ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24SEP907

Effect of Health on Economic Growth in the Republic of Congo: The Case of Manultrition

MASSAMBA AWA Carine Divine[1]; MADINGOU BOUANA Gamerine Florès[2]
Economic and Social Research and Studies Laboratory (ESRSL/LARES)

Abstract:-

- ***Introduction:***

This study examines the relationship between health, specifically malnutrition, and economic growth in the Republic of Congo. There is growing concern about the deteriorating nutritional status of the population, characterized by high rates of malnutrition (FAO, 2012). This work aims to reassess the effects of malnutrition on long-term economic growth, based on theoretical frameworks established in the economic literature.

- ***Methodology:***

The model used is an augmented version of Solow model, incorporating health and education as components of human capital, folloxin the approach of Mankiw and al (1992) and Knowles and Owen (1995). The data come from various sources, including the World Bank, the World Food Program (WFP), the FAO and UNESCO. An Error Correction Model (ECM) was applied to assess the long-term effect of malnutrition, measured by the Food Deficit in Kilocalories per person per day, on economic growth measured by Gross Domestic Product in Congo.

- ***Results:***

The resuts show that malnutrition has a significant and negative effect on long-term economic growth in the Republic of Congo. Each increase in the food deficit leads to a significant drop in GDP, underlining the importance of improving nutritional status to stimulate economic growth.

- ***Discussion and Conclusion:***

The study highlights the crucial role of health and nutrition in economic growth. It is therefore essential to adopt public policies aimed at reducing malnutrition in order to promote sustained and sustainable growth in the Republic of Congo.

Keywords: *Health, Malnutrition, Economic Growth, Republic of Congo.*

I. INTRODUCTION

Human capital accumulation is essential for long-term economic growth, as new economic theories show. Among the components of human capital, education is often highlighted, but health, although long recognized as crucial by authors such as Betham (1780) and Marx (1867), was long neglected in economic theories until the emergence of health economics and endogenous growth theories in the 1990s. Today, health is widely accepted as a key factor in economic growth, alongside research, development, and government spending.

However, despite international efforts to improve the problem of malnutrition, particularly through conferences and global strategies such as those of theworld food conference1974,the 1978 Alma-Ata Declaration on Primary Health CareAndthe United Nations Decade of Action on Nutrition2016, malnutrition problems persist. Malnutrition, whether due to undernutrition, dietary deficiencies or overnutrition, is a major public health problem, with an estimated 840 million people worldwide unable to meet their energy needs, and more than 2 billion suffering from micronutrient deficiencies,to thisIndeed, WHO (2013) states that more than 500 million adults worldwide were obese.

Africa, and particularly the Republic of Congo, is seriously affected by malnutrition. With a high dependence on food imports and an alarming prevalence of undernourishment, the nutritional situation in Congo is worrying with more than 60% of food imports, which shows widespread micronutrient deficiencies and food insecurity affecting millions of people FAO (2012), with considerable economic consequences. Indeed, it affects productivity, increases health costs, and can lead to significant GDP losses; malnutrition can reduce labor productivity by up to 15%, and estimates show that it could cost between 2 and 3% of global GDP. In addition, it has adverse effects on children's cognitive and physical development, creating a vicious cycle of poverty and malnutrition.

In response to these challenges, the Congolese government has taken steps such as joining the Scaling Up Nutrition (SUN) movement and establishing a strategic framework for 2025. However, increased efforts are needed to improve the nutritional situation and support economic development. Reducing malnutrition is not only a matter of immediate survival but also a crucial investment to prevent physical and intellectual disabilities in future generations and to ensure sustainable economic growth.

For years, malnutrition has been added to the many health problems affecting the Congolese, with worrying consequences for their nutritional status. The hunger score increased from 18.8% in 2008 to 20.5% in 2011, and the country depends heavily on food imports, representing more than 60% of its needs, or approximately 132 billion CFA francs (FAO, 2012). This dependence contributes to the rise

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24SEP907

in food prices, reducing vulnerable households' access to sufficient food.

Despite a slight improvement in malnutrition indicators—stunting declined from 31% in 2005 to 25% in 2011 and undernourishment decreased from 30.2% in 2005 to 25.3% in 2011—the number of undernourished people increased from 1.1 million in 2005 to 1.3 million in 2011. At the same time, Congo experienced average annual economic growth of close to 7% between 2008 and 2011, supported by the oil and non-oil sectors, despite the global economic crisis. In 2010, the country reached the completion point of the Heavily Indebted Poor Countries Initiative (HIPC), thereby reducing its external debt.

The question of whether malnutrition has an impact on economic growth in the Republic of Congo is one of the current issues that has attracted particular attention from international opinion. The Congolese population has been subject for years to numerous health problems in general and malnutrition in particular, thus contributing to the deterioration of their nutritional status., in the face of a crucial concern, the central question of this study is what impact does malnutrition have on its economic growth? and the objective pursued by the study is to analyze the effects of malnutrition on economic growth in Congo. Specifically, the study aims to describe the situation of malnutrition in the country and to assess the relationship between malnutrition and economic growth in the short and long term.

II. LITERATURE REVIEW

The analysis of the relationship between health/malnutrition and economic growth cannot be carried out without the inventory of theories and empirical work. This necessity justifies the presence of a section which gives its content.

A. Theoretical Review

This subsection reviews theories that help explain the link between health/malnutrition and economic growth in the Republic of Congo.

- *The Theory of Endogenous Growth*

The theory of endogenous growth originated in 1986 in an article by Romer entitled "Incrasing returns and long run growth" which links growth to the behavior, initiatives and development of skills of economic agents. Indeed, this theory calls into question the neoclassical model (known as the exogenous growth model) of Solow (1956), for which technical progress is an exogenous factor, that is to say that technical progress is considered as a residue, without explaining the reason and which concludes with a convergence of economies towards a stationary state.

Developed by Romer, Lucas, and Barro, these theories are very recent and are also adapted to current economic problems. Indeed, according to the proponents of this theory, technical progress is endogenous, that is to say, it is the result of economic activity. In order to increase their productivity gains and to face competition, companies will want to improve their performance by integrating technical progress, which will generate growth and subsequently this growth will itself make new technical progress necessary.

This theory refers to four factors that are likely to influence the rate of economic growth, among which we have public capital (infrastructure and basic research); human capital (qualification, education and health); physical capital (equipment and organization) and technical capital (technology, innovation and research and development). Being in the framework of our work, we are interested in human capital which constitutes a source of growth.

- *The Theory of Capital*

Developed by Schultz (1960;1961) and Becker (1964), emphasize that the quality of the workforce, influenced by health and nutrition, is a crucial asset for economic development. Good health, considered as an element of human capital, improves the productivity of individuals and contributes to sustained economic growth.

Studies show that investing in health and nutrition is essential to increase productivity and reduce poverty. Health, as a component of human capital, is fundamental to improving levels of well-being and, therefore, stimulating economic growth.

III. EMPIRICAL REVIEW

In this section, we will first highlight the authors who, through their work, have been able to verify the existence of a positive relationship between health and malnutrition on economic growth. Secondly, we will present the work of authors who 'admit rather that health has a negative and marginal impact on economic growth.

A. Health/Malnutrition: A Major Determinant of Economic Growth

Good nutrition is not only a matter of individual health and development, but also has implications for the health and productivity of the entire country. Good nutrition begins at the household level and its benefits cascade throughout society. The health and productivity gains resulting from policies to combat malnutrition can improve economic growth performance in the country. To this end,The literature aimed at demonstrating the hypothesis of the existence of a positive relationship between health/malnutrition and economic growth is abundant.

Schultz (2005), examines this relationship by choosing as a proxy economic growth and health, the results found show that good health as a major component of human capital has a positive and significant impact on wages and productivity of workers. In his study, he shows how developing countries lack the resources to invest in health so he says poor health slows down economic growth in these countries. Which generates a vicious circle of poverty.

Akram, Padda, and Khan (2008), pursue the same objective in Pakistan using Granger Cointegration techniques on time series data from Pakistan between 1972-2006. They

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24SEP907

obtain the result that health indicators positively influence economic growth which is captured by gross domestic product per capita. Similarly,

Boachie (2015), usesas a proxy for health, life expectancy and as a proxy for growth, gross domestic product. The latter uses the ARDL approach to estimate its model on time-domain data between 1983-2012. The results obtained reveal that health has a positive and significant effect on economic growth.

B. Health / Malnutrition: A Determinant with Mixed Effects on Economic Growth

The positive causal relationship between health and economic growth is questioned by some and is the subject of significant debate. Indeed, health is not always positively correlated with economic growth. Some studies have revealed a negative relationship. This is the case of the study by Knowles and Owen (1995) by incorporating life expectancy as a proxy for health in a Mankiw-Romer-Weil (1992) type growth model with a global sample of 84 countries showed that the correlation between per capita income (or growth rate) and life expectancy is strong and robust (stronger than that between education and income), but negative.

Along the same lines, a study by Acemoglu and Johnson (2008) showed that increasing life expectancy (one of the health indicators) does not have a significant impact on total GDP, as it leads to an increase in the population growth rate. Therefore, a significant reduction in GDP per capita.

Ashraf et al (2009); show that in the long term, improving health status has a marginal effect on economic growth. Indeed, the benefits of this improvement are only perceived in the long term. This is confirmed by another study by Mandiefe and Chupezi (2015) whose aim is to measure the contribution of investments in public health to economic growth in Cameroon. To make the estimates, they use the vector error correction model as an econometric model and annual data spanning the period from 1988 to 2013. It emerges from these estimates that investments in health contribute to economic growth in Cameroon only in the long term.

It should be noted that health/malnutrition can have repercussions on economic growth. This review of the theoretical and empirical literature presented in this section, the aim of which was to highlight the relationship between health/malnutrition and economic growth. Indeed, the following lessons emerge from this review: malnutrition as a deterioration in health status can have positive or negligible, or even negative effects on economic growth. The results are not convergent, they vary from one country to another or from one group of countries to another. It goes without saying that the relationship between malnutrition and economic growth needs to be explored in each country, taking into account its particularity, in particular the extent of malnutrition. Also, the study of the effect of malnutrition on growth calls for a multiplicity of estimation methods.

IV. METHODOLOGY

This methodological section consists of two parts, the first of which will be devoted to the method of investigation and data source and the second will focus on the modeling of the effects of health/malnutrition on economic growth.

A. Investigation Mode and Data Source

The data used in this work come from various sources. In particular the FAO database, the World Bank database, others come from the WFP. Some come from UNESCO, the period from 1985 to 2016 is the one we have chosen for our estimates.

B. Modelingof the Health/Malnutrition Effects on Economic Growth

In this section, we will first present the theoretical model and then the model for estimation purposes as well as the variables retained.

➢ *Theoretical Model*

The growth model chosen, serving as a basis in the context of our work, is the neoclassical model developed by Solow (1956). In fact, the author uses a Cobb-Douglas type production function, in which labor is a homogeneous factor, and physical capital is the only production factor that can be accumulated.

This function looks like this:

$$Y_t = A.K_t^{\alpha} L_t^{\beta} \tag{1}$$

Where Y denotes production, corresponds respectively to the shares of capital and labor remuneration in GDP, A represents the level of production.$\alpha\ et\ (1-\alpha)$

Later Mankiw, Romer, Weil (1992) developed a model (MRV) that derived from the Solow model a human capital argument in the production function. This model is known as the "augmented Solow model". The authors modeled this human capital as a determinant of production in the following form:

$$Y = K^{\alpha} + H^{\beta} + (AL)^{1-\alpha-\beta} \tag{2}$$

Where are the respective shares of physical capital, human capital and labor in production where returns to scale are constant.α, β et $(1-\alpha-\beta)$

Indeed, to understand the relationship between health and economic growth, Knowles and Owen (1995) will propose an augmented Solow formulation by integrating health and education as factors of human capital.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24SEP907

Thus, the MRW model (1992) becomes:

$$Y_t = K_t^{\alpha} E^{\beta} H^{\alpha} (A_t L_t)^{1-\alpha-\beta-\gamma} \quad (3)$$

OrY is output, K is physical capital, E represents human capital (education) and H is human capital (health), L is labor force and A is the technology level. Following Knowles and Owen (1995), we assume that L and A grow at exogenous rates n_{it} g_{it}.

$$L_t = L_0 e^{nt} \quad (4)$$

$$A_t = A_0 e^{gt} \quad (5)$$

The growth rate of labor $A_t L_t$ is then equal to $n + g$.

Let be $S_k, S_e,\ et\ S_h$ the fractions of output invested respectively in the accumulation of physical capital, human capital "education" and human capital "health", and let be $\bar{k}$ $\bar{e}\ et\ \bar{h}$ the stocks of physical capital, education capital and health capital per unit of efficient work, such that: $\bar{k}\ \bar{e}\ et\ \bar{h}$ Si on dénote par $\bar{y} = Y/AL$, and . If we denote by the level of output per efficient unit, then the expression of the product per capita is written:

$$\bar{y}_t = \bar{k}_t^{\alpha}\ \bar{e}_t^{\beta}\ \bar{h}_t^{\gamma} \quad (6)$$

The growth dynamics of the variables $\bar{k}\ \bar{e}\ et\ \bar{h}$ are then given by:

$$\bar{k}_t = S_k \bar{y}_t - (n \ + g + \delta)\bar{k}_t = S_k \bar{k}_t^{\alpha} + \bar{e}_t^{\beta}\ \bar{h}_t^{\gamma} - (n_t + gt + \delta)\bar{k}_t \quad (7)$$

$$\bar{e}_t = S_e \bar{y}_t - (n + g + \delta)\bar{e}_t = S_e \bar{k}_t^{\alpha} + \bar{e}_t^{\beta}\ \bar{h}_t^{\gamma} - (n_t + gt + \delta)\bar{e}_t \quad (8)$$

$$\bar{h}_t = S_h \bar{y}_t - (n + g + \delta)\bar{h}_t = S_h \bar{k}_t^{\alpha} + \bar{e}_t^{\beta}\ \bar{e}_t^{\beta} - (n_t + gt + \delta)\bar{h}_t \quad (9)$$

Where δ represents the depreciation rate of physical capital, assumed to be constant over time. This implies that $\bar{k}\ \bar{e}\ et\ \bar{h}$ converge towards their equilibrium values $\bar{k}^{*} \bar{e}^{*}$ et $\bar{h}^{*}$ such that:

$$\bar{k}_t^{*} = \left[\left[\frac{S_{kt}^{1-\beta-\gamma} S_{et}^{\beta} S_{ht}^{\gamma}}{n_t + gt + \delta}\right]\right]^{1/\theta} \quad (10)$$

$$\bar{e}_t^{*} = \left[\left[\frac{S_{kt}^{\alpha} S_{et}^{1-\alpha-\gamma} S_{ht}^{\gamma}}{n_t + gt + \delta}\right]\right]^{1/\theta} \quad (11)$$

$$\bar{h}_t^{*} = \left[\left[\frac{S_{kt}^{\alpha} S_{et}^{\beta} S_{ht}^{1-\alpha-\beta}}{n_t + gt + \delta}\right]\right]^{1/\theta} \quad (12)$$

With $\theta = 1 - \alpha - \beta - \gamma$. By substituting equations (3), (8), (9), and (10) into (4) and applying a log-linear transformation, we obtain the expression for income per capita in the regular state:

$$ln\ y_t = lnA_0 + \text{gt} + \frac{\alpha}{\theta} lnS_{kt} + \frac{\beta}{\theta} lnS_{et} + \frac{\gamma}{\theta} lnS_h - \frac{1-\theta}{\theta} \ln(n_t + \text{gt} + \delta) \quad (13)$$

Note that the threshold gt et δln given by MRW is 0.005%.

However, taking into account the economic literature, This econometric modeling uses a variable of interest and three control variables. Growth is measured by the gross domestic product per capita which is one of the control variables. We use this growth indicator because it takes into account the weight of demography. It is measured in real terms at constant prices.

The gross enrollment rate (GERP) is a good proxy for other measures of human capital such as the number of years of schooling or the literacy rate, and this for the main reason that the enrollment rate is based on several recent data and years concerning several countries at different levels of development, unlike other measures resulting from approximations of econometric techniques. (Baldaci et al. 2008).

The "health" human capital, which is represented here by the severity of the food deficit (GDA), is an indicator set up by FAOSTAT. The latter is calculated each year and represents the number of calories necessary for an undernourished individual to escape undernourishment.The characteristics of the explained variable and the optimal mix of explanatory variables are summarized in Table 1.

Table 1: Characteristic Features of the Variables Under Study

Variables	Definition	Data source	Period	Expected sign
GDP_hab	Gross domestic product per capita	BM	1985-2016	Control variable
TBSP	Gross primary school enrollment rate	UNESCO	1985-2016	Positive
TCD	Population growth rate		1985-2016	Negative
GFCF	Gross human capital formation	BM	1985-2016	Positive
GDA	Severity of the food deficit	FAO	1985-2016	Variable of interest (positive)

Source: The Author Based on Data from the WB, UNESCO and FAO

To estimate an econometric model in the context of time series, it is first necessary to study the stochastic characteristics of the two types of variables (endogenous and exogenous). Among them, mention is made of the study of stationarity which counts, groups together three tests which are the Augmented Dickey-Fuller test (DFA), followed by that of Philips and Perron (PP), finally, the Kwiatkowski, Phillips, Schmidt, Shin (KPSS) test. The use of the different stationarity tests first calls upon variables which follow a normal distribution.

Table 2: Descriptive statistics

Variables	GDP_HAB1	FBCFF1	TBSP1	TCD1	GDA_KCAL_P_J1
Average	7.847750	21.29217	4.701745	1.038710	5.539169
Jarque-Bera	1.276916	4.294421	214.6113	5.323029	2.797088
Probability	0.528106	0.116810	0.000000	0.069842	0.246956
Standard deviation	0.067537	0.533192	0.137857	0.083072	0.207406
Observations	31	31	31	31	31

Source: The Author from the Results Obtained on Eviews 9

The results of descriptive statistics, specifically that of Jacque-Berra over the study period (1985-2016), show that the gross domestic product per capita, gross fixed capital formation, population growth rate, and the severity of the food deficit (kcal per person per day), follow a normal distribution because their respective probabilities 0.528106; 0.116810; 0.069842; and 0.246956 are greater than the critical value (0.05%). This is not the case for the gross primary school enrollment rate whose probability provided is less than the critical value (0.05%). The corresponding minima are 7.723443; 20.56124; 4.084124; 0.911566; and 5.236442. The standard deviations are respectively 0.067537; 0.533192; 0.137857; 0.083072; and 0.207406. Considering the number of observations that greatly exceed the minimum of 30 observations. For this purpose,

We can conclude that the different variables are normally distributed. This allows us to carry out the different stationarity tests.

➢ *Study of Stationarity*

The stationarity of a time series is defined by the constant of its mean and variance over time with the value of the covariance between two time periods depending only on the distance or gap between the latter two. For a seriesX_t

- *This Study is Defined by the Following Model:*

$$\begin{cases} \boldsymbol{E(X_t) = \mu} \\ \boldsymbol{Var(X_t) = \sigma^2} \\ \boldsymbol{Cov(X_t,\ X_{t-i}) = f(i)} \end{cases}$$

With t=1,…, n

- *This Study is Defined by the Following Model:*

When a series is stationary, we say that it is integrated of order 0 and we note: → I(0).$X_t X_t$.

On the other hand, a series is said to be integrated of order d (noted → (d)) if it admits differentiating it d times so that it becomes stationary.$X_t X_t$

Several tests can be used to verify the stationarity of a series.1The most common will be used in empirical work, namely the Augmented Dickey-Fuller (ADF) test, followed by the Phillips and Perron (PP) test, and finally the Kwiatkowski–Phillips–Schmidt–Shi (KPSS) stationarity test.

- *Augmented Dikey-Fuller Stationarity Test*

Unlike simple Dickey-Fuller tests which are performed under the assumption that the process is white noise, in Augmented Duckey-Fuller tests there is no reason to assume a priori that the error is uncorrelated. Duckey-Fuller testsε_t Augmented therefore take into account the hypothesis of autocorrelation of error and are therefore under the alternative hypothesis absolute value on the estimation by OLS of the following models.$\theta_1 < 1$,

- ✓ Model (A):$\Delta Y_t = \lambda Y_{t-1} - \sum_{i=2}^{k} \theta_i \Delta Y_{t-i+1} + \varepsilon_t$
- ✓ Model (B):$\Delta Y_t = \lambda Y_{t-1} - \sum_{i=2}^{k} \theta_i \Delta Y_{t-i+1} + c + \varepsilon_{t\varepsilon}$
- ✓ Model (C):$\Delta Y_t = \lambda Y_{t-1} - \sum_{i=2}^{k} \theta_i \Delta Y_{t-i+1} + c + b_t + \varepsilon_t$
- ✓ The test is performed in the same way as simple DF tests, only the statistical tables differ.

- *Test of by Phillips and Perron (PP)*

The use of the Phillips and Perron test is based on a non-parametric Duckey-Fuller correction to take into account the Heroscedastic errors. The latter takes place in four stages: the first of which concerns the estimation by the OLS of three basic models of Duckey-Fuller test and calculation of the associated statistics, the second concerns the estimation of the short-term site variance$\sigma 2 = \frac{1}{n}\sum_{t=1}^{n} e_t^2$. The third is the estimate.of a corrective factor established from the structure of the error coefficients of the models previously estimated such that the transformations carried out lead to distributions identical to those of the standard Duckey Fuller:

$$s_t^2 s_t^2 = \frac{1}{N}\sum_{t=1}^{n} e_t^2 + 2\sum_{1}^{l}(1 - \frac{i}{l+1})\frac{1}{n}\sum_{t=i+l}^{n} e_t e_{t-1}$$

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24SEP907

To estimate this long-term variance it is necessary to determine a number of lags l estimated as a function of the number of observations n:$l = 4(^{n}/_{100})^{\frac{2}{9}}$

Calculate the PP : $t^{*}_{\phi_1} = \sqrt{k} \times \frac{\phi_1 - 1}{\sigma_{\phi_1}} + \frac{n(k-1)\sigma_{\phi_1}}{\sqrt{k}}$, avec $k = \frac{\sigma^2}{s_t^2}$. With This statistic is to be compared to Mac Kinnon's critical values.

- *Stationarity Test of from Kwiatkowski–Phillips–Schmidt–Shi (KPSS)*

This is a stationarity test by Kwiatkowski et al. (1992) who proposed the use of the Lagrange Multiplier (LM) test based on the null hypothesis of stationarity. The principle consists in estimating the two models (models with constant and model with constant and trend) and then calculating the statistic and estimating the long-term variance as for the Phillips and Perron test.$s_t = \sum_{t=1}^{n} e_t \, s_t^2$

✓ The Two Hypotheses for the KPSS Test Are:

- Ho: There is presence of unit root (non-stationary series);
- H1: There is no unit root (stationary series).

✓ *The Decision Rule is as Follows:*

If the LM statistic is less than the Mackinnon critical value at the 5% threshold, then hypothesis H1 is accepted, there is an absence of the unit root hence the series is stationary.

If the LM statistic is greater than the Mackinnon critical value at the 5% threshold, then the Ho hypothesis is accepted, there is presence of the unit root hence the series is non-stationary.

Stationarity tests are applied in level, then in differences in case there is a presence of unit root at this first stage. After the stationarity tests, if it turns out that the series under study are stationary and integrated of the same order, it is necessary to move on to the cointegration test. The execution of these different tests within the framework of this study gave the results summarized in the table below.

Table 3: Results of Stationarity Tests

Variables	Type of test	Without constant and without trend	With constant and without trend	With constant and trend	Critical values at 5%	Test Stats	Decisions
GDP_HAB1	ADF	YES	NO	NO	-1.95	-5.39	I(1)
	PP	YES	NO	NO	-1.95	-5.40	I(1)
	KPSS	NO	YES	NO	0.46	0.27	I(1)
FBCF1	ADF	YES	NO	NO	-1.95	-5.77	I(1)
	PP	YES	NO	NO	-1.95	-5.78	I(1)
	KPSS	NO	NO	YES	0.14	0.12	I(1)
TBSP1	ADF	YES	NO	NO	-1.95	-5.76	I(1)
	PP	YES	NO	NO	-1.95	-7.58	I(1)
	KPSS	NO	YES	NO	0.46	0.28	I(1)
TCD1	ADF	NO	NO	YES	-3.58	-6.87	I(1)
	PP	YES	NO	NO	-1.95	-2.14	I(1)
	KPSS	NO	NO	YES	0.14	0.06	I(1)
GDA	ADF	YES	NO	NO	-1.95	-2.83	I(1)
	PP	YES	NO	NO	-1.95	-5.04	I(1)
	KPSS	NO	NO	YES	0.14	0.08	I(1)

Source: Author's Calculation based on Data from the WB, FA, and PAM

The table above shows the synthesis of the results of the stationarity tests obtained on Eviews 9 respectively by the ADF, Phillips-Perron and KPSS stationarity tests. The results reveal that all the variables are stationary in first difference, that is to say they are integrated at order I (1). The results below therefore lead to carrying out cointegration tests in order to understand whether there is a cointegration relationship.

➢ *Study of the Cointegration of Series*

The concept of cointegration provides a theoretical framework of reference for the study of equilibrium and disequilibrium situations that prevail respectively in the long and short term. If the variables are cointegrated, they then admit a dynamic specification of the error correction type, resulting in the transformation of the initial regression problem on the so-called non-stationary variables. Cointegration allows the identification of the true relationship between the variables, by searching for the existence of a cointegration vector and by removing its action, if applicable.

In order to ensure that the regression performed on non-stationary variables does not admit any error, it is important to first perform a cointegration test. To this end, we do not have a spurious regression if the variables are cointegrated. The test is done in two approaches: the Engle and Granger approach and the Johansen approach. Being in the framework of this work we note that all the variables retained are integrated of the same order, that is to say they are I (1), a cointegration in the sense of Engel and Granger can be envisaged. Indeed, we will therefore estimate the long-term model in order to verify if these residuals are stationary.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24SEP907

Table 4: Estimation of the Long-Term Model

Dependent Variable: PIB_HAB1
Method: Least Squares
Date: 04/21/18 Time: 09:17
Sample: 1990 2016
Included observations: 27

Variable	Coefficient	Std. Error	t-Statistic	Prob.
FBCFF1	0.078752	0.022812	3.452224	0.0023
TBSP1	0.153807	0.059269	2.595061	0.0165
GDA1	-0.020666	0.055111	-0.374992	0.7113
TCD1	-0.158338	0.099027	-1.598933	0.1241
C	5.721940	0.801044	7.143101	0.0000

R-squared	0.714690	Mean dependent var	7.844485
Adjusted R-squared	0.662816	S.D. dependent var	0.071941
S.E. of regression	0.041775	Akaike info criterion	-3.347484
Sum squared resid	0.038392	Schwarz criterion	-3.107514
Log likelihood	50.19103	Hannan-Quinn criter.	-3.276128
F-statistic	13.77729	Durbin-Watson stat	1.250953
Prob(F-statistic)	0.000009		

Source: Author's Calculation based on Data from FAO, UNESCO and WB

Table 5: Correlogram of Model Residuals

Date: 02/05/18 Time: 02:41
Sample: 1990 2016
Included observations: 27
Q-statistic probabilities adjusted for 9 dynamic regressors

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob...
		1	-0.16...	-0.16...	0.8141	0.367
		2	-0.24...	-0.27...	2.6185	0.270
		3	-0.12...	-0.24...	3.1557	0.368
		4	0.086	-0.08...	3.4073	0.492
		5	0.091	-0.00...	3.6988	0.594
		6	-0.09...	-0.11...	4.0216	0.674
		7	-0.14...	-0.19...	4.8418	0.679
		8	0.072	-0.06...	5.0584	0.751
		9	0.201	0.104	6.8217	0.656
		1...	0.186	0.290	8.4135	0.589
		1...	-0.33...	-0.11...	13.834	0.242
		1...	-0.13...	-0.10...	14.793	0.253

*Probabilities may not be valid for this equation specification.

Source: Author's Calculation based on Data from FAO, UNESCO, and WB

The residuals of the above model are stationary because their simple and partial correlograms show no lag outside the corridors. The test performed using a graph proves that the residuals of the model are stationary. Therefore, these variables are cointegrated and can be subjected to an error correction model (ECM)

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24SEP907

V. INTERPRETATION AND DISCUSSION OF THE RESULTS OF THE ERROR CORRECTION MODEL ESTIMATION

Table 6: Result of the Error Correction Model

Dependent Variable: D(PIB_HAB1)
Method: Least Squares
Date: 02/03/18 Time: 15:08
Sample: 1990 2016
Included observations: 27

Variable	Coefficient	Std. Error	t-Statistic	Prob.
PIB_HAB1(-1)	-0.407492	0.197678	-2.061395	0.0549
FBCFF1(-1)	-0.001496	0.022828	-0.065545	0.9485
TBSP1(-1)	0.032090	0.056898	0.563979	0.5801
GDA1(-1)	-0.113766	0.041467	-2.743533	0.0139
TCD1(-1)	-0.069373	0.082612	-0.839742	0.4127
D(FBCFF1)	-0.023830	0.034448	-0.691764	0.4984
D(TBSP1)	0.083553	0.047440	1.761238	0.0962
D(GDA1)	0.101249	0.080562	1.256781	0.2258
D(TCD1)	-0.587053	0.206169	-2.847435	0.0111
C	3.783301	1.356306	2.789415	0.0126

R-squared	0.635283	Mean dependent var	0.002318
Adjusted R-squared	0.442198	S.D. dependent var	0.035450
S.E. of regression	0.026476	Akaike info criterion	-4.147029
Sum squared resid	0.011917	Schwarz criterion	-3.667090
Log likelihood	65.98490	Hannan-Quinn criter.	-4.004318
F-statistic	3.290165	Durbin-Watson stat	2.296964
Prob(F-statistic)	0.016574		

Source: Author's Calculation based on Data from FAO, UNESCO, and WB

The results from the model cannot be interpreted without first checking whether the hypotheses made on the model are validated. These are stochastic tests (stationarity, non-autocorrelation, homoscedasticity and normality of residuals), model specification test (Ramsey test) and structural change tests (simple Cusum test and Cusum squared test).

Stochastic tests.

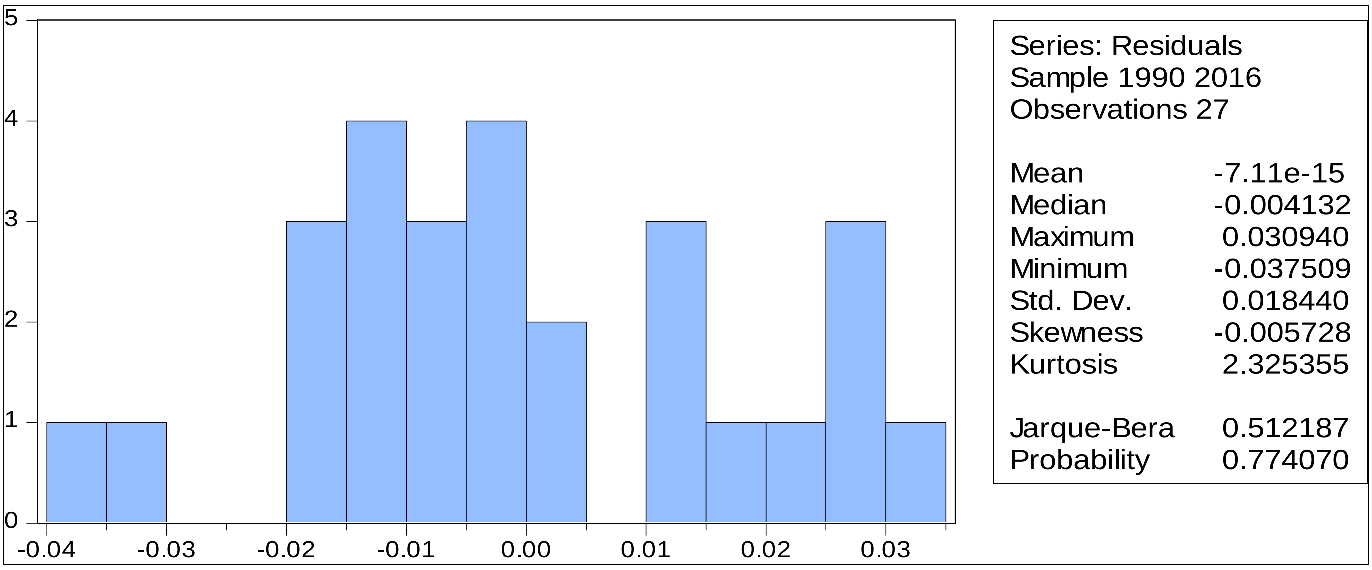

Fig 1: Normality Test of MCE Residuals

From the test results, it appears that the P-value (0.7740) is significantly greater than 5%. This means that the residuals follow the normal distribution.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24SEP907

Table 7: Homoscedasticity Test of MCE Residuals

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	0.897914	Prob. F(9,17)	0.5476
Obs*R-squared	8.699459	Prob. Chi-Square(9)	0.4655
Scaled explained SS	2.084650	Prob. Chi-Square(9)	0.9901

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 04/17/18 Time: 02:37
Sample: 1990 2016
Included observations: 27

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.006965	0.025793	-0.270028	0.7904
PIB_HAB1(-1)	-0.000743	0.003759	-0.197685	0.8456
FBCFF1(-1)	0.000268	0.000434	0.617468	0.5451
TBSP1(-1)	0.000908	0.001082	0.839522	0.4128
GDA1(-1)	0.000414	0.000789	0.525079	0.6063
TCD1(-1)	0.000899	0.001571	0.572088	0.5748
D(FBCFF1)	0.000864	0.000655	1.318602	0.2048
D(TBSP1)	0.000352	0.000902	0.389651	0.7016
D(GDA1)	0.000173	0.001532	0.112975	0.9114
D(TCD1)	0.006601	0.003921	1.683701	0.1105

R-squared	0.322202	Mean dependent var	0.000441
Adjusted R-squared	-0.036632	S.D. dependent var	0.000495
S.E. of regression	0.000504	Akaike info criterion	-12.07185
Sum squared resid	4.31E-06	Schwarz criterion	-11.59191
Log likelihood	172.9699	Hannan-Quinn criter.	-11.92914
F-statistic	0.897914	Durbin-Watson stat	2.536096
Prob(F-statistic)	0.547589		

Source: Author from *Data from FAO, UNESCO, and WB*

The above test performed on the model residuals shows that the latter are homoscedastic because all the P-values (0.409; 0.364; 0.413) are greater than 5%.

Table 8: Test of non-Autocorrelation of MCE Residuals

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.204209	Prob. F(2,19)	0.8171
Obs*R-squared	0.568169	Prob. Chi-Square(2)	0.7527

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 02/02/18 Time: 10:54
Sample: 1990 2016
Included observations: 27
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
FBCFF1	0.001429	0.024944	0.057300	0.9549
TBSP1	-0.331942	3.960334	-0.083817	0.9341
GDA1	-0.271279	3.228313	-0.084031	0.9339
TCD1	-0.008940	0.099554	-0.089795	0.9294
TBSP1*GDA1	0.058196	0.687421	0.084659	0.9334
C	1.526613	18.51892	0.082435	0.9352
RESID(-1)	0.081522	0.252099	0.323372	0.7499
RESID(-2)	-0.139246	0.260076	-0.535406	0.5986

R-squared	0.021043	Mean dependent var	1.43E-14
Adjusted R-squared	-0.339625	S.D. dependent var	0.035324
S.E. of regression	0.040885	Akaike info criterion	-3.314899
Sum squared resid	0.031761	Schwarz criterion	-2.930947
Log likelihood	52.75114	Hannan-Quinn criter.	-3.200730
F-statistic	0.058345	Durbin-Watson stat	1.876798
Prob(F-statistic)	0.999594		

Source: Author from *Data from FAO, UNESCO, and WB*

This test above is used to test the non-autocorrelation of the residuals. The latter is based on the Fisher test of nullity of the coefficients (F-statistic) or the Lagrange multiplier (LM-Test) whose test statistic is nR2.

The objective of the test is to find a significant relationship between the residue and its same shifted residues. Thus, for p=2, the results from this test show that no delay is significant (all P-values of RESID (-1) and RESID (-2) are greater than 5%). For this, we conclude that there is no autocorrelation of errors.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24SEP907

Table 9: Ramsey Test on the Residuals of the MCE Model

Ramsey RESET Test
Equation: EQ_CT
Specification: D(PIB_HAB1) PIB_HAB1(-1) FBCFF1(-1) TBSP1(-1) GDA1(-1) TCD1(-1) D(FBCFF1) D(TBSP1) D(GDA1) D(TCD1) C
Omitted Variables: Squares of fitted values

	Value	df	Probability
t-statistic	0.210924	16	0.8356
F-statistic	0.044489	(1, 16)	0.8356
Likelihood ratio	0.074971	1	0.7842

F-test summary:

	Sum of Sq...	df	Mean Squares
Test SSR	3.30E-05	1	3.30E-05
Restricted SSR	0.011917	17	0.000701
Unrestricted SSR	0.011884	16	0.000743

LR test summary:

	Value	df
Restricted LogL	65.98490	17
Unrestricted LogL	66.02238	16

Unrestricted Test Equation:
Dependent Variable: D(PIB_HAB1)
Method: Least Squares
Date: 04/23/18 Time: 07:39
Sample: 1990 2016
Included observations: 27

Variable	Coefficien...	Std. Error	t-Statistic	Prob.
PIB_HAB1(-1)	-0.397299	0.209139	-1.899687	0.0757
FBCFF1(-1)	-0.004418	0.027278	-0.161977	0.8734
TBSP1(-1)	0.029216	0.060131	0.485877	0.6336
GDA1(-1)	-0.114636	0.042883	-2.673245	0.0167
TCD1(-1)	-0.072749	0.086530	-0.840739	0.4129
D(FBCFF1)	-0.023169	0.035597	-0.650864	0.5244
D(TBSP1)	0.081532	0.049764	1.638354	0.1209
D(GDA1)	0.108030	0.088939	1.214647	0.2421
D(TCD1)	-0.601227	0.222605	-2.700872	0.0157
C	3.788797	1.396352	2.713354	0.0153
FITTED^2	-1.828816	8.670499	-0.210924	0.8356

R-squared	0.636294	Mean dependent var	0.002318
Adjusted R-squared	0.408978	S.D. dependent var	0.035450
S.E. of regression	0.027253	Akaike info criterion	-4.075732
Sum squared resid	0.011884	Schwarz criterion	-3.547798
Log likelihood	66.02238	Hannan-Quinn criter.	-3.918750
F-statistic	2.799161	Durbin-Watson stat	2.288654
Prob(F-statistic)	0.032357		

Source: Author from Data from FAO, UNESCO, and WB

The objective pursued by this test is to check whether no important variable in the model has been omitted. This test, the results of which are presented in the table above, shows that no important variable has been omitted in the model. Indeed, the P-value of the variable "FITTED" being far from being significant, allows us to conclude that the model retained in the context of this work is well specified.

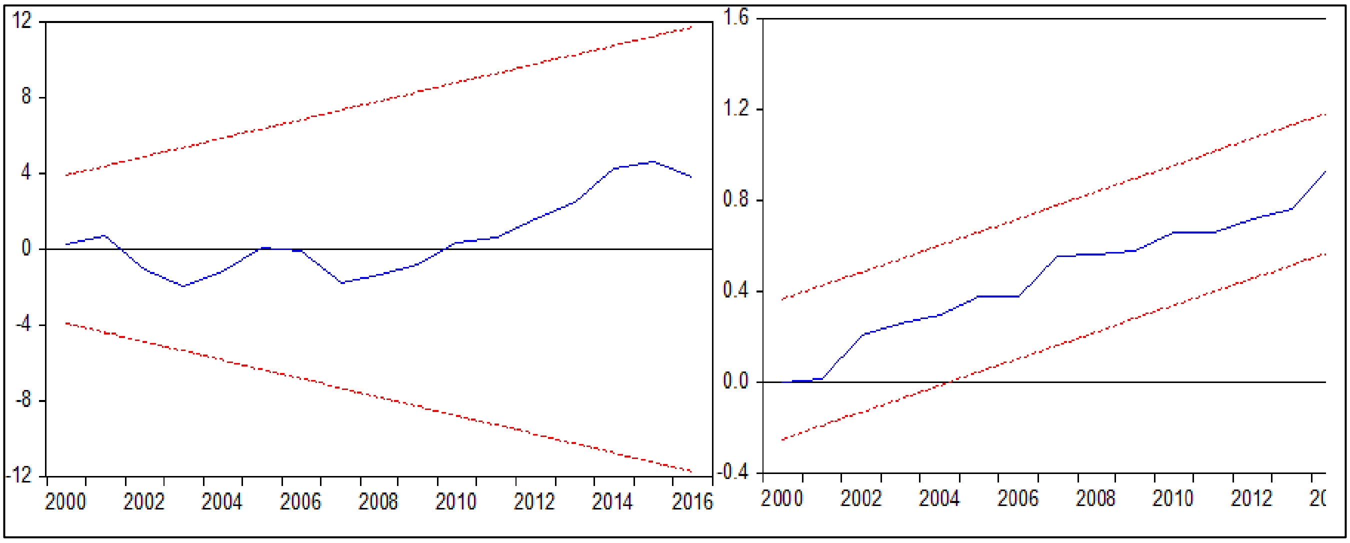

Fig 2: Coefficient Stability Tests

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24SEP907

Looking at these two graphs, we can conclude that there is structural (or long-term: from the result of the first graph) and punctual (or short-term: result of the second graph) stability of the model parameters. Because the curves of the two graphs are entirely contained in the air formed by the two lines which represent the confidence threshold. Thus, we can conclude that over the period considered, the coefficients of the model are globally stable.

Once the observation has been made showing that all the hypotheses of the model are validated, it is therefore important to interpret the coefficients of said model.

VI. DISCUSSION OF THE RESULTS FROM THE ESTIMATION

In view of the results from the estimates of the MCE model used in our work, two main results emerge. These extend over the short and long term. The latter reveal that the restoring force or the error correction coefficient is negative and significant at the 5% threshold. We can therefore consider that the MCE model is acceptable. That is to say that the convergence mechanism towards equilibrium works well. The negative value of the restoring force (-0.4074) means that in the face of a shock, the adjustment towards equilibrium is carried out at a speed of approximately 41% by the "feedback" effect. In other words, a shock on growth observed during a year is completely absorbed after 1 year 5 months. Also, the probability of F-statistic being equal to (0.016) this means that there is at least one explanatory variable that explains the model. Moreover, the R2 amounts to (0.63), meaning that the explanatory variables explain the growth up to 63%.

In the short term, the results show that the severity of the food deficit proxy variable of malnutrition does not influence the gross domestic product per capita. These results corroborate with those obtained in Pakistan in 2008, by Akhram, Padda, and Khan on temporal data from 1972-2006. The conclusions of their study are such that, malnutrition in the short term does not positively influence the gross domestic product per capita. These results can be justified by the simple reason that the benefits of human capital on economic growth generally emerge in the long term whether for education or health. A child suffering from malnutrition in childhood will have low academic performance in the long term and once an adult, the latter will have low productivity. Compared to a child who has not suffered from it.

In the long term, it is noted that malnutrition captured by the severity of the food deficit negatively influences economic growth because its coefficient (-0.113) is negative and significant at the 5% threshold. These results are supported by other authors who have obtained the same result like Knowles and Owen (1995)which by incorporating life expectancy as a proxy for health in a growth model of the type Mankiw-Romer-Weil (1992) witha global sample of 84 countries showed that the correlation between income per capita (or growth rate) and life expectancy is strong and robust (stronger than that between education and income), but negative.Acemoglu and Johnson in 2008, have shown that increasing life expectancy (one of the health indicators) does not have a significant impact on total GDP, as it leads to an increase in the population growth rate. Therefore, a significant reduction in GDP per capita. In addition, Ezzati et al (2002), support the argument that the loss of productivity during the day is due to malnutrition. This study is added to that of the UN which states that inadequate nutrition is the cause of the reduction in gross domestic product per capita.

In short, the results obtained in the Congo can be justified by various reasons among which we have:

First, a lack of sustained and sustainable development of the agricultural sector. This is what makes the level of food imports on a large scale. It should be noted that the agricultural sector is a key sector in combating malnutrition in all its forms and achieving food security.

Secondly, these results are also justified by a weakness in the control of the quality of imported food products at the customs level, which means that some imported products are of poor quality and are not likely to be marketed and consumed.

Finally, the justification given for its results is that it concerns the crucial and important role that women play in the issues of combating malnutrition as well as in the development of the agricultural sector. Because it is women who literally feed the world and constitute 43% of the agricultural workforce in developing countries FAO (2014). The latter, produce, process, cook food and serve it. However, the crucial role they play in consuming food products and taking care of their families, are still misunderstood and underestimated.

VII. CONCLUSION

The objective of this thesis was to highlight in general the effects of health on growth and in particular those of malnutrition on economic growth in the Republic of Congo. It was a question of verifying the existence of a negative effect between malnutrition and economic growth, of measuring the extent of this effect in the context of our country, and of drawing the implications of economic policies.

Throughout our study, we used data showing the nutritional status of the Congolese population (the severity of the food deficit), and data on gross domestic product per capita, data on gross fixed capital formation, those on the demographic growth rate, and finally those on the gross primary school enrollment rate. These, covering the period from 1985-2016, were used to estimate the error correction model (ECM), to verify the effect of malnutrition on economic growth in Congo.

The results obtained conclude that in the short term the variable measuring the state of malnutrition (food deficit, measured in terms of kilocalories per person per day), which is the variable of interest has no effect on the gross domestic product per capita in the Congo. Similarly, the gross primary

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24SEP907

school enrollment rate, although it is affected by a positive sign, is not significant at the 5% threshold. However, the population growth rate has a negative effect on economic growth in Congo and is significant at 5%. It should be noted that apart from the variable of interest, the rest are control variables.

However, in the long term, it is noted that the variable severity of the food deficit exerts a negative influence on growth, taking into account its coefficient which has a negative sign (-0.1138) and is significant at 5%. Also, the gross primary school enrollment rate exerts a positive influence on growth. These are the conclusions of the results from the estimation of the error correction model (ECM).

Having access to adequate food is one of the fundamental rights of every human being. Indeed, given the urgency of health issues in general and malnutrition in particular, the government of the Republic of Congo should develop the agricultural sector in order to guarantee food security for its population.

REFERENCES

[1]. Acemoglu, D., and SS Johnson. 2008. "Disease and Development: The Effect of Life Expectancy on Economic Growth",*Journal of Political Economy*, 113 (5): 949-995.

[2]. Akram, N., Padda, IUH and Khan, M. (2008). The long term impact of health on the long term impact of health on economic growth. Journal of Economic and Sustainable Development, 1–17.

[3]. Ashraf, Quamrul H., Ashley Lester and David N. Weil. 2008. "When Does Improving Health Raise GDP?"

[4]. Becker, G.S. (1964). Human capital: A theoretical and empirical analysis, with special reference to education. University of Chicago Press

[5]. Bentham, J. (1789). An introduction to the principles of morals and legislation. T. Payne and Son. (The first edition is 1780, but the APA citation often follows the year of first publication or the relevant reissue.)

[6]. Becker, G.S. (1964). Human capital: A theoretical and empirical analysis, with special reference to education. University of Chicago Press.

[7]. FAO. (2012). The State of Food Insecurity in the World 2012: Economic growth is necessary but not sufficient to accelerate reductions in hunger and malnutrition. Food and Agriculture Organization of the United Nations.

[8]. Knowles, S., & Owen, P. D. (1995). Health capital and cross-country variation in per capita income in the Mankiw-Romer-Weil model. Economics letters, 48 (1), 99-106.

[9]. Mankiw, G., Romer, D., and D. Weil. 1992 "A Contribution to the Empirics of Economic Growth", *The Quarterly Journal of Economics*, 107(2): 407-437.

[10]. Mandief SP* and Chipezi JT (2015), "Contribution of public health investments to the economic growth of Cameroon", Business and economic journal.

[11]. Michael Kofi Boachie, (2015); "Effect of Health on Economic Growth in Ghana" MPRA paper No.67201, ext. 21

[12]. Marx, K. (1867). Capital: A critique of political economy (Vol. 1). Penguin Classics. (Original work published 1867)

[13]. World Health Organization. (2013). World health report 2013: the quest for universal health coverage. World Health Organization.https://iris.who.int/handle/10665/85764

[14]. Schultz, T. W. (2005). Adam Smith and human capital. In Adam Smith's Legacy (pp. 147-158). Routledge.

[15]. Schultz, T. W. (1961). Investment in human capital. American Economic Review.