Public health expenditure, government effectiveness and labour productivity in West Africa

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ABSTRACT

Purpose: This study aimed at empirically exploring how the expenditure of public health and the effectiveness of government impacted the productivity of labour in West Africa.

Design/Methodology/Approach: This study used data from 1980 to 2022 generated by the World Bank and adopted multiple regression, mediation and correlation analysis. Additionally, the co-integration test of Johansen and the residual-based test using the Engel-Granger approach were used.

Findings: Expenditures on the health of the public and the effectiveness of government indicated some positive but insignificant impacts on labour productivity in the short run. At the same time, the expenditure on public health indicated a long-term, significant and adverse impact on labour productivity in Nigeria, Togo, Guinea, Senegal and Mali.

Conclusion: The present study explored how expenditure on public health and the effectiveness of the government impacted the productivity of labour in West Africa. Apparently, the level of public health expenditure and government effectiveness are yet to positively impact the productivity of labour.

Practical Implications: These results presented the critical role of public health expenditure and government effectiveness in enhancing the productivity of labour. Therefore, the study suggests that the government invest significantly in healthcare services in order to promote and safeguard the health of the people.

Contribution to the Literature: This study offers an innovative perspective on labour productivity by highlighting the crucial roles played by governments in public health investment for productivity.

Keywords: *Capital, Government effectiveness, Human, Investment, Labour productivity, Life expectancy rate, Public health expenditure.*

1. INTRODUCTION

Governments, corporations and civil society must work together to address the complex and varied issues impacting labour productivity on a global scale. Investments in governance, labour market efficiency, infrastructure, education and training, governance, health outcomes and financial access, particularly in West Africa may be essential to address these issues (Adeniyi & Abiodun, 2021) which indicated factors that have limited labour productivity include limited access to education and training, poor infrastructure, weak governance, inefficient labour markets, high levels of informality and low levels of job security, poor health outcomes and restricted financial access (Akram, Khan, & Mohammad, 2018). Poor labor productivity in West Africa has negative consequences for individuals, businesses and the widespread economy. This results in slow economic growth, high unemployment and low earnings (Bakare & Olubokun, 2020). Other consequences include low competitiveness, high Human Immunodeficiency Virus (HIV), heightened Acquired Immune Deficiency Syndrome (AIDS), low Gross Domestic Product (GDP), increased poverty and social unrest which has been creating a sense of frustration and hopelessness among young people and the wider population in West Africa.

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2. THEORETICAL BACKGROUND

The labour force in West Africa has grown significantly over the past few decades due to population growth and urbanization. According to the World Bank (2016) and the Organization for Economic Co-operation and Development (OECD) (2017), West Africa's labour force participation rate increased from 52.2% in 1990 to 57.1% in 2020. The labour force participation rate varies widely across countries in the region with some countries having participation rates as low as 35%. (Barro, 2016). However, jobs available in West Africa are also changing from agriculture to services and industry. However, many workers in West Africa still work in the informal sector which can limit their access to social protection and other benefits. Nevertheless, the labour force participation rate varies widely across countries. For example, in countries like Liberia and Sierra Leone, the labour force participation rate is around 35% while in countries like Ghana and Senegal, it is above 60% (Basta, Karyadi, & Scrimshaw, 1979). Most of the jobs in West Africa are in the informal sector which can be challenging for workers due to the lack of social protection and other benefits. According to the World Bank (2016), 90% of employment in West Africa has informally evolved such that more women partake than men and they often face additional challenges such as discrimination and limited access to finance.

There has been a shift from agriculture towards industrial sectors as the African region's economies develop and urbanize (Bloom & Canning, 2018). This change has created new employment opportunities in sectors such as construction, manufacturing and information technology. Bloom, Canning, and Graham (2021) argued that many workers in West Africa still work in low-paying jobs in the informal sector and youth unemployment remains a significant challenge. Addressing these issues would therefore necessitate investments in education and training, job-creating policies and actions to enhance the business climate and labor market effectiveness.

2.1. Labour Productivity

Labour productivity is defined as the quantity of goods and services that an employee can produce in a specific time such as an hour or a day. According to William Easterly and Levine (1997), it is computed by dividing the sum of all products and services produced by the sum of all hours worked. Labour productivity is an important measure of economic efficiency and is closely linked to a country's level of economic development (Eatwell & Newman, 2021). Higher labor productivity levels generally lead to higher levels of economic growth and higher living standards. Some studies have shown that improving labor productivity often involves investments in education and training, technology, infrastructure and policies that promote a more efficient and competitive business environment (Edeme, Emecheta, & Omeje, 2017; Elliott, Rothenberg, & Stock, 2016). Therefore, businesses and policymakers should measure labour productivity because it offers information about the economy's effectiveness and competitiveness. It can also help identify areas where improvements can be made to increase productivity and promote economic growth in the study area.

2.2. Public Health Expenditure

The term "public health spending" has been used to describe the sum of money that a government or other public organisation spends on medical services and initiatives designed to improve and safeguard people's health (Hamoudi & Sachs, 2019). This includes spending on healthcare services such as hospitals, clinics and primary care services as well as public health programmes such as disease prevention and control, health education and research (Howitt, 2015). Ifijeh (2017) added that public health expenditures can be funded through a variety of sources including taxes, grants and donations. Public health expenditures can differ significantly between countries depending on variables including population size, disease prevalence and economic development. This suggests that public health expenditure is an important indicator of a government's commitment to promoting the health and well-being of its citizens (Maduka, Madichie, & Ekesiobi, 2016). Adequate public health expenditure is essential for ensuring access to quality healthcare services and for addressing public health challenges such as infectious diseases, non-communicable diseases and environmental health hazards. On the other hand, effective public health spending appears to be undermined in the majority of West African nations by problems such as inadequate funding, unequal resource distribution, inadequate health systems, inefficient resource usage and a lack of transparency and responsibility by public authorities (Mankiw, Romer, & Weil, 1992).

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2.3. Government Effectiveness

Government effectiveness refers to the ability of a government to carry out its functions, deliver public services, and respond to the needs and expectations of its citizens. It is a measure of how well the government is able to implement policies, enforce laws and manage public resources (Mizushima, 2018). Government effectiveness is influenced by a range of factors including the quality of public institutions, the degree of civil stability, the level of corruption, the effectiveness of public services and the degree of citizen participation in decision-making processes (Mohsen & Maysam, 2021). An effective government is able to provide essential public services such as education, healthcare and infrastructure and promote economic growth and development respond to the needs and demands of its citizens and provide an environment that fosters social cohesion and stability (Odior, 2021). Assessing government effectiveness is important for policymakers as it provides insights into the strengths and weaknesses of the government and can help identify areas where improvements can be made. It is also crucial for citizens because it may help hold the government accountable and promote transparency and good governance in other parts of the world including West Africa.

2.4. Research Statement and Questions

The rate of low productivity recently among the active labour force in West African region is quite surprising. Low productivity has become a concern for many businesses and industries. There are a number of factors that can contribute to low productivity in the workplace. One major factor is the quality of labour including the skills, experience and motivation of the workforce but available literature has indicated that public health expenditures and government effectiveness are key drivers of labour productivity. The case is different in West Africa because it appears to have become a region where most government policies are not focused on improving the quality of labour by providing training and development opportunities, creating a positive work environment, offering competitive compensation and benefits, implementing effective management practices and investing in technology and resources that can streamline processes and increase labour efficiency. Therefore, the following research questions were raised:

1. How much do public health expenditures impact government effectiveness in improving labour productivity in West Africa?
2. To what extent does government effectiveness mediate the relationship (α=0.05) between public health expenditures and the productivity of labour in West Africa?
3. What is the significant relationship (α=0.05) between government effectiveness and the expenditures of public health in promoting the productivity of labour in West Africa?

There is evidence to suggest that public health expenditure and government effectiveness can have a positive impact on the productivity of labour in West Africa. Investments in public health such as improving access to healthcare services can have a direct impact on the health of the workforce, reducing absenteeism and increasing productivity (World Health Organization, 2015). Additionally, investments in public health can lead to indirect benefits such as improving healthcare, reducing diseases, and increasing life expectancy which can all contribute to increased productivity (Adeniyi & Abiodun, 2021). Moreover, government effectiveness is an important factor in creating an enabling environment for economic growth and development. Effective governance can help business activities, reduce corruption and improve the delivery of public services including healthcare. This can create a more stable and predictable environment for businesses which can increase investment, job creation, and productivity (Akram et al., 2018).

However, the relationship between public health expenditure, government effectiveness and labor productivity is complex and dependent on a variety of factors such as the specific policies and strategies implemented as well as the social, economic and political context of each country (Bakare & Olubokun, 2013). It is important to note that there may be trade-offs between investing in public health and other areas of government spending such as education or infrastructure. Therefore, policymakers must carefully consider the potential benefits and costs of different policy options and prioritize investments that will have an impact on the growth of the economy in tandem with public expenditure (Barro, 2016). According to Basta et al. (1979), public health expenditure refers to the amount of money that governments spend on promoting, protecting and improving the health of their populations such as investments in healthcare services as well as public health programmed aimed at preventing and controlling diseases, improving nutrition, promoting healthy behaviors and addressing environmental health risks. Spending on public health includes investments in health research and development, initiatives to improve

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underserved populations' access to healthcare and initiatives to improve health care systems. Public health expenditures are a sizable portion of government spending in West Africa as they are on many other continents throughout the world, demonstrating the significance of health in fostering economic growth and development (Bloom & Canning, 2018). However, the level of public health expenditure can vary widely between countries and can be influenced by factors such as the level of economic development, political priorities and the availability of external funding from sources such as international aid and philanthropic organizations.

Unfortunately, the researcher has observed that the available data on health from 1980 to 2022 show that the Nigerian government and Benin, Burkina Faso, Cape Verde, Ivory Coast, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Mauritania, Niger, Senegal, Sierra Leone and Togo are the West African nations that have not made significant efforts to increase the level of public expenditure on health suggesting that the public is living below expectations. Statistics show that in advanced economy, an average of over 16.3 per cent of GDP is spent on public healthcare annually (William Easterly & Levine, 1997). On the other hand, in West African countries, public health expenditure is below 4.1 percent of the country's GDP compared to the 4.6 per cent African average. The overall health sector performance outcomes in West Africa have not been so encouraging. For instance, consider the 2017 budget for healthcare in the US, Switzerland and Nigeria. In 2017, the national budget for health was only 4.17 per cent of the budget (Bloom et al., 2021).

The federal government in their budget plans to spend 304 billion naira on the healthcare of over 180 million Nigerians amounting to 1,688 naira per citizen for a whole year. In terms of healthcare, the United States and Switzerland spend approximately $7,000 and $6,000 per citizen, respectively. Nigeria and other West African countries have the worst health statistics in the world (Eatwell & Newman, 2021). In 2001, all African leaders declared to commit a minimum of 15% of their total spending to improve their respective health sectors. Despite the 15% declaration, Nigeria and other West African countries have hardly committed more than 4% of their annual budgets on average to the advancement of the health sector (Edeme et al., 2017). This strongly suggests that successive governments in West Africa have neglected the people's health. This is observed in inadequate healthcare facilities, poor sanitation and the unavailability of clean water among others that characterize the Western African economy today (Elliott et al., 2016).

Furthermore, an in-depth analysis of the Human Development Index (HDI) of Nigeria and Ghana reveals an unfavourable view of human capital. In 2016, they ranked 152nd and I84th among 188 countries with HDI value of 0.527. Nigeria's health performance was ranked 187th in 2016 among the 191 member states by the World Health Organization (WHO). West African nations continuously have poor health conditions compared to other countries in the world. For instance, the life expectancy rate for West Africans was 45.5 years in 1980 (one of the lowest rates in the world at the time), 47.9 years in 2003, and 47 years in 2011 (World Bank, 2011, 2013). In 2016, it was 52.8 years which is below the sub-Saharan African rate and that of other developing countries (World Bank, 2016). West Africa's health statistics for infant mortality, maternal mortality and life expectancy have been poor for decades (National Bureau of Statistics, 2016).

On the other hand, government efficacy refers to a government's capacity to carry out its duties, provide public services and enact laws that respond to the needs and priorities of its citizens (Hamoudi & Sachs, 2019).

It encompasses a range of factors, including the worth of public services, the level of corruption, the rule of law, and the responsiveness and accountability of government institutions. An effective government is able to develop and carry out policies that are consistent with the requirements and priorities of its constituents and provide public services such as healthcare, education and infrastructure effectively and efficiently (Howitt, 2015; Ifijeh, 2017). On the other hand, in West African countries, the researcher has observed that the governments are not effective. They are considered inadequate in terms of upholding the rule of law, protecting human rights and promoting social justice. They do not foster economic growth and development by creating an environment that is conducive to business activities and investment (Maduka et al., 2016). There is no promotion of transparency, accountability or reducing corruption. It is quite overwhelming to observe that government ineffectiveness is negatively affecting economic growth and development as well as social wellbeing (Mankiw et al., 1992) because an ineffective government cannot create an enabling environment for businesses, attract investment or create jobs. Additionally, it cannot guarantee the effective and efficient use of public resources or the availability of high-quality public services for the general public, like as healthcare and education. All of these and other issues are widespread throughout West African nations (Mizushima, 2018).

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The aforementioned discussion makes it clear that West Africa's public health expenditure is insufficient and its health status is bad. Can public health expenditure be declared a determining element of labour productivity in West Africa in light of these poor health indicators brought on by insufficient public health investment? Therefore, it is still unclear if government efficiency and public health spending have a major impact on labour productivity in West Africa. This research is intended to fill this gap. As a result, West Africa's public spending on health and productivity needs to be seriously re-evaluated.

2.5. Empirical Literature Review

Previous research has extensively examined the relationship between public health expenditure and economic productivity, yielding varying findings. Some studies have identified a positive and significant correlation while others have reported mixed results. For instance, Hamoudi and Sachs (2019) employed an augmented Solow growth model with co-integration analysis (ECM) to investigate the relationship between healthcare expenditure and economic growth in Pakistan from 1973 to 2003. Their analysis revealed a significant relationship between the variables in both the short and long term. In a study conducted by Maduka et al. (2016), a causal relationship was identified between government health spending, health outcomes and economic growth in Nigeria from 1970 to 2013. Similarly, Gallup, Sachs, and Mellinger (2018) used life expectancy rates to assess the relationship between health and economic growth and discovered a strong correlation between them. Nasiru and Usman (2011) conducted research in Nigeria and found evidence of a causal relationship between health spending and economic growth indicating a unidirectional and long-term relationship. Additionally, Bloom et al. (2021) investigated the impact of good health on output by incorporating human capital into their production models which considered factors such as health and job history. Their findings demonstrated that good health had a positive and significant effect on overall output. Similarly, Rivera and Currais (2013) observed a favorable relationship between public health spending and economic expansion. Furthermore, Bloom and Canning (2018) identified a beneficial and statistically significant impact of good health on economic outcomes.

Zhang (2020) conducted a study in China using a panel dataset encompassing 31 provinces from 2003 to 2017 to investigate the influence of public health spending on labor productivity. The results indicated that an increase in public health spending had a favorable and substantial effect on labor productivity. Similarly, Kwon and Scott (2017) examined the relationship between public health spending and labor productivity in OECD nations. Their findings revealed that higher levels of public health spending were associated with increased worker productivity, particularly in countries with lower baseline productivity levels. Chakraborty and Kavikumar (2019) focused on India and employed a panel dataset covering 20 Indian states from 2005 to 2013 to explore the impact of public health spending on labor productivity. The study suggested that public health could be an effective strategy for promoting economic growth in emerging countries by enhancing labor productivity. According to Xu (2018), the effect of public health expenditures on labor productivity in China was using a panel dataset encompassing 31 provinces from 2003 to 2015. The results indicated a positive and significant relationship between public health expenditure and labor productivity. Specifically, a 1% increase in public health expenditure was associated with a 0.15% increase in labor productivity. The empirical literature strongly suggests that public health expenditure can have substantial and positive impacts on labor productivity particularly in developing countries. These findings underscore the importance of investing in public health as a means of fostering economic growth and improving the well-being of workers.

There is a scarcity of empirical research that specifically examines the combined impact of public health expenditure and government effectiveness on labor productivity. However, various studies have investigated the individual effects of these factors on labor productivity. In one study, Chen (2018) examined the influence of government performance on health outcomes and economic growth in China. The findings revealed a positive relationship between better health outcomes, faster economic growth, and levels of government effectiveness. Although the study did not specifically explore the direct relationship between government effectiveness and worker productivity, it argued that effective government policies can have a positive effect on economic growth. Similarly, Greco (2018) conducted a study on the impact of public health spending on labor productivity in OECD nations. The study discovered that higher levels of public health expenditures were associated with increased levels of labor productivity, even after considering other factors such as education and infrastructure. There is limited research on the joint influence of public health expenditure and government effectiveness on labor productivity. These studies provide valuable insights into the individual effects of these factors on economic

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outcomes. Further research is needed to explore the specific relationship between public health expenditure, government effectiveness and worker productivity. The combined effects of public health spending and government performance on worker productivity were not investigated in the study. Similarly, Hanushek and Woessmann (2012) investigated how the performance of the government affected labor productivity in a sample of OECD nations. The study discovered a favorable correlation between government health education expenditure effectiveness and labor productivity. Although the study did not specifically look at how public health spending or government performance affected labor productivity, it indicates that expenditures on human capital may have a favorable influence.

2.6. Theoretical framework

Romer (1990) and Lucas (1988) created the endogenous growth model which explains how health spending and output are related. Wagner's law of growing state activities and the Keynesian theory of public expenditure can also be used to explain this relationship. This article's hypothetical organization is based on the augmented growth model proposed by Mankiw et al. (1992). They use the same growth model as Solow (1956) but they add human capital to extend the Solow growth model to take the development of human capital into account. The model makes the assumption that efficiency growth rates across nations are equal. The initial level of growth efficiency is assumed to differ randomly from one country to another. This implies that local factors, such as climatic conditions can contribute to the occurrence of certain outcomes and these factors can be taken into account to explain the remaining unexplained variations also known as the error term. Their research avoids the Solow model's premise that technological differences account for a major portion of cross-country variation in labor productivity. The output (Y) was stated in the model as a function of the physical stock of capital (K), human capital (H), labor force (L) and technical progress coefficient (A). This is expressed in functional as

$$Y_t = f\ (K, H, AL) \qquad (1)$$

Equation 1 describes the relationship between the inputs (K, H, and AL) and the output (Y) of a production process. This equation indicates that Y represents the total output of goods and services produced by a firm or an economy. K represents the amount of capital invested in factories, machinery and the production process. H represents the amount of labor such as workers used in the production process. AL represents the aggregate labor force which is the total number of workers available for production while f is a function that represents the technology or production process used to transform the inputs (K, H, and AL) into output (Y). The function f can take various forms such as a linear or nonlinear function depending on the complexity of the production process. The production function Y = f (K, H, AL) indicates that the output Y is a function of the inputs K, H, and AL. The function f that captures the technical relationship between the inputs and outputs can be estimated using various statistical techniques. Using the Cobb Douglas production model and a world consisting of I = 1n countries, Equation 1 can be represented in this way.

$$Y ¿ = K ¿ \alpha\ H ¿ \beta\ (AL) ¿ 1 - \alpha - \beta \qquad (2)$$

Equation 2 is a version of the Cobb-Douglas production function which is a widely used model in economics to describe the relationship between inputs and outputs in the production of goods and services. Equation 2 reveals that Y represents the total output of goods and services produced by a firm or an economy. K represents the amount of capital such as factories, machinery and equipment used in the production process while H represents the amount of labor such as workers used in the production process. It is obvious that α is a parameter that represents the elasticity of output with respect to capital which means that it measures how much the output changes when the amount of capital changes. If α = 0, it means that the output is not affected by changes in capital. If α > 0, it means that the output increases as capital increases while β is a parameter that represents the elasticity of output with respect to labor which means that it measures how much the output changes when the amount of labor changes. If β = 0, it means that the output is not affected by changes in labor. If β > 0, it means that the output increases as labor increases. AL represents the aggregate labor force which is the total number of workers available for production while α - β represents the total amount of output that is produced using the available capital and labor resources. In a nutshell, this equation shows how the total output of goods and services is determined by the interaction of capital, labor, and their respective elasticities and it is a useful tool for understanding the impact of changes in these inputs on the overall production process where 0< α < 1; 0< β < 1 and α + β < 1. According to empirical applications, the fundamental Solow model has been changed to produce the augmented Solow growth model where the rate of output growth for a given country depends on trade, fiscal

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policy and monetary policy in addition to technical change, capital, and labor (Easterly & Levine, 2021; Ologun, 2013). Specification of the model and methodology is based on the theoretical framework. We propose the following functional model for productivity:

$$GDPL = f\,(PHE, MMR, GE, HPR\ and\ LER) \quad (3)$$

Equation 3 presents the functional relationship between the growth rate of Gross Domestic Product (GDPL) and five other macroeconomic variables: the price of housing and equipment (PHE), the money supply (MMR), government expenditure (GE), labor productivity (HPR) and the labor force (LER). The equation suggests that the growth rate of GDP (GDPL) is a function of these five variables that changes in any of these variables will affect the growth rate of GDP. The exact nature of this relationship is represented by the function that captures the complex interactions between these variables. The brief explanation of each variable entails that PHE is the price of housing and equipment as a measure of the average price of goods and services related to housing and equipment. Changes in PHE can affect the growth rate of GDP by influencing consumption and investment decisions. MMR is a measure of the amount of money circulating in the economy. Changes in MMR can affect the growth rate of GDP by influencing the availability of credit and the overall level of economic activity. GE is government expenditure which is a measure of the amount of money spent by the government on goods and services. Changes in GE can affect the growth rate of GDP by influencing the overall level of economic activity and government purchases. LPR represents labor productivity is a measure of the output per hour of work. Changes in HPR can affect the growth rate of GDP by influencing the efficiency of production and the overall level of output. LER is the labor force which is a measure of the number of people employed or seeking employment. Changes in LER can affect the growth rate of GDP by influencing the overall level of employment and the availability of labor. The function f represents the complex relationships between these variables and the growth rate of GDP. The exact form of the function f is not specified in the equation and it is typically estimated using econometric techniques where GDPL = Gross Domestic Product Per Labour (Productivity), PHE = Public Health Expenditure, MMR = Material Mortality Rate; HPR = HIV/AIDs prevalence rate; GE= Government Effectiveness; LER = Life Expectancy Rate and INV = Investment For Empirical Analysis. The functional model can be expressed in econometric form as

$$GDPL_t = \alpha_0 + \alpha_1 PHE_t + \alpha_2 MMR_t + \alpha_3 GE + \alpha_4 HPR_t + \alpha_5 LER_t + \alpha_6 INV_t + \mu_t \quad (4)$$

Equation 4 relates the growth rate of Gross Domestic Product (GDPL) to various macroeconomic variables. The breakdown of the equation indicates that GDPLt represents the growth rate of Gross Domestic Product at time t while α0 is the intercept or constant term in the equation. It represents the growth rate of GDP when all the other variables in the equation are equal to zero. Also, α1 PHEt represents the effect of a change in the price of housing and equipment (PHEt) on the growth rate of GDP. The α1 coefficient captures the change in GDP growth associated with a one-unit change in PHEt while holding all other variables in the equation constant. Similarly, α2 MMRt represents the effect of a change in the money supply (MMRt) on the growth rate of GDP. The α2 coefficient captures the change in GDP growth associated with a one-unit change in MMRt while holding all other variables in the equation constant. α3GE represents the effect of a change in government expenditure (GE) on the growth rate of GDP. The α3 coefficient captures the change in GDP growth associated with a one-unit change in GE while holding all other variables in the equation constant. The α4 HPRt represents the effect of a change in labor productivity (HPRt) on the growth rate of GDP. The α4 coefficient captures the change in GDP growth associated with a one-unit change in HPRt while holding all other variables in the equation constant. The α5 LERt represents the effect of a change in the labor force (LERt) on the growth rate of GDP while the α5 coefficient captures the change in GDP growth associated with a one-unit change in LERt while holding all other variables in the equation constant. It is obvious that α6 INVt represents the effect of a change in business investment (INVt) on the growth rate of GDP. The α6 coefficient captures the change in GDP growth associated with a one-unit change in INVt while holding all other variables in the equation constant and μt represents the random error term at time t. It captures any other factors that may affect GDP growth and are not captured by the other variables in the equation.

Where α 1, α 2, α3, α4, α5 ∧α 6 are the long-run parameter elasticity estimates for μt= Error term. The a priori signs of public health expenditure and life expectancy rate are expected to be positive while the infant mortality rate, maternal mortality rate and HIV/AIDs prevalence rate are expected to be negative. Symbolically, the a priori expectations are α1, α6, α4, α5>0; α2, α3<0. It is convenient to present the long run estimates in line with the model.

$$\Delta\, GDPL_t = \rho + \partial\Delta\, PHE_t + \emptyset\Delta\, MMR_t + \partial\Delta\, GE\ \tau\ \Delta\, HPR_t + \pi\, \Delta\, LER_t + \theta\, \Delta\, INV_t + \sigma ecm\,(-1) + \varepsilon_t \quad (5)$$

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Equation 5 describes the relationship between the growth rate of GDP (GDPL) and various other macroeconomic variables. In this equation, ΔGDPLt represents the growth rate of GDP at time t. The Δ symbol indicates that this is a change in GDP rather than its level while ρ is a parameter that represents the long-run relationship between GDP growth and the other variables in the model. It is the coefficient of the intercept term. ∂ΔPHEt represents the change in the price of housing and equipment (PHE) at time t. The ∂ symbol indicates that this is a partial derivative which means that the effect of a change in PHE on GDP growth is being isolated while holding the other variables in the model constant. ØΔMMRt represents the change in the money supply (MMR) at time t. The Ø symbol indicates that this is a lagged variable meaning that the effect of a change in MMR on GDP growth is being measured with a one-period lag. ∂ΔGEτ represents the change in government expenditure (GE) at time t. ∂ΔPHEt is a partial derivative which means that the effect of a change in GE on GDP growth is being isolated while holding the other variables in the model constant.

Furthermore, πΔLERt represents the change in labor productivity (LER) at time t. The π symbol indicates that this is a partial derivative which means that the effect of a change in LER on GDP growth is being isolated while holding the other variables in the model constant. Then, θΔINVt represents the change in business investment (INV) at time t. Like ∂ΔPHEt and ∂ΔGEτ, this is a partial derivative which means that the effect of a change in INV on GDP growth is being isolated while holding the other variables in the model constant. The σecm (−1) represents the error correction term (ECT) at time t-1. The σ symbol indicates that this is a parameter and the (-1) subscript indicates that the ECT is lagged by one period. The ECT measures the difference between the actual value of GDP growth and its expected value based on the previous values of the variables in the model while εt represents the random error term at time t. It is the residual variation in GDP growth that cannot be explained by the other variables in the model. Therefore, the equation can be read as the growth rate of GDP at time t is equal to a long-run relationship (ρ), the effect of a change in the price of housing and equipment at time t (∂ΔPHEt), the effect of a change in the money supply at time t-1 (ØΔMMRt), the effect of a change in government expenditure at time t (∂ΔGEτ), the effect of a change in labor productivity at time t (πΔLERt), the effect of a change in business investment at time t (θΔINVt), the error correction term at time t-1 (σecm(−1)) and a random error term at time t (εt)". Thus, ∂, Ø, τ, πΛθ are the short run dynamic coefficients of the convergence of the model to equilibrium, Δ denotes differencing and σ is the coefficient of adjustment expected to be negative.

2.7. Methods

2.7.1. Sources of Data

The annual reports of the central banks of all 15 member countries of the Economic Community of West African States (ECOWAS), the National Bureau of Statistics (NBS) annual reports and World Bank Development Indicators data from 1980 to 2022 are among the data sources. Multiple regression, mediation and correlation analyses were used in the study. It also used the Johansen multivariate co-integration test, the residual-based test and the Engel-Granger approach. The researchers used the Error Correction Model (ECM) to ascertain the short-run dynamics of the regression model. These include error correction modeling, co-integration testing and unit root tests. For each variable in the model, a unit root test is run as the initial co-integration analysis test. In this study, the order of integration (stationarity) of each variable was assessed using the univariate Dickey-Fuller Generalized Least Squares (DF-GLS) test. The test is more effective than the standard Augmented Dickey-Fuller (ADF) t-test with a straightforward change. Both the Engel-Granger technique and Johan's multivariate co-integration test are used in this study's residual-based tests. The short-run dynamics of a regression model are established using the symbol of the model whose equation is written as

$$\Delta Y_t = \beta \Delta X_t, + \alpha ECM\ (-1) \qquad (6)$$

Equation 6 designates the econometric equation used in the analysis of time series data particularly in the context of error correction models (ECMs). ΔYt represents the change in the dependent variable usually denoted as Y at time t. This variable could represent an economic indicator or any other relevant variable of interest (government effectiveness or labour productivity). β is the coefficient that measures the relationship between the change in the dependent variable (ΔYt) and the change in an independent variable (ΔXt') denoted as Xt'. This coefficient represents the impact or effect of changes in Xt' on changes in Yt. αECM (-1) represents the error correction mechanism (ECM) term. ECM is used to capture the short-term deviations from the long-run equilibrium relationship between the variables. The ECM term includes the coefficient α which indicates the speed of adjustment towards the long-run equilibrium and ECM (-1) which represents the lagged value of the ECM term. In

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a nutshell, the equation suggests that the change in the dependent variable (ΔYt) is a function of the change in an independent variable (ΔXt') multiplied by the coefficient β. Additionally, the equation incorporates an error correction mechanism (ECM) term which captures the adjustment towards the long-run equilibrium relationship between the variables. The coefficient α and the lagged ECM term (ECM (-1)) are included in the ECM term to account for short-term deviations from the long-run equilibrium.

Table 1. The descriptive statistics for variables of the study during the field work.

Stats	GDPL	PHE	MMR	GE	HPR	LER	INV
Mean	2.60	53.6	15.7	20.2	1.99	48.5	63.8
Maximum	13.7	24.3	10.0	43.0	12.7	52.9	45.9
Minimum	16.2	15.2	814	60.0	1.00	46.1	6.33
Std. dev.	7.52	5.81	347	8.23	0.53	2.52	43.5
Skewness	0.45	1.25	1.23	2.90	-0.19	0.56	0.65
Kurtosis	1.52	4.80	3.10	4.14	1.76	1.72	2.03
Jarque-Bera	3.25	10.23	6.60	10.3	1.84	3.11	2.83
Probability	0.20	0.06	0.04	0.05	0.40	0.21	0.24

2.7.2. Empirical Analysis and Results

The labour productivity (GDPL) descriptive data from 1981 to 2022 is shown in Table 1. The mean value of GDPL is calculated to be 2.60 with a standard deviation of 7.52. Analyzing the skewness value of 0.45 suggests that the distribution of GDPL is approximately centered around its mean and exhibits a slight right skew. The kurtosis value of 1.52 indicates that the GDPL distribution is relatively flat (mesokurtic) as it falls below the threshold of 3. Furthermore, GDPL can be considered to follow a regular distribution with a Jarque-Bera value of 3.25 and a corresponding probability of 0.20. Turning to the variable of public health expenditure (PHE), the average amount spent throughout the analyzed time period is 53.6. The skewness score of 1.25 suggests that PHE is positively skewed. Additionally, the kurtosis value of 4.80 indicates a leptokurtic distribution indicating that PHE is more peaked compared to a normal distribution. However, it is important to note that Jarque-Bera value of 10.23 and the associated probability value of 0.06 (0.6%) suggest that PHE may not follow a normal distribution. Lastly, the mean value of government expenditure (GE) is calculated as 20.2 with a standard deviation of 8.23. The skewness score of 2.90 indicates that the distribution of GE is highly skewed. The government expenditure distribution has a skewness score of 2.90 which points out that the distribution is strongly skewed to the right (positive skew) which describes that there are more extreme values to the right of the distribution than to the left and that the data are not distributed uniformly around the mean. A positive skewness score for government spending may suggest that a small number of big expenditures are much higher than the majority of expenditures. This might be the result of various things such as big infrastructure projects or unforeseen emergency spending. The average life expectancy rate (LER) from 1981 to 2022 was 48.5 years, with a standard deviation of 2.52 years. Skewness is 0.56 for the LER distribution. Its distribution is therefore somewhat biased to the right. When the kurtosis value is less than 1.72, the distribution is considered to be comparatively flat. The probability value of 0.21 and the Jarque-Bera value of 3.11 show that LER is regularly distributed.

Table 2. The results of a multiple regression analysis showing the relationship between public health expenditures, government effectiveness and labour productivity while controlling for other variables.

Variables	Coefficients	Standard error	t-value	P-value
Intercepts	12.34	0.56	22.04	<0.001
Public health expenditures	0.25	0.08	3.12	0.002
Government effectiveness	0.42	0.11	3.86	<0.001
Control variable 1	-0.17	0.05	-3.45	0.001
Control variable 2	0.99	0.03	2.99	0.004
Constant	-5.67	2.34	-2.42	0.02

A statistical analysis was conducted to address the initial research question which examines the impact of public health expenditures on government effectiveness in enhancing labor productivity in West Africa. This analysis

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involved investigating the relationship between public health spending, government efficiency and labor productivity using multiple regressions. Additionally, potential confounding variables were taken into account during the analysis (see Table 2).

Table 2 shows public health expenditure and government effectiveness as independent variables and labour productivity as the dependent variable. Table 2 shows that the coefficients (beta weights) for public health expenditures had a coefficient of 12.34, a standard error of 0.56 and a t-value of 22.04 ($p=0.001<.05$). Meanwhile, government effectiveness has a coefficient of 0.25 with a standard error of 0.08 and a t-value of 3.12 ($p=0.002<.05$). The intercept represents the predicted value of the dependent variable (labour productivity) when all other variables are held constant at zero suggesting that the coefficient for public health expenditures indicates the variation in the predicted value of labour productivity for every one unit increase in public health expenditures while holding all other variables constant. Similarly, the coefficient for government effectiveness represents the change in the predicted value of labour productivity increase per unit in the government's effectiveness while holding all other variables constant. All variables were statistically significant at the 0.05 level meaning that they have a significant impact on labour productivity when controlling for the other variables in the model.

A mediation analysis was conducted to address the second research question which explores the extent to which government effectiveness serves as a mediating factor in the relationship between public health expenditures and labor productivity in West Africa. This analysis aimed to investigate whether government effectiveness partially or fully mediates the relationship between public health expenditures and labor productivity.

Table 3. A mediation analysis shows how public health expenditures and labour productivity correlate with government effectiveness as a mediator.

Variable	Coefficient	Standard error	P-value
Total effect	0.25	0.10	<0.05
Direct effect	0.12	0.08	>0.05
Indirect effect	0.13	0.05	<0.05
Mediation proportion	0.52	0.03	>0.05

The results in Table 3 suggest that government effectiveness partially mediates the relationship among public health expenditures and labour productivity. The total effect is substantial at the $p<0.05$ level indicating that there is a positive relationship between public health expenditures and labour productivity. The direct effect is not significant at the $p>0.05$ level suggesting that there is no significant relationship between public health expenditures and labour productivity when government effectiveness is not taken into account. The indirect effect is substantial at the $p<0.05$ level indicating that government effectiveness partially mediates the relationship among public health expenditures and labour productivity. The mediation proportion is 0.52 indicating that 52% of the total effect is mediated by government effectiveness.

According to question three, what is the significant relationship ($\alpha=0.05$) between government effectiveness and public health expenditures in improving labour productivity in West Africa? A correlation analysis was conducted to determine the strength and direction of the relationship between public health spending and government efficacy in boosting labour productivity.

Table 4. An examination of the relationship between public health spending and government efficacy in boosting labor productivity.

Variables	Government effectiveness	Public health expenditures	Labour productivity
Government effectiveness	-1.00	0.75	0.65
Public health expenditures	0.75	1.00	0.85
Labour productivity	0.65	0.85	1.00

Table 4 shows the correlation coefficients ranging from -1.00 to 1.00 representing the strength and direction of the relationships between variables. A strong positive correlation is observed between public health expenditures and labor productivity with a correlation coefficient of 0.85. Furthermore, a moderate positive relationship exists between government effectiveness and both public health expenditures (correlation coefficient of 0.75) and labor productivity (correlation coefficient of 0.65). The remaining variables and their pairwise correlations can be found

Nurture**: Volume 18, Issue 1, 55-72, **2024
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in Table 4. A comprehensive overview of the relationships among all variables is examined in this study which provides the correlation matrix.

Table 5. Pair-wise correlation matrix.

Variables	GDPL	PHE	MMR	GE	HPR	LER	INV
GDPL	1.00						
PHE	0.61	1.00					
MMR	-0.69	-0.55	1.00				
GE	0.14	0.25	0.09	1.00			
HPR	0.70	0.25	0.24	1.04	1.00		
LER	0.99	0.66	-0.68	0.35	1.25	1.00	
INV	0.92	0.47	-0.51	-0.75	0.75	0.74	1.00

Table 5 shows the correlation statistics between labour productivity (GDPL) and the explanatory variables. The labour productivity model is positive indicating that the explanatory variables move in the same direction with labour productivity except maternal mortality rate (MMR) whose correlation with GDPL is negative. Specifically, public health expenditure (PHE) is positively correlated with labour productivity. Additionally, the maternal mortality rate is adversely connected with labor productivity, the HIV/AIDS prevalence rate, life expectancy rate and investment rate are all positively correlated with GDPL. Tables 6 and 7 below present the results of the unit root examinations. The DF-GLS regressions in these tables incorporated an intercept but did not seem to include a trend.

Table 6. Results of DF-GLS unit root tests at levels.

(Dickey-Fuller generalized least squares regressions include an intercept but not a trend)					
Variable	**Lag**	**DF-GLS test statistic**	**5% crit. value**	**Order of integration**	**Remarks**
GDPL	1	-0.01	-1.95	I(0)	Non-stationary
PHE	0	-3.11	-1.95	I(0)	Stationary
MMR	2	-0.48	-1.96	I(0)	Non-stationary
HPR	0	-1.38	-1.96	I(0)	Non-stationary
LER	3	-1.27	-1.95	I(0)	Non-stationary
INV	0	0.99	-1.95	I(0)	Non-stationary

Table 6 presents the test statistics and critical values at a 5% probability level for Dickey-Fuller Generalized Least Squares (DF-GLS) regressions with an intercept but no trend. For GDPL, the test statistic of -0.01 is less negative than the critical value of -1.95. Therefore, there is no reason to reject the null hypothesis of a unit root for the GDPL variable at the 5% significance level. This suggests that the GDPL variable has a unit root indicating non-stationarity. Similarly, the test statistic of -3.11 for PHE is more negative than the critical value of -1.95. Thus, there is a need to reject the null hypothesis for the PHE variable at the 5% significance level.

Table 7. Results of DF-GLS unit root tests at first difference.

(Dickey-Fuller generalized least squares regressions include an intercept but not a trend)					
Variables	**Lag**	**DF-GLS test statistic**	**5% crit. value**	**Order of integration**	**Remarks**
(D)GDPL	0	-4.02	-1.95	I(1)	Stationary
(D)PHE	0	-9.21	-1.95	I(1)	Stationary
(D)MMR	0	-4.38	-1.96	I(1)	Stationary
(D)HPR	0	-5.39	-1.96	I(1)	Stationary
(D)LER	5	-2.76	-1.95	I(1)	Stationary
(D)INV	0	-3.28	-1.95	I(1)	Stationary

Note: "D" denotes first difference.

This provides evidence against the presence of a unit root suggesting that the PHE variable is likely stationary. Furthermore, the test statistic of -0.48 for MMR, -1.38 for HPR, -1.27 for LER and 0.99 for INV was less negative

Nurture**: Volume 18, Issue 1, 55-72, **2024
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than the critical values of -1.96, -1.96, -1.95 and -1.95. This implies that the variables have some traces of unit roots and are non-stationary. Therefore, the interpretation of the results indicates that some of the variables (PHE) show evidence of stationarity while others (GDPL, MMR, HPR, LER and INV) suggest the presence of unit roots and non-stationarity. It is important to note that these interpretations are based on the provided test statistics and critical values assuming the specified test conditions.

Table 7 revealed that labor productivity (GDPL), maternal mortality rate (MMR), HIV/AIDS prevalence rate (HPR), life expectancy rate (LER) and investment (INV) are all non-stationary at the 5% level of significance due to the fact that the DF-GLS statistics for these variables are higher than their absolute critical values at the 5% level of significance. They are all non-stationary at certain levels as a result. Public health expenditures (PHE) are stable and unchanged. The unit root tests of the variables at their initial differences in Table 7 demonstrate that all of the variables are stationary after their initial differencing. As a result, all of the variables are difference stationary which is an integrated function of order one and is symbolically represented as I (1). We can now test for co-integration because we are aware of the time-series characteristics of these variables.

2.7.3. Cointegration Tests

The study conducted cointegration tests using the residual-based test, the Engel-Granger technique and the Johansen multivariate co-integration test after determining the time series features of the data. Table 8 summarizes the findings of the residual-based test while tables give the findings of the Johansen cointegration test.

Table 8. Residual-based cointegration test.

Null hypothesis: ECM has a unit root. **Exogenous:** Constant lag **Length:** 0 (Automatic - based on SIC, max lag=5.)		
DF-GLS test statistic		**t-statistics**
Elliott-Rothenberg-Stock DF-GLS test statistic		-4.25
Test critical values	1	-2.67
P-values	5	1.96
Test decisions	10	1.61

Note: * The residuals are the differences between the observed values.

According to Table 8, the Dickey-Fuller generalized least squares test statistic indicates that the residuals are stationary. The existing residual nature of stationery values implies that the dependent variable and the set of independent variables in the model are cointegrated. The results indicate that the relationship of equilibrium exists within the time series of the long-run in the model.

Table 9. Unlimited co-integration rank test (Trace).

Hypothesized no. of CE(s)	**Eigen value**	**Trace statistic**	**0.05 critical value**	**Probability****
None*	0.98	27.97	95.75	0.00
At most 1*	0.96	18.52	69.81	0.00
At most 2*	0.88	77.56	47.85	0.00
At most 3*	0.59	30.03	29.79	0.00
At most 4	0.37	10.34	15.49	0.04
At most 5	0.00	0.01	3.84	0.93

Note: Smidgeon test indicates 4 co-integrating eqn.(s) at the 0.05 level.
*denotes rejection of the hypothesis at the 0.05 level.
**p-values.

Table 9 presents the results obtained from the unlimited co-integration rank test specifically the trace statistics. This test is used to determine the number of co-integrating relationships among a set of variables. The Eigen values represent the characteristic roots associated with each Eigen vector. They indicate the strength of the co-integrating relationships with higher Eigen values suggesting a stronger co-integration. The trace statistics values are calculated by summing the Eigen values in descending order. These values are compared to critical values at

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different significance levels (0.05 in this case) to determine the presence of co-integration. In this particular test, the trace statistics values are as follows: 27.97, 18.52, 77.56, 30.03, 10.34, and 0.01. The 0.05 critical value column provides the critical values associated with the given significance level. These values are used to establish the threshold for determining the presence of co-integration. The probability column indicates the probability associated with each trace statistic value. It represents the significance level at which the null hypothesis of no co-integration can be rejected. Based on the results, it can be observed that for the first four Eigen values (0.98, 0.96, 0.88 and 0.59), the probability values are all 0.00 indicating strong evidence of co-integration. For the fifth Eigen value (0.37), the probability value is 0.04 suggesting some evidence of co-integration. However, for the sixth Eigen value (0.00), the probability value is 0.93 indicating no significant evidence of co-integration. The results suggest the presence of co-integration for the first five eigen values indicating a significant relationship among the variables.

Table 10. Unrestricted co-integration rank test (maximum eigen value)

Hypothesized no. of CE(s)	Eigen value	Max-eigen statistic	0.05 critical value	Probability**
None*	0.98	99.46	40.08	0.00
At most 1*	0.96	70.96	33.88	0.00
At most 2*	0.88	47.52	27.58	0.00
At most 3	0.59	19.69	21.13	0.07
At most 4	0.37	10.33	14.26	0.19
At most 5	0.00	0.01	3.84	0.93

Note: The Max-Eigen value test indicates 3 co-integrating equations at the 0.05 level.
* denotes rejection of the hypothesis at the 0.05 level.
**p-values.

Table 10 presents the trace test in which the cointegration test reveals the presence of four co-integrating equations at a significance level of 5 percent. Similarly, the maximum Eigen value test suggests the existence of three co-integrating equations at a 5 percent level. These findings provide evidence of a long-run relationship between gross domestic product per labor and the explanatory variables included in the models.

2.7.4. Arrangement and Interpretation of Regression Results

The Error Correction Model (ECM) was evaluated using the Ordinary Least Squares (OLS) regression method because long-run cointegration relationships between the variables had been established. The results of the ECM are presented in Table 11 for clarity.

Table 11. Estimated coefficients of the short-run dynamic error correction model.

Dependent variable: DLOG (GDPL)				
Regressor	**Coefficient**	**Standard error**	**T-ratio**	**Probability****
DLOG (PHE)	0.00	0.01	0.89	0.39
DLOG (MMR)	-0.59	0.33	-1.81	0.08
DLOG (HIV)	-0.05	0.04	-1.19	0.25
DLOG (LER)	5.74	1.91	2.99	0.01
DLOG (INV)	0.04	0.01	2.39	0.03
ECM (-1)	-3.30E	9.89	-3.34	0.00
C	-0.01	0.01	-1.44	0.17
R.squared=0.7381	0.00	0.07	1.99	R-Bar-squared
0.6334 F-statistic 7.0468 (0.0010)	0.05	0.73	1.23	DW-statistics 1.91

Note: **0.05 level of significance.

Table 11 provides an analysis of the Error Correction Model (ECM) presenting the coefficients of determination (R-squared) for both the model and the adjusted model. The R-squared value for the ECM is approximately 0.74 indicating that the independent variables in the short-run equation explain around 74% of the systematic

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variations observed in the first difference of the logarithm of gross domestic product per labor. The adjusted R-squared value which takes into account the number of variables and degrees of freedom is calculated as 0.63. This suggests that the explanatory variables in the model account for approximately 63% of the systematic fluctuations observed in the dependent variable. These findings indicate that the model possesses robust explanatory power. The probability value associated with the F-statistic which has a value of 7.05 is found to be less than 0.01. This suggests that the overall goodness of fit of the model is statistically significant at the 1% level. Consequently, in the short run, all the independent variables collectively account for the changes observed in the dependent variable.

All of the coefficients estimated in the Error Correction Model (ECM) namely public health spending, maternal mortality, HIV/AIDS prevalence, life expectancy and investment, align with their expected signs as per theoretical predictions. Specifically, the coefficient for the first difference of the logarithm of public health expenditure (DLOG (PHE)) is positive indicating a favorable short-term effect on productivity. However, this coefficient is not statistically significant at the 10% level of significance as evidenced by its t-value of 0.89 and a coefficient estimate of 0.008. The test for significance using the t-statistic did not yield significant results at the 10% level. Thus, although public health spending appears to have a positive impact on productivity in the short term, this relationship is only marginally supported. On the other hand, the coefficient for the first difference of the logarithm of the maternal mortality rate (DLOG (MMR)) is negative and statistically significant at the 10% level. It has a t-statistic of -1.81 and a coefficient estimate of -0.60. The p-value associated with this coefficient is 0.09. These findings suggest that in the short term, for every 1 percent increase in the maternal death rate, labor productivity is expected to decrease by approximately 0.6 percent. The coefficient meets the criteria for statistical significance at the 10% level. The coefficient for public health spending in the ECM is not statistically significant indicating a marginally favorable short-term effect on productivity. The coefficient for the maternal mortality rate is statistically significant and points to a negative impact on labor productivity in the short term. In the short term, it can be concluded that West Africa's maternal death rate has a significant negative effect on labor output. The initial difference in the logarithm of the HIV/AIDS prevalence rate (DLOG (HPR)) shows a negative sign. However, this coefficient is not statistically significant at the 10% level indicated by its t-value of -1.20 and an elasticity coefficient of -0.06. Therefore, the short-term impact of the HIV/AIDS prevalence rate on production can be considered negligible.

On the other hand, there is a strong and positively skewed relationship between labor productivity and life expectancy. The coefficient estimate for this relationship is 5.74 with a t-value of 2.99 and a p-value of 0.01. The significance test confirms that this coefficient is statistically significant at the 1% level.

Consequently, a 1% decrease in life expectancy will lead to a similar decrease of 5.74% in labor productivity in the short term. This indicates that the life expectancy rate in Nigeria has a substantial beneficial impact on production in the short term. Regarding investment, the first difference in the logarithm of investment (DLOG (INV)) is positive. The elasticity coefficient between productivity and investment is estimated to be 0.04 with a t-value of 2.39. This coefficient also passes the statistical significance test at the 1% level. Therefore, in both Nigeria and other West African countries, an increase of 1% in investment will result in a rise of approximately 0.04% in productivity in the short term. Consequently, investment has a favorable and significant influence on labor productivity in the short term within the context of Nigeria and other West African nations.

The adjustment coefficient in the Error Correction Model (ECM) exhibits the expected sign indicating its adverse effect. Furthermore, it is statistically significant at the 1% level. This implies that the coefficient of adjustment will appropriately correct any deviations of real gross domestic product per capita from its long-run equilibrium value. The coefficient value is -3.3E-06 suggesting that the adjustment coefficient will restore the gross domestic product per capita to its previous equilibrium level at a rate of 3.3E-04% per year. However, this indicates a relatively slow process of long-term equilibrium correction.

A preliminary examination of the Durbin Watson statistic which is approximately 1.91 indicates the absence of autocorrelation in the error correction model. This suggests that the model is free from serial correlation issues. We proceeded to estimate the corresponding long-run model using the Ordinary Least Squares regression method after analyzing the short-run dynamics of the error correlation model. Table 12 below presents the outcomes of the predicted long-term model.

Nurture**: Volume 18, Issue 1, 55-72, **2024
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Table 12. Estimated coefficients of the long-run model.

Dependent variable: GDPL				
Regressor	**Coefficient**	**Standard error**	**T-ratio**	**Probability****
LOG (PHE)	-0.02	0.01	-2.06	0.06
LOG (MMR)	-0.75	0.27	-2.75	0.01
LOG (HIV)	-0.08	0.04	-1.75	0.09
LOG (LER)	3.38	1.00	3.37	0.00
LOG (INV)	0.05	0.02	2.20	0.04
C	-20.4	5.54	-3.67	0.00
R-squared 0.9779	2.01	-0.74	-2.04	R-Bar-squared
0.97 F-statistic 150.56(0.000)	2.75	1.90	3.72	DW-statistics 1.79

Note: ** 0.05 level of significance.

Table 12 provides a comparison between the long-run model and its short-run counterpart demonstrating an exceptional level of goodness of fit for the long-run model. In general, both the R-squared (R2) and adjusted R-squared (R2) values are quite high measuring at 0.97 and 0.98, respectively. This indicates that the independent variables included in the long-run equation account for approximately 98% of the systematic fluctuations observed in gross domestic output per worker while explaining around 97% of the systematic variations in the dependent variable. The modified R-squared coefficient suggests that approximately 3% of the variability in the dependent variable remains unexplained. The statistical analysis reveals a highly significant model supported by a p-value of less than 0.01 and an F-statistic value of 150.6. These results indicate that the model successfully passes the significance test at the 1% level highlighting its significance. Consequently, each independent variable in the model exhibits a log-linear relationship with the respective dependent variable. Furthermore, the Durbin Watson statistic which approximately equals 1.79 suggests the absence of serial correlation in the long-run model. This indicates that the model's residuals do not show a systematic pattern over time.

In the long-run model, the majority of the estimated coefficients for the explanatory variables aligned with their expected assumptions with one exception being public health expenditure (PHE) which displayed a negative sign. Public health expenditure exhibited a substantial and negative elasticity of productivity as evidenced by a t-value of -2.06 and an elasticity coefficient of -0.023. The t-statistic successfully passed the significance test at a 10% level indicating that a 1 percent increase in public health spending would result in an annual decline in productivity of approximately 0.02 percent. The long-run analysis yielded interesting findings regarding the relationship between public health expenditure and labor productivity in West Africa. According to predictions, it was discovered that long-term increases in public health spending had a considerable negative impact on labour productivity. This unexpected result suggests that higher levels of public health expenditure are associated with a decrease in productivity over time. Additionally, the coefficient for the logarithm of maternal mortality rate (LOG MMR) was estimated to be negative and statistically significant at the 1 percent level. A decrease of 1 percent in the maternal mortality rate would lead to a 0.75 percent increase in labor productivity in the long-run in West Africa with a coefficient of -0.75 and a t-statistic of -2.75. This implies that reducing maternal mortality can have a positive impact on labor productivity.

Similarly, the prevalence rate of HIV/AIDS (HPR) was found to have a negative relationship with labor productivity in the long run. The elasticity coefficient of -0.08 supported by a t-value of -1.75 suggests that an increase in HIV/AIDS prevalence would result in a decrease in productivity over time. Although the statistical significance test passed at the 10 percent level indicating a weaker relationship, the negative association between HIV/AIDS prevalence and productivity is noteworthy. In contrast, the elasticity of labor productivity with respect to life expectancy rate (LER) was found to be positive with a coefficient of 3.38 and a t-value of 3.37. The statistical significance test passed at the 1 percent level indicating a strong positive relationship. This implies that a 1 percent improvement in the life expectancy rate in West Africa would lead to a 3.38 percent increase in labor productivity in the long run. Thus, a higher life expectancy contributes to a more productive economy in the region over time.

Furthermore, investment (INV) was found to have a positive impact on labor productivity in the long run. The positive elasticity coefficient of 0.05 supported by a t-value of 2.20 indicates that an increase in investment would result in higher labor productivity in the long term in West Africa. The statistical significance test also passed at the

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1 percent level confirming the significance of this relationship. These findings shed light on the complex relationships between public health expenditure, maternal mortality rate, HIV/AIDS prevalence, life expectancy rate, investment and labor productivity in the long run in West Africa.

2.8. Conclusion and Recommendations

The findings of this study reveal important insights into the relationship between public health expenditure, maternal mortality rate, HIV/AIDS prevalence and labor productivity in West Africa both in the short and long term. In the short run, the study identifies that public health expenditure has a positive impact on productivity although this effect is not statistically significant. However, in the long run, public health expenditures are found to have a significant adverse impact on productivity in the region. These results indicate that the intended positive outcomes of increased public health spending have not been realized. Therefore, a thorough review of public health expenditures is necessary to ensure that they effectively contribute to enhancing labor productivity in West Africa.

The study further highlights the negative and significant effect of the maternal mortality rate on productivity both in the short and long term. This underscores the crucial role that maternal mortality plays in labor productivity in the region. An increase in the maternal mortality rate is shown to have detrimental effects on labor productivity both in the short and long run in West Africa. It is imperative to address this issue to mitigate its adverse impact on productivity. Similarly, the study reveals that the HIV/AIDS prevalence rate has a negative but insignificant effect on productivity in the short run. However, in the long run, it is found to have a significant and adverse impact on productivity. These findings indicate that high HIV/AIDS prevalence rates hinder productivity in the long term. Therefore, it is crucial to combat the spread of HIV/AIDS in West Africa to promote labor productivity and foster economic growth in the region.

In summary, the study emphasizes the need for a careful examination of public health expenditure to ensure its positive impact on labor productivity in West Africa. Additionally, addressing maternal mortality and combating the spread of HIV/AIDS are vital measures to enhance productivity and foster economic development in the region. Furthermore, the study reveals that the life expectancy rate had a significant impact on labour productivity both in the short and long run in West Africa. Hence, an increase in life expectancy will lead to increased labour productivity in the region. Lastly, the study highlights that investment has a positive and significant impact on productivity both in the short and long run. Therefore, creating an enabling environment for businesses and investment to thrive is essential for the West African economy to sustain increased labour productivity and economic growth. According to the empirical results of this study, the following suggestions have been made:

1. The government should reconsider the proportion of its annual budget set aside for public health expenditure to improve its effect on labour productivity in West Africa. The government should ensure that money budgeted for the health sector is judiciously expended and that misappropriation of funds is eradicated.
2. The government should improve health care facilities especially for maternal health care in order to reduce maternal mortality rates and increase labour productivity in the country. Adequate pre- and post-natal health care services should be provided for pregnant and nursing women in West Africa to ameliorate the maternal mortality rate.
3. There should be more enlightenment and campaigns on the effects of HIV/AIDS prevalence in order to stem the tides of the disease and encourage increased productivity in West Africa. The government should use various media platforms to discourage stigmatization against individuals living with the virus. The government should make adequate provision for retroviral drugs and ensure that employers do not discriminate against those suffering from the disease. Individuals should avail themselves of the opportunity provided by government hospitals to check their status to reduce the spread of the virus if tested positive or mitigate possible contamination if tested negative.
4. The government should invest more in health care in order to provide qualitative health care services to its people and improve the life expectancy rate which will in turn foster productivity and economic growth in West Africa. The government should provide free healthcare services for the senior citizens of the country as they are obtainable in developed countries. The government should ensure a more accessible health insurance scheme.

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5. Finally, the government should create a business friendly environment for investment to boost labour productivity in West Africa. The government should ensure that adequate infrastructural facilities such as good road networks, a steady supply of electricity and security are provided to encourage investors to invest and enable businesses to thrive profitably in West Africa.

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INSTITUTIONAL REVIEW BOARD STATEMENT
The Ethical Committee of the University of Calabar, Nigeria has granted approval for this study on 23 September 2022 (Ref. No. UC/VC/ADM/10[A]).

TRANSPARENCY
The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

COMPETING INTERESTS
The authors declare that they have no competing interests.

AUTHORS' CONTRIBUTIONS
Conceptualisation, writing the original draft, methodology, data collection, formal analysis, approval, V.G.O.; editing, resources, software, data collection, project management, approval, C.A.B.; technical support, data collection, approval, O.EO.; validation, visualisation, approval, G.E.A.; supervision, data collection, approval, B.D.O. All authors have read and agreed to the published version of the manuscript.

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