Research on World Agricultural Economy
https://journals.nasspublishing.com/index.php/rwae

RESEARCH ARTICLE

Determinants of the Share of the Economy Contributed by the Forestry Industry in Ghana from 1975 to 2023

Kwabena Asomanin Anaman [1,*] **, *Samuel Ampomah*** [2] **, *Joseph Manzvera*** [1]

[1] *Department of Agricultural Economics and Agribusiness, College of Basic and Applied Sciences, University of Ghana, P.O. Box LG68, Legon, Accra, Ghana*

[2] *Department of Agricultural and Resource Economics, University of Saskatchewan, Saskatoon, SK S7N 5B5, Canada*

ABSTRACT

The macroeconomic determinants of the share of the economy contributed by the forestry industry in Ghana were examined over the period from 1975 to 2023, based on the development of time-series cointegration and error correction models. The analysis indicated that the share of the forestry industry was positively influenced by the real value of the cocoa industry, the exchange rate, and the real interest rate. The relationship between the forestry industry's share and per capita real gross domestic product (GDP) was found to be curvilinear: at low levels of per capita income, the share of the forestry industry in the economy increased with increasing income; beyond a certain level of per capita income, the share of the forestry industry declined. Additionally, economic shocks, namely the El Nino weather phenomenon, and political instability, related to the occurrence of military coups, were identified as negative influences on the share of the economy attributed to the forestry industry.

Journal of Economic Literature Classification Codes: Q23, Q28, Q50

Keywords: Determinants of forestry output; Forestry economics; Ghana; Macroeconomic analysis of industry; Marginalization; Resource economics

*CORRESPONDING AUTHOR:
Kwabena Asomanin Anaman, Department of Agricultural Economics and Agribusiness, College of Basic and Applied Sciences, University of Ghana, P.O. Box LG68, Legon, Accra, Ghana; Email: kanaman@ug.edu.gh; kwabenaasomanin@hotmail.com

ARTICLE INFO
Received: 28 July 2024 | Revised: 19 August 2024 | Accepted: 26 August 2024 | Published Online: 20 September 2024
https://doi.org/10.36956/rwae.v5i4.1205

CITATION
Anaman, K.A., Ampomah, S., Manzvera, J., 2024. Determinants of the Share of the Economy Contributed by the Forestry Industry in Ghana from 1975 to 2023. 5(4): 16–36. DOI: https://doi.org/10.36956/rwae.v5i4.1205

Highlights: Importance of the forestry industry to the economy of Ghana; Economic growth and the forestry in Ghana; Macroeconomic factors and their impact on the forestry industry of Ghana.

1. Introduction

The forestry industry is a key component of many economies owing to the interlinked nature of human beings with other animals and plants in the natural forest-based environments governed by the laws of evolution and increasingly by one-sided human interferences and rules. A forest is defined as a territory characterized by more than ten percent tree cover and a physical space of more than 0.5 hectare[1]. Natural forests play a key role in human societies including the sustenance of economies by providing watersheds and water reservoirs which provide fresh water for billions of people, control climate change through the storage of released carbon, and offer products for direct human uses, such as firewood, timber, fruits, medicinal items, and also provide spaces for the congregation of people for the observance of religious ceremonies especially those linked to traditional religions.

The decline of natural forests across the globe has been mainly due to the activities of human beings. Natural forests have been destroyed around the world through several activities such as agriculture, logging for local uses and exports, and mining activities, especially those linked to the illegal extraction of minerals from rainforests. The rate of deforestation was about ten million hectares annually from 2015 to 2020 [2]. Further, the area of primary natural forests declined by over 80 million hectares since 1990. Much of the current deforestation takes place in tropical countries.

The rate of destruction of natural forests in Ghana is one of the highest in the world[3]. Much of the natural forests in the country have been destroyed over the last one hundred years[4–7]. The rate of destruction of Ghanaian forests sharply increased starting with the implementation of structural adjustment programmes in April 1983. These programmes were undertaken by the government with the support of the International Monetary Fund and the World Bank with the objectives of reversing the slow growth linked to political instability arising from military coups, the occurrences of El Nino-linked droughts in 1977, 1978, 1982 and 1983, and very high world prices of crude oil over the ten-year period from 1974 to 1983 when world crude oil prices tripled in value.

The Ghanaian forestry industry has several components such as timber for exports and reafforestation and tree planting for commercial purposes. The rapid growth of the planting of teak trees required for the extension of electricity supply around the country and for overseas export markets was a factor in the increased economic growth of the country since the 1980s. The Ghanaian forestry industry contributed an average of 2.21% of the country's real GDP over the 49-year period from 1975 to 2023. This share fluctuated from 2% to 3% from 1975 to 2000. Starting from 1997, the share increased to 3% and above till 2005. There was a steady decline of the forestry industry share from 2010 to 2023 as shown in **Figure 1** below shown as fractional shares of GDP. The steady increase in the share of the forestry industry during the period from 1997 to 2005 was due to the emergence of teak wood as a major export item.

The Forestry Commission of Ghana, the State regulatory authority in charge of the forestry industry, defines forest tree species as belonging to several groups. These include (a) species with high export demand and are exported, (b) species which are exported but are commonly found in domestic markets, (c) species of potential economic value but not established on both the domestic and export markets and (d) protected species which are endangered and are close to extinction. A factor influencing the share of the economy attributed to the forestry industry is continuing concerns about the extinction of certain types of forest tree species and the need to double down on state and community efforts to prevent the extinction of these tree species together with their ecosystems [8].

The fluctuating share of the forestry industry in the Ghanaian economy could reflect changes within the in-

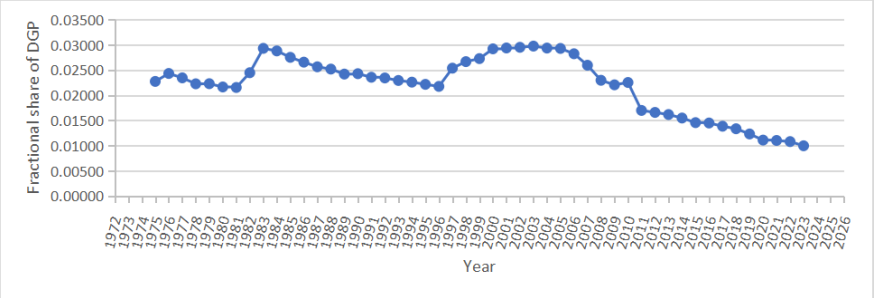

Figure 1. The real value of the forestry industry as a proportion of the real GDP in Ghana, 1975–2023 illustrated in fractions. Source: Developed by the authors from data collated by the Ghana Statistical Service.

dustry itself and the wider economy which include economic shocks. The ban on the exportation of certain timber products, expansion of the production of teak and artificial forest products, political instability, and changes in government policies related to democratic political transitions arising from one political party taking power after presidential elections could all affect the forestry industry's share of the economy.

Companies engage in the production of forestry products for the construction industry. The production of teak trees and bamboos is now a thriving activity serving the electricity and construction industries and is a major source of exports for the forestry industry. Ghana only allows the export of plantation-grown logs which are mainly teak; the country exported logs valued at US$165.1 million in 2019, the pre-coronavirus Covid-19 pandemic year [9]. The Forestry Commission of Ghana indicated that plantation timber exports reached a volume of 209,485 cubic meters in 2022 and accounted for about 61% of the total volume of timber and wood products from Ghana in 2022. The exported value of plantation timber products was 78,951,728.69, constituting 51% of the total timber export value of €153,861,837.67 [8].

The Forest Law Enforcement, Governance and Trade (FLEGT) voluntary partnership agreement has been initiated by the European Union to assess and evaluate the legality and environmental sustainability of timber products exported to the European Union. Ghana has been working with the European Union over the last decade to obtain a FLEGT licence [9]. The economic value of Ghanaian forest-exported products could be undermined by illegal timber trade and illegal mining in the government forest reserves in the country.

Poverty continues to be a major developmental challenge in Ghana with poverty concentrated in rural areas and among several vulnerable groups such as people with disabilities, followers of traditional African religions, female-headed rural agricultural households, and members of small tribes in the country [10–12]. The potential of the forestry industry in the poverty alleviation programmes of Ghana is immense as the source of the products of this industry is in the rural areas where much of the poverty exists. The advancement of the forestry industry, especially in the promotion of tree planting programmes, is essential to increase the incomes of rural dwellers and is an important mitigation measure against climate change. Payments for ecosystem services arising from the production and growing of tree crops such as teak and cashew offer an incentive to enhance poverty alleviation efforts in Ghana using international carbon reduction payment schemes such as REDD and REED Plus [13]. Efforts in this direction could increase the economic and social contributions of the forestry industry in Ghana. Hence the challenges that affect the forestry industry needs to be addressed to improve its potential to advance inclusive development of the country.

Factors which influence the performance of the Ghanaian forestry industry include both microeconomic firm-based variables and macroeconomic forces. However, the assessment of the macroeconomic factors driving the Ghanaian forestry industry has not been extensively researched. Macroeconomic variables such as interest rates and exchange rates do affect the performance of firms in the industry. Further, the efforts of the Ghanaian government to improve the economic fortunes of the forestry industry through targeted interventions are also dependent on its capacity and available resources; these are influenced by macroeconomic fac-

tors and the overall state of the economy. As indicated in the 2022 annual report of the Forestry Commission of Ghana, the constraints that it faced with the implementation of its programmes included the delays in the disbursement of approved funds to some stakeholders and inadequate logistical support [8]. These constraints were related to the macroeconomic difficulties and challenges faced by the State such as the rapid depreciation of the Ghanaian currency, the Ghana cedi, and a three-decade inflation high of 54.1% registered during 2022.

Given the background material, we seek to establish the major macro-economic factors which have influenced the contribution of the forestry industry to the Ghanaian economy covering a period of 49 years, from 1975 to 2023. This period covered the political instability period from 1975 to 1992, and the political stability period starting with the Fourth Republican era from 1993 to 2023, thus providing an evaluation covering a bigger spectrum of the economic forces at work in the Ghanaian forestry industry. The study is also of importance to international audiences given the similarity of Ghanaian macroeconomic conditions with other African countries and the widespread destruction of forests in Ghana which is also a common development theme in many developing countries. Following the statement of the objectives of the study, the next sections are devoted to a review of the literature, the theoretical and conceptual frameworks of the study, the methodology employed, the reporting and discussion of the results, conclusions, and recommendations.

2. Literature Review

2.1. History and Political Economy of Governance in Ghana

2.1.1. Brief History of Ghana

Ghana is a Republic situated in the western part of Africa with a population of about 32 million and is made up of people from nine broad ethnic groups and 89 tribes; 80 relatively small tribes, and nine relatively big tribes, based on the shares of the citizen population, using the 3% share and above to define big tribes. Historically, the landmass of Ghana has been inhabited by humans for at least 30,000 years with the earliest surviving settlers called Guans [14]. The movement of humans to Ghana was linked to the general migration of humans from Eastern Africa, the source of the known 200,000-year-old evolution of the human species *(homo sapiens sapiens)*, to other parts of the world starting around 70,000 years ago [15]. These early humans by the time of their first major migrations from Eastern Africa had acquired basic skills in hunting and gathering, human burial rituals, and religious beliefs revolving around a Supreme Being (God) and the existence of lower-level deities as evidenced by the commonality and universality of religious belief systems of newly-contacted tribes around the world, especially in Africa, Asia and South America.

Except for the Guan ethnic group, all the other eight broad ethnic groups and their associated 60 tribes in Ghana, migrated into its land mass from other parts of Africa starting from the 11th Century AD, about 1,000 years ago. The 1,000-year settlement on the Ghanaian landmass by the eight ethnic groups was marked by the first 500 years of generally peaceful settlement and formation of various traditional states. This was followed by 400 years of the Trans-Atlantic Slave Trade, from the 15th to 19th Century AD, the period when marginalized people were traded and exported as slaves to work in Europe, North America and South America. This was then followed by over 100 years of European colonial rule.

Ghana gained its political independence from Great Britain on 6 March 1957 with the independence struggle led by Dr. Kwame Nkrumah and the Convention People's Party. The country became a Republic within the English-speaking Commonwealth of Nations on 1 July 1960 after a referendum on 27 April 1960. The first Ghanaian successful military coup occurred on 24 February 1966. After that event, the country underwent a 27-year prolonged period of instability, from 1966 to 1992, characterized by four more successful coups, erratic economic growth, and persistent periods of high inflation. The Fourth Republican era starting on 7 January 1993 has been marked by the absence of military coups in the country. Beyond the political stability, characterized by the absence of coups, the era has also seen three relatively peaceful transfers of political power between

the two main political parties, the National Democratic Congress (NDC) and the New Patriotic Party (NPP), in 2001, 2009 and 2017, amid many unresolved electoral-related violence incidents in every election year since 1992.

2.1.2. Economic Growth, Environmental Destruction, and Inequality in Ghana

Other features of the Fourth Republican era include the rapid growth of government foreign debts. By 2000, Ghana's debt situation was very challenging even though the country had never defaulted on the payment of its foreign debts since independence in 1957. The new government, installed in 2001, accepted to join the highly indebted poor country (HIPC) programme of the International Monetary Fund (IMF) and the World Bank. As a result of the HIPC programme, the total foreign debts of Ghana were reduced from 6.3 billion United States dollars (USD) to 2.1 billion USD in December 2006, a reduction of 4.2 billion USD. The government also received grants from Western development partners worth 9.23 billion USD over the 2001 to 2017 period[16]. The total foreign debts rose from 2.1 billion USD in December 2006 to 30.1 billion USD in December 2023, an increase of 28 billion USD in 18 years[17].

In December 2022, the government, for the first time in the history of the country, declared a default on the payment of its local and foreign debts; it had applied to the IMF for an emergency programme of stabilization earlier in the year amid a rapidly worsening economy characterized by very high depreciation of the Ghanaian currency, a three-decade inflation high, very high financial losses of the Central Bank of Ghana in 2022, and again in 2023. The Fourth Republican era has also seen large judgement debts worth hundreds of millions of USD made against Ghana in overseas courts for the cancellations of agreements made by previous governments with foreign companies; an important issue given the eight-year cycle of change of ruling parties, between the NDC and NPP, in an antagonistic two-party political system.

Another characteristic of the Fourth Republican era has been modestly high economic growth, averaging 5.3% per year from 1993 to 2023. This growth propelled Ghana to the status of a lower-middle-income (LMI) country in 2009 based on an LMI status of per capita income of over 1,000 USD. Generally, the Ghanaian economic growth over the last three decades has been generated considerably through large-scale environmental destruction related to the severe pollution of the three natural environmental media of air, land and water, including very high depletion of natural forests[3, 5, 6], and the destruction of many rivers and streams in the country through mining activities[18, 19]. The extensive destruction of natural rivers and forests during the Fourth Republican era, especially over the last decade, is related to the political-economy dynamics of natural resource governance and political power structures in the country. The President of the Republic appoints all the District Chief Executive (DCE) and Mayors of the 261 districts; these people can be dismissed at any time by him, with many of them holding the position for only about two years, before the termination of their appointments instead of the procedural four years in office.

While most lands in Ghana are governed under traditional cultural arrangements, with chiefs being custodians of these assets on behalf of extended families and clans, the State owns all minerals and assets underneath the soil, a right conferred by legislation. This right means that it is the State agencies directly under the President of the Republic which give final approval with regards to all mining leases in Ghana. With known vast gold and mineral resources within the riverine systems of Ghana, unconstrained wealth seeking, assisted by a political patronage system, has led to massive destruction of rivers and streams turning many once pristine rivers and streams into pools of mud using mercury and other poisonous substances. Without elected DCEs and Mayors, who could mobilize community support to effectively prevent illegal mining activities, several riverine systems have been destroyed over the last decade including forest reserves in the southern part of the country.

The Fourth Republican era has also produced increasing national income inequality with the national Gini coefficient steadily rising from 35.3 in 1987 to 43.5 in 2017 [20–22]. The political settlement in this era has been extensively dominated by the elites of a few big tribes who also control and manage the State's economic

and financial agencies and institutions, with the occurrences of State capture of national resources by powerful elites. There has been marginalization of many of the 80 small tribes in the country linked to the inequitable distribution of State resources such as allocations of administrative districts, electoral constituencies, financial resources, local and overseas appointments, scholarships, honours, proper roads and infrastructure, and the right to use of local or closely-related local languages in public primary and junior high schools by members of small tribes in their communities. There has been increasing poverty for many small tribes amidst an expanding economy [12]. Based on the analysis of the per year growth of national income inequality over the last four decades for 48 African countries with available data, the study assessed Ghana as the third worst country in the growth of national income inequality (refer to **Table A1** for the assessment using World Bank data).

Marginalization of small tribes has been an important factor in the increasing national income inequality and has been influenced partly by the creation of new districts for areas which do not meet the constitutionally mandated minimum population of 75,000 people; this practice has favoured areas largely inhabited by members of big tribes linked to influential elites of the two main political parties such as major executive members of the two main political parties, State ministers, and the sitting Presidents of the Republic (the latter have been mostly lawyers and legal scholars). Thirty percent of the existing 261 districts in the country do not meet the minimum population criterion based on population data from the Ghana Statistical Service [12]. This "unconstitutional" creation of new districts in a multi-tribal country has been a major factor for the perennial government budget deficits as the infrastructural development necessary for sustainable and inclusive economic growth and increased government tax revenues has been sacrificed for an expanded and bloated bureaucracy.

From an environmental perspective, the Fourth Republican era has produced a dual-marginalization development outcome as follows: (1) marginalization of non-human living species through the extensive destruction of the natural environment by human beings, and (2) the marginalization occurring in the human society considerably affecting its vulnerable members. The political economy dynamics related to the three superstructures of the Ghanaian society—Markets, Community and the State—suggest that an environmentally sustainable forest industry in Ghana would require reforms of the 1992 Fourth Republican Constitution to allow for greater involvement of local communities in forests governance. One such reform is the direct election of DCEs and Mayors for the existing 261 districts. This reform is necessary to eliminate the destruction of forests and water bodies by activities which are not properly supervised by Central State authorities. The market failures and state failures related to the destruction of forests and water bodies need Community-based corrections through greater mobilization of local communities; this mobilization could be undertaken more easily with directly elected DCEs and Mayors working with local traditional councils. Individual chiefs and professionals have sometimes been able to undertake the adequate mobilization of local people to prevent the destruction of forests and rivers in their communities. However, these mobilization activities tend to be risk-increasing and risk-inefficient for individuals.

The institutionalization of elected DCEs and Mayors stands a better chance of improving the governance of environmental systems. The current hybrid system of local governance system, characterized by appointed DCEs (Mayors), and an elected district legislature, is grossly ineffective. The current system involves the DCE nominated by the President to be approved by the district legislature with the nominee given only two chances of approval based on the support of two-thirds of the members of the legislature. Thus, the nominee commonly gives financial inducements to members of district legislature to seek approval at the first or second sitting of the legislature. This process is repeated till a nominee is approved. After the approval of the nominee, he/she is responsible to the President who is the only person with the power to dismiss him/her. This arrangement encourages administrative corruption including cases involving the management of public forests and environmental resources. This hybrid system could be useful for situations where considerable local violence and anarchy exist; this situation does not apply to many

areas of the country which could benefit more from directly elected DCEs instead of the current situation where residents are always looking to the Central Government based in the capital city, Accra to come and solve sanitation problems and other development issues.

The other defect of the current local governance system is that the nominees for the position of DCEs tend to be local ruling party activists who originate from the big tribes closely associated with the ruling party; this factor is entrenching an imperial big-tribes-dominated system of local governance rather than the free choice of local people to choose their own elected DCEs as they currently do for their Members of Parliament. Further, in response to the permanent electioneering activities of DCEs for the ruling party, mobilization activities of activists of the main opposition party tend to derail local development; these activists try to impress their regional and national party executives for them to be nominated by the President for the position of DCEs once their party wins power in the national election. These activities are often negative in nature; they raise the transaction costs of project activities derailing the quality of projects being implemented by State and non-governmental organizations.

2.2. Review of Empirical Works

In developing countries including Ghana, forest products such as wood fuel (fuelwood and charcoal) particularly make an important contribution to the welfare of many households. The collection of fuel wood to produce charcoal or for direct use as cooking fuel is undertaken by about one billion people worldwide[1, 2]. The critical contribution of natural forests to economic growth is evident in both rural and urban areas. There are several arguments proposed in the literature which support forest-led poverty alleviation school of thought [23]. One argument is that over 40 million people are involved with commercial fuelwood and charcoal production to meet the growing demand by the urban population. Another point often raised is the creation of direct and indirect employment by the forestry industry[1, 2].

In general, agricultural expansion has been a major driver of deforestation. However, biodiversity is fundamental to the adaptability of human sustenance frameworks and their capacity to adjust to future change. Commercial agriculture represented 40% of tropical deforestation [1, 2]. Many challenges arise because of rapid urbanization; the most important of which is the loss and deterioration of natural habitats[24]. The fast population growth in many developing countries has led to the acceleration of the use of wood as fuel resulting in large-scale deforestation and increasing health concerns arising from indoor pollution [25–27].

Specifically dealing with Ghana, the forestry industry employed about 120,000 individuals in 2010 based on data from the 2010 national population census[28]. The 2017/ 2018 National Census of Agriculture established that there were 765,885 tree crop holders in Ghana employed as owners and managers growing trees mainly avocado, banana, cashew, cocoa, coconut, coffee, cola, citrus, mango, oil palm, guava, pawpaw, shea nut and rubber. Almost three-quarters (74.7%) of these holders were male. Further, 619,866 holders were producing cocoa, the most important agricultural export crop in Ghana [29]. There were 11,660 holders who specialized in the production of forest trees with 84.3% being males[29].

In addition, many homes in Ghana rely on forest products for heating and cooking. Fuel wood serves as an important source of energy and accounts for about 40% of energy consumption in Ghana [30]. Fuel wood in Ghana is derived through the collection of dead branches of trees by rural dwellers. In the cocoa-producing areas of the country, many rural dwellers collect fuel wood from cocoa farms based on picking the dead rotten branches. The harvesting of fuelwood and its conversion to charcoal as a major economic activity by rural householders is a major cause of deforestation in Ghana.

In the mid-1990s, the Ghanaian timber industry experienced a severe pressure due to excessive exploitation of the forest and illegal harvesting. This imposed on the forestry industry a severe problem with regards to raw materials availability and efficient utilization of limited timber available. The issue called for a working group in government, the private sector, and communities to develop the Forestry Sector Development Plan.

Upon completing the plan in year 1996, temporary emergency measures were put into operation to reduce the excessive depletion of the forest resource. This initiative spurred several other state-led activities to reduce the excessive exploitation of natural forests in Ghana [31].

The production of teak wood products for local use and exports has been one of the dynamic changes in the economy of Ghana over the last four decades. Spurred by the increasing demand for teak wood in the country's ambitious electricity distribution and access drive initiated in the 1980s, and continued thereafter, teak wood was sought after to replace the use of metal poles in the extension of electricity supply to households. The export of teak wood was an inevitable consequence of domestic production as the supply exceeded demand. Teak has now become the most exported timber species from Ghana with over 200,000 hectares of land devoted to teak accounting for about 70% of forest plantations and providing an important source of climate change mitigation [32].

Biological products derived from forestry resources, other than timber, such as fruits and mushrooms, are referred to as non-timber forest products[33]. People who live in rural areas close to forests collect fruits, honey, and mushrooms for their own consumption or to sell [34]. These benefits are not peculiar to Ghana; evidence has shown that rural residents in other African nations often collect non-timber forest products for both household consumption and commercial purposes. For instance, smallholder farmers in Zimbabwe's Chivi district pick fruits and vegetables from the forestry resources for sale, their own consumption, or both[35]. Concurrently, a significant source of livelihood for rural residents adjacent to the Nuba mountains in Sudan gathers fruits from the mountains to sell [36]. This evidence further underscored the critical role forestry resources play in poverty eradication.

Several factors are noted in the literature to affect the contribution of the forestry industry to GDP globally. For instance, natural disturbances such as wildfires, pests and diseases alter the flow of goods and services provided by the forestry industry[37, 38]. Between 2003 and 2012, Africa and South America lost about 67 million hectares of forest land due to wildfire[38]. More than 85 million hectares of forest land were lost due to pests in North America during the same period[38]. In 2015 alone, wildfires destroyed 2.6 million hectares of land in Indonesia, costing 16.1 billion United States dollars equivalent to 2% of GDP[39].

Climate change, particularly rising temperatures, also hurt the development and diversity of tree species, decreasing the harvestability of forest products[38, 40]. This has a negative impact on the supply (quantity and quality) of forestry products and diminishes the forestry industry's contribution to economic growth[38]. Between 2003 and 2012, severe weather events devastated about 38 million hectares of forest land, primarily in Asia, resulting in massive economic losses[38]. Government support also affects the forestry industry's contribution to GDP. For example, the recent evidence from Inner Mongolia of China showed that government support significantly and positively contributed to the growth of forestry resources[41]. Thus, government policy initiatives such as boosting public spending and protecting forestry resources are crucial in promoting the sustainable growth of the forestry industry and its contribution to economic growth[41]. The global economic shocks such as COVID-19 and financial crises such as that of 2008–2010 also negatively affected the growth of the forestry industry and its contribution to GDP[42]. This is primarily due to increased logging efforts because of economic challenges, which lead to deforestation [41].

The impacts of specific macroeconomic variables on the performance of industries have been extensively researched often using econometric and statistical models. For the dependent variable, scholars use a variety of indicators. Some choose to use average firm performance indicators such as the return on equity and return on assets. These firm-based measures are common in the accounting and finance literature [43–45]. Other research workers, mainly economists, use the aggregate output or income of the industry as the performance measure treating it as the dependent variable in a multiple regression analytic framework [46–49].

2.3. Gaps in the Literature

For the performance of firms and industries, many scholars use efficiency measures connoting maximum

output per input use (technical efficiency) or economic efficiency which combine both technical efficiency and allocative efficiency. From a competitive performance perspective, a comparison of the performance of industries in an economy would require the use of the share of the economy attributed to the various industries in the economy. This approach is used in limited forms in the literature. The use of the industry share of the GDP as the performance index for industries allows for the comparison of the resilience and competitive edge of an industry among its peer industries within the same country. Thus, an industry with a continuously declining share of GDP could still be profitable and strong, but overall, the demand for its products from local and overseas consumers could be declining.

A second noticeable gap in the literature is the limited number of studies undertaken on the effects of economic shocks on the relative share of GDP attributed to industries. While there are many studies on the impacts of economic shocks on the size and performance of industries based on various measures [50, 51], the emphasis has been more on the effects on the outputs of the industries; less focus has been placed on the shrinkage or expansion of the affected industries relative to the other industries in the whole economy. It is well known that the share of the economy attributed to agriculture and other primary industries shrinks with economic growth over time. However, what is not clear is whether this shrinkage is accelerated by economic shocks, such as political instability and extreme weather phenomena, which tend to occur irregularly. There has been limited attention paid to the impact on the relative size of the forestry industry in the advent of economic shocks. For example, during severe droughts, trees which form the backbone of the forestry industry, are more resilient as compared to crops and livestock. Further, for economic shocks coming from the biosphere, such as Covid-19 pandemic, their impacts would vary by industry with the biggest impacts hitting the service-based industries such as tourism. For example, during the 2020 Covid-19 pandemic year in Ghana, the growth rate of the agricultural sector was 7.3% compared to the growth rates of -2.5%, 0.7%, for the industrial sector and the services sector, respectively. The accommodation and food services industry, an industry within the services sector, contracted by 37% in 2020 [52].

3. Theoretical Framework

The theoretical framework used in this study is situated in the influence of the macroeconomy on the performance of business firms. The overall performance of an industry, such as the Ghanaian forestry industry, is driven by both internal and external factors. The internal factors are related to the efficiency of the use of resources by firms in the industry. External factors affecting the performance of an industry include external shocks such as political instability, conflicts and wars, and international trade disturbances, among others. Another key factor deals with the changing demand and tastes for the products of an industry over time, arising from both domestic and overseas sources.

Macroeconomic variables could be external factors beyond the control of business firms which could positively or negatively impact their performance. Economic shocks, such as the El Nino weather phenomenon, could be considered as variables within the larger macroeconomic discourse. The overall performance of an economy is gauged on indicators such as inflation, interest rates, and total economic output, often measured by the gross domestic product, unemployment, fiscal policy, monetary policy, and business cycles related to recessions and expansion of the economy. Firms can make more informed decisions when they are sufficiently aware of macroeconomic indicators. Macroeconomic variables positively impact the economy when they stimulate economic growth and the stability of the financial system which results in the increased demand for goods and services providing incentives for business to expand. On the other hand, macroeconomic variables negatively impact the economy when they severely slow down the economy leading to higher unemployment, and when the general level of prices rises too quickly, hurting consumer and business confidence.

In terms of the relative performance of the forestry industry, macroeconomic factors could negatively affect performance through raising the costs of operations of firms within the industry, for example, via increased real

interest rates. On the other hand, depreciating exchange rates could increase the performance of the firms in the industry through increased revenues. However, excessive depreciation of the local currency could raise substantially the costs of imported inputs used by firms. Government policies which could hurt the forestry industry include the ban on selected forestry products and very high minimum wages. Increasing per capita income of residents could change the demand for selected products of forestry industry affecting the industry's share of the total economy.

4. Conceptual Framework

The conceptual framework is outlined in **Figure 2**. This framework shows the direct relationship between the key macroeconomic variables, indicated by the per capita GDP, exchange rate, real interest rate and the dependent variable which is the relative share of the GDP contributed by the forestry industry. This relationship is moderated by variables such as cocoa production, population and trend factors. These moderating variables strengthen the relationship between the three macroeconomic variables and the forestry's share of the economy. Policy initiatives could also act as moderating variables. The control variables of interest in the study are the El Nino weather phenomenon and political instability. These control variables which could affect the relative size of the forestry industry of the economy, either negatively or positively; the exact directional influence on the Ghanaian forestry industry is being investigated in this study.

5. Methodology Including Data Sources and Econometric Models

Following the discussion on the gaps in the literature, we followed the approach used by some economists for analysing the determinants of the industry's contribution to GDP[53,54] we used the time-series econometric methodology to analyse the macro-level determinants of the share of the GDP attributed to the forestry industry over the period, 1975 to 2023. The data were gathered from several secondary sources with the major source being Ghana Statistical Service (GSS), the State producer of economic statistics in Ghana[52,55–59]. The four time-series data produced by the GSS were back cast to form a consistent series from 1975 to 2023 using the most recent base year of 2013 adopted by GSS. The GSS classifies the real economy of Ghana into three sectors: (1) agriculture, (2) industry, and (3) services. The forestry industry is one of the five components of the agricultural sector. The other four components of the agricultural sector are cocoa, crops other than cocoa, livestock, and fisheries. Processing activities related to forestry, such as wood manufacturing, are considered under the manufacturing industry in the industrial sector; hence, they are not counted in the value of the forestry industry used in this study.

The relationship between the forestry industry's GDP share and various independent variables driving this share, is expressed in Equation (1) in its linear form.

$$\begin{gathered} FORESRTSHAREGDPt = J0+ \\ J1PCRGDPt + J2PCRGDPSQt+ \\ J3RCOCOAt + J4EXRATEt \\ +J5REALINTRATEt+ \\ J6TRENDt + J7ELNINOt+ \\ J8PINSTABt + Ut \end{gathered} \tag{1}$$

From Equation (1), the log-linear form is presented in Equation (2).

$$\begin{gathered} LFORESTSHAREGDPt = K0+ \\ K1LPCRGDPt + +K2LPCRGDPSQt+ \\ K3LRCOCOAt + K4LEXRATEt+ \\ K5RINTRATEt + K6LTRENDt+ \\ K7ELNINOt + K8PINSTABt + Wt \end{gathered} \tag{2}$$

where $LFORESTSHAREGDP_t$, $LPCRGDP_t$, $LPCRGDPSQ_t$, $LRCOCOA_t$, $LEXRATE_t$ and $LTREND_t$, are the natural logarithmic forms of $FORESTSHAREGDP_t$, $PCRGDP_t$, $PCRGDPSQ_t$, $RCOCOA_t$, $EXRATE_t$ and $TREND_t$ respectively. Ji and Ki are the parameters, and U_t and W_t are the equations error terms.

The superiority of the log-linear model over the linear version was confirmed by the cointegration analysis (discussed later in this section); this analysis did not establish any valid cointegration among the continuous variables in the linear model for any lag. Thus we employed the log-linear model (Equation (2)) for the econometric analysis. The establishment of the stationarity of the variables was performed using unit root tests involv-

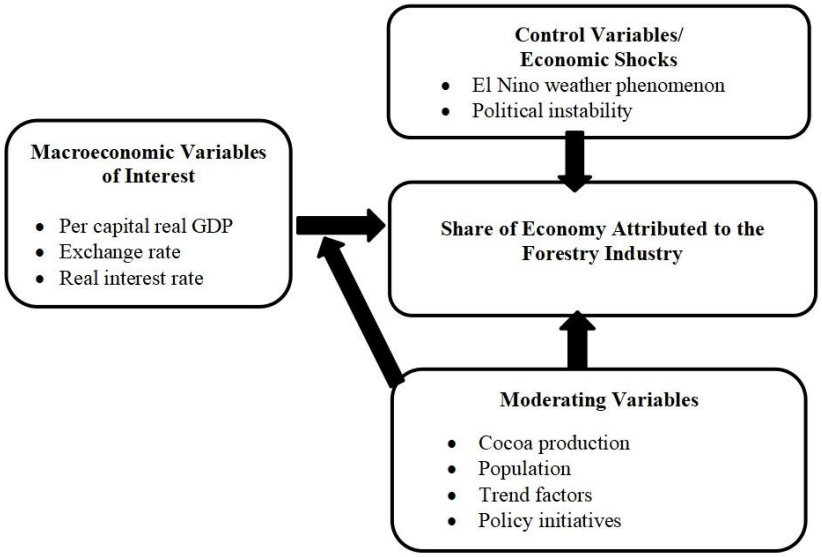

Figure 2. Illustration of the conceptual framework of the study. Source: Developed by the Authors, 2024.

ing the augmented Dickey-Fuller (ADF) test[60] and the Phillips–Perron test (PP)[61].

The method used for the derivation of a long run cointegration relationship among the variables declared in Equation (2) was the autoregressive distributed lag (ARDL) method. The ARDL method is a vector autoregressive (VAR) model that uses the bounds test to establish the existence of a long-run relationship among the dependent and independent variables, except the dummy variables [62]. The ARDL method can be applied to variables either stationary or non-stationary, or both [63]. Once a valid long-run cointegration function is established among the variables, several econometric diagnostic tests are undertaken for the chosen model. Equation (3) presents the error correction model, which includes W_{t-1}, the error correction term, from the long-run relationship and X_t, the equation error term. The first differences of the variables are denoted with the prefix "DIF" attached to the names of the long-run variables.

$$DIFLFORESTSHAREGDPt = M0 + M1DIFLPCRGDPt + M2DIFLPCRGDPSQt + M3DIFLRCOCOAt + M4DIFLEXRATEt + M5DIFRINTRATEt + M6DIFLTRENDt + M7DIFELNINOt + M8DIFPINSTAB + M9Wt - 1 + Xt \quad (3)$$

Table 1 lists the variables used in the econometric model and their definitions.

6. Results and Discussion

6.1. Unit Root and Cointegration Tests

Unit root tests were performed on all the variables, both at their levels and first differences and the results are reported in **Table 2**. Using the maximum 10% critical p-value level adopted in this study, most of the variables were non-stationary at their levels based on both the Augmented Dickey-Fuller (ADF) and the Phillips-Perron (PP) tests. Based on the first differences, all the variables were stationary using both the ADF and PP test values.

With the proven stationarity of the variables at their first differences, the ARDL cointegration test was performed. A unique characteristic of this test is that it admits both stationary and non-stationary variables (both I(0) and I(1)). The results of the ARDL cointegration test are reported in **Tables 3a**, **3b** and **3c**. The optimal ARDL cointegration function was determined based on an optimal lag length of two using the Schwarz-Bayesian criterion. The validity of the cointegration function was proven with the F-statistic (10.466) being greater than the 95% upper bound critical value of 4.083. The W statistic also produced a similar result with a value (72.262) greater than the 95% critical value of 28.581 (refer to **Table 3b**).

Several econometric diagnostic tests were per-

Table 1. Description of variables used in the study.

Variable	Description
Dependent variable	
$FORESTSHAREGDP_t$	The fractional share of the GDP attributed to the forestry industry, defined as the real value of the forestry industry divided by the real GDP.
Explanatory variables	
PCRGDP	The per capita GDP of Ghana derived by dividing the real GDP by the population.
PCRGDPSQ	This is the square of PCRGDP and is introduced into the model to allow for the possible derivation of a curvilinear relationship between per capita real GDP and the share of GDP attributed to the forestry industry.
$RCOCOA_t$	The real value of cocoa production, defined by the nominal value of cocoa adjusted for by its price deflator, at time t.
$EXRATE_t$	The exchange rate of the Ghana cedi to the USD at time t.
$REALINTRATE_tt$	Real interest rate, defined as the nominal interest rate, adjusted for by inflation, at time t.
$TREND_t$	A variable that represents trend factors not captured by the other independent variables, with 1975 represented as 1, with the trend variable increasing by 1 till 2023 (49).
$ELNINO_t$	A dummy variable with a value of 1 for years that the El Nino weather phenomenon occurred and zero for years with the absence of El Nino. The years, 1977, 1982, 1983, 1990, 1998, 2007, 2014, 2015 and 2023.
$PINSTAB_t$	A dummy variable with a value of 1 for years of military coups in Ghana. 1978, 1979 and 1981 were assigned the value of 1; other years were assigned a value of zero.

Source: Derived from data from GSS and Bank of Ghana published in various reports.

Table 2. Unit root test results of the continuous variables at their levels and first differences.

Variable	ADF Statistic	P-Value	PP Statistic	P-Value
LFORESTSHAREGDP	−0.680	0.974	−1.268	0.985
LPCRGDP	−4.631	0.001***	−4.269	0.870
LPCRGDPSQ	−4.499	0.002***	−4.081	0.882
LRCOCOA	−2.882	0.169	−5.491	0.785
LEXRATE	−1.612	0.788	−2.259	0.963
RINTRATE	−1.799	0.870	−39.119	0.001***
LTREND	−5.091	0.000***	−11.422	0.348
DIFLFORESTSHAREGDP	−3.216	0.081*	−34.802	0.003***
DIFLPCRGDP	−3.925	0.011**	−35.604	0.003***
DIFLPCRGDPSQ	−4.366	0.002***	−38.288	0.001***
DIFLRCOCOA	−3.186	0.087*	−36.701	0.002***
DIFLEXRATE	−3.463	0.044**	−25.980	0.021**
DIFRINTRATE	−4.014	0.008***	−46.118	0.000***
DIFLTREND	−3.438	0.047**	−20.618	0.062*

Note: DIF is the first difference operator. The probability of rejection of the null hypothesis of a unit root is based on the p-value. This comes with three critical p values which are 1%, 5% and 10%. *** indicates 1% significance level; ** indicates 5% significance level; * indicates 10% significance level.

formed; the results are reported in **Table 3c**. The model was adequately specified based on the Ramsey Reset Test [64] with the computed test p-value of 0.625, which is above the maximum critical p-value of 0.10. The equation error term was normally distributed based on the central limit theorem [65] given the large sample size of 49. The absence of significant autocorrelation was confirmed by the general test of autocorrelation [66] with a computed p-value of 0.353 above the critical p-value of 0.10. There was absence of significant heteroscedasticity based on the Lagrange Multiplier (LM) test [67]. The computed LM test p value was 0.232, which is above the 0.10 critical p-value.

6.2. Results and Discussion of the Long Run Function

The results of the estimated long-run function derived from the estimated ARDL cointegration function are reported in **Table 4**. The parameters of all the eight independent variables and the intercept were statistically significant in influencing the variation of the dependent variable. The power of the model was very high with a R^2 of 0.994; this indicated that the eight independent variables explained 99.4% of the variation in the dependent variable. The effect of per capita income on the share of the forestry industry in GDP was curvilinear indicating the positive impact at low levels of income and negative impact on the share after a turning point of per capita income.

The per capita income result could suggest a con-

Table 3. (**a**) Results of the estimated optimal ARDL cointegration function of the forestry industry as a share of the GDP based on data from 1975 to 2023. (**b**) Test for the existence of one valid (long run) cointegration equation. (**c**) Summary of econometric diagnostic test results.

(a)

Independent Variable	Parameter Estimate	Student t-Statistic	P-Value
INTERCEPT	−20.200	−2.203	0.037**
$LFORESTSHAREGDP_{t-1}$	0.243	2.313	0.029**
$LPCRGDP_t$	−29.584	−4.334	0.007***
$LPCRGDP_{t-1}$	7.5524	0.761	0.454
$LPCRGDP_{t-2}$	27.933	3.509	0.002***
$LPCRGDPSQ_t$	1.659	3.995	0.000***
$PCRGDPSQ_{t-1}$	−0.426	−0.703	0.488
$LPCRGDPSQ_{t-2}$	−1.705	−3.491	0.002***
$LRCOCOA_t$	0.338	3.390	0.002***
$LRCOCOA_{t-1}$	−0.159	−1.262	0.218
$LRCOCOA_{t-2}$	0.307	3.325	0.003***
$LEXRATE_t$	0.074	1.899	0.069*
$LEXRATE_{t-1}$	0.175	3.662	0.001***
$RINTRATE_t$	0.362	3.882	0.001***
$RINTRATE_{t-1}$	0.268	2.665	0.013**
$RINTRATE_{t-2}$	0.159	1.708	0.100
$LTREND_t$	11.850	2.326	0.028**
$LTREND_{t-1}$	−19.461	−2.871	0.008***
$LTREND_{t-2}$	6.716	3.395	0.002***
$ELNINO_t$	−0.313	−1.896	0.069*
$PINSTAB_t$	−0.152	−2.522	0.018**
R^2	0.994***		
Adjusted R^2	0.989***		

(b)

Test Statistic	Value	Level of Significance	Lower Bound Critical Value	Upper Bound Critical Value
F-statistic	10.466**	5%	2.786	4.083
W statistic	72.262**	5%	19.500	28.581

(c)

Test	Test Method	Prob. > Chi-Square
Model specification	Ramsey Reset	0.625
Heteroscedasticity	Breusch-Pagan-Godfrey	0.232
Autocorrelation	Breusch-Godfrey	0.353

Note: The dependent variable is $LFORESTSHAREGDP_t$ (the natural logarithm of the share of the real GDP contributed by the forestry industry in Ghana for year t). ***—1% significance level; **—5% significance level; *—10% significance level.

firmation of the Environmental Kuznets Curve hypothesis [68] with regards to the use of the products of the forestry industry in Ghana (demand side). This result could reflect the increasing use of non-wood products for energy by the middle and upper classes of people in Ghana due to the increased availability of gas and electricity. Electricity supply reached over 80% of the population during the period, 2009 to 2023, when continuous and steady decline in the share of GDP attributed to the forestry industry was observed (refer to **Figure 1**). Ghana formally became a lower-middle-income country in 2009 and has maintained this status since that time. An alternative explanation for the result (supply side) dealing with per capita income is the nature of the growth of the GDP which has been dominated by mining revenues and growth in the services sector. When the economy is booming, the forestry industry could be expanding but not at the rate at which the key industries are expanding. Thus, the increased per capita income would reflect greater shares of the GDP to mining and services as compared to forestry given the way the GDP is conventionally measured which allows for double counting of many environmental costs related to the mining industry.

The positive impact from increasing level of production of the cocoa industry on the share of the forestry in-

dustry is because the real value of the cocoa industry reflected the value of bearing cocoa trees producing cocoa beans which were used to derive the output of the cocoa industry. Increasing amounts of bearing cocoa trees would provide increasing amounts of dead and rotten cocoa tree branches which would be harvested sustainably as firewood and to produce charcoal. Under customary laws of Ghana, rotten and dead branches of cocoa trees could be removed by residents of the area and used for energy needs without the need for special permits.

The two financial sector variables, the exchange rate of the Ghana cedi to USD and the real interest rate, both had a positive effect on the share of the forestry industry. Increasing value of the exchange rate meant a depreciating Ghanaian currency and this would increase the Ghana cedi value of forestry industry exports. While a depreciating Ghanaian currency increases the real value of exported forestry products, it also hurts exporters who rely on imported inputs for their operations. However, for the Ghanaian forestry industry, imported inputs are not critical to the operations of its export component. Increasing the real interest rate implied that economic agents valued returns in the present period much more than future returns. This preference would result in more production of natural forest products for use; for example, the felling of trees, for the making of charcoal products to service the demand of an increasing population. The preference of returns in the present period as compared to the future period also represents a moral hazard problem created by the current generation of human beings knowing that it is the future generations which would largely bear the costs of their environmental destruction.

Trend factors, represented by the variable, LTREND, had a significant negative effect on the share of the forestry industry. This result was due to this variable representing the relative decline of forestry products over time due partly to changing tastes from an increasing population. Trend factors also embody land use patterns such as increasing crop land used to feed a population growing at about 2.1% annually. The increasing use of shifting cultivation and other extensive land use practices contribute to the decline of forested areas. The trend factors influencing the declining share of GDP attributed to the forestry industry also include the impacts of migration and urbanization. Rural-urban migration has increased steadily in Ghana with the 2010 Ghana Population and Housing Census showing that the proportion of the population living in urban areas had exceeded those living in rural areas [58, 69]. The greater concentration of people in rural areas leads to greater demand for fuel wood for energy for cooking. Nevertheless, this demand has been slowed down by increasing use of gas for cooking among the urban population.

The El Nino weather phenomenon and political instability, which are economic shocks, had the negative effects on the share of forestry product of the GDP (refer to **Table 4**). The result confirms that the competitive performance of the forestry industry relative to the other industries in Ghana is weakened by economic shocks. The relative weaker performance relative to the other industries in the presence of economic shocks could reflect the greater difficulties that policymakers face in enforcing laws and regulations related to the forestry industry when there are serious economic shocks given the increased poverty that the shocks create for both the rural and urban poor. These vulnerable people would tend to rely more heavily on fuel wood thus increasing deforestation. Overall, the long run analysis indicates that the fluctuating share of the forestry industry as a proportion of the GDP reflected gradual changes in the economy and the impacts of economic shocks such as military coups and severe droughts linked to El Nino.

6.3. Results and Discussion of the Error Correction Model Analysis

Table 5 is a summary of the results of the error correction model analytic results. The power of the model equation was very high as indicated by the 86.9% R^2. The error correction term was highly significant. Its value of −0.758 implied that a return to the long-run trends in about 1.32 (1/0.758) years after disequilibrium caused by economic shocks. Short-run annual changes in per capita income negatively affected the short-run changes to the forestry industry share based on first and second lag effects. Short-run changes in population, exchange rate and interest rate positively influenced forestry industry share. The effect of short-

Table 4. Results of long run cointegration function of the forestry industry's share of GDP.

Independent Variable	Parameter Estimate	Student t-Statistic	P-Value
INTERCEPT	−26.665	−2.241	0.034**
LPCRGDPt	7.790	2.631	0.014**
LPCRGDPSQt	−0.624	−3.604	0.001***
LRCOCOAt	0.641	6.920	0.000***
LEXRATEt	0.329	7.172	0.000***
RINTRATE	1.043	4.794	0.000***
LTRENDt	−1.182	−2.594	0.015**
ELNINOt	−0.041	−1.911	0.067*
PINSTABt	−0.200	−2.346	−0.027**

Notes: The dependent variable is $LFORESTSHAREGDP_t$ (the natural logarithm of the share of GDP accruing to the forestry industry). ***—1% significance level; **—5% significance level; *—10% significance level.

run changes for cocoa was positive for the first lag and negative for the second lag effect. Short-run changes in trend factors negatively affected short-run changes in the forestry industry share of the GDP. The short run results are not significantly different from the long run results discussed above. However, in the short run period, trend factors influence the share of the GDP attributed to the forestry in both positive and negative ways unlike the long run model assessment of only negative effects.

7. Conclusions and Recommendations

7.1. Conclusions

A macroeconomic analysis conducted on the determinants of the fluctuating share of the economy of Ghana attributed to the forest industry, using time-series econometric methodology based on data from 1975 to 2023, revealed that the share of the forestry industry was positively influenced by the real value of the cocoa industry, captured by the size of bearing cocoa trees, the exchange rate, and the real interest rate. The influence of per capita real GDP was curvilinear: at low levels of per capita income, the share of the forestry industry increased with increasing income; beyond a certain level of per capita income, the share of the forestry industry declined. The study established that the fluctuating share of the forestry industry as a proportion of the GDP reflected changes in the economy and economic shocks—the El Nino weather phenomenon and military coups. The findings suggest that the information related to the effect of the relative share of the economy, attributed to the forestry industry arising from economic shocks, could be useful for policymakers to prioritize their assistance for industries which are affected by several economic shocks within a particular period.

The results obtained from this study indicate that policy actions have contributed to the fluctuating shares of the forestry industry in terms of its contribution to GDP. The ban on the export of logs from natural forests contributed to the relative decline in the share of the industry; however, the active promotion of the production of teak and other commercial plantation tree logs for export increased the contribution of the industry to GDP. Government policies on gradual fuel energy transition from wood and forest products, such as charcoal, to gas and other non-polluting sources, appear to have made some headway. This energy transition policy could be reinforced with the expansion of retail gas outlets and electricity services.

7.2. Recommendations

A recommendation that flows from this study is the need for increased use of intensification practices in crop production to reduce the encroachment and destruction of forest lands for the growing of annual crops. This recommendation also applies to startup cocoa production. Bearing cocoa farms are complementary to the expansion of the forestry industry through the sustainable use of firewood gathered from cocoa farms, based on dead and rotten branches of cocoa trees. However, the expansion of cocoa production through the destruction of virgin forests is not an environmentally friendly practice and needs to be discouraged through intensification practices on existing farms. Given the rapid rate of depletion of forests in the country, it is suggested that

Table 5. Results of short-run error correction function of the forestry industry's share of GDP.

Independent Variable	Parameter Estimate	Student t-Statistic	P Value
$DIFLPCRGDP_t$	−29.584	−4.334	0.000***
$DIFLPCRGDP_{t-1}$	−27.933	−3.509	0.001***
$DIFLPCRGDP_{t-2}$	1.659	3.995	0.000***
$DIFLPCRGDPSQ_t$	1.705	3.491	0.001***
$DIFLRCOCOA_t$	0.338	3.390	0.002***
$DIFLRCOCOA_{t-1}$	−0.307	−3.325	0.002***
$DIFLEXRATE_t$	0.074	1.899	0.067*
$DIFRINTRATE_t$	0.362	3.882	0.000***
$DIFRINTRATE_{t-1}$	−0.159	−1.708	0.097*
$DIFLTREND_t$	11.850	2.326	0.027**
W_{t-1} (Error Correction Term)	−0.758	−7.227	0.000***
R^2			0.869***
Adjusted R^2			0.769***

Note: The dependent variable is $DIFLFORESTSHAREGDP_t$. ***—1% significance level; **—5% significance level; *—10% significance level.

companies which obtain some of their inputs from the forests should contribute a small proportion of their revenues to a Fund to be used for more active forest planting and regeneration programmes to be implemented by the Forestry Commission. This initiative could support the recently introduced annual tree planting programme throughout the country based on the increased mobilization of the general population.

The sustainable development of the Ghanaian forestry industry is dependent on forests as inputs. The destruction of forests, rivers and streams during the Fourth Republican era is arguably the fastest during the entire 30,000 years of human settlement on the landmass of Ghana. Estimates of the serious pollution and destruction of rivers over the last decade arising from illegal mining and other activities range from 22% (government official estimate) [19] to 60% [18] (estimate from foreign source). Special State-appointed task forces including military teams have been unable to stem the tide of illegal mining of forests, rivers and streams. The human-health hazard and extent of the damages to the riverine systems of Ghana require the Government to publicly declare the problem as a national disaster and empower the existing State organization charged with handling disasters, the National Disaster Management Organization, to deal with the problem and improve the long-term management of forests.

The Fourth Republican era in Ghana has produced poor governance with regards to the management of forests and related environmental resources such as rivers and streams. This poor management has coincided with the rapid growth of Christianity in the country. The proportion of the population declaring themselves as Christians reached 71.3% in 2021 [69]. The most important and first commandment of Christianity, as indicated in Matthew Chapter 22 verses 37 and 38 [70], is loving God with all your heart, all your soul and all your mind. The sustainable use of forests and their protection need the active involvement of Christian churches and allied organizations given that much of the destruction of forests and rivers in Ghana occurs in areas whose people are overwhelmingly Christians. The involvement of Christian leaders could be through regular preaching of messages to modify the excessive self-interested nature of their followers in line with the fundamental Christian axiom of fully loving God by taking proper care of His creations of forests, rivers, streams, and non-human animal species.

Finally, the sustainable development of the Ghanaian forestry industry would require amendments to the 1992 Fourth Republican Constitution to allow for greater role of local people in the management of their community affairs and these include the direct election of Mayors to manage district assemblies or councils. Ghana has now become one of the biggest country destroyers of forests and rivers in the world. A stakeholder-based conference is needed to produce amendments to the Constitution to improve governance of forests and other natural resources. Without formal constitutional amendments, the President of the Republic could still allow the citizens of a district to choose their directly elected DCE or Mayor in elections organized by the Electoral Commission [10]. The Parliament could enact legislation for a small-sized Cabinet to support the work of the DCE in

addition to workers from the existing Local Government Service. The management of national security at the district level is then handled by the District Commander of the Ghana Police Service. The Supreme Court of Ghana and the Chief Justice could establish a special court to deal with any conflicts between the national and district authorities that cannot be resolved by mediation processes of the Traditional Councils.

7.2.1. Limitations of the Study

A limitation of this study is its focus on the production aspects of the Ghanaian forestry industry. This is due to the nature of the available secondary data with its focus on the production aspects of the industry. The analysis of the manufacturing and service activities of the forest products would require several types of data and new methodologies beyond the scope of this study. Further, the study does not evaluate the impact of democratic political transition on the share of the economy attributed to the forestry industry related to the transfer of political power from one party to another after the conduct of national presidential elections in Ghana; this transition has occurred three times during the Fourth Republican era.

Author Contributions

Conceptualization, Kwabena Asomanin Anaman; data collation, Kwabena Asomanin Anaman; methodology, Kwabena Asomanin Anaman; literature review, Kwabena Asomanin Anaman, Samuel Ampomah, and Joseph Manzvera; writing including review and editing, Kwabena Asomanin Anaman, Samuel Ampomah and Joseph Manzvera.

Funding

The study received no external funding.

Acknowledgments

This paper is the ninth refereed journal article produced by the Political Economy Analysis of Economic Growth and International Trade in Post-Independence Ghana Research Project implemented at the Department of Agricultural Economics and Agribusiness, University of Ghana from August 2018 to August 2024. The project involved the enhancement of secondary data produced by 15 Ghanaian State agencies and five Ministries covering the period from the year of Ghana's independence, 1957 to 2023. The 15 Ghanaian agencies were Central Bank of Ghana, Cocoa Board, Electoral Commission, Electricity Company of Ghana, Energy Commission, Environmental Protection Agency, Ghana Export Promotion Authority, Ghana Statistical Service, Ghana Stock Exchange, Ghana Water Company Limited, National House of Chiefs, National Archives, Social Security and Investment Trust, Tourism Board, and University of Ghana. The five Ministries were Energy, Employment and Labour Relations, Food and Agriculture, Finance, and Transport. Secondary data were also obtained from five international agencies: Food and Agriculture Organization (FAO), IMF, International Cocoa Organization, United States Agency for International Development and World Bank.

Centralized files were established to link data from various agencies for analysis using data science procedures involving programming and spreadsheet simulation links. The enhanced data produced from the project were used for the development of three Doctor of Philosophy theses, seven Master of Philosophy theses, and 23 Bachelor of Science dissertation reports from 2019 to 2024. The research assistance support of Messrs. Michael Ameyaw Somuah, Kinsley Delanyo Adjei, Joshua Bissah, Gideon Ayettey, Benjamin Addo and Ms. Emma Adom is gratefully acknowledged. The project received no external funding. Data collection and outputs [71, 72] started when the senior author was a Visiting Senior Research Fellow at the Institute for Fiscal Studies, Accra, Ghana from March to August 2018.

Data Availability

The data presented in this study are available on request.

Conflict of Interest

There are no conflicts of interest.

Appendix A

Table A1. Compiled national income inequality Gini coefficient indices of African countries.

No.	Country	Benchmark Year	Gini Value	Most Recent Year	Gini Value	Years between Measurements	Percent Inequality Growth	Percent Inequality Growth per Year	Ranking of per Year Growth Inequality
1	Angola	2000	52.0	2018	51.3	18	−1.35	−0.075	13
2	Burundi	1992	33.3	2020	37.5	28	12.61	0.450	6
3	Benin	2003	38.6	2021	34.4	18	−10.88	−0.604	24
4	Burkina Faso	1994	48.1	2021	37.4	27	−22.25	−0.824	33
5	Botswana	1985	54.2	20115	53.3	30	−1.66	−0.055	12
6	Central African Republic	1992	61.3	2021	43.0	29	−29.85	−1.029	38
7	Cote d'Ivoire	1985	45.5	2021	35.3	36	−22.42	−0.623	27
8	Cameroon	1996	44.4	2021	42.2	25	−4.95	−0.198	15
9	Congo, Democratic Republic	2004	42.2	2020	44.7	16	5.92	0.370	7
10	Congo, Republic	2005	47.3	2011	48.9	6	3.38	0.564	4
11	Cabo Verde	2001	52.5	2015	42.4	14	−19.24	−1.374	45
12	Algeria	1988	40.2	2011	27.6	23	−31.34	−1.363	44
13	Egypt, Arab Republic	1990	32.0	2019	31.9	29	−0.31	−0.011	11
14	Eritrea								
15	Ethiopia	1995	44.6	2015	35.0	20	−21.52	−1.076	39
16	Gabon	2005	42.2	2017	38.0	12	−9.95	−0.829	34
17	Ghana	1987	35.3	2017	43.5	30	23.23	0.774	3
18	Guinea	1991	46.8	2018	29.6	27	−36.75	−1.361	43
19	Gambia, The	1998	48.5	2020	38.8	22	−20.00	−0.909	37
20	Guinea-Bissau	1993	43.6	2021	33.4	28	−23.39	−0.836	35
21	Equatorial Guinea								
22	Kenya	1992	57.5	2021	38.7	29	−32.70	−1.127	42
23	Liberia	2007	36.5	2016	35.3	9	−3.29	−0.365	20
24	Lesotho	1986	56.0	2017	44.9	31	−19.82	−0.639	28
25	Morocco	1984	39.2	2013	39.5	29	0.77	0.026	10
26	Madagascar	1980	46.8	2012	42.6	32	−8.97	−0.280	17
27	Mali	1994	50.4	2021	35.7	27	−29.17	−1.080	40
28	Mozambique	1996	53.6	2019	50.5	23	−5.78	−0.251	16
29	Mauritania	1987	43.9	2019	32.0	32	−27.11	−0.847	36
30	Mauritius	2006	35.7	2017	36.8	11	3.08	0.280	9
31	Malawi	1997	65.8	2019	38.5	22	−41.49	−1.886	46
32	Namibia	2003	63.3	2015	59.1	12	−6.64	−0.553	23
33	Niger	1992	36.1	2021	32.9	29	−8.86	−0.306	18
34	Nigeria	1985	38.7	2018	35.1	33	−9.30	−0.282	17
35	Rwanda	2000	48.5	2016	43.7	16	−9.90	−0.619	25
36	Sudan	2009	35.4	2014	34.2	5	−3.39	−0.678	29
37	Senegal	1991	54.1	2021	36.2	30	−33.09	−1.103	41
38	Sierra Leone	2003	40.2	2018	35.7	15	−11.19	−0.746	32
39	Somalia								
40	South Sudan	2009	46.3	2016	44.1	7	−4.75	−0.679	30
41	Sao Tome and Principe	2000	32.1	2017	40.7	17	26.79	1.576	2
42	Eswatini (Swaziland)	1994	60.5	2016	54.6	22	−9.75	−0.443	21
43	Seychelles	2013	46.8	2018	32.1	5	−31.41	−6.282	47
44	Tchad	2003	39.8	2022	37.4	19	−6.03	−0.317	19
45	Togo	2006	42.2	2021	37.9	15	−10.19	−0.679	31
46	Tunisia	1985	43.4	2021	33.7	36	−22.35	−0.621	26
47	Tanzania	1991	35.3	2018	40.5	27	14.73	0.546	5
48	Uganda	1989	44.4	2019	42.7	30	−3.83	−0.128	14
49	South Africa	1993	59.3	2014	63.0	21	6.24	0.297	8
50	Zambia	1991	60.5	2022	51.5	31	−14.88	−0.480	22
51	Zimbabwe	2011	43.2	2019	50.3	8	16.44	2.054	1

Source: Enhanced data produced by the authors from World Bank Development Indicators, accessed on 26 June 2024.

References

[1] Food and Agriculture Organization (FAO), 2018. Global Forest Resources Assessment 2018. FAO: Rome.

[2] Food and Agriculture Organization (FAO), 2020. Global Forest Resources Assessment 2020. FAO: Rome.

[3] Atteridge, A., Searight H., Sharma N., et al., 2022. Supporting Just Transitions to Sustainable Land Use in Ghana. Climate Investment Funds: Washington, DC.

[4] Anaman, K.A., Agyei-Sasu, F., 2014. The economic value of the environmental capital inputs used to produce gross domestic product in Ghana, 1993 to 2012. Research in World Economy. 5, 74–92. DOI: https://doi.org/10.5430/rwe.v5n2p74

[5] Acheampong, E.O., Macgregor, C.J., Sloan, S., et al., 2019. Deforestation is driven by agricultural expansion in Ghana's forest reserves. Scientific African. 5, 1–11. DOI: https://doi.org/10.1016/-j.sciaf.2019.e00146

[6] Amoah, A., Korle, K., 2020. Forest depletion in Ghana: The empirical evidence and associated driver intensities. Forestry Economics Review. 2, 61–80. DOI: https://doi.org/10.1108/FER-12-2019-0020

[7] Abubakari, M.M., Anaman, K.A., Ahene-Codjoe, A.A., 2022. Urbanization and arable land use in Northern Ghana: A case study of the Sagnarigu Municipality in the Greater Tamale Area. Applied Economics and Finance. 9, 68–85.

[8] Forestry Commission of Ghana (FCG), 2023. Annual Report 2022 Ghana Forest Plantation Strategy. FCG: Accra.

[9] Flegt Independent Market Monitor on Ghana [Internet]. VPA Africa-Latin America. Available from: https://flegtvpafacility.org/countries/ghana/

[cited on 10 May 2024].
[10] Anaman, K.A., Bukari, G.A., 2019. Political economy analysis of voter participation and choices in national elections in Ghana's fourth republican era. Research in World Economy. 10(3), 174–198.
[11] Anaman, K.A., Bukari, G.A., 2021. Voter turnouts in presidential elections in Ghana: A political economy analysis using district-level data. Applied Economics and Finance. 8(1), 13–31. DOI: https://doi.org/10.11114/aef.v8i1.5083
[12] Anaman, K.A., Shaibu, A.F., 2024. Development of regional input-output tables for Northern Ghana: an analysis using location quotients. Cogent Social Sciences. 10(1), 2340429. DOI: https://doi.org/-10.1080/23311886.2024.2340429
[13] Osei, B., Abugre, F., Obeng, E.A., Adams, M., 2023. Prospects of payment for ecosystem services: A case for teak and cashew plantation development in Ghana. African Crop Science Journal. 31(2), 239–262. DOI: https://doi.org/10.4314/acsj.v31i2.9
[14] Anquandah, J., 2013. The people of Ghana: Their origins and cultures. Transactions of the Historical Society of Ghana New Series. 15, 1–25.
[15] Dawkins, R., 2024. We are all Africans [Internet]. Available from: https://www.youtube.com/-watch?v=jNIOz-JN5kE [cited on 10 May 2024].
[16] Anaman, K.A., Bukari, G.A., 2019. Political economy analysis of the macroeconomic impact of national elections in Ghana during the fourth republican era, 1992 to 2016. Applied Economics and Finance. 6(3), 28–44.
[17] Bank of Ghana, 2024. Summary of Economic and Financial Data. Bank of Ghana: Accra.
[18] British Broadcasting Corporation (BBC), 2021. The Illegal Gold Miners Killing Rivers and Livelihoods in Ghana Documentary. BBC: London.
[19] Government of Ghana, 2022. Quality of Ghana's water resources generally unhealthy. Report to Parliament of Ghana. Ministry of Water Resources: Accra.
[20] Ghana Statistical Service (GSS), 2018. Ghana Living Standards Survey Round 7 Poverty Trends in Ghana 2005–2017. GSS: Accra.
[21] Oxfam International, 2024. Ghana: Extreme inequality in numbers [Internet]. Available from: https://www.oxfam.org/en/ghana-extreme-inequality-numbers [cited on 30 May 2024].
[22] World Bank, 2024. World Development Indicators—Gini Coefficients of African Countries. World Bank: Washington, DC.
[23] Mendako, R.K., Gang, T., Ullah, S., et al., 2022. Assessing the economic contribution of forest use to rural livelihoods in the Rubi-Tele hunting domain, Democratic Republic of Congo. Forests. 13(1), 130.
[24] Cleveland, S.M., Hebblewhite, M., Thompson, M., et al., 2012. Linking elk movement and resource selection to hunting pressure in a heterogeneous landscape. Wildlife Society Bulletin. 3694, 658–668.
[25] Pearson, T.R., Brown, S., Murray, L., et al., 2017. Greenhouse gas emissions from tropical forest degradation: An underestimated source. Carbon Balance and Management. 12(1), 1–11.
[26] Pendrill, F., Persson, U.M., Godar, J., et al., 2019. Agricultural and forestry trade drives large share of tropical deforestation emissions. Global Environmental Change. 56, 1–10.
[27] Stocking, M., 2021. Evaluating the poverty–environment nexus in Africa. Evaluating Environment in International Development. Routledge: London. pp. 197–218.
[28] Ankomah, F., 2012. Impact of Anthropogenic Activities on Changes in Forest Cover, Diversity and Structure in the Bobri and Oboyow Forest Reserves in Ghana [Master's Thesis]. Kumasi, Ghana: Kwame Nkrumah University of Science and Technology.
[29] Ghana Statistical Service (GSS), 2020. 2017/2018 Ghana Census of Agriculture National Report. GSS: Accra.
[30] Antwi-Boasiako, C., Glalah, M., 2022. Proximate analysis and strength properties of carbonized woods from the most-used tropical timbers from the Afram Plains, Ghana's charcoal production hub. Journal of Sustainable Forestry. 41, 1064–1077.
[31] Domson, O., Vlosky, R.P., 2007. A Strategic Overview of the Forest Sector in Ghana. Lousiana State University: Baton Rouge.
[32] Environmental Protection Agency Ghana, 2021. Ghana's Third Biennial Update Report to United Nations Climate Change [Internet]. Available from: https://unfccc.int/sites/default/files/resource/-gh_BUR3_1282021_submission.pdf [cited on 30 May 2024].
[33] Asamoah, O., Danquah, J.A., Bamwesigye, D., et al., 2024. The perception of the locals on the impact of climate variability on non-timber forest products in Ghana. Ecological Frontiers. 44(3), 489–499.
[34] Asamoah, O., Danquah, J.A., Bamwesigye, D., et al., 2023. Perceptions of commercialisation and value-addition of non-timber forest products in forest adjacent communities in Ghana. Discover Sustainability. 4(1), 30.
[35] Kugedera, A.T., Kupurai, P., Sakadzo, N., 2021. Evaluating the potential contribution of Non-Timber Forest Products (NTFPs) to smallholder farmers in semi-arid and arid regions: A case of Chivi, Zimbabwe. Research in Ecology. 3(01), 22–30. DOI: https://doi.org/10.30564/re.v3i1.2874
[36] Adam, Y.O., Pretzsch, J., Pettenella, D., 2013. Contribution of Non-Timber Forest Products livelihood strategies to rural development in drylands of Su-

dan: Potentials and failures. Agricultural Systems. 117, 90–97.
[37] Montagné-Huck, C., Brunette, M., 2018. Economic analysis of natural forest disturbances: A century of research. Journal of Forest Economics. 32, 42–71.
[38] Van Lierop, P., Lindquist, E., Sathyapala, S., et al., 2015. Global forest area disturbance from fire, insect pests, diseases and severe weather events. Forest Ecology and Management. 352, 78–88.
[39] Kala, C.P., 2023. Environmental and socioeconomic impacts of forest fires: A call for multilateral cooperation and management interventions. Natural Hazards Research. 3(2), 286–294.
[40] Brecka, A.F., Shahi, C., Chen, H.Y., 2018. Climate change impacts on boreal forest timber supply. Forest Policy and Economics. 92, 11–21.
[41] Wu, X., Liu, G., Bao, Q., 2023. Impact of economic growth on the changes in forest resources in Inner Mongolia of China. Frontiers in Environmental Science. 11, 1241703.
[42] Prochazka, P., Abrham, J., Cerveny, J., et al., 2023. Understanding the socio-economic causes of deforestation: A global perspective. Frontiers in Forests and Global Change. 6, 1288365.
[43] Mitra, G., Gupta, V., Gupta, G., 2023. Impact of macroeconomic factors on firm performance: Empirical evidence from India. Investment Management and Financial Innovations. 20(4), 1–12.
[44] Al-Homaidi, E.A., Ahmad, A., Khaled, A.S., et al., 2019. External factors and banks' performance: An empirical examination of commercial banks listed on Bombay Stock Exchange (BSE). International Journal of Emerging Technologies and Innovative Research. 6(6), 368–371.
[45] Gwahula, R., 2018. Examining key macroeconomic factors influencing the stock market performance: Evidence from Tanzania, International Journal of Academic Research in Accounting, Finance and Management Sciences. 8(2), 228234.
[46] Bekele, D.T., 2020. The impact of macroeconomic factors on manufacturing sector value added in Ethiopia: An application of bounds testing approach to cointegration. Journal of Economics, Business, and Accountancy Ventura. 23(1), 96–107. DOI: https://doi.org/10.14414/jebav.v23i1.2164
[47] Abebaw, A., 2019. The effect of macroeconomic variables on the industry sector output growth of Ethiopia. International Journal of Business and Economics Research. 8(6), 325–338.
[48] Onakoya, A.B., 2018. Macroeconomic dynamics and the manufacturing output in Nigeria. Mediterranean Journal of Social Sciences. 9(2), 43–43.
[49] Sokunle, R.O., Chase, J.M., Harper, A., 2017. The determinants of manufacturing growth sector growth in Sub-Saharan Africa. Research in Business and Economics. 12(2), 29–40.
[50] Botzen, W.J.W., Deschenes, O., Sanders, M., 2020. The economic impacts of natural disasters: A review of models and empirical studies. Review of Environmental Economics and Policy. 13(12), 167–188.
[51] Shang, Y., Li, H., Zhang, R., 2021. Effects of pandemic outbreak on economies: evidence from business history context. Frontiers in Public Health. 9, 632043.
[52] Ghana Statistical Service (GSS), 2024. Annual 2013–2023 GDP Data Series. GSS: Accra.
[53] Louri, H., Minoglou, I.P., 2001. A quantitative exploration on the determinants of (de-) industrialization: The case of Greece. International Review of Applied Economics. 15, 397–410.
[54] Anaman, K.A., Osei-Amponsah, C., 2009. Determinants of the output of the manufacturing industry in Ghana from 1974 to 2006. Ghana Policy Journal. 3, 69–89.
[55] Ghana Statistical Service (GSS), 2009. Annual 1975–1992 GDP Data Series. GSS: Accra.
[56] Ghana Statistical Service (GSS), 2009. Annual 1993–2009 GDP Data Series. GSS: Accra.
[57] Ghana Statistical Service (GSS), 2017. Annual 2006–2016 GDP Data Series. GSS: Accra.
[58] Ghana Statistical Service (GSS), 2021. 2021 Population and Housing Census General Report Volume 3E Economic Activity. GSS: Accra.
[59] Ghana Statistical Service (GSS), 2024. Ghana 2023 Annual Household Income and Expenditure Survey: Labour Statistics 2023 Third Quarter Bulletin. GSS: Accra.
[60] Dickey, D.A., Fuller, W.A., 1981. Likelihood ratio statistics for autoregressive time series with a unit root. Econometrica. 49, 1057–1072.
[61] Philips, P.C., Perron, P., 1988. Testing for a unit root in time series regression. Biometrika. 75, 335–346.
[62] Pesaran, M.H., Shin, Y., Smith, R.J., 2001. Bounds testing approaches to the analysis of level relationships. Journal of Applied Economics. 16, 289–326.
[63] Pesaran, B., Pesaran, M.H., 2017. Time Series Econometrics Using Microfit 5.0: A User's Manual. Oxford University Press: Oxford.
[64] Ramsey, J.B., 1969. Tests for specification errors in classical linear least-squares regression analysis. Journal of the Royal Statistical Society Series B. 31, 350–371.
[65] Stark, B.A., 2017. Studying moments of the central limit theorem. The Mathematics Enthusiast. 14, 53–76.
[66] Breusch, T.S., 1978. Testing for autocorrelation in dynamic linear models. Australian Economic Pa-

pers. 17, 334–335. DOI: https://doi.org/10.1111/-j.1467-8454.1978.tb00635.x

[67] Breusch, T.S., Pagan, A.R., 1979. A simple test for heteroskedasticity and random coefficient variation. Econometrica. 47(5), 1287–1294. DOI: https://doi.org/10.2307/1911963

[68] Usenata, N., 2018. Environmental Kuznets Curve: A Review of Theoretical and Empirical Literature. MPRA: Munich.

[69] Ghana Statistical Service (GSS), 2021. 2021 Population and Housing Census General Report Volume 3C Background Characteristics. GSS: Accra.

[70] Biblica Inc., 2011. Holy Bible New International Version, Book of Matthew [Internet]. Available from: https://www.biblegateway.com/passage/-?search=Matthew%2022%3A34-40&version=NIV [cited on 21 August 2024].

[71] Anaman, K.A., 2018. Economic Shocks and Growth in Post-Independence Ghana, 1957 to 2017. Institute for Fiscal Studies: Accra.

[72] Anaman, K.A., 2018. Analysis of Unemployment in Ghana Using District Level National Population Census Data. Institute for Fiscal Studies: Accra.