republic of Tanzania, Zambia and Zimbabwe have announced

between 1 and 10 new cases in 2018. While, countries such as Burkina Faso, Ghana, and Nigeria, have reported sporadic cases in the last 10 years.The problem, therefore, is what is the effect that NTDs have on economic growth in Africa? While many studies in the field of NTDs have been reviewed over the years, the emphasis in the field of human African trypanosomiasis has always been neglected, as it is considered to be one of the least prevalent among 17 diseases. The aim of this study is therefore to investigate the burden of neglected tropical diseases in Africa, taking the case of human African trypanosomiasis into account.

The contribution of this paper is as follows: first, the application of Breusch-Pagan (1980) LM, Pesaran (2004) Scaled LM, Baltagi, Feng and Kao (2012) Bias-Corrected Scaled LM and Pesaran CD tests to assess the presence of cross-section dependency between selected African countries. Second, the use of the Roy-Zellner test suggested by Baltagi (2008) and Swamy (1970) as a parameter stability test to assess the presence of slope heterogeneity in a panel data model for neglected tropical diseases and economic growth in selected African economies. The use of the Westerlund Cointegration Test to test the existence of a long-term relationship and, finally, the use of second generation econometric estimation techniques (The Pesaran and Smith (1995)), Mean Group (MG), that is not concerned with cross section dependence, Pesaran (2006)Common Correlated Estimated Mean Group (CCEMG)) that allows for cross section dependence, time variant unobservable with heterogeneous impact across panel countries and solves the problem of identification and Eberhardt and Teal (2010) Augmented Mean Group (AMG)that is more nuanced and can handle both slope heterogeneity and cross-section dependence, also employed in the study.

The remainder of this paper is structured as follows in addition to the introduction; section 2 provides the data and methodology employed, section 3 presents and discusses the empirical findings, and section 4 concludes the research and provides recommendations.

2. MATERIALS AND METHODS

2.1. Data requirements and source

The sample of study used is 12 African countries: Angola, Cameroon, Central African Republic, Chad, Cote d'Ivoire, Congo, Democratic Republic of Congo, Gabon, Guinea, Nigeria and Uganda. The span covered runs from 2000 to 2018. The selection of the nations used and the selection of the timeline was based on data accessibility for every African country. The data used are Gross Domestic Product, the number of newly reported cases of Human African Trypanosomiasis (T.b. gambiense), current health expenditure (% of GDP), net official development assistance (% of gross capital formation) consumer price index (2010 = 100) and official exchange rate. The variables used were retrieved from the World Development Indicators (http://data.worldbank.org).

Current health expenditure is derived from (http://apps.who.int/nha/database). And the number of newly reported cases of Human African Trypanosomiasis was retrieved from: https://apps.who.int/gho/data/node.main.A1636?lang=en.

Model specification and methods of estimation

NTDs are characterized by a number of factors, the most common of which is poverty. The socio-economic influence of NTDs and the wide-ranging implications they have on health and well-being of affected individuals and households need to be given priority. This effect isn't universal because NTDs are related to deprivation and other inequity axes, for example disadvantaged groups. Additionally, gender, disability and ethnicity may become vulnerable.Furthermore, NTDs not only cause the loss of health and life expectancy, but can also lead to economic implications like decreased workability (Lenk *et al*, 2016). Therefore, given the fact that neglected tropical diseases have an impact on economic growth, we specified the functional form of our model as:

$$GDP=f(NTD, CHE, ODA, INF, EXR) \quad (1)$$

Where GDP = gross domestic product. NTD = Neglected tropical diseases proxied by Human African Trypanosomiasis. Human African Trypanosomiasis is chosen because it is regarded as African disease (WHO, 2020). CHE = Current Health Expenditure (% 0f GDP). ODA = official development assistance. INF =

Inflation rate proxied by consumer price index and EXR = official exchange rate. Equation (2) in an econometric log form is re-specified as:

$$LogGDP_{it} = \beta_0 + \beta_1 NTD_{it} + \beta_2 LogCHE_{it} + \beta_3 LogODA_{it} + \beta_4 INF_{it} + \beta_6 EXR_{it} + \varepsilon_{it} \quad (2)$$

Where $\beta_0 =$ constant term, β_k(k = 1, 2, 3, 4, 5) = coefficients on independent variables, ε_{it} = error term. On a priori we expect $\beta_1 < 0, \beta_2 > 0, \beta_3 > 0, \beta_4 < 0 \; and \; \beta_5 < 0$.

Estimation Techniques

Preliminary Tests

Cross – Sectional Dependence

The problem of cross-sectional dependence results in bias and inconsistency. Therefore, we check whether the existence of cross-sections is independent or not before examining the stationarity and the cointegrating properties. Cross-sectional dependency usually takes place when one country's economic data is affected in another country by the same economic data, whereby the countries within the panel dataset are either globally or regionally related. There are four distinct cross-sectional measures for dependency and they are tested in this paper. These include the Breusch-Pegan LM test (1980), the Pesaran, Ullah and Yamagata (2008), the Bias – the corrected LM scale test and the Pesaran CD test. All tests are based on a test statistics that is tested under the null hypothesis of cross-sectional independence from the alternative hypothesis. For a model consisting of N number of cross-sections for the time period T, the test statistics for the four tests may be given as follows:

Breusch-Pagan (1980) LM test specified

$$LM = \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} T_{ij} \, \hat{p}_{ij}^2 \rightarrow \chi^2 \frac{N(N-1)}{2} \quad (3)$$

Where $\hat{p}_{ij}^2$ is the correlation coefficients of the residuals extracted from the equation.

The Pesaran (2004) LM statistics follows:

$$LM_s = \sqrt{\frac{1}{N(N-1)}}\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\left(T_{ij}\hat{p}_{ij}^2 - 1\right) \rightarrow N(0.1) \quad (4)$$

The third, which is the Bias – corrected Scaled LM test by Baltagi, Feng and Kao (2012), is of the form:

$$LM_{BC} = \sqrt{\frac{1}{N(N-1)}}\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\left(T_{ij}\hat{p}_{ij}^2 - 1\right) - \frac{N}{2(T-1)} \rightarrow N(0.1) \quad (5)$$

Finally, Pesaran CD test based on the average of coefficients of correlation $\hat{p}_{ij}$. The test takes the form

$$CD_p = \sqrt{\frac{1}{N(N-1)}}\sum_{i=1}^{N-1}\sum_{j=i+1}^{N} T_{ij}\hat{p}_{ij} \rightarrow N(0.1) \quad (6)$$

Given the four different variations of the cross-sectional dependence test statistics, the null hypothesis of no cross- sectional dependence is denoted as:

$$H_0: \hat{p}_{ij} = cor\left(\mu_{it,}\mu_{jt}\right) = 0 \; for \; i \neq j \quad (7)$$

Slope Homogeneity Test

Another key issue for this study is the heterogeneity of the slope (cross-country). The evidence that major economic shocks discovered in one country are not necessarily imitated in other countries is the presence of heterogeneity of slopes in a series. For this paper, the Pesaran and Yamagata (2008) slope heterogeneity tests were used to prevent this, using the standardized version of the Swamy (1970) homogeneity test called the delta test. However, the modified version of the Swamy test (1970) is first calculated as shown in the following equation.

$$\hat{S}_w = \sum_{i=1}^{N}(\hat{\alpha}_i - \hat{\alpha}_{WFEP})' \, X_I' \frac{M_T X_i}{\delta_i^2}(\hat{\alpha}_i - \hat{\alpha}_{WFEP}) \quad (8)$$

From 8, $\hat{\alpha}_i$ is the pooled OLS estimator, $\hat{\alpha}_{WFEP}$ is the weighted fixed effect pooled estimator and δ_i^2 is the estimator. The standard dispersion statistics of equation 6 is computed to take the form specified in equation 7 and 8 below

$$\hat{\Delta} = N^{\frac{1}{2}} = \left(\frac{N^{-1}\hat{S}_w - k}{2k}\right). \quad (9)$$

Otherwise, the bias adjusted version of the standard dispersion statistics in 8 can be computed as

$$\hat{\Delta}_{adj} = N^{\frac{1}{2}}\left(\frac{N^{-1}\hat{S}_w - E(\tilde{Z}_{it})}{\sqrt{var}(\tilde{Z}_{it})}\right) \quad (10)$$

Panel Unit Root Test

Within the background of the interlinked panels, the application of unit root estimation techniques for the first-generation panel data is no longer sufficient because these methods cannot compensate for cross-sectional dependence. Therefore, unit root tests of the second-generation panel data that are used are robust to handle cross-sectional dependence in the results. This paper uses the unit root estimation techniques suggested by Pesaran (2007) for the Cross sectionally Augmented Dickey-Fuller (CADF) and the Cross-sectionally Augmented by Im, Pesaran and Shin (2003) (CIPS). According to Pesaran (2007) the CADF statistics is calculated as:

$$\Delta y_{it} = \alpha_i + b_i y_{i,t-1} + c_i \bar{y}_{t-1} + d_i \Delta \bar{y}_t + e_{it} \quad (11)$$

Where $\bar{y}\ and\ \Delta\bar{y}$ are the cross-sectional averages of lagged levels and first differences respectively, at time T for all countries. According to Pesaran (2007) the CADF is given as

$$CADF_i = t_i(N,T) = \frac{\Delta y_i' \bar{M}_w y_{i,-1}}{\hat{\sigma}_i (y_{i,-1}' \bar{M}_w y_{i.-1})^{\frac{1}{2}}} \quad (12)$$

The estimated t-statistics from equation (11) is then used to compute the CIPS statistics which can be shown as:

$$CIPS = \frac{1}{N}\sum_{i=1}^{N} CADF_i \quad (13)$$

Westerlund Cointegration Test

Likewise, the first-generation panel unit root tests, the traditional panel cointegration estimator such as the residual-based cointegration technique Pedroni (1999) does not consider the cross-sectional dependence inside the panels. Therefore, the Westerlund (2007) panel cointegration study, which is robust to handle

cross-sectionally dependent panel data collection, is used to investigate the long-term correlations between variables. Cross-sectional dependency is compensated for by using bootstrapping methods to estimate the probability values of the test statistics. Under the null hypothesis of no cointegration, a total of two group-mean tests and two panel tests are carried out against the alternative hypothesis of cointegration with at least one cross-sectional unit or cointegration within the entire panel, respectively. The Westerlund tests (2007) are formulated in the sense of a model for error correction that can be represented as:

$$\Delta y_{it} = \delta_i' d_t + \alpha_i\left(y_{i,t-1} - \beta_i' x_{i,t-1}\right) + \sum_{j=1}^{pi} \alpha_{ij}\Delta y_{i,t-j} + \sum_{qi}^{pi} \gamma_{ij}\Delta x_{i,t-j} + \varepsilon_{it} \quad (14)$$

where $d_t$stands for the deterministic components and pi and qi are the lag lengths and lead orders

which vary across individual cross-sections. The two group-mean test statistics G_{-tau} and G_{-alpha} and the two-panel test statistics P_{-tau} and P_{-alpha} within the Westerlund (2007) cointegration analysis can be shown as:

$$G_{-tau} = \frac{1}{N}\sum_{i=1}^{N} \frac{\hat{\alpha}_i}{SE(\hat{\alpha}_i)} \quad (15)$$

and

$$G_{-alpha} = \frac{1}{N}\sum_{i=1}^{N} \frac{T\hat{\alpha}_i}{\hat{\alpha}_i(1)} \quad (16)$$

In which $\hat{\alpha}_i$ = error correction estimate, and $SE(\hat{\alpha}_i)$ = standard error of $\hat{\alpha}_i$.

The panel statistics is constructed as:

$$P_{-tau} = \frac{\hat{\alpha}}{SE(\hat{\alpha})} \quad (17)$$

and

$$P_{-alpha} = T\hat{\alpha} \quad (18)$$

3. RESULTS AND DISSCUSION

Summary Statistics

The study begins with the descriptive statistics of the variables used. Table 1 presents the descriptive statistics of the variables used and the African countries. In terms of the gross domestic product which is on the logarithm form, Nigeria recorded the highest mean value with 11.503 followed by Angola and Cote d'Ivoire with 10.851 and 10.424 respectively. Central Africa Republic recorded the minimum value with 9.173 followed by Equatorial Guinea and Chad with 9.582 and 9.586 respectively. The maximum value is recorded in Nigeria with 11.672 followed by Angola and Cote d'Ivoire with 11.019 and 10.628 respectively. The reported case of Human African Trypanosomiasis showed that Democratic Republic of Congo recorded the highest with 17300 cases followed by Angola with 4577 and Central African Republic with a reported case of 1194. The last country is Nigeria with 31 cases reported as the highest followed by Equatorial Guinea with 32 reported cases. The minimum cases reported in the African country is 0 and these figures are found in Cote d'Ivoire, Equatorial Guinea, Nigeria and Uganda. In terms of current health expenditure in Africa, the maximum amount of health expenditure is found in Uganda with 11.793 million dollars followed by Central African Republic and Chad with 7.362 and 7.268 respectively. Equatorial Guinea reported the minimum amount spent on current health expenditure and Democratic Republic of Congo with $1.572million and $1.694million respectively. Looking at the official development assistance to the selected African countries in the study, the Central Africa Republic and the Democratic Republic of Congo received the highest average value with $98.553million and $98.036million. Democratic Republic of Congo recorded the highest maximum amount with $636.352 followed by Central African Republic. In terms of the consumer price index, Angola recorded the highest in terms of the maximum value with 337.45 followed by Central Africa Republic, Guinea and Nigeria with 300.167, 240.201 and 240.143 respectively. The minimum value is reported in Angola with 2.909 and Democratic Republic of Congo with 6.798. For exchange rate, Guinea reported the highest in the maximum value for the period used with 9088.319 followed by Democratic Republic of Congo with 1622.54, then Nigeria with 306.084. Angola, however, recorded the lowest minimum value with 10.041 followed by Democratic Republic of Congo with 21.818, then Nigeria with 101.697.

Table 1. Descriptive Analysis of Variables

Country	Mean	Std. Dev	Min	Max
Gross Domestic Product				
Angola	10.851	0.162	10.556	11.019
Cameroon	10.411	0.101	10.25	10.578
Central Africa Republic	9.244	0.059	9.173	9.369
Chad	9.944	0.173	9.586	10.130
Congo	10.038	0.098	9.882	10.165
Cote d'Ivoire	10.424	0.095	10.336	10.628
Dem. Rep of Congo	10.322	0.143	10.126	10.547
Equatorial Guinea	10.093	0.208	9.528	10.274
Gabon	10.175	0.069	10.096	10.282
Guinea	9.843	0.102	9.703	10.047
Nigeria	11.503	0.147	11.228	11.672
Uganda	10.258	0.157	9.996	10.482
Panel	10.259	0.544	9.173	11.672
Human African Trypanosomiasis				
Angola	1214.474	1609.753	18	4577
Cameroon	13.684	9.304	3	33
Central Africa Republic	400.263	356.807	57	1194
Chad	217.684	179.552	12	715
Congo	267.211	340.103	15	1005
Cote d'Ivoire	35.421	48.799	0	188
Dem. Rep of Congo	7510.368	4920.439	660	17300
Equatorial Guinea	10.421	9.100	0	32
Gabon	23.526	13.672	9	53
Guinea	79.842	31.275	29	139
Nigeria	6.684	9.855	0	31
Uganda	208.789	258.036	0	948
Panel	839.031	2514.723	0	17300
Current Health Expenditure				
Angola	2.989	0.621	1.909	4.484
Cameroon	4.332	0.320	3.399	4.699
Central Africa Republic	4.668	0.922	3.742	7.362
Chad	4.723	0.830	3.856	7.268
Congo	2.334	0.505	1.694	3.487
Cote d'Ivoire	5.299	0.733	4.369	6.317
Dem. Rep of Congo	3.824	0.809	1.572	5.141
Equatorial Guinea	2.104	0.591	1.264	3.157
Gabon	2.945	0.395	2.421	3.84
Guinea	3.666	0.837	2.887	5.809
Nigeria	3.688	0.592	2.491	5.054
Uganda	8.691	1.922	6.049	11.793
Panel	4.105	1.867	1.264	11.793

Country	Mean	Std. Dev	Min	Max
Official Development Assistance				
Angola	3.738	4.702	0.587	15.731
Cameroon	16.665	10.436	8.642	42.326
Central Africa Republic	98.553	28.093	62.89	159.589
Chad	21.806	9.075	8.339	40.741
Congo	15.938	26.849	1.813	115.995
Cote d'Ivoire	32.326	36.997	3.833	120.423
Dem. Rep of Congo	98.036	138.853	6.477	636.352
Equatorial Guinea	0.687	0.449	0.008	1.372
Gabon	1.950	1.237	0.742	5.375
Guinea	27.228	13.872	12.384	61.955
Nigeria	4.008	4.330	0.733	17.376
Uganda	46.911	21.008	21.941	76.407
Panel	30.654	54.041	0.008	636.352
Consumer Price Index				
Angola	108.419	90.389	2.909	337.45
Cameroon	97.631	12.845	77.614	115.808
Central Africa Republic	123.975	67.688	72.551	300.167
Chad	98.286	15.891	72.169	124.457
Congo	97.863	16.272	75.836	121.198
Cote d'Ivoire	67.248	12.726	75.227	112.946
Dem. Rep of Congo	89.565	41.881	6.798	141.359
Equatorial Guinea	93.372	22.336	56.005	122.825
Gabon	97.678	11.797	81.588	119.718
Guinea	107.483	70.322	32.149	240.201
Nigeria	104.153	61.966	29.601	240.143
Uganda	101.991	41.140	53.699	169.022
Panel	101.472	46.604	2.909	337.45
Exchange Rate				
Angola	95.315	53.904	10.041	252.856
Cameroon	552.079	83.985	447.805	733.039
Central Africa Republic	552.079	83.985	447.805	733.039
Chad	552.079	83.985	447.805	733.039
Congo	552.079	83.985	447.805	733.039
Cote d'Ivoire	552.079	83.985	447.805	733.039
Dem. Rep of Congo	727.409	407.027	21.818	1622.524
Equatorial Guinea	552.079	83.985	447.805	733.039
Gabon	552.079	83.985	447.805	733.039
Guinea	5270.124	2545.219	1746.87	9088.319
Nigeria	162.323	60.675	101.697	306.084
Uganda	2339.409	495.463	1644.475	3727.069
Panel	1038.261	1579.716	10.041	9088.319

Source: Author's computation 2020 Using Stata 14

Preliminary analysis

Cross sectional and Slope Homogeneity

The findings of the four cross-sectional measures for dependency are shown in Table 2. In all cases, we find evidence in favor of rejecting the null hypothesis of no cross-sectional dependence at 1% and 5% levels of relevance.Likewise, the significant test statistics for all delta tests and the adjusted delta tests in Table 3 contribute to the rejection of zero slope homogeneity at 1%. Thus, we confirm the presence of slope heterogeneity.

Table 2. Cross - sectional dependence test result

	Test Statistics and probability					
	GDP	NTD	CHE	ODA	CPI	EXR
Breusch - Pagan LM	844.847*	471.966*	191.317*	135.276*	1111.605*	600.034*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Pesaran Scaled LM	66.746*	34.289*	9.863*	4.985*	89.964*	45.437*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Bias-Corrected Scaled LM	66.412*	33.955*	9.529*	4.652*	89.63*	45.104*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Pesaran CD	26.681*	20.233*	0.782	2.437**	33.267*	11.808*
	(0.000)	(0.000)	(0.434)	(0.015)	(0.000)	(0.000)

Source: Author's computation, 2020 using Eviews 9. (2) the optimal lags are based on Schwarz Information Criterion (SIC) (3) the probabilities values are reported within the parentheses (4) *and**, indicate rejection of the null hypothesis of no cross-sectional dependence at the 1%, and 5%,levels, respectively.

Table 3. Slope homogeneity test rest

Delta Tests	Test Statistics and Prob.					
	GDP	NTD	CHE	ODA	CPI	EXR
Delta Tilde	6.516*	7.342*	4.407*	4.769*	7.686*	3.298*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Delta Tilde adjusted	7.101*	8.001*	4.803*	5.197*	8.375*	3.594*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

Source: Author's computation, 2020 using GAUSS 14. Note: (1) the probabilities values are reported within the parentheses (2)*denotes sig. at 1%.

Panel Unit root test results

Table 4 presents the CADF and CIPS panel unit root test results with intercept and trend at levels. At this point NTD and ODA were stationary. Table 5 reports the CADF and CIPS results with intercept and trend after first difference. The CIPS estimates showed that on average, all the variables are stationary after first difference as reported in Table 5. We therefore conclude that while NTD and ODA are integrated of order zero, all other variables are integrated of order one as presented in Table5.Therefore, based on the result, we conclude that after their first difference, all variables are stationary.

Table 4. Panel unit root test with intercept at levels

Countries	Test Statistics						Critical Values		
	GDP	NTD	CHE	ODA	INF	EXR	1%	5%	10%
Angola	-2.27	-1.60	-2.68	-2.94	-3.72	-0.45	-4.97	-4.01	-3.65
Cameroon	-2.22	-3.34	-1.77	-2.68	-0.81	-2.34	-4.97	-4.01	-3.65
Central Africa Republic	-2.84	-2.47	-0.95	-1.90	-0.14	-2.34	-4.97	-4.01	-3.65
Chad	-3.17	-3.22	-1.61	-1.01	-4.48*	-2.40	-4.97	-4.01	-3.65
Congo	-1.64	-2.52	-1.42	-6.15*	-1.22	-2.40	-4.97	-4.01	-3.65
Cote d'Ivoire	-1.46	-1.51	-1.00	-1.76	-1.28	-2.40	-4.97	-4.01	-3.65
Dem. Rep. of Congo	-1.84	-1.10	-2.92	-2.64	-0.25	-2.26	-4.97	-4.01	-3.65
Eq. Guinea	-1.56	-3.05	-1.34	-1.84	-0.29	-2.34	-4.97	-4.01	-3.65
Gabon	-0.95	-2.86	-2.12	-4.80*	-1.94	-2.40	-4.97	-4.01	-3.65
Guinea	-3.24	-4.89*	-3.26	-1.59	-3.20	-1.18	-4.97	-4.01	-3.65
Nigeria	-1.67	--2.43	-2.97	-5.09*	-1.92	-2.19	-4.97	-4.01	-3.65
Uganda	-2.01	-1.89	-0.84	-2.24	-0.32	-1.38	-4.97	-4.01	-3.65
CIPS Stat for all countries (Panel)	-2.07	-2.57*	-1.75	-2.89*	-1.01	-1.99	-2.98	-2.75	-2.63

Source: Author's computation 2020 using GAUSS 14.

Table 5. Panel unit root test with intercept and trend after first difference

Countries	Test Statistics						Critical Values		
	GDP	NTD	CHE	ODA	INF	EXR	1%	5%	10%
Angola	-4.14	-3.78	-5.07	-7.07	-5.66	-2.38	-4.97	-4.01	-3.65
Cameroon	-3.98	-5.93	-6.26	-7.03	-3.99	-5.18	-4.97	-4.01	-3.65
Central Africa Republic	-4.35	-5.23	-5.84	-4.70	-3.18	-5.18	-4.97	-4.01	-3.65
Chad	-4.59	-5.54	-7.06	-5.09	-6.78	-5.18	-4.97	-4.01	-3.65
Congo	-5.20	-9.22	-4.78	-6.35	-4.17	-5.18	-4.97	-4.01	-3.65
Cote d'Ivoire	-4.43	-4.82	-4.45	-5.07	-3.17	-5.18	-4.97	-4.01	-3.65

Countries	Test Statistics						Critical Values		
	GDP	NTD	CHE	ODA	INF	EXR	1%	5%	10%
Dem. Rep. of Congo	-3.94	-4.29	-4.60	-5.78	-5.60	-3.93	-4.97	-4.01	-3.65
Eq. Guinea	-5.85	-7.16	-3.95	-5.22	-3.23	-5.18	-4.97	-4.01	-3.65
Gabon	-3.09	-5.63	-6.31	-6.06	-3.87	-5.18	-4.97	-4.01	-3.65
Guinea	-6.13	-6.67	-4.17	-5.39	-4.25	-5.29	-4.97	-4.01	-3.65
Nigeria	-4.32	-5.00	-5.63	-6.23	-5.87	-4.39	-4.97	-4.01	-3.65
Uganda	-4.08	-6.82	-4.00	-3.18	-2.44	-4.16	-4.97	-4.01	-3.65
CIPS Stat for all countries (Panel)	-5.51*	-5.84*	-5.17*	-5.62*	-4.90*	-5.10*	-2.98	-2.75	-2.63

Westerlund Cointegration Test

Next, the cointegration test for the second-generation panel data is used to verify the long-run relationship between the variables. The results of the panel cointegration test by Westerlund (2007) which reflects the cross-sectionally based panels in the dataset, are reported in Table 6. All the estimated statistics are statistically significant, which rejects the null hypothesis of nocointegration at 1% and 5% levels of significance. Therefore, it can be said that the variables considered in this paper have long-run associations.

Table 6. Westerlund (2007) cointegration test result

Statistics	Value	ρ -value
g-tau	-4.957*	0.000
g-alpha	-4.382*	0.005
p-tau	-3.782*	0.008
p-alpha	-2.983**	0.015

Source: Author's computation 2019 using GAUSS 14. Note * and ** indicate rejection of the null of no cointegration at the 1%, and 5%, levels, respectively.

After confirming the cointegration of the variables, the next step involves estimating long-term elasticity using appropriate panel regression estimators that account for cross-sectional dependence across panels. Although, MG does not account for cross sectional dependence, the result was also explained along with AMG and CCEMG estimators that account for cross sectional dependence. These

three regression techniques are tapped to unearth the long-run relationships. Estimates of elasticity in the context of the three estimates are shown in Table 7. In general, the estimates show the robustness of the results with the different regression techniques that are evident from the similarity of the predicted signs of the estimated elasticity.

In the context of the results from MG, AMG and CCEMG, the statistically significant long-run elasticities advocate in favor of an inverse relationship between the neglected tropical disease and economic growth within the concerned African countries. It is found that a rise in the reported case of neglected tropical disease by one person will attributes to afall in economic growth figures by 0.0001%-0.0003%, on average, *ceteris paribus.* Hence, it canbe asserted that neglected tropical disease is a barrier that impedes the economic growth of African countries. Moreover, the result was significant, which shows that neglected tropical disease is a major determinant of economic growth in the African countries studied.

In terms of current health expenditure, it can be asserted that spending more on health can effectively enhance economic growth in Africa. The positive estimated elasticity parameters imply that 1% rise in government expenditure on health increases economic growth by 2.1% - 8.3%, on average, *ceteris paribus.* Hence, from the perspective of theoretical underpinning, the result conforms to a priori expectation. A plausible explanation in this regard could be made in the sense that spending more on the health sector in other to improve the health facilities in the African countries will improve economic growth in Africa. The result was significant.

However, despite rising official development assistance to African economies, it does not quite guarantee growth in the economy. This can be clearly understood from the negative signs that exist between ODA and GDP from the results. It is found that 1% rise in official development assistance improves economic growth levels by 2% - 4%, on average, *ceteris paribus*. This result was significant.

Other important results show that inflation rate impacted negatively and significantly with economic growth across the selected African economies, from the statistical significance of the associated estimated elasticity parameters. The results indicate that 1 percentage point rise in inflation rate, holding all other factors

constant, reduces economic growth by 0.25% - 0.46%. Similar result was found by Okoroafor, Adeniji and Olasehinde, 2018 and Idris and Baker 2017 who found inflation rate to be inversely related with economic growth.

It is evident from the elasticity estimates that the overall impacts of exchange rate on economic growth are inverse in the African economies. These can be understood from the statistically significant elasticity parameters attached to the interaction terms which tend to implicate that higher exchange rate is effective in reducing economic growth in Africa. These results conform to the conclusions made by Ahiabor&Amoah, 2019; Ha &Hoany, 2020; Hussain, Hussain, Khan & Khan, 2019. The result shows that 1 percentage point increase in exchange rate will reduce economic growth by 0.42% - 0.92%.

Table 7. Results from ME, AMG and CCEMG Estimates

	MG Estimate		AMG Estimate		CCEMG Estimate	
	Coeff.	*ρ value*	Coeff.	*ρ value*	Coeff.	*ρ value*
NTD	-0.00001*	0.001	-0.000019*	0.003	-0.000025*	0.088
CHE	0.083***	0.088	0.021***	0.053	0.045**	0.038
ODA	0.039	0.322	0.070	0.320	0.024	0.113
CPI	-0.0046*	0.000	-0.025*	0.003	-0.049**	0.033
EXR	-0.0048**	0.029	-0.092**	0.047	-0.042**	0.012

Source: Author's computation, 2020 using GAUSS 14. Note *, ** and *** denotes sig. at 1%, 5% and 10% respectively.

Conclusion and Recommendations

This study examined the economic burden of a neglected tropical disease in Africa taking the case of Human African Trypanosomiasis. The study concludes as follows. First, cross – sectional dependence exists among the African countries. Second, there exists a long run relationship between economic growth and neglected tropical disease in Africa. Third, neglected tropical disease impacted negatively and significantly economic growth in Africa. This shows that neglected tropical diseases stand as an impediment towards achieving economic growth in

Africa. Hence, the inescapable conclusion is that NTDs are a serious detriment to economic development in Africa

Our findings have important policy implications for African governments as well as for the entire world at large. As one of the biggest continents in the world, achieving sustainable development by 2030 may not be a reality. Far too often, NTDs have been categorized as "other diseases" and are overshadowed by efforts to combat HIV/AIDS, malaria and tuberculosis. Yet, given the disproportionate impact of NTDs on the African economies, efforts to create sustainable growth will be slowed if NTDs are not addressed quickly. Therefore, given the disproportionate impact of NTDs on the African economies, sustainability efforts in Africa will falter unless NTDs are fought with integrated programs through long term public – private partnerships. Furthermore, considering the high burden of NTDs on women and children, addressing these diseases is critical to reaching the SDGs.

Therefore, the study recommends as follows. First, there is a need to increase attention and funding from the African governments to control the spread of the neglected tropical diseases. This can be done through investment in water and sanitation infrastructure, improvement in health expenditure and creating successful integration programs to address multiple infections. Mass drug administration is essential and programs that focus on water and sanitation, environment and vector control are needed as well. Second, funding from international community needs to be utilized effectively in areas they are meant for and the high rate of corruption should be curbed. This is because of the negative effects of ODA on economic growth. But even as African countries received greater recognition and economic assistance from countries, donors, organizations and corporations throughout the world, it is imperative for these entities, and particularly African nations, not only to maintain their commitment to fight NTDs, but to increase their investments towards reducing their spread. Price and exchange rate stability are also essential to assist the poor who are most affected by these diseases.

Finally, achieving the Sustainable Development Goals (SDGs) simply can't be done without eliminating NTDs. African government critical work to combat these diseases, which affect the poorest and the most vulnerable among us with

the least access to safe sanitation and health care, is essential to the goals of reducing poverty, ending malnutrition, improving water and sanitation, and achieving gender equality. In fact, SDG 3 specifically names NTDs as a target for eradication by 2030. Not only must some African governments celebrate the impressive strides they have made in such a short time, they also must capitalize on them. They must push forward with measures such as preventive chemotherapy in the most at-risk communities, ensure that everyone has access to timely treatment and care, because no one should suffer needlessly from entirely preventable and treatable diseases. With over 1.5 billion people still needing help, including about 60 million in Africa, this is not the time to slow down. Rather, it is time to ramp up efforts and take advantage of this opportunity to eliminate NTDs once and for all. This would be a historic legacy of this African government generation and a better life for the next generation.

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ЕКОНОМСКИ ТЕРЕТ ЗАНЕМАРЕНЕ ТРОПСКЕ БОЛЕСТИ У АФРИЦИ: СЛУЧАЈ АФРИЧКЕ ТРИПАНОЗОМИЈАЗЕ КОД ЉУДИ

1 Џозеф Афолаби Ибикунле, Економски факултет, Ајаји Краутер Универзитет, Ојо, Нигерија

САЖЕТАК

Занемарене тропске болести (НТД) су категорија болести које узрокују тешка обољења код више од милијарду људи широм свијета. Оне утичу на најсиромашније људе на свијету, смањују квалитета живота, продуктивност запослених, ометају физички и когнитивни раст, доприносе болести мајке и дјеце и узрокују смрт. Упркос својим ризицима, оне су засјењене напорима борбе против ХИВ-а, маларије и туберкулозе, а сматрају се „другим болестима“ о којима се не води рачуна. Стога је у овом раду анализиран економски терет занемарених тропских болести у Африци од 2000. до 2018. године. Употребљени су подаци о бруто домаћем производу (БДП), пријављеним случајевима афричке трипанозомијазе код људи, тренутној здравственој потрошњи, нето службеној развојној помоћи, индексу потрошачких цијена и курсу. Примијењене су економетријске методе друге генерације; зависност попречног пресјека, хомогеност нагиба, Westerlund коинтеграција, Pesaran&Smith MG метод, Pesaran CCEMG метод и Eberhadt&Teal AMG метод оцјењивања. Налази потврђују сљедеће: прво, зависност попречног пресека и хетерогеност нагиба постоје у афричким земљама; друго, постоји дугорочна веза између БДП-а и НТД-а; треће, НТД негативно и значајно утиче на БДП, стога наноси озбиљну штету економском расту у Африци. Студија сугерише да би владе у Африци требало да прикупе средства за искорјењивање НТД-а и осигурају побољшање услова у животној средини који доводе до њиховог ширења, попут чисте воде, појачаних санитарних иницијатива и векторске контроле.

Кључне ријечи: афричка трипанозомијаза код људи, економски раст, оцјена групних средина, оцјена проширених групних средина, оцјена групних средина са заједничким корелисаним ефектима.