UNIVERSITY OF CAPE COAST

# FOREIGN DIRECT INVESTMENT AND ENVIRONMENTAL QUALITY NEXUS IN WEST AFRICA: THE ROLE OF ENVIRONMENTAL POLICY AND CLEAN TECHNOLOGY

CHRISTIAN KOFI DUAH

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# FOREIGN DIRECT INVESTMENT AND ENVIRONMENTAL QUALITY NEXUS IN WEST AFRICA: THE ROLE OF ENVIRONMENTAL POLICY AND CLEAN TECHNOLOGY

BY

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Thesis Submitted to the Department of Economic Studies of the School of Economics, College of Humanities and Legal Studies, University of Cape Coast, in Partial Fulfilment of the Requirements for the Award of Master of Philosophy Degree in Economics

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# DECLARATION

## Candidate's Declaration

I hereby declare that this thesis is the result of my own original work and that no part of it has been presented for another degree in this university or elsewhere.

Candidate's Signature: …… Date: …….

Name: Christian Kofi Duah

## Supervisors' Declaration

We hereby declare that the preparation and presentation of the thesis were supervised in accordance with the guidelines on supervision of thesis laid down by the University of Cape Coast.

Principal Supervisor's Signature: ……. …… Date……..…….

Name: Dr. Mark Kojo Armah

Co-Supervisor's Signature: ……..... Date……..……

Name: Mr Kwabena Nkansah Darfor

## ABSTRACT

This study assessed how clean technology and policy for environmental sustainability mediate the link between between FDI and environmental quality in West Africa. The study used macroeconomic data from 2005 to 2020 from all the West African countries based on available data. The Generalised Method of Moments was used as estimation technique for the study. The findings of the study revealed that foreign direct investment (FDI) enhances environmental quality lending credence to the pollution halo hypothesis in West Africa. Again, the result indicated that both clean technology and environmental policy enhance environmental quality in West Africa. Finally, the net effect calculation provides evidence for the last hypothesis that only environmental policy mediates the link between FDI and environmental quality in West Africa. Thus, while FDI improves environmental quality in West Africa, the effect is more prominent in the presence of environmental policies. The study suggest that environmental policy is necessary when it comes to environmental quality, and as a matter of fact, various West African governments through their environmental protection agencies should institute and implement environmental policies focusing on environmental protection. This policy should aim to direct the activities of corporations receiving foreign direct investment (FDI) towards environmental concerns. Additionally, policymakers and governments should step up efforts to attract FDI to West Africa, while also enforcing environmental regulations in multinational corporations' operations.

## KEY WORDS

Clean Technology

Environmental Policy

Environmental Quality

Foreign Direct Investments

West Africa

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## DEDICATION

To my parents

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| | |
|---|---|
| ANS | Adjusted Net Savings |
| AQI | Air Quality Index |
| ARDL | Autoregressive Distributed Lag Model |
| CFCs | Chlorofluorocarbons |
| CO2 | Carbon dioxide emissions |
| CPIA | Country Policy Institutional Assessment |
| DK | Driscoll- Kraay |
| FDI | Foreign Direct Investment |
| GDP | Gross Domestic Product |
| GMM | Generalized Method of Moments |
| MNC's | Multinational Companies |
| POLS | Pooled Ordinary Least Squares |
| SEM | Structural equation modeling |
| STIRPAT | Stochastic Impacts by Regression on Population, Affluence and Technology |
| WDI | World Development Indicators |
| WGI | Worldwide Governance Indicators |
| WQI | Water Quality Index |

# CHAPTER ONE

# INTRODUCTION

This chapter provides an overview of the study. This study encompasses the existing research about the link between financial development and environmental quality. Additionally, it provides a clear definition of the issue, emphasising the reasons for doing the study, identifying areas where previous studies are lacking, and explaining its contribution to existing literature. This chapter also includes the study's goal, aims, research hypotheses, importance, scope, limitations, and structure.

## Background to the Study

Environmental pollution is now one of the most severe global issues. Low-income countries have several public health challenges, and pollution's effect on the environment is a significant concern among them (Chen, Ebenstein, Greenstone & Li, 2013). According to UNICEF (2014), temperature variations, particularly in impoverished countries, expedite the transmission of malaria to areas that were previously unaffected. Between 1990 and 2017, the rise in outdoor air pollution led to a surge in African fatalities, escalating from 164,000 to 258,000 (Cohen et al., 2017). Approximately 60% of the countries severely affected by natural catastrophes are located in Sub-Saharan Africa (Jibrilla, 2018).

It is a well-known fact that there are growing threats from climate change to human health, food and water security, and socioeconomic development (WHO, 2021). In West Africa, environmental pollution which cause climate change mainly affects vital water resources, energy supplies, crop production and food security. This makes economies in West Africa

vulnerable to climate change since the sub-region is agriculture-dominated which is predominantly rain-dependent. These climate-related yield losses in Sub-Saharan Africa are projected to have a detrimental impact on food security in the region. By 2050, it is anticipated that there would be a decrease of around 22% in maize yields, 17% in millet and sorghum yields, and 8% in cassava yields (Heinzeller et al, 2017). The 2020 United Nations State of the Climate in Africa report contends that climate change may cause a decline in Gross Domestic Product (GDP) of up to 3% by 2050. Additionally, it predicts that as many as 118 million individuals living in extreme poverty in Africa will face increased vulnerability to droughts, floods, and extreme heat. These climate-related challenges are expected to impede efforts to alleviate poverty and foster economic growth.

Due to the numerous adverse effects of environmental pollution, the quest to achieve global environmental sustainability has become a necessity and a matter of great concern among policymakers in all countries of the world. The Paris Agreement is one example of a recent attempt to reduce greenhouse gas emissions through international treaties; it is a legally enforceable multilateral agreement whose primary goal is to keep the increase in global temperature below 2 degrees Celsius, ideally to 1.5 degrees Celsius, by the year 2100. In an effort to lower emissions, the UN has been providing technical paths that leverage private sector innovation, green funding, and unrealized potential (Joshi, 2014).

At the sixth Global Environment Summit in Paris, nations were urged to prioritise policies that address critical environmental concerns in order to limit the effects of climate change and achieve the Sustainable Development

Goals (Garces, 2019). Several environmental objectives are part of the Sustainable Development Goals (SDGs) with the overarching goal of improving environmental quality. The following are a few of the goals: safeguarding terrestrial ecosystems; reforestation and sustainable development; fighting desertification; stopping and reversing land degradation and biodiversity loss; conserving and responsibly using marine resources for sustainable development; and, lastly, goal 15, which stresses the need of the aforementioned.

North Africa received an average of $4.84 billion in FDI in Africa between 1970 and 2013. With an average of US$1.65 billion, Central Africa ranked worst, while West Africa came in at US$3.64 billion. West Africa got the biggest amount at 31.29% of all inflows to Africa during that time, followed by North Africa at 29.67%, Central Africa at 15.25%, Southern Africa at 12.02%, and East Africa at 11.77%. For the first time since 2006, FDI into West Africa fell 15% in 2018 to $9.6 billion (UNCTAD, 2018). The key reason for this is the sharp 43% decline in FDI to $2 billion in Nigeria. Even though FDI inflows fell by 8% to $3 billion, Ghana surpassed Nigeria to become the biggest recipient in West Africa, according to UNCTAD (2019).

FDI into African nations reached a new high of $83 billion in 2021, a significant recovery after the decline in 2020 caused by the COVID-19 epidemic, according to the UNCTAD World Investment Report 2022. Interesting enough, FDI in West Africa surged 48% to $14 billion, with the biggest recipient, Nigeria, seeing a doubling of its flows to $4.8 billion. This was due to an upturn in investments in the oil and gas sectors and a rise of $7 billion in international project finance deals in the country. Ghana also

recorded an increase of 39% to $2.6 billion compared with 2020 which is mainly due to projects in extractive industries. Similarly, FDI inflows in Senegal increased by 21% to $2.2 billion. According to Adam et al 2020, environmental policy instruments in West Africa that seek to improve the environment in the area of Plastic pollution for example largely exist. It is interesting to note that, out of the 16 countries in West Africa, 11 have instituted bans which carry punishment such as fines and prison sentence, four (4) has no strategy and the remaining one (1) has a market-based instrument. They further report that stakeholder consultation when drafting environmental policies in West Africa is limited.

Foreign Direct Investment inflows have been seen as having rippling effects on the economy at large, particularly the activities of multinational corporations on the environment, over the years (Sane, 2016; Ullah & Khan, 2017; Gochero & Boopen, 2020). FDI plays a major role in the development of an economy as it provides direct capital financing, increases employment avenues and leads to the transfer of managerial skills and technology (Lee, 2013). According to several studies (Ngowi, 2001; Saud et al., 2019; Hao et al., 2020; Khan et al., 2020; Ahmad et al., 2020), FDI helps economies grow sustainably because it brings new knowledge, skills, and production methods, opens doors to global markets, makes better use of resources, decreases pollution and waste, increases product diversity, and creates jobs.

Despite the numerous positive environmental impact of FDI on the host economy, FDI is also detrimental to environmental sustainability in the absence of coherent regulations governing natural resource extraction and operations of multinational companies (MNC's). Environmental sustainability

in Africa is threatened because of the high dependence on natural resources for agriculture and low technological advancement (Adzawla, Sawaneh, & Yusuf, 2019). In Africa, FDI leads to higher levels of carbon dioxide emissions in nations that have abundant natural resources but lack strong environmental laws, rules, and regulations. This situation plunges the host nation into a state of disarray, as it grapples with a multitude of health-related difficulties. Several African countries are exposed to contaminated water sources and poor sanitation due to environmental degradation in the region (UNECA, 2015).

Pollution poses several hazards to the health of the population, especially children and adolescents who are still in the process of growing their bodies, organs, and immune systems. These risks have varying impacts on individuals and are transmitted via different means. Exposure to air pollution heightens the susceptibility to respiratory infections, cardiovascular ailments, and lung cancer. Several disorders, including stroke, chronic obstructive pulmonary disease, lung, trachea, and bronchus cancers, aggravated asthma, and lower respiratory infections, may result from both brief and extended exposure to air pollution. The World Health Organisation (WHO) has released information establishing a correlation between exposure to air pollution and the development of type 2 diabetes, obesity, systemic inflammation, Alzheimer's disease, and dementia. According to the International Agency for Research on Cancer, air pollution, particularly particulate matter 2.5 (PM2.5), has a substantial role in causing cancer. Extended exposure to this kind of pollution may have a negative impact on all physiological functions and worsen pre-existing medical issues.

Multinational companies (MNCs) in sectors like extractive, transport, manufacturing, and agriculture contribute to environmental degradation through the emission of greenhouse and ozone-depleting gases such as carbon dioxide, sulphur dioxide, and chlorofluorocarbons (CFCs). These emissions are significant contributors to global warming and climate change (Brown, 2014; Zugravu-Soilita, 2017). Sarkodie and Strezov (2019) contend that it is imperative to enhance consciousness regarding the reduction of climate change due to the potential role of (FDI) in the recent escalation of global climate change. This is because multinational corporations operating in the extractive and manufacturing subsectors significantly contribute to the heightened levels of greenhouse gas emissions.

Clean technology encompasses the use of materials, processes, or practices that aim to prevent or minimise the generation of pollutants or wastes, hence mitigating environmental harm.The ultimate objective of clean technology is to mitigate environmental contamination. In a broad sense, it is an effort to maintain the environmental impact of technology to the barest minimum, particularly in terms of changes to process systems, production systems, product attributes, and techniques (Muralikrishna & Manickam, 2017). The use of clean technology has led to the adoption of more environmentally friendly practices, the management of our natural resources, and the transition to solar and other renewable energy sources. FDI in clean technology usually involves financing for renewable energy sources and energy-efficient processes which result in improvement in environmental quality by assisting industries to lower their energy consumption, carbon footprint, and reliance on non-renewable resources. According to the

International energy agency (IEA), the adoption rate of clean technology in Africa has been slow as access to electricity and clean technology is very limited with about 48% having access to electricity access and only 17% having access to clean technology. In sub-Saharan Africa, traditional biomass usage (charcoal, fuelwood etc) continues to make up about half of the region's primary energy mix. This means that about 923 million sub-Saharan Africans (83%) are without access to clean technology for cooking (IEA et al., 2022).

Researchers and policymakers have articulated the complementary role of clean technology and environmental policies as far as discussions on the environmental effects of FDI are concerned. Whiles innovation in clean technology most likely minimizes the negative environmental impacts of firms since clean technology leads to energy efficiency, economies with stringent policies and standards for environmental sustainability are more likely to implement policies that scrutinize the flow of FDI and operations of multinational companies, which improves environmental performance (Costantini, Crespi, Marin, & Paglialunga, 2017; Dogan & Inglesi-Lotz, 2017; InglesiLotz & Dogan, 2018).

There is a need to empirically examine the health of the environment in West Africa since the sub-region has been battling climate challenges (Bediako et al 2022). However, the influx of multinational investment in the sub-region could explain the current West Africa's CO2 emissions levels and climate challenges (Demena & Afesorgbor, 2020). According to Kamara 2013, West African nations have not saved enough for many years, which has left private foreign money as their primary source of investment funding. In West Africa, multinational corporations (MNCs) primarily make investments

in the manufacturing and extractive industries. These multinational corporations (MNCs) have a variety of positive effects on the host nation, but they also release a number of chemicals that deplete the ozone layer and cause greenhouse warming, such as carbon dioxide, sulfur dioxide, and chlorofluorocarbons (CFCs). According to Brown (2014), these gases are the main catalysts for climate change in West Africa. The research aimed to examine the impact of clean technology and environmental policy on the relationship between FDI and environmental quality in West Africa.

**Statement of the Problem**

Natural resource-rich nations with loose environmental rules such as countries in West Africa Sub-region frequently see increases in carbon dioxide emissions due to FDI as it is predicted that between 2000 and 2030, emissions of greenhouse gases and other ozone-depleting gases could increase from 25% to 90% leading to numerous health challenges in the host nation (Sarkodie, 2018). Thus, compared to affluent industrial countries, developing nations, particularly those in West Africa, are more vulnerable to the consequences of climate change (Fankhauser & Mcdermott, 2014). Africa is already experiencing a temperature rise of about 0.7°C between 1990 and 2000, which has resulted in a decrease in food production, floods, droughts, and a loss of biodiversity, according to a report from the United Nations Climate Change Conference in Nairobi, 2002. The United state Environmental Protection Agency's (USEPA) Air Quality Index (AQI) indicates that the sub-region of West Africa has seen a substantial reduction in air quality in recent years and as a result continuous exposure to these dangerous air conditions can result in

deaths and serious health issues including lung or heart disease, irritation of the eyes, nose and throat, coughing; phlegm; chest tightness etc

FDI plays a crucial role in the future development of West Africa. It serves as a mechanism for augmenting the available capital for investment and fostering the necessary economic growth to alleviate poverty and enhance living standards in the sub-region. Empirical data has shown that the environmental effect of FDI on the host economy is equivocal, despite its significant contribution to economic growth (Ndeffo et al., 2018). Zhenghui et al. (2022) contend that the impact of FDI on the environment is still a subject of debate globally, mostly because of the conflicting or inconclusive empirical data. These inconsistent findings may be attributed to the limited examination of the influence of FDI on environmental quality across various samples and quantiles in prior studies (Zhenghui et al., 2022). FDI has the potential to enhance environmental quality, as shown by studies conducted by Saud et al. (2019), Hao et al. (2020), Khan et al. (2020), and Ahmad et al. (2020). However, it is important to note that FDI may also have detrimental effects on the environment, as indicated by research conducted by Abokyi et al. (2019), Udemba (2019), Ma et al. (2019), and Farooq et al. (2020).

Several studies have attempted to address the environmental effect of FDI, (Twerefou et al., 2017; Riti et al., 2016; Ojewumi & Akinlo, 2017; Gill et al., 2018; Ssali *et al.,* 2019; Assamoi et al., 2020; Asongu & Odhiambo, 2020; Awodumi, 2020) but these studies especially those on West Africa have failed to extensively consider the merit of clean technology and environmental policy even though theory and evidence suggest that environmental policies and clean technology are important factors to be considered when addressing

the environmental effect of FDI. Environmental policies are implemented to govern human activities and mitigate the negative impact they have on the environment. These policies include a complex set of laws that require enterprises to get licences and comply with stringent environmental standards. Adopting clean technology leads to the implementation of more sustainable practices, the management of our natural resources, and the transition to solar and other renewable energy sources, ultimately resulting in the betterment of environmental well-being. This study contributes to the literature on the West African sub-region by incorporating clean technology and environmental policy as well as their interaction with FDI which has been given less attention.

The study departs from existing literature by using a measure of policy which primarily focuses on the quality of the environment (environmental policies) instead of using quality of general political institutions' variables which existing literature largely uses (Asongu & Odhiambo, 2020; Sarkodie *et al.*, 2020; Farooq *et al.*, 2020; Baloch & Wang, 2019; Abid, 2017; Bokpin, 2017). This is an important contribution as its inclusion allows us to assess the extent to which the implementation of environmental policies affects environmental quality.

Furthermore, the majority of studies (for example, Bediako *et al.*, 2022; Ganda, 2020; Asongu & Odhiambo, 2020) on environmental quality in West Africa have only looked at carbon dioxide emissions ($CO_2$) as the only measure of environmental quality, ignoring the more comprehensive idea of sustainability. By disregarding the idea of sustainability, these studies might not be accounting for the wider effects of human actions on the environment

and society. This study fills this gap by focusing on adjusted net savings (ANS) as a measure of environmental quality instead of $CO_2$ emissions which has largely been used in existing empirical studies. Adjusted net savings (ANS) is a widely accepted indicator for environmental sustainability based on the concepts of the green national account and the Hartwick rule.

**Purpose of the Study**

The purpose of the study is to examine how clean technology and policy for environmental sustainability mediate the effect of foreign direct investments on environmental quality in West Africa.

**Objectives of the Study**

1. Examine the effect of FDI on environmental quality in West Africa.
2. Determine the effect of clean technology on environmental quality in West Africa.
3. Examine the effect of environmental Policy on environmental quality in West Africa.
4. Examine how clean technology and environmental Policy mediate the effect of FDI on environmental quality in West Africa.

**Research Hypotheses**

Based on the objectives, the following hypotheses were tested:

1. $H_0$: FDI has no significant effect on environmental quality in West Africa.

   $H_1$: FDI has a significant effect on environmental quality in West Africa.
2. $H_0$: Clean technology has no significant effect on environmental quality in West Africa.

$H_1$: Clean technology has a significant effect on environmental quality in West Africa.

3. $H_0$: Environmental Policy has no significant effect on environmental quality in West Africa.

   $H_1$: Environmental Policy has a significant effect on environmental quality in West Africa.

4. $H_0$: Clean technology and Environmental Policy do not significantly mediate the effect of FDI on environmental quality in West Africa

   $H_1$: Clean technology and Environmental Policy significantly mediate the effect of FDI on environmental quality in West Africa.

**Significance of the study**

The importance of the study cannot be overemphasized given the repercussions of poor environmental quality on the health of human lives and the economy in West Africa. The findings of the study will provide evidence to unveil the drivers of West Africa's worrying environmental problems. This will therefore serve as a guide to policymakers towards the development of comprehensive environmental and macroeconomic policies as well as reforms to achieve environmental sustainability in West Africa.

Also, the study significantly enhances the existing literature on the subject matter of FDI and environmental quality, especially in the case of West Africa. Therefore, this study will serve as a source of literature and a basis for further research into the subject matter.

**Delimitations**

The objective of this research is to analyse the impact of FDI (FDI), clean technology, and environmental sustainability policies on the

environmental quality in West Africa. The analysis used macroeconomic data from 2005 to 2020 including all West African nations, taking into account data availability. The analysis is based on the Stochastic Impacts by Regression on Population, Affluence, and Technology (STIRPAT) model, which was developed by Dietz and Rosa. This study selected data on several variables, including FDI, adjusted net savings, clean technology, environmental policy, industrial value-added, access to electricity, population, and financial development measured by domestic credit to the private sector, in order to test the hypotheses based on the STIRPAT model and existing literature.

**Limitations of the study**

The main limitation of the study primarily involves the unavailability of data. Specifically, all variables included did not have enough data points. For example, the environmental policy variable only covers the years 2005 to 2020. This means that any attempt to extend the data length backward or further was hampered by a lack of data. The study had to rely on a smaller number of observation. The researcher was unable to use a large number of observation due to missing values for some of the variables. Despite the above limitation, the use of the available data does not pose risk to the reliability of the results. The study complements the existing knowledge on FDI and environmental sustainability.

**Organization of the study**

The research is divided into five chapters. Chapter one provides an overview of the research, including the issue description, contribution to existing literature, study goals, hypotheses to be investigated, importance of the investigation, limits, and organisation. Chapter two carefully examines the

relevant theoretical and empirical literature. The third chapter covers the approach to be used, the empirical definition of the model, and the estimate strategy. Chapter four presents the comprehensive findings and key outcomes derived from the investigation, including both the theoretical and empirical literature. Chapter five serves as the last section of the research, providing a concise review of the results and deriving inferences from the findings. Chapter five of the paper includes policy suggestions derived from the findings, as well as prospective topics for further research.

# CHAPTER TWO

# LITERATURE REVIEW

## Introduction

The chapter is divided into two sections. The first section captures the theoretical underpinnings and the conceptual review of the study while the second division of this chapter presents literature on the empirical foundations of FDI, environmental quality, environmental policy and clean technology nexus in west Africa.

## Theoretical Review

The effect of FDI on the quality of the environment has been a bone of contention that has attracted many views in both theoretical and empirical literature. Largely, it has been argued that the effect of FDI on environmental quality depends on the type of technology being transferred to the host country through FDI inflows. These effects have been explained by several hypotheses postulated in the literature such as the pollution haven hypothesis, the pollution halo hypothesis, the porter hypothesis and the factor endowment hypothesis. For this study, the first three hypotheses have been reviewed.

### Pollution Haven Hypothesis

The pollution haven hypothesis postulates that sometimes, developing countries in their quest to improve their economic outcomes become vulnerable by becoming the sites for imported goods, "Pollution" from developed countries. This is made possible due to the weak or non-stringent environmental laws and regulations in developing countries on corporations whose activities involve emitting pollutants into the environment hence these developing countries become the destination of multinational corporations

who engage in dirty activities because they find it relatively cheaper to operate and comply with environmental policies and regulations in developing countries compared to the stringent environmental standards of developed nations (Javorcik & Wei, 2004).

The disparity in emission requirements between developed and developing nations leads to the relocation of polluting industries from developed countries to developing ones in the form of foreign multinational enterprises. When faced with this situation, manufacturers that prioritise maximising profits often choose to move their production to locations with less stringent environmental regulations in order to maintain their long-term viability (Rezza, 2013). This was confirmed by Stavropoulos et al. (2018) in their investigation. It has been shown that lax environmental rules in underdeveloped nations incentivize investment projects that prioritise minimal manufacturing costs. These projects would not be permitted in developed countries owing to their stringent regulatory requirements and higher production costs.

The influx of polluting firms into developing countries according to Walter and Ugelow (1979) is what is termed pollution havens. It has also been argued that countries with a high level of corruption give room for multinational firms in developed countries who are non-compliant with environmental regulations to drift to developing countries in which corruption is high, thus becoming a pollution haven. Cole *et al.* (2006) realized that in high corruption index countries, the presence of multinational corporations further exacerbates weak environmental laws resulting in a pollution haven. Zugravu-Soilita (2017) contends that FDI leads to an increase in emissions in

nations with moderate levels of capital resources and inadequate environmental legislation. Cherniwchan (2017) argues that the pollution haven hypothesis is heavily influenced by environmental policies and regulations. Two key factors determine its validity: the impact of these policies on the host country's competitiveness in both domestic and international markets, and the potential for industries to relocate due to differences in environmental regulations between countries. Hu, Zhang, Huang, and Teng (2017) contend that the accuracy of the pollution haven hypothesis depends on the specificities of environmental policy and industry attributes.

Developing countries' high carbon dioxide emissions, together with lax environmental restrictions, are mostly due to the dominance of FDI in extractive and industrial sectors, according to the pollution haven theory. In the specific case of West Africa, this investment accounts for 70% of the total share. The concept is supported by empirical research conducted by Blanco et al. (2013), Cole (2004), Solarin et al. (2017), and Wagner and Timmins (2009).

**Pollution Halo Effects**

The pollution halo theory, in contrast to the pollution haven hypothesis, posits beneficial consequences. The pollution halo theory posits that the entry of multinational firms into a country brings in sophisticated, superior, and efficient technology, which have a positive impact on the environment of the host country. It argues that the presence of multinational corporations from developed countries in the recipient country tends to prompt the recipient country to implement stricter environmental legislation and regulations (Gallagher & Zarsky, 2007; Zugravu-Soilita, 2017). The

multinational corporation is motivated to adopt stringent environmental policies, such as employing low-pollution technologies, in the host country. This is facilitated by their possession of advanced production equipment, technology, and efficient management skills (Eskeland & Harrison, 2003; Kim & Adilov, 2012).

When this happens, the host country benefits from the presence of the multinational firms in the form of positive impacts on its environment via curbing some of the host country's environmental challenges, as well as other benefits like diffusion of up-to-date knowledge on economic activities, technology spill-overs through efficient use of resources, funds transfer which results into the expansion of the host country's industry, creates jobs, and diversify host country's consumer products. Transnational relationships also improve the host country's environmental protection technology by aiding policymakers to embrace sophisticated policy innovations from foreign industries. This raises awareness among the local population to engage in more environmentally-conscious acts, such as implementing regulations to mitigate particular environmental issues by establishing CO2 emission limits to tackle climate change concerns caused by human activities.

In general, the pollution haven hypothesis posits that FDI leads to increased pollution in the host country, while the pollution halo hypothesis claims that FDI provided by multinational corporations to developing host countries actually decreases pollution. This has been well confirmed by literature. (see, Bao *et al.*, 2011; Kim & Adilov, 2012; Wang, Dong & Liu, 2019; Zugravu-Soilita, 2017; Solarin & Al-mulali, 2018; Yu et al., 2019; Demena & Afesorgbor, 2020).

**Porter Hypothesis**

In his analysis, Porter (1991) argued that the existence of stringent environmental laws and regulations do not always pose adverse effects on firms in the form of increased production costs in a developed country but are sometimes also beneficial to the firms. Porter observed that tight environmental regulations result in companies investing in innovations that enhance and improves the efficiency of the environment which also results in a rise in productivity. Hence industries in countries with such policies can appreciate the beneficial effect of such policies by internalizing the cost incurred in complying with the stern environmental standards. Porter (1991) claims that the beneficial spill-over effects of strict environmental rules can sometimes not only offset the costs borne by the corporation but also result in additional profits.

Furthermore, the porter hypothesis indicate that strict but flexible environmental rules generate environmental innovations, which, in turn, produce environmental performance by default and, in certain cases, corporate performance. This result is applicable only when environmental legislations are appropriately drafted to serve the intended objective, according to Porter (1991). However, when it comes to the consequences of stringent environmental policies on FDI, Porter (1991) points out that some companies in industrialized nations disregard these benefits and focus instead on the costs associated with the policies. This lays the groundwork for their expansion into less developed countries with relatively weak environmental policies, which will have to deal with the pollution generated by MNCs.

Porter and Van Der Linde (1995) expanded on the porter hypothesis idea, claiming that there are five reasons why good environmental rules will result in a beneficial outcome."First, regulation alerts businesses to potential resource inefficiencies and technological advancements." "Second, by improving business awareness, regulation focused on information gathering can produce enormous benefits." "Third, regulation lessens the risk that investments in environmental protection will be worthwhile." "Regulation, once again, generates a pressure that encourages innovation and advancement." "Fifth, regulation evens out the playing field during the changeover period. Regulation ensures that one corporation cannot gain an advantage by avoiding environmental investments during the transition phase to innovation-based solutions." "Despite the aforementioned assumption, Porter and van der Linde (1995) acknowledged that innovation does not always entirely offset the cost of compliance, particularly in the short run before learning can reduce the cost of innovation-based solutions."

**Conceptual Review**

This section looks at the definition of some of the key concepts used in the study.

**Foreign Direct Investment**

FDI refers to a kind of investment in which a party from a different economy enters into a long-term investment partnership in order to gain permanent control over a business located in that country. When an investor engages in FDI, they are essentially taking over the management of a company based in the other economy. The original deal between the two companies and any future deals between them and their overseas affiliates, whether

incorporated or not, are both considered part of this investment (OECD, 1996).Investors from other countries might be people or legal companies. FDI flows may include both the outflow of money from a company to an investor and the reinvestment of capital from an enterprise to an investor.. In general, FDI has three components, namely, equity capital (where the foreign investor buys the shares of a company in an economy other than the investors), reinvested earnings (where the foreign investor's shares comprise undistributed earnings or unremitted earnings to the investor which are reinvested) and intra-company loans (which are long and/or short-term lending and borrowing of funds between the foreign investor and the affiliate firm) (Jackson & Markowski, 1995).

In West Africa, local companies in industries similar to foreign businesses are able to attract FDI, particularly in the extractive sectors. The overall advantages of FDI inflows are significant, so many developing countries utilise trade restrictions in their financial sectors to facilitate the unrestricted entry of foreign investment. As a result, there has been a substantial rise in investment in West Africa..

**Environmental Quality**

Environmental quality encompasses a wide range of interrelated factors that have an impact on the health and wellbeing of the environment and the communities that depend on it, making it a complex and multifaceted concept. These elements include, among others, ecosystem services, biodiversity, and the quality of the air, water, and soil (UNEP, 2020). Both natural and human activities, such as climate change, pollution, deforestation, and changes in land use, can have an impact on environmental quality.

Environmental quality, therefore, constitutes the state or condition of the environment, including its physical, chemical, and biological characteristics (UNEP, 2020). Given that it can have a big impact on people's health, social well-being, and economic prosperity, it is a crucial indicator of the health and well-being of natural systems and human communities. It is impossible to overstate how crucial environmental quality is to maintaining human health and wellbeing as well as the functionality of natural systems.

Poor environmental quality can have a variety of detrimental effects on human health, such as cancer, neurological disorders, and respiratory diseases, as well as social and economic effects like decreased productivity and higher healthcare costs. Moreover, because it supports the provision of necessities like food, water, and clean air, environmental quality is closely linked to the viability of human societies. Environmental quality assessment requires evaluating a number of interrelated factors at various spatial and temporal scales, making it a challenging task. Environmental quality can be evaluated using a variety of indicators, including chemical, physical, and biological measurements as well as socioeconomic indicators (IPCC, 2018; UNEP, 2020). For instance, the Air Quality Index (AQI) is a frequently used air quality indicator that calculates the concentration of different pollutants in the air, including ozone and particulate matter. In a similar manner, the Water Quality Index (WQI) gauges the water's quality using a variety of physical, chemical, and biological parameters, including pH, dissolved oxygen, and bacterial contamination.

**Environmental Policy**

As a whole, environmental policy refers to the steps taken by public and private entities to address the environmental impacts of human activities and the ways in which these impacts might be mitigated via regulation. Typically, organisations fail to take environmental values into account when making decisions, leading to the under-pricing of natural resources and negative externalities. To address this, certain policies are typically crafted.There are a number of environmental statutes that deal with particular matters, such hazardous material management and preventing oil spills, as well as more general topics like air, water, and land. A plethora of regulations mandating licences and stringent restrictions for companies are spawned by this. Businesses could have to ask the state for authorization before making changes to industrial processes that don't affect environmental quality much. Some examples of such legislation are RCRA, which deals with resource recovery and conservation, and the Safe Drinking Water Act, which deals with air pollution (US EPA, 2010).

**Clean Technology**

Clean technology refers to any product, process, system, or service that has a lower environmental impact than its alternatives. Clean technology adds value to the customer while also reducing detrimental environmental effects, either directly or indirectly through the value chain. Clean technology, or cleaner production, refers to the ongoing implementation of an integrated environmental strategy that aims to enhance overall efficiency and reduce risks and hazards to persons and the environment in processes, commodities, and services (Chavalparit, 2006). Cleaner production may be advantageous for

processes used in many industries, as well as for the goods and services offered in society. Cleaner manufacturing is an anticipatory approach that employs environmentally friendly technology and organisational tactics to minimise the ecological impact of production and commodities. The term encompasses alterations in primary resources, procedural technologies, and internal reutilization, together with organisational adaptations, incentives, and training for effective maintenance.

Cleaner production encompasses a mentality that aims to minimise the environmental effect of the manufacturing process and provision of goods and services, within the limitations imposed by existing technology and economic conditions. Implementing cleaner manufacturing is a mutually beneficial method. The UNEP (2020) states that it enhances industrial productivity, profitability, and competitiveness while ensuring the protection of the environment, customers, and workers. Cleaner production is a comprehensive approach to managing waste and pollution in industrial settings. The word refers to a broad concept that includes eco-efficiency, waste reduction, pollution avoidance, and environmentally friendly manufacturing. These concepts are often used by some governments and organisations (Chavalparit, 2006). This notion is particularly applicable to emerging nations that have limited energy and natural resources, as well as those experiencing a rapid increase in environmental degradation (Hamed & Mahgary, 2004).

**Empirical Review**

Duodu *et al*. (2021) examined the connection between FDIs and environmental quality in sub-Saharan Africa. The authors contend that while FDI may have a favorable impact on regional economic development and

growth, it also has the potential to have a negative impact on the environment. As a result, the authors investigated how institutional and policy frameworks can ensure environmental sustainability in the context of FDI. The study uses a quantitative research methodology and panel data covering 43 sub-Saharan African countries from 1990 to 2018. The fixed effects, random effects, and system generalized method of moments (GMM) regression models were employed to estimate the relationship between FDI and environmental quality. The Environmental Performance Index (EPI) measures environmental quality, and the Worldwide Governance Indicators (WGI) measures institutional and policy aspects of governance.

The study's findings indicated that FDI has a significant positive influence on environmental quality in sub-Saharan Africa. The study findings suggests that FDI inflows have an advantageous effect on the environment, perhaps through the adoption of more environmentally friendly technologies and tighter environmental regulations. The study also demonstrates the critical role that institutional and policy frameworks play in ensuring that FDI results in environmental sustainability. In particular, the study discovers that good governance, high-quality regulations, and corruption control positively.

Demena and Afesorgbor (2020) performed a meta-analysis to determine how FDI affects environmental emissions. Utilizing meta-regression analysis, the authors found 27 empirical studies that satisfied their inclusion requirements. The authors found that FDI significantly reduces environmental emissions. The authors discovered, specifically, that a 10% increase in FDI inflows causes a 3.3% decrease in environmental emissions. All parts of the world, except for Europe and Central Asia, were found to be

significantly affected by the effect. To investigate potential sources of the findings' heterogeneity, the authors also performed subgroup analyses. They discovered that FDI has a greater impact on greenhouse gas emissions in developing nations, where environmental regulations may be laxer, and enforcement may be laxer. Comparing carbon dioxide emissions to others like sulfur dioxide and nitrogen oxide, it was also discovered that the impact was stronger for carbon dioxide emissions.

Adams, Boateng, and Acheampong (2020) looked at the relationship between Ghana's urbanization, environmental quality, and transportation energy consumption. The authors analyzed the stationarity of the variables using the Augmented Dickey-Fuller (ADF) test, and they use the Johansen cointegration test to identify the long-run equilibrium relationship between transportation energy consumption, urbanization, and environmental quality. Additionally, they apply the Granger causality test to determine the causal link between the variables.“According to the study's findings,Ghana's urbanization, transportation energy use, and environmental quality all have long-term equilibrium relationships. The study discovered that urbanization increases the amount of energy used for transportation, which has a detrimental effect on environmental quality.

Mabey and McNally (1999) investigated the nexus between FDI and its effects on the environment in developing countries. The authors contend that FDI may have both favorable and unfavorable effects on the environment. On the one hand, FDI can bring new managerial abilities, capital, and technologies that can enhance the host nation's environmental performance. On the other hand, FDI can exacerbate environmental problems like pollution,

deforestation, and the loss of biodiversity if businesses put profits before environmental considerations. To ensure sustainable development, the policy recommendations call for fostering openness and accountability, establishing environmental standards and laws, encouraging technology transfer, and fostering collaborations between the private sector and civil society.

Shahbaz *et al.* (2015) examined the relationship between FDI and environmental quality in high-, middle-, and low-income nations. Data from 119 nations were examined between 1984 and 2010 by the authors, who used panel data analysis techniques. According to the study, the degree to which FDI affects environmental quality depends on the income of the host nation. Particularly, FDI affects environmental quality favorably in middle-income countries while negatively affecting it in low-income ones. Environmental quality in high-income nations is unaffected significantly by FDI. The study also highlights several ways that FDI impacts environmental quality. Due to lax environmental regulations and ineffective enforcement, FDI increases pollution levels in low-income countries. In contrast, FDI supports cleaner technologies, better environmental management techniques, and the adoption of environmental regulations in middle-income countries, which results in improvements in environmental quality. The study's conclusions have significant policy ramifications.

Ojewumi and Akinlo (2017) used a dynamic model analysis to examine the connections between FDI, economic growth, and environmental quality in sub-Saharan Africa between 1980 and 2013. The authors discovered that FDI inflows have a favorable effect on regional economic expansion. This bolsters the idea that FDI is a significant source of capital that can spur

economic growth. However, the study discovered that FDI negatively impacts environmental quality, suggesting that FDI inflows may have unfavorable effects on the environment. The authors speculate that this might be the result of the concentration of many FDI projects in sub-Saharan Africa's extractive industries, which are well-known to have significant environmental effects.

Nagdeve (2007) investigated the correlation between population and environmental degradation was investigated. The findings suggest that as the population grows, poverty and urbanization increase, resulting in a decline in the quality of the environment. Through analyzing trends and changes spanning the past fifty years, the study indicates that the expanding population is placing a greater burden on India's limited and diminishing natural resources. Despite the fact that most individuals survive at a subsistence level, the strain on natural resources is escalating. Additionally, the escalating population and rising affluence have already led to a significant expansion in energy production and consumption in India. The pressure exerted by population growth on arable land is contributing to land degradation.

Weber and Sciubba (2019) conducted an empirical investigation of the nexus between population growth and environmental deterioration in European regions. The study finds a correlation between population growth and environmental degradation between 1995 and 2012 using data from 220 European regions. The authors discover that a 1% increase in population results in an increase of 0.2-0.5% in $CO_2$ emissions, 0.5-0.9% in waste generation, and 0.3-0.6% in water consumption. These results show that population growth can have a significant effect on the environment and are consistent with earlier studies on the subject. The authors also examine how

urbanization and economic growth may moderate the relationship between population growth and environmental deterioration. They discover that the impact of population growth on $CO_2$ emissions, waste generation, and water consumption can be lessened by economic development. Urbanization doesn't seem to have much of a moderating impact.

Costantini *et al*. (2017) explored the effects of eco-innovation, environmentally responsible supply chains, on environmental quality in European industries. Data from 1,095 European businesses in a variety of sectors, including manufacturing, services, and construction, served as the study's data source. Structural equation modeling (SEM) is used in the empirical analysis to look at the relationships between the relevant variables. The study's findings suggest that eco-innovation has a positive impact on sustainable supply chains, which in turn improve environmental quality. According to the research, eco-innovation can be a major force behind the adoption of sustainable supply chain techniques, which can enhance environmental performance. The study also reveals that the relationships between the variables in various industries differ significantly from one another.

Furthermore, several studies have also examined the enduring equilibrium connections between macroeconomic factors and indices of environmental deterioration.

Behera and Dash (2017) conducted a panel cointegration study to examine the correlation between FDI, gross domestic product (GDP), energy consumption, urbanisation, and carbon dioxide (CO2) emissions in 17 Asian countries from 1980 to 2012. Westerlund tests indicate that there is a long-

term connection between FDI and carbon dioxide (CO2) emissions in low- and middle-income countries in South and Southeast Asia. However, this correlation is not seen in high-income countries in the same region. The Westerlund and Pedroni tests demonstrated a long-term equilibrium link between the variables across all countries in the panel. The research revealed that FDI has a causal relationship with environmental contamination, as shown by the Granger causality test.

Assi (2018) used time-series data and the ARDL approach to examine the influence of FDI on carbon dioxide emissions spanning the years 1975 to 2014. The research revealed that in the near term, the coefficient of CO2 is positively and significantly different from zero, so expanding upon Kizilkaya's study on the relationship between FDI and the environment in Turkey. Consequently, the rate of increase in carbon dioxide emissions is slower compared to the growth of FDI. Specifically, a one-point (100 percent) increase in FDI leads to a 0.03 percent increase in CO2 emissions. Ultimately, the analysis reaffirmed the initial observation that a higher influx of FDI results in elevated levels of carbon emissions. The increase in FDI by 1 point (100%) led to a 0.14% rise in carbon dioxide emissions.In their dynamic panel data study of the relationship between financial development and environmental performance (specifically ecological footprint)".

Majeed and Mazhar (2019) used a thorough method of measuring environmental quality. This worldwide investigation used longitudinal data from 131 economies spanning the years 1971 to 2017 in order to provide a thorough assessment of their ecological footprint. The research included many analytical techniques like pooled ordinary least squares (POLS), Driscoll-

Kraay (DK) standard errors, fixed-effects model, random-effects model, and system generalised method of moments (S-GMM) for its analysis. Majeed and Mahza (2019) found that the financial sector's three indicators had a positive influence on the environment. Greater economic growth leads to less environmental degradation, resulting in enhanced environmental quality. In contrast to FDI influx, which leads to an increase in ecological footprint and a decline in environmental quality, this result presents a different viewpoint. The expansion of the finding indicates that FDI flows towards developing nations that have less strict environmental rules and regulations concerning pollution.

In contrast to the previously reported associations between FDI and environmental quality, several research have shown no connections between them. Kizilkaya (2017) assessed the influence of FDI and economic development on carbon dioxide emissions in Turkey. The research used the ARDL bound testing technique to analyse a time series dataset spanning 34 years from 1970 to 2014. Kizilkaya's findings revealed a dearth of data on FDI that hinders the ability to predict its long-term influence on carbon dioxide emissions. Contrary to what was anticipated in the near run, a long-term analytical evaluation revealed that the FDI coefficient lacks statistical significance. The research concluded that there is no empirical correlation between FDI and environmental quality in the long term.

**Conceptual framework**

FDI may have both beneficial and negative effects on the environment. FDI may contribute to environmental improvement by bringing clean technology that reduce pollution and promote environmental

sustainability. However, FDI may also lead to environmental degradation due to industrial operations, mining activities, and deforestation. The role of clean technology and policy for environmental sustainability becomes vital in mitigating the impacts of FDI on the quality of the environment in West Africa. The objective of this theoretical framework is to demonstrate the interplay between FDI, clean technology, and environmental sustainability policies in West Africa.

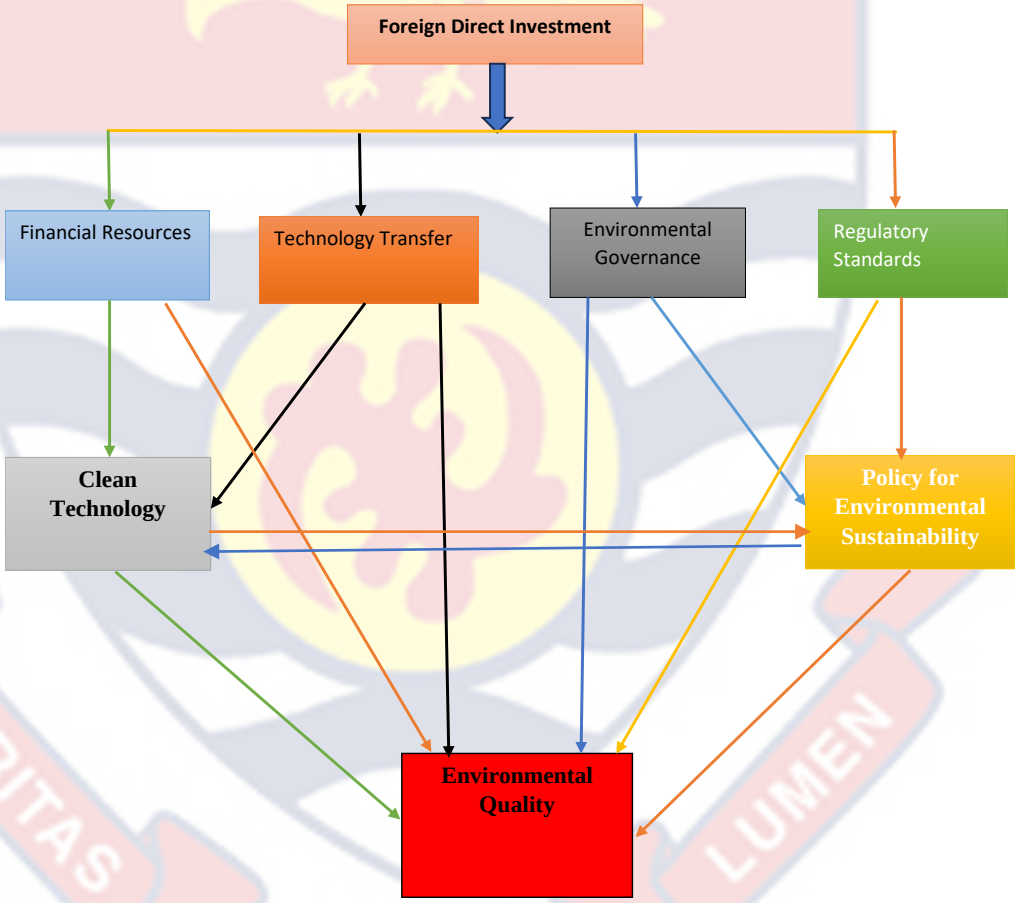


***Figure 1:*** **Conceptual Framework**
**Source : Author's construct**

From the conceptual framework, the impact of FDIs on West Africa's environmental quality will be moderated by policies for environmental sustainability and clean technology. FDI, clean technology and policy, and environmental sustainability make up the framework's three main parts.

Incentives for the use of clean technology, regulations on pollution and emissions, and the promotion of environmentally friendly production and consumption methods are all examples of policies that support environmental sustainability. For environmental sustainability, the interaction of clean technology and policy is essential. Without policies that encourage its adoption and use, clean technology is necessary but insufficient. Contrarily, policy needs to be supported by reliable scientific data and environmentally sound technology.

**Chapter Summary**

This chapter presents a literature review based on the study's research objectives. The study discovered that the results of the reviewed empirical literature varied. Some strands of the literature provide evidence of the positive impact of FDI on environmental quality, indicating that FDI significantly reduces ecological emissions. However, the negative view of FDI's effects on the environment predominates in the literature. The later studies, especially those on West Africa, failed to extensively consider the merit of clean technology and environmental policy, even though theory and evidence suggest that environmental policies and clean technology are important factors to be considered when addressing the environmental effect of FDI. This study contributes to the literature on the West African sub-region by incorporating clean technology and environmental policy as well as their interaction with FDI, which has been given less attention. Additionally, this study employed adjusted net savings (ANS) as a measure of environmental quality instead of CO2 emissions, which have largely been used in existing empirical studies.

# CHAPTER THREE

# RESEARCH METHODS

## Introduction

Chapter three provides a comprehensive explanation of the research design used for the study. The chapter is partitioned into four distinct parts. The study design is outlined in the first part. The following section outlines the theoretical framework used in the investigation. The third component outlines the empirical model definition, the measurement of pertinent variables used in the model, together with the anticipated direction of each variable, and the sources of data. Ultimately, the methods of estimate and the instruments for analysing data are introduced.

## Research Paradigm

This research adhered to the positivist tenets. An objective truth may be used when a scientific approach is used to analyse a phenomena, according to positivist philosophy (Ballard, 2018; Alnaser, Ghani & Rahi, 2019). Consequently, the study expects that scientific research technique would lead to the generation of objective findings pertinent to the specific research aims, thereby facilitating decision-making based on scientific evidence. By adhering to this principle, researchers may be confident that our their biases as they will not control the results (Levine, 2011). Since the researcher is presumed to have had no direct impact on the observed data, this method limits the inclusion of normative judgements. The positivist school of thought separates the researcher from the research and emphasizes objectivity while conducting experiments to evaluate hypotheses (Kumar, 2019). By adhering to positivism,

this research produced results that can be repeated and applied to other contexts (Kiyala, 2019).

**Research Approach**

The study employed a quantitative research methodology, which was chosen based on various factors. These factors include the quantitative nature of the collected data (Kumar, 2019), the statistical methods used for data processing and analysis (Shiau, Sarstedt & Hair, 2019), the specific research objectives, theoretical implications, and research design characteristics (Viotti & Kauppi, 2019), as well as the underlying research paradigm (Eisend & Kuss, 2019). By utilising the quantitative approach, the study ensures that its conclusions are prescriptive, explanatory, and confirmatory (Payne, Moore, Griffis & Autry, 2011). The quantitative approach was employed to test a hypothesis and identify factors that influence outcomes (Creswell, 2014). Therefore, this approach was used to investigate the mediation effect of clean technology and environmental sustainability policies on the relationship between FDIs and environmental quality in West Africa..

**Research Design**

This study employed the explanatory research design under the quantitative approach. The choice of the expanatory research design was based on the objective of the study which is explanatory and it follows the quantitative approach. Additonally, an explanatory study strategy aids in establishing causal correlations between variables and elucidating the underlying mechanisms underlying such interactions (Trochim & Donnelly, 2001). In the study, environmental quality was treated as the dependent variable whist FDI was also treated as the key regressor. A number of

mediating factors were considered, including policies pertaining to environmental sustainability and clean technology. According to Birru, Runhaar, Zaalberg, Lans, and Mulder (2019), while conducting explanatory investigations, it is common practice to formulate hypotheses about the kind, degree, and direction of correlations between the variables under investigation.

**Theoretical Model Specification**

As a theoretical foundation, this study is based on the STIRPAT model put forward by Dietz and Rosa (1997). Although STIRPAT is based on IPAT, which was developed by Ehrlich and Holdren (1971), it fixes the main problem with IPAT, which is that it has a mathematical identity equation that renders hypotheses useless (Li & Lin, 2015). An economic, demographic, and technical impact on the environment may be studied using the IPAT framework; however, the STIRPAT model converts this framework into a stochastic model. As seen in equation 1, the STIRPAT model is represented by:

$$I_{it} = \emptyset P_{it}^{\beta_1} A_{it}^{\beta_2} T_{it}^{\beta_3} \mu_{it}{}^{\varepsilon_i} \quad (1)$$

Where $I$ is environmental quality proxied by Adjusted Net Savings; $P$ is population; $A$ is affluence proxied by GDP, $T$ is technology; $\emptyset_i$ is a constant term; $\mu$ is the error term; $i$ represents the countries; $t$ is the time for the study and $\beta_1$, $\beta_2$ and $\beta_3$ represents the slope coefficients.

Taking the natural log of each of the variables in equation 1 to overcome any data fluctuation, outliers and heteroskedasticity issues to get equation 2 as:

$$lnI_{it} = ln\emptyset + \beta_1 lnP_{it} + \beta_2 lnA_{it} + \beta_3 lnT_{it} + \mu_{it} \quad (2)$$

**Empirical Model Specification**

The empirical model is generated by including variables of interest in the STIRPAT model in equation 2. Following the works of Aluko and Obalade (2020); Ding *et al.* (2017) and Tamazian, Chousa and Vadlamannati (2009) the technological progress is influenced by FDI, industrial value-added, access to electricity and financial development measured by domestic credit to the private sector. Hence, $T = f(FDI, INDUS, ACCE, DCRE)$. We then transform equation (2) into equation (3) as our baseline model to capture the first objective of examining the effect of FDI on Environmental quality in West Africa as:

$$lnI_{it} = \emptyset + \beta_1 lnFDI_{it} + \beta_2 lnGDP_{it} + \beta_3 lnPOP_{it} + \beta_4 lnINDUS_{it} + \beta_5 lnACCE_{it} + \beta_6 lnDCRE_{it} + \mu_{it} \quad (3)$$

Where: $FDI$ is FDI, $GDP$ is Gross Domestic Product, $POP$ is population, $INDUS$ is industrial value-added, $ACCE$ is access to electricity and $DCRE$ is domestic credit to private sector.

We extend equation (3) by adding clean technology variable to achieve objective two as follows:

$$lnI_{it} = \emptyset + \beta_1 lnPOP_{it} + \beta_2 lnGDP_{it} + \beta_3 lnFDI_{it} + \beta_4 lnINDUS_{it} + \beta_5 lnACCE_{it} + \beta_6 lnDCRE_{it} + \beta_7 CL\_TEC_{it} + \mu_{it} \quad (4)$$

Where $CL\_TEC$ is clean technology.

Equation (4) is further modified to capture the Policy for environmental sustainability variable to achieve the third objective of the study as follows:

$$lnI_{it} = \emptyset + \beta_1 lnPOP_{it} + \beta_2 lnGDP_{it} + \beta_3 lnFDI_{it} + \beta_4 lnINDUS_{it} + \beta_5 lnACCE_{it} + \beta_6 lnDCRE_{it} + \beta_7 CL\_TEC_{it} + \beta_8 POL_{it} + \mu_{it} \quad (5)$$

Where $POL$ is Policy for environmental sustainability.

Finally, we extend equation (5) to incorporate the interaction term between FDI and clean technology as well as FDI and Policy for environmental sustainability and to test the moderating effect of clean technology and Policy for environmental sustainability as follows:

$$lnI_{it} = \emptyset + \beta_1 lnPOP_{it} + \beta_2 lnGDP_{it} + \beta_3 lnFDI_{it} + \beta_4 lnINDUS_{it} + \beta_5 lnACCE_{it} + \beta_6 lnDCRE_{it} + \beta_7 CL\_TEC_{it} + \beta_8 POL_{it} + \beta_9 (lnFDI_{it} * CL\_TEC_{it}) + +\beta_{10} (lnFDI_{it} * lnPOL_{it}) + \mu_{it} \quad (6)$$

Where $(lnFDI_{it} * CL\_TEC_{it})$ is the interaction between FDI and clean technology and $(lnFDI_{it} * lnPOL_{it})$ is the interaction between FDI and Policy for environmental sustainability.

**Justification of the Variables**

**Environmental Quality**

Environmental quality is a measure of the health of the environment itself and of the impacts it has on the wellbeing, physiological, and mental state of the individuals that occupy it (Aluko & Obalade, 2020; Danso-Mensa, 2015). The study employed the adjusted net savings (% of GNI) which is regarded as one of the key environmental indicators to measure environmental quality (Twerefou, Danso-Mensah, Bokpin, 2017). The adjusted net savings may be calculated by adding the net national savings and education spending, and subtracting the energy depletion, mineral depletion, net forest depletion, and carbon dioxide emissions (according to the WDI Database). This series does not include any harmful effects caused by particle pollution. The adjusted net savings also gives a degree of a country‘s sustainability in the face of environmental degradation and resource depletion by measuring the change in comprehensive wealth amid a specified accounting period (Hamilton &

Naikal, 2014). The Adjusted Net saving was utilized to measure environmental quality to ensure a comprehensive and environmentally friendly approach. It incorporates long-term sustainability, aids in policy assessment, makes international comparisons easier, and acts as an indicator of actual advancement in environmental quality (Yahya & Lee, 2023; Wei & Huang, 2022). A positive relationship between adjusted net savings (ANS) and any of the independent variables signifies that the variable improves environmental quality and a negative relationship means that the variable deteriorates environmental quality.

**Foreign Direct Investment (FDI)**

This refers to the investment made by foreign nationals in a domestic economy. FDI is measured as total annual FDI-inflow as a percentage of GDP and it is used as the primary independent variable. This is because the extractive and industrial sub-sectors receive 70% of FDI inflows to the West African sub-region. The existence of a liberal government policy in a targeted country leads to an increase in FDI hence economic growth. FDI flow into West Africa has been expanding over the years. In recent years, there is a growing debate on the potential impacts of the rising FDI on environmental quality (Ding *et al.*, 2017; Tamazian, Chousa & Vadlamannati, 2009). Whiles FDI plays a crucial role in the economic growth of nations, it has also led to numerous increases in Carbon dioxide emissions in many countries.

The relationship between FDI and environmental quality is uncertain in the empirical literature. Some studies have argued that FDI emanating from technologically advanced countries is likely to introduce new technologies and improved environmental management strategies which will enhance the

environmental quality (Seker, Ertugrul & Cetin, 2015; Wang, Gu, David & Yim, 2013). However, in most developing countries where the environmental regulation is less stringent, multinational companies from the developed economies, particularly in pollution-intensive industries, tend to set up their businesses there which could increase the levels of local pollution (Cole, Elliott, & Zhang, 2017; Tamazian, Chousa, & Vadlamannati, 2009). Based on these assertions, the coefficient of FDI is expected to be either positive or negative.

**Population**

There is no doubt that population plays a role in environmental quality. Population growth produces industrial pollution and carbon dioxide emissions which have a detrimental effect on the environment. In China, population growth was responsible for around two-thirds of the rise in carbon dioxide emissions (Schneising *et al.*, 2013). In this study, population is measured by the World Bank estimates which consist of all residents regardless of legal status or citizenship. The values are mid-year estimates. High population growth is also associated with a growing demand for environmental resources to produce more food. Most developing countries suffer because of the rapid increase in population, which in turn results in natural resources depletion, and increasing air and water pollution. The study considered urban population only largely because of its impact on urbanization and consequently affecting emnvironmental quality (Ntow-Gyamfi, Bokpin, Aboagye & Ackah, 2020). It is expected that population will negatively impact environmental quality.

**Clean Technology**

Technology plays a crucial role in environmental sustainability. Technology can be a tool to facilitate more sustainable practices. Better economic growth along with efficient utilization of energy resources can be achieved by considering technological innovation as an endogenous factor in the process of production**.** Yeh *et al.* (2011) further asserted that the long-run issues related to energy use and the environment, especially climate change assessment, are dependent upon the nature and rate of technology change.

Technology allows real-time observation of environmental conditions. Clean technology adds value to the customer while also reducing detrimental environmental effects, either directly or indirectly through the value chain. The study used access to clean fuels and technologies for cooking (% of the population) as a proxy for clean technology. Clean technology as employed in this study is measured as the proportion of the total population primarily using clean cooking fuels and technologies for cooking. Clean technology is expected to positively influence environmental quality.

**Environmental Policy**

The environmental policy constitutes the measures by governments, corporations and other private organisations with regards to how human activities affect the environment and how to regulate human activities to help prevent or reduce harmful effects of human activities on the environment. In general, these policies are designed because environmental values are usually not considered in organisational decision making resulting in externalities and under-pricing of natural resources. The Clean Air Act, the Resource

Conservation and Recovery Act, and the Safe Drinking Water Act are examples of such laws (US EPA, 2010; Ahuja, 2019).

Environmental sustainability policies and institutions assess the extent to which environmental policies promote the conservation and sustainable use of natural resources, as well as pollution management. This study employed the policy and institutions for environmental sustainability variables from the CPIA exercise. The variable is measured as the extent to which environmental policies foster the protection and sustainable use of natural resources and the management of pollution. It ranges from 1=low to 6=high. Several studies such as Farooq et al. (2020) and Asongu and Odhiambo (2020) indicated that environmental policy ehnaces environmental quality, These authors arged that environmental policies regulate human activities to help prevent or reduce the harmful effects of human activities on the environment. Hence, it is expected that environmental policy will positively influence environmental quality.

**Financial Development**

Financial development is any activities geared toward the perfection of financial functions such as providing information and allocation of capital on investments opportunities as well as mobilisation of savings and easing exchange activities within the economy (Sakyi, Kofi Boachie, & Immurana, 2016). Calderón and Liu (2003) opined that financial development constitutes an improvement in the quantity, quality and efficiency of financial intermediary services. There are various measures of financial development in the empirical literature. The common measure employed by many authors is credit to the private sector (Anderson, 2003; Kemal, Quayyum & Hanif, 2007), market size and liquidity to bank development, (Levine & Zervos,

1998) and life insurance and private pension fund assets (Pesaran, Shin & Smith, 2001).

However, this study employed credit to the private sector as a measure of financial development. The credit to the private sector was employed because banks have long been the leading players in a country's financial intermediary functions. Besides, most studies have used bank-based indicators as proxies for financial development (Ofori-Abebrese, Pickson, & Diabah, 2017; Quartey & Prah, 2008). Financial development has been recognised as a significant factor influencing environmental quality (Esmaeilpour Moghadam & Dehbashi, 2018; Pao & Tsai, 2011; Jalil & Feridun, 2011). Furthermore, because private credit measures the most active portion of funds in financial activities, employing the private credit/GDP ratio as a proxy variable for the level of financial development has theoretical merits (Levine et al., 2000; Beck et al., 2007). Financial development can increase $CO_2$ emissions when it attracts foreign investors (FDI) which boosts the amount of energy utilisation and the scale of financial activities within the host country (Esmaeilpour Moghadam & Dehbashi, 2018). It is thus expected to impact negatively on environmental quality.

**Gross Domestic Product**

It is the monetary worth of all commodities and services produced within the geographic boundaries of a country over a specific period, usually a financial year. It is denominated in the currency of the country. It is measured as the total market value of all final goods and services produced in a given economy during a given period. It is anticipated that an increase in economic growth will lead to the deterioration of the environment since countries will

tap existing natural resources to fund economic growth (Cialani, 2007). It is expected that economic growth as measured by GDP will negatively influence environmental quality with the intention that as the economy expands, pollution level increases.

**Energy Use**

Access to electricity (% of total population) is used as a proxy to capture the effect of energy consumption on the environment. It is measured as the percentage of population with access to electricity. Electrification data are collected from industry, national surveys and international sources. The environmental effects of the use of electricity are detrimental. Almost all forms of electricity generate waste. For example, natural gas releases carbon dioxide and nitrogen oxide. Earth's atmosphere traps these gases, leading to air pollution and smog. Weather patterns and geological variations can affect the prevalence of smog in a particular area (Environmental Protection Agency, United States of America, 2011). The study expects access to electricity to have a negative effect on environmental quality.

**Industrial Value Added**

The net output of a sector after adding all outputs and subtracting intermediate inputs is known as value-added. It is calculated without accounting for the depreciation of manufactured assets or the depletion and degradation of natural resources. The industrial value-added is measured as the value-added in mining, manufacturing (also reported as a separate subgroup), construction, electricity, water, and gas. Industrial value-added could imply an improved technology or increased output. The former could result in reduced emission whilst the latter would mean increased emissions as

a result of increased production. Therefore, the effect of value-added in the industrial sector on environmental quality is expected to be positive or negative.

**Data Type and Sources**

The study made use of secondary data collected from established sources. Macroeconomic data from 2005 to 2020 was used to achieve the objectives of the study. The choice of the period was based on consistent data availability. Annual data on $CO_2$ emissions, adjusted net savings, urban population, education, FDI were obtained from the World Development Indicators (WDI) which is hosted by the World Bank database.

**Estimation Technique**

The study employed the generalized method of moments (GMM) estimators developed by Holtz-Eakin et al. (1990), Arellano and Bond (1991), and Arellano and Bover (1995) for dynamic models of panel data. GMM can correct for any potential issue of endogeneity. The GMM system solves the endogeneity problem by generating internal instruments composed of the lagged values of the endogenous regressors rather than their current values, to generate efficient and unbiased estimates. The GMM estimation technique is ideal for situations with a short period and a large cross-sectional unit (Beck, Demirgüç-Kunt & Levine, 2000). However, the GMM has some drawbacks of assuming that the panel members have homogenous slope coefficients (homogenous panel) as well as ignoring cross-sectional dependence. The GMM was used to estimate equations 3-6. The GMM specification for the baseline model to achieve objective one is given by:

$$\Delta lnI_{i,t} = \beta_1 \Delta lnI_{i,t-1} + \beta_2 \Delta lnPOP_{i,t} + \beta_3 \Delta lnGDP_{i,t} + \beta_4 \Delta lnFDI_{i,t} + \beta_5 \Delta lnINDUS_{i,t} + \beta_6 \Delta lnACCE_{i,t} + \beta_7 \Delta lnDCRE_{i,t} + \Delta\mu_{it} + \Delta\varepsilon_{i,t} \quad (7)$$

Where i =1, 2, 3,…,17; t =1, 2,…,16

The GMM specification to achieve objective two is given by:

$$\Delta lnI_{i,t} = \beta_1 \Delta lnI_{i,t-1} + \beta_2 \Delta lnPOP_{i,t} + \beta_3 \Delta lnGDP_{i,t} + \beta_4 \Delta lnFDI_{i,t} + \beta_5 \Delta lnINDUS_{i,t} + \beta_6 \Delta lnACCE_{i,t} + \beta_7 \Delta lnDCRE_{i,t} + \beta_8 \Delta CL\_TEC_{i,t} + \Delta\mu_{it} + \Delta\varepsilon_{i,t} \quad (8)$$

Where i =1, 2, 3,…,17; t =1, 2,…,16

For the third objective, The GMM specification is given by:

$$\Delta lnI_{i,t} = \beta_1 \Delta lnI_{i,t-1} + \beta_2 \Delta lnPOP_{i,t} + \beta_3 \Delta lnGDP_{i,t} + \beta_4 \Delta lnFDI_{i,t} + \beta_5 \Delta lnINDUS_{i,t} + \beta_6 \Delta lnACCE_{i,t} + \beta_7 \Delta lnDCRE_{i,t} + \beta_8 \Delta CL\_TEC_{i,t} + \beta_9 \Delta POL_{i,t-1} + \Delta\mu_{it} + \Delta\varepsilon_{i,t} \quad (9)$$

Where i =1, 2, 3,…,17; t =1, 2,…,16

The GMM specification to achieve the final objective is given by:

$$\Delta lnI_{i,t} = \beta_1 \Delta lnI_{i,t-1} + \beta_2 \Delta lnPOP_{i,t} + \beta_3 \Delta lnGDP_{i,t} + \beta_4 \Delta lnFDI_{i,t} + \beta_5 \Delta lnINDUS_{i,t} + \beta_6 \Delta lnACCE_{i,t} + \beta_7 \Delta lnDCRE_{i,t} + \beta_8 \Delta CL_{TEC_{i,t}} + \beta_9 \Delta POL_{i,t-1} + \beta_{10} \Delta FDI_{it} * \Delta CL\_TEC_{i,t} + \beta_{11} \Delta FDI_{i,t} * \Delta POL_{i,t} + \Delta\mu_{it} + \Delta\varepsilon_{i,t} \quad (10)$$

Where i =1, 2, 3,…,17; t =1, 2,…,16

**Post-Estimation Test**

It is important to note that several post-estimation tests are performed to determine whether there is evidence of second-order serial correlation in the residuals, whether the interaction terms are significant, and the significance of the overall model. The post-estimation tests conducted in the study are the test

for zero autocorrelation in first differenced, second-order serial correlation tests and the Wald Chi-Sq test for joint significance of the parameters.

**Chapter Summary**

This chapter developed and presented the methodological framework suitable for conducting the study. The study was situated within the context and assumptions of positivist philosophy which supports the use of the quantitative method. The study followed the standard literature on Stochastic Impacts by Regression on Population, Affluence, and Technology (STIRPAT) model advanced by Dietz and Rosa (1997) to serve as the theoretical underpinning for this research. The model was developed to study the environmental effects of economic, demographic, and technological activities, in a stochastic model. Annual data on $CO_2$ emissions, adjusted net savings, urban population, education, FDI were obtained from the World Development Indicators (WDI). Finally, the generalized method of moments (GMM) estimators was used to estimate the model to achieve the objectives of the study.

# CHAPTER FOUR

# RESULTS AND DISCUSSION

## Introduction

The results and discussion of the study are presented in this chapter. The purpose of the study was to examine how clean technology and policy for environmental sustainability mediate the effect of FDIs on environmental quality in West Africa. This chapter is divided into three sections. The first chapter presents the descriptive or summary statistics of the variables employed in the study. The second section presents the correlation matrix. The final section presents the empirical results of the study. The results are presented in sequence with the objectives of the study.

## Descriptive Statistics

This section of the study presents descriptive statistics of the variables involved. The descriptive statistics are based on the true values (level) of the variables. Mean, median, maximum, minimum, standard deviation, skewness, kurtosis, sum, sum squared deviation, and number of observations are among the descriptive statistics. The average values specify the mean of the indicators used in the entire model. The standard deviation captures the data distribution around the average value. The standard deviation indicates how close the data is to the mean value. The highest and lowest values represent the spread of the data's. The greater the range of values, the greater the variability in a variable. Conversely, the smaller the range of values, the lower the level of variability in the variable. The summary statistics are presented in Table 1.

**Table 1: Summary Statistics of the Variables**

| Variable | | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| ANS | Overall | 1.944 | 0.971 | -1.782 | 3.464 |
| | Between | | 0.723 | 0.891 | 3.103 |
| | Within | | 0.699 | -0.829 | 3.662 |
| FDI*CL_E | Overall | 19.018 | 38.572 | -7.489 | 163.916 |
| | Between | | 38.106 | 0.842 | 139.092 |
| | Within | | 9.544 - | 29.134 | 65.249 |
| FDI*LPOL | Overall | 1.268 | 1.332 | -6.689 | 4.906 |
| | Between | | 0.912 | -0.152 | 2.961 |
| | Within | | 1.006 | -6.086 | 4.281 |
| ACCE | Overall | 3.443 | 0.724 | 0.263 | 4.559 |
| | Between | | 0.678 | 2.087 | 4.394 |
| | Within | | 0.322 | 1.619 | 4.676 |
| FDI | Overall | 1.133 | 1.146 | -6.089 | 4.638 |
| | Between | | 0.785 | -0.133 | 2.709 |
| | Within | | 0.851 | -5.635 | 3.389 |
| CL_TEC | Overall | 12.571 | 18.378 | 0.27 | 71.05 |
| | Between | | 18.853 | 0.593 | 67.263 |
| | Within | | 1.664 | 6.480 | 19.289 |
| POL | Overall | 1.169 | 0.155 | 0.693 | 1.386 |
| | Between | | 0.110 | 0.950 | 1.336 |
| | Within | | 0.112 | 0.812 | 1.463 |
| DCRE | Overall | 2.656 | 0.684 | 0.467 | 4.186 |
| | Between | | 0.659 | 1.412493 | 4.042 |
| | Within | | 0.304 | 1.127565 | 3.427 |
| INDUS | Overall | 26.392 | 2.964 | 18.042 | 31.317 |
| | Between | | 3.006 | 19.171 | 30.398 |
| | Within | | 0.531 | 24.305 | 28.128 |
| GDP | Overall | 12.118 | 2.271 | 5.687 | 15.995 |
| | Between | | 2.307 | 6.316 | 15.291 |
| | Within | | 0.384 | 10.222 | 13.471 |
| POP | Overall | 2.04e+07 | 3.93e+07 | 463032 | 2.01e+08 |
| | Between | | 4.02e+07 | 505908.3 | 1.68e+08 |
| | Within | | 5055164 | -8998241 | 5.31e+07 |

**Source: Author's estimate (2021)**

Per the results in Table 1, the overall average adjusted net savings (ANS) over the study period is 1.944 percentage of GNI. The low average value of adjusted net savings implies that environmental quality has been low in most West African countries. Adjusted net savings also recorded a

maximum value of 3.464 and a minimum value of -1.782 with an overall standard deviation of 0.971. Besides, the overall average value of FDI is 1.133 percentage of GDP, a maximum value of 4.638, a minimum value of -6.089, and an overall standard deviation of 1.146. This result also illustrates the gradual reduction in FDI as a percentage of GDP in West Africa. The implication is seen in low positive linkages with especially with local communities.

Moreover, clean technology (CL_TEC) recorded an overall average value of 12.571 over the period. It also recorded maximum and minimum values of 71.05 and 0.270 followed by an overall standard deviation of 18.378. The average value of clean technology implies the high growth of clean technology in recent years which is relevant for reducing detrimental environmental effects, either directly or indirectly through the value chain. Similarly, environmental policy (POL) recorded an overall average value of 1.69 over the period. It also recorded maximum and minimum values of 0.693 and 1.386 with an overall standard deviation of 0.155 over the period. These values show the slow rate of implementation of environmental policy which has dire consequences on the environment. The overall mean GDP used in this study is about 12.118. This implies that on average, most countries in West Africa grow by 12%. The maximum GDP is 15.995, while the minimum GPD is 5.687, varying by 2.271 from the mean.

Furthermore, the overall average value of access to electricity (ACCE) is about 3.443, with the highest value being 0.263 and the lowest value being 4.559. It deviates from the mean by 21.785. The average value of the domestic credit to the private sector is 17.837 with a maximum value of

65.742 and a minimum value is 1.596. Nevertheless, the variation in the domestic credit to the private sector (DCRE) as a proportion of the GDP is 13.145 about the mean. Finally, the mean value of population (POP) stood at 20393740 and that of the industry value added (INDUS) stood at 26.392. The maximum value of population is 2.04e+07. Population recorded minimum and maximum values of 463032 and 2.01e+08 respectively over the study period. The mean value of population implies that there is a high rate of population growth in West Africa

With respect ot the within deviation, the within deviation of 0.699 of adjusted net savings indicates that there is a lot of variation in the environmental quality measure within each group, which may make it more challenging to identify environmental quality differences between groups. Simlialry, the between deviation of 0.723 indicates that there is a significant amount of variation in environmental quality between groups, which may be brought on by factors like dissimilarities in environmental policies, geographic location, or population density. Overall, it appears that there is significant variation in environmental quality both within and between various groups or regions, which could have significant ramifications for environmental management and policy. This trend is consistent with the findings of Zahoor, Khan and Hou (2022); Musah, Owusu-Akomeah, Nyeadi, Alfred and Mensah (2022).

The respective within deviations and between deviation of 0.785 and 0.851 FDI shows a wide variation in FDI within and between each group, which may be brought by economic factors like GDP growth rates, inflation rates, and exchange rates. Moreover, similar wide between and with varitions

were found in most of the variables such as clean technology, environmental policy, domestic credit to the private sector, industrial value added, population and GDP. This appears that there is significant variation in both within and between various groups or regions with respect to these variables, which could have significant ramifications for environmental quality. This trend is consistent with the findings of Ntow-Gyamfi, Bokpin, Aboagye and Ackah (2020) who found similar trends in these variables.

**Pairwise Correlation Test**

A correlation matrix of the indicators was constructed to test for a possible degree of correlation among the regressors. The purpose of this is also to determine the degree of correlation between the independent variables. The correlation matrix has been presented in Table 2

**Table 2: Matrix of Correlations**

| Variables | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| (1) ANS | 1.000 | | | | | | | | | | |
| (2) FDI*CL_E | 0.418 | 1.000 | | | | | | | | | |
| (3) FDI*POL | -0.277 | 0.395 | 1.000 | | | | | | | | |
| (4)ACCE | 0.417 | 0.665 | 0.041 | 1.000 | | | | | | | |
| (5) FDI | -0.495 | -0.057 | 0.660 | -0.204 | 1.000 | | | | | | |
| (6) CL_TEC | 0.440 | 0.835 | 0.196 | 0.703 | -0.031 | 1.000 | | | | | |
| (7) POL | 0.143 | 0.214 | 0.069 | 0.266 | -0.124 | 0.144 | 1.000 | | | | |
| (8) DCRE | 0.373 | 0.664 | 0.140 | 0.625 | -0.042 | 0.813 | 0.179 | 1.000 | | | |
| (9) INDUS | 0.082 | -0.216 | -0.269 | 0.155 | -0.132 | -0.168 | -0.009 | -0.173 | 1.000 | | |
| (10) GDP | -0.062 | -0.248 | -0.042 | -0.162 | -0.060 | -0.147 | -0.259 | -0.234 | 0.365 | 1.000 | |
| (11) POP | 0.168 | -0.143 | -0.223 | 0.227 | -0.129 | -0.165 | 0.143 | -0.115 | 0.827 | -0.065 | 1.00 |

**Source: Authors' estimate (2021)**

The correlation matrix has been presented in Table 2. An observation from Table 2 revealed that there is a negative relationship between FDI and adjusted net savings which is a measure of environmental quality. However, both environmental policy and clean technology have a positive relationship with Adjusted net savings, implying that an increase in both environmental policy and clean technology will improve environmental quality in West Africa. Similarly, access to electricity, industrial value-added, credit to the private sector and population have a positive correlation with environmental quality in West Africa. Finally, the correlation between Gross Domestic Product and environmental quality is negative in West Africa. According to Bryman and Cramer (1997); Judge, Hill, Griffiths, Lutkepohl and Lee (1982), a simple association between independent variables should not be considered harmful until it exceeds 0.80. Hence, the variables employed in the study are free from any problem of multicollinearity.

**Post-Estimation Tests**

We begin by validating the estimated model prior to interpreting the GMM results. It is essential to note that, given the inclusion of the lag of environmental quality there is the possibility of endogeneity in estimating the result of the study. The adoption of the GMM corrects for this endogeneity (Arellano & Bover, 1995; Blundell & Bond, 1998). However, the effectiveness of the GMM technique in producing reliable estimates depends on a number of post-estimation checks. We use the Hansen's test of over-identification to assess the validity of the instrument, following Alagidede and Ibrahim (2017). The Hansen test is based on the null hypothesis that there is no correlation between the identified instruments and the residuals. The

consistency of the estimates was supported by the failure of both tests to reject the null hypothesis.

The validity of our estimates is then assessed using the post estimation tests for (a) the presence or absence of evidence of second-order serial correlation in the residuals, (b) the Wald test for the significance of the entire model and (c) validity of the instruments, and. The results are presented in Table 3

**Table 3: Diagnostics**

| | Model 1 | Model 2 | Model 3 | Model 4 |
|---|---|---|---|---|
| Wald chi2 | 2016.60 | 1321.27 | 1470.08 | 1125.40 |
| Prob > chi2 | 0.000*** | 0.000*** | 0.000*** | 0.000*** |
| AR(1) | (0.000***) | (0.000***) | (0.002***) | (0.000***) |
| AR(2) | (0.921) | (0.458) | (0.456) | (0.868) |
| Sargan-Hansen test | (0.21) | (0.42) | (0.29) | (0.37) |

*** *p<.01, ** p<.05, * p<.1*

"The p-values of the AR (1). AR(2) and the Hansee test are reported in parethesis.

**Source: Author's estimate (2021)**

The postestimation test result is presented in Table 3. The findings clearly demonstrate that the null hypothesis of no first order autocorrelation, AR (1), has been rejected for all three estimated models. Hence, the result demonstrates absence of second-order serial correlation in the residuals and as a result, it can be said that the moment conditions are valid. Also, the Wald test statistics in all the models also indicate that the parameters are jointly significant. Finally, we discover that our instruments are valid indicating the robustness our estimates and consequently attesting to the effectiveness of the GMM technique in producing reliable estimates.

**Estimated results on the effect of FDI on Environmental Quality**

**Table 4: GMM results on the effect of FDI on Environmental Quality. (Dependent Variable: Adjusted Net savings)**

| Variables | Coef. | St.Err. | t-value | p-value |
|---|---|---|---|---|
| LnANS (lag) | 0.014 | 0.095 | 0.15 | 0.882 |
| LnFDI | 0.365*** | 0.102 | 3.58 | 0.000 |
| LnACCE | 0.531 | 0.454 | 1.17 | 0.243 |
| LnDCRE | -0.95** | 0.386 | -2.46 | 0.014 |
| LnINDUS | 0.776*** | 0.281 | 2.76 | 0.006 |
| LnGDP | -0.676** | 0.328 | -2.06 | 0.039 |
| POP | -2.43e-08*** | 5.33e-09 | -4.56 | 0.000 |
| Constant | -9.466** | 4.117 | -2.30 | 0.021 |
| Wald chi2(7) = 2016.60 | | AR(1)= 0.000 | | |
| Prob > chi2 = 0.000 | | AR(2)= 0.921 | | |
| Number of obs = 121 | | | | |

**** p<.01, ** p<.05, * p<.1*

**Source: Author's estimate (2021)**

The estimated results on the effect of FDI on environmental quality in West Africa are presented in Table 4. The results provide evidence for the first hypothesis that FDI has a significant effect on environmental quality in West Africa. FDI exhibited a positive effect and it was significant at the 1% significance level. The magnitude of the coefficient of FDI implies that a 1% increase in FDI enhances environmental quality in West Africa by 0.37% over the study period. This result is consistent with the findings of Duodu, Kwarteng, Oteng-Abayie and Frimpong (2021); Demena and Afesorgbor (2020) "; "Adams et al. (2020) and Hoffmann et al. (2005) who revealed that FDI improves environmental quality in their studies. The result also supports the pollution halo hypothesis adopted in this study which asserts that the influx of multinational corporations into a country introduces advanced, superior, and efficient technologies into the host country which have a beneficial effect

on the environment of the host country. Mabey and Mcnally (1999) maintained that updated technology in recent production is transitioning the economy from a pollution haven to a pollution halo and sustainable development.

This outcome suggests that FDI has a crucial role in determining environmental quality and should not be disregarded. Furthermore, this study highlights the need of taking into account the influence of FDI on environmental quality while examining the factors that determine environmental conditions, especially in West Africa. Shahbaz et al. (2015) argue that FDI expansion has several positive impacts on the development process, including spill-over effects, higher productivity, and the introduction of new production techniques, knowledge, and management practices. Therefore, the possible influence on the environmental quality of the host nations should undeniably be a matter of concern. Demena and Afesorgbor (2020) posited that FDI (FDI) has the potential to contribute to environmental sustainability, especially when it involves the adoption of green technology and has positive effects for local industries.

Similarly, Abid (2017) revealed that FDI has a significant negative impact on $CO_2$ emissions (improvement in environmental quality). The key intuition behind this result is that the numerous FDI inflows in West Africa has provided capital to support industrial upgradingas well ase exacerbating local environmental pollution to create a "pollution paradise" in the region. Additionally, the presence of multinational companies from advanced economies in region encourage the host country to adopt more stringent environmental laws and regulation, This compels the multinational

corporation to implement high standards for environmental policies, such as the use of environmentally efficient (low-pollution producing) technologies in the host nation (Eskeland & Harrison, 2003; Kim & Adilov, 2012). The firm has access to cutting-edge production equipment, technology, and highly skilled management personnel. In this case, the presence of the multinational corporations benefits the host nation by having a positive environmental impact and reducing some of the environmental challenges that the nation faces.

Concerning the control variables, population exerted a negative influence on environmental quality in West Africa all other things held constant. This result supports the findings of Nagdeve (2007) and Weber and Sciubba (2019) who argued that pressure on the environment as the population grows can result in the poor waste disposal and depletion of natural resources, resulting in poor environmental quality. Weber and Sciubba (2019) further opined that population growth increases the demand for consumer goods, which in turn exacerbates the trend of over-exploitation and mismanagement of natural resources. According to Mitra (1984), the country's population growth is putting an increasing strain on the country's limited and rapidly depleting natural resource base. Resources like electricity, water, and land are in greater demand as the population grows. Due to these factors, the ecosystem may deteriorate, including through deforestation, land degradation, the depletion of water resources, and a rise in pollutants.

Furthermore, communities frequently become more urbanized as a result of rapid population growth. Urban sprawl has the potential to cause biodiversity loss, habitat degradation, and a rise in residential and industrial

pollutants. Environmental issues can be made worse by inadequate waste management systems and restricted access to essential services in highly populated places. This result supports the findings of Ntow-Gyamfi, Bokpin, Aboagye and Ackah (2020) who documented that it is challenging to achieve sustainability since rural-urban migration puts strain on the social amenities in urban areas. The phenomenon of overpopulation has led to a significant lack of environmental stewardship, resulting in widespread pollution, especially the contamination of water sources, in large African cities that have seen a surge in urban migration.

GDP-based economic expansion in West Africa has a detrimental impact on environmental quality. The findings indicate that a 1% enhancement in economic growth leads to a decrease in environmental quality by -0.676%, and this relationship is statistically significant at a 5% significance level, assuming that all other factors remain constant. The adverse impact aligns with the conclusions drawn by Bokpin (2017) and Duodu, Kwarteng, Oteng-Abayie, and Frimpong (2021), who observed that heightened economic development is associated with a detrimental influence on environmental quality. This finding has shown that the ongoing population expansion is a significant factor contributing to environmental deterioration in West Africa. Indeed, human activities have undeniably played a role in the emission of harmful substances into the atmosphere, posing a threat to both human well-being and the delicate balance of the natural environment. Additionally, these activities have also contributed to the phenomenon of the greenhouse effect, as noted by Khed (2016).

Additionally, the tendency is for resource consumption to rise along with economic growth. Land, energy, and other basic supplies are in higher demand as economies grow. Deforestation, deterioration of the land, loss of biodiversity, and overuse of natural resources are all potential consequences. The use of chemical pesticides and fertilizers in farming is one example of an unsustainable agricultural practice that can worsen the environment. Intense industrialization and urbanization are frequently caused by rapid economic expansion, and these trends can have a negative impact on the environment (Bokpin, 2017). Industries and factories have the potential to emit pollutants into the air, water, and soil, which contributes to pollution of the air and water, deforestation, and habitat degradation.

Furthermore, it was shown that there is a negative correlation between environmental quality and financial growth, namely in terms of domestic credit provided by the private sector. According to the findings, a 1% increase in financial development leads to a 0.95% decrease in environmental quality, and this relationship is statistically significant at a 5% significance level. This discovery supports the conclusions of Al-Mulali et al. (2015), Khan et al. (2020), and Ganda (2020) that the consumption of renewable energy and the development of financial systems have a notable adverse effect on environmental quality. Conversely, economic growth has a positive and substantial effect on environmental quality. Private sector credit growth and financial development might encourage increasing spending. People may consume more as a result of having easier access to credit, which could boost the demand for goods and services that could be harmful to the environment (Ganda, 2020). For instance, increased access to credit may encourage

consumers to buy more environmentally harmful goods, such as those with large carbon footprints or unnecessary packaging.

Finally, industrial value Added exerted a positive influence on environmental quality in West Africa. The coefficient of industrial value-added implies that a 1% increase in value-added will improve environmental quality by 0.776%% and it is significant at a 1% level. This result supports the finding of Khan, Hou, Le and Ali (2021) who asserted that industrial activities offer significant economic growth opportunities, but they are frequently associated with high pollution and environmental degradation". Industrial activity can also create job opportunities and boost the economy, which indirectly supports environmental preservation initiatives. Governments and communities may have more resources and capacity to fund environmental preservation and conservation efforts when the economy improves. This may entail providing financing for environmental study, enacting stronger laws, and supporting sustainable development methods.

**Estimated Results on the Effect of Clean Technology on Environmental Quality.**

**Table 5: GMM results on the effect of Clean Technology on Environmental Quality. (Dependent Variable: Adjusted Net savings)**

| Variables | Coef. | St.Err. | t-value | p-value |
|---|---|---|---|---|
| ANS (lag) | -0.067 | 0.111 | -0.60 | 0.549 |
| LnFDI | 0.414* | 0.162 | 2.55 | 0.011 |
| CL_TEC | 0.05** | 0.021 | 2.46 | 0.014 |
| LnACCE | -0.726 | 0.743 | -0.98 | 0.328 |
| LnDCR | -0.714 | 0.482 | -1.48 | 0.138 |
| LnINDUS | 1.235** | 0.374 | 3.30 | 0.001 |
| LnGDP | -1.052* | 0.632 | -1.66 | 0.096 |
| POP | -2.39e-08*** | 6.38e-09 | -3.75 | 0.000 |
| Constant | -14.288** | 5.178 | -2.76 | 0.006 |
| Wald chi2(8) = | 1321.27 | AR(1)= | 0.000 | |
| Prob > chi2 = | 0.000 | AR(2)= | 0.458 | |
| Number of obs | 92 | | | |

**** p<.01, ** p<.05, * p<.1*

**Source: Author's estimate (2021)**

The results in Table 5 provide evidence for the second hypothesis that clean technology has a significant effect on environmental quality in West Africa. Clean technology is positive and significant at a 5% significance level. The magnitude of the coefficient of clean technology implies that a 1 unit rise in the use of clean technology improves environmental quality in West Africa by 5% and it is significant at a 5% significance level. This result demonstrated the crucial role of clean technology in West Africa on the environment. The major intuition of this result is innovation in clean technology in some West African countries is most likely minimizing the negative environmental impacts of firms since clean technology leads to energy efficiency, Consequlently enhancing the quality of the environment. Further, the quality of the environment in West Africa has been significantly improved by clean technology, as demonstrated by programs like waste management and renewable energy implemented in most countries in the region.

The result corroborates with the findings of Eskeland and Harrison (2003) who asserted that firms that resort to the use of clean technology often are more efficient energy users and do not harm the environment. Clean technology adds value to the customer while also reducing detrimental environmental effects, either directly or indirectly through the value chain (Eskeland & Harrison, 2003).

The end goal of clean technology is to reduce environmental pollution. In a broad sense, it is an effort to maintain the environmental impact of technology to the barest minimum, particularly in terms of changes to process systems, production systems, product attributes, and techniques (Muralikrishna & Manickam, 2017). Clean technology is the key

accumulation of technology, methods, and means within man's needs to provide the most rational use of natural resources, energy, and environmental quality. The use of clean technology has led to the adoption of more sustainable practices, the management of our natural resources, and the transition towards solar and other renewable energy sources. Research has shown that they have a very beneficial effect on the environment. Furthermore, governments and organizations that place a high priority on clean technology investments frequently put supportive rules and incentives in place, such as renewable energy targets. These regulations foster a climate that is favorable for the spread and acceptance of clean technologies, resulting in positive change and elevated environmental standards.

According to UNEP (2001), the implementation of clean technology involves the consistent use of an integrated environmental strategy that aims to avoid issues and reduce risks to persons and the environment by improving the efficiency of processes, commodities, and services. Muralikrishna and Manickam (2017) proposed that clean technologies, in relation to the environment, include the utilisation of minimum resources with optimal efficiency to attain both resource preservation and environmental safeguarding. Economically, it refers to the efficient allocation of resources resulting in optimal cost-effectiveness and heightened production. Finally, Costantini, Crespi, Marin and Paglialunga (2017) maintained that investment in clean technology is most likely to minimise the negative environmental impacts on firms since clean technology leads to energy efficiency.

The findings for the control variables are in order. FDI and industrial value-added maintained their positive influence on environmental quality in

West Africa. The result shows that a 1% increase in both FDI and industrial value-added will enhance environmental quality by 0.414% and 1.235% respectively. Similarly, economic growth (GDP) and population continued to exert an adverse influence on environmental quality in West Africa. The result indicated that a 1% rise in both GDP and population will deteriorate environmental quality by 1.052% and 2.39e-08% respectively. However, domestic credit to the private sector, even though maintained its negative influence on environmental quality, was insignificant.

**Estimated results on the Effect of Environmental Policy on Environmental Quality**

Measures by governments, corporations and other private organizations with regards to how human activities affect the environment. Hence, the third hypothesis of the study was developed to validate the effect of environmental policy on Environmental quality in West Africa. The result is presented in Table 6.

**Table 6: GMM results on the effect of Environmental Policy on Environmental Quality. (Dependent Variable: Adjusted Net savings)**

| Variables | Coef. | St.Err. | t-value | p-value |
|---|---|---|---|---|
| ANS (lag) | -0.027 | 0.089 | -0.30 | 0.765 |
| POL | 0.466* | 0.262 | 1.78 | 0.075 |
| CL_TEC | 0.040** | 0.018 | 2.27 | 0.023 |
| LnFDI | 0.252 | 0.165 | 1.53 | 0.126 |
| LnACCE | -1.88** | 0.679 | -2.77 | 0.006 |
| LnDCRE | 0.650 | 0.504 | 1.29 | 0.197 |
| LnGDP | 0.702 | 0.708 | 0.99 | 0.321 |
| LINDUS | 0.783** | 0.354 | 2.21 | 0.027 |
| POP | -1.92e-088** | 8.65e-09 | -2.22 | 0.027 |
| Constant | -16.871*** | 5.196 | -3.25 | 0.001 |
| Wald chi2(9) = | 1470.08 | | AR(1)= | 0.002 |
| Prob > chi2 = | 0.000 | | AR(2)= | 0.456 |
| Number of obs | 92 | | | |

**** p<.01, ** p<.05, * p<.1*

**Source: Author's estimate (2021)**

The result in Table 6 shows that there is evidence for the third hypothesis of the study that environmental policy has a significant effect on environmental quality in West Africa. From the result, a 1% rise in environmental policy will enhance environmental quality in West Africa by 4.67% and it is significant at a 10% significance level. The intuition is that countries in West African may be providing enough money and resources to carry out and uphold their environmental laws. Sufficient resources can guarantee the efficient execution of policies and yield noticeable results in practice. Addiotionally, these countries may participate in regional or international agreements and campaigns aimed at promoting environmental preservation. The effectiveness of environmental policies can be enhanced by regional and international cooperation through the resolution of cross-border issues and the promotion of shared responsibilities.

The result supports the findings of Farooq et al. (2020) and Asongu and Odhiambo (2020) but it is inconsistent with the findings of Abid (2017) and Adams *et al.* (2020). Environmental policies regulate human activities to help prevent or reduce the harmful effects of human activities on the environment. They give rise to a bewildering number of rules requiring businesses to seek permits and adhere to strict guidelines. Before implementing adjustments to industrial processes that have little or no influence on environmental quality, businesses may need to seek permission from state authorities.

Standards and rules established by environmental policies control how people, corporations, and entire industries behave. These criteria may include restrictions on pollutant emissions, rules for waste management, restrictions

on the extraction of resources, and benchmarks for environmental impact assessments. Environmental policies guarantee that actions are carried out in a way that minimizes damage to the environment by providing explicit norms and expectations (Asongu & Odhiambo, 2020). Furthermore, environmental rules frequently make it easier to conserve and safeguard natural assets and ecosystems. Policies can create protected areas, control how natural resources are used, and aid in biodiversity conservation efforts. These regulations help to maintain ecological balance and the general health of the environment by maintaining ecosystems and habitats.

The environmental policy reiterates the government's dedication, in cooperation with the public, to efficiently oversee the environment for the benefit of present and future generations. The environmental policy ensures the provision of purified water and improved air quality, therefore creating a more secure and conducive atmosphere for enhanced well-being. The need for the central government to consider environmental implications serves as a crucial mechanism for ensuring oversight and accountability in federal planning and decision-making processes. Moreover, it enables the general people to articulate their apprehensions about the repercussions of governmental measures on their well-being, security, surroundings, and society. The policy ensures sound environmental management within the context of long-term development (Udagama, Jayasinghe-Mudalige & Anjalee, 2012). Environmental policies have shifted from end-of-pipe solutions to prevention and control since the early 1970s. Such solutions rely on mitigating negative consequences (Maor, 2017).

The findings for the control variables are in order. FDI, clean technology and industrial value-added maintained their positive influence on environmental quality in West Africa. Whiles economic growth (GDP) and population continued to exert an adverse influence on environmental quality in West Africa.

**Estimated Results on how Clean Technology and Environmental Policy Mediate the Effect of FDI on Environmental Quality**

**Table 7: GMM results on how Clean Technology and Policy for environmental sustainability mediate the effect of FDI on Environmental Quality**

| Variables | Coef. | Std. Err. | t-value | P>z |
|---|---|---|---|---|
| ANS (lag) | 0.133 | 0.096 | 1.38 | 0.167 |
| POL | 1.093*** | 0.409 | 2.67 | 0.007 |
| LFDI | 2.408*** | 0.862 | 2.79 | 0.005 |
| CL_TEC | 0.049** | 0.021 | 2.30 | 0.021 |
| FDI*POL | -0.601** | 0.256 | -2.35 | 0.019 |
| FDI*CL_TEC | -0.013 | 0.009 | -1.47 | 0.141 |
| LnACCE | -1.096* | 0.654 | -1.68 | 0.094 |
| LnDCRE | -0.606 | 0.439 | -1.38 | 0.168 |
| LnGDP | 0.079 | 0.818 | 0.10 | 0.923 |
| LnINDUS | 0.803** | 0.414 | 1.94 | 0.052 |
| POP | -2.32e-08** | 9.61e-09 | -2.42 | 0.016 |
| Constant | -14.417*** | 5.569 | -2.59 | 0.010 |
| Wald chi2(11) = 1125.40 | | AR(1)= 0.000 | | |
| Prob > chi2 = 0.000 | | AR(2)= 0.868 | | |
| Number of obs 92 | | | | |

*** *p<.01*, ** *p<.05*, * *p<.1*

**Source: Author's estimate (2021)**

In estimating the results on how clean technology and policy for environmental sustainability mediate the effect of FDI on environmental quality. The researcher computed the net effects given the mean FDI value of 1.133. The net effects calculations are:

$$ANS = 3.701049\text{POL} - 1.37056\text{FDI} * \text{POL}$$

$$\frac{\partial ANS}{\partial POL} = 1.093 - 0.601(\overline{FDI})$$

From the summary statistics, $\overline{FDI}$ is 1.133

$$\frac{\partial ANS}{\partial POL} = 1.093 - 0.601(1.133)$$

$$=0.412$$

$$ANS = 0.049\text{CL\_TEC} - 0.013\text{FDI} * \text{CL\_TEC}$$

$$\frac{\partial ANS}{\partial \text{CL\_TEC}} = 0.049 - 0.013(\overline{FDI})$$

$$==0.049 - 0.013(\overline{1.133})$$

$$=0.034271$$

The net effects provide evidence for the last hypothesis that clean technology and environmental policy mediate the impact of FDI on environmental quality in West Africa. But, the statistical significance is evident for only FDI and environmental policy interaction. One possible explanation for the statistical insignificance of clean technology and FDI interaction is that using clean technology does not always result in less pollution (Fan, Lian & Wang, 2021; Bréchet & Meunier, 2014). Niu *et al.*, (2021) demonstrated using spatial econometric analysis tools that an increase in investment in scientific and technological innovation does not always result in an improvement in environmental quality. Bréchet and Meunier (2014) further posited that overly strict environmental policy can be detrimental to the adoption of clean technology which can also account for the statistical insignificance.

From the result, when the various governments in West Africa implement environmental policy by a certain percentage point than the rest of

the world, the net effect of the environmental policy-FDI interaction on envrionemtal quality is 0.412. From the net effect calculation, a 1% increase in FDI given the existence of an environmental policy will enhance environmental quality in West Africa by 0.412% and it is significant at a 5% significance level. The significance and distinctiveness of this finding are that, while FDI improves environmental quality in West Africa, the effect is more prominent in the presence of environmental policies. Thus, it is possible that well-thought-out laws, strict enforcement procedures, and public awareness campaigns that result in constructive modifications to firm's behavior and practices are the cause of this effectiveness.This finding indicates that environmental policies can maximize the impact of FDI on environmental quality. This result corroborates the findings of Bokpin (2017), Abid (2017) and Adams et al. (2020) and Duodu, Kwarteng, Oteng-Abayie, and Frimpong (2021). The authors presume that if policy and institutions are strong against carbon dioxide emissions, this could reduce CO2 emissions.

The findings indicate that environmental policy is a crucial factor in the connection between FDI and the state of the environment. There is a connection between FDI and environmental quality. Specifically, economies that have well-functioning environmental regulations and institutions are more inclined to adopt measures aimed at enhancing environmental quality. A nation with efficient environmental regulations and institutions is more inclined to enforce rules that closely examine the influx of FDI, therefore enhancing environmental quality (Duodu, Kwarteng, Oteng-Abayie, & Frimpong (2021). Environmental legislation primarily focuses on distinct areas such as air, water, and land, and addresses particular concerns such as

the management of hazardous substances and the prevention of oil spills. They generate a vast array of regulations that need firms to get licences and comply with rigorous requirements.

Porter (1991) claims that the beneficial spill-over effects of strict environmental rules can sometimes not only offset the costs borne by the corporation but also result in additional profits. In addition, according to the porter hypothesis, environmental performance is a byproduct of innovations spurred by stringent but flexible environmental regulations. Porter went on to say that businesses invest in inventions that make the environment better and more efficient because of strict environmental restrictions. According to Eskeland and Harrison (2003), when environmental policies are in place, multinational firms with strong management skills and cutting-edge production equipment are more likely to implement high-standard environmental policies, such as the use of environmentally efficient technology, which produces less pollution, in the host country.

The Pollution Haven Hypothesis states that firms that struggle to comply with industrialised nations' environmental regulations move to developing nations with less rigorous regulations in order to avoid these countries' restrictions. Multinational corporations (MNCs) become environmentally conscious when they invest in the country where they are based. Consequently, they begin their manufacturing lives in the host nation with an eye towards environmental consciousness. They are cautious in their operations because they adhere to environmental guidelines and regulations.

Concerning the FDI and clean technology interaction, there is no evidence of statistical significance. However, the net effect calculation shows

that a 1% increase in FDI given the existence of clean technology will enhance environmental quality in West Africa by 0.0504% and it is significant at 5%.

In addition to boosting industrial efficiency, profitability, and competitiveness, clean technology may help multinational firms protect customers, employees, and the environment (UNEP, 2001). Countries experiencing rapid environmental degradation and emerging nations with little energy and natural resources are prime candidates for the notion of clean energy (Hamed & Mahgary, 2004). Improved environmental quality can result from FDI invested in sectors that use clean technology. Clean technology can assist minimize resource consumption, enhance energy efficiency, and reduce pollution. Positive environmental effects may result from foreign investors bringing in cutting-edge clean technologies or investing in updating current ones.

**Chapter Summary**

This chapter presented the findings and discusses the objectives. The overarching goal of this research is to find out how FDI affects environmental quality in West Africa and how clean tech and sustainability policies mitigate that effect. As an estimating approach, the research employs the Generalised Method of Moments (system-GMM, to be exact). The results provide support to the pollution halo theory in West Africa by demonstrating that FDI improves environmental quality. In addition, clean technology and environmental policy both contribute to better environmental quality in West Africa, but the link between FDI and EP was the only one that mattered. Lastly, the research found that environmental regulations enhance the impact of FDI on West African environmental quality.

# CHAPTER FIVE

# SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

## Introduction

This chapter contains the synopsis, deductions, and suggestions derived from the research. The conclusions include all the results pertaining to the study's findings, which are derived from the research goals. Additionally, the report includes policy suggestions derived from the results. Lastly, recommendations for further study are proposed.

## Summary

The research aimed to investigate the role of clean technology and environmental sustainability policies in moderating the influence of FDIs on environmental quality in West Africa. This study used the Stochastic Impacts by Regression on Population, Affluence, and Technology (STIRPAT) model. The analysis used macroeconomic data from 2005 to 2020 including all West African nations, taking into account data availability. The research used the Generalised Method of Moment (specifically system-GMM) as an estimating approach.

The study's results indicate that FDI improves environmental quality, supporting the pollution halo theory in West Africa. Regarding the control variables, the industrial value-added had a beneficial impact on the environmental quality in West Africa. Nevertheless, the economic expansion (GDP), domestic lending to the private sector, and population had a negative impact on environmental quality in West Africa.

Regarding the second and third objectives, the findings indicate that both clean technology and environmental policy contribute to the

improvement of environmental quality in West Africa. Ultimately, the computation of the net effect offers support for the final hypothesis that alone environmental policy serves as a mediator for the influence of FDI on environmental quality in West Africa. FDI enhances environmental quality in West Africa, with a more pronounced impact shown when environmental regulations are in place.

**Conclusions**

Conclusively, the study provides substantial evidence that FDI stimulates environmental quality in Africa. This means that FDI is an amplifier for environmental improvement. Additionally, clean technology and environmental policies are relevat in improving environmental quality in West Africa. Thus, both clean technology and environmental policies has the ability to minimize environmental damage, safeguard natural resources, and protect the environment. Finally, environmental policies serves as a significant pathway which alters the degree and direction of FDI's effect on environmental quality in Africa. This implies that, in the absence of appropriate regulatory frameworks, FDI may result in environmental deterioration and adverse effects.

**Recommendations**

1. The Investment Promotion Centres and Policymakers in the various countries in Africa should create a favourite atmosphere to attract sustainable FDI. Thus, these aganecies should step up efforts by enhancing the legal environment and infrastructure to attract more FDI to West Africa. The inflow of FDI has the possibility to enhance environmental quality in Africa.

2. To ensure environmental sustainability, the various Ministries of Environment in West Africa should intensify investments in clean technology education on the use of clean technologies for domestic production in West African countries, particularly by foreign corporations.
3. The study recommends that environmental policy matters when it comes to environmental quality, and as a matter of fact, The Ministry of Environment and Environmental Protection Agencies in West Africa should institute and implement environmental policies focusing on environmental protection. This policy should target FDI inflows corporations' activities toward the environment.

**Suggestion of Future Study**

This study considered all countries in West Africa, future studies can consider how clean technology and policy for environmental sustainability mediate the impact of FDIs on environmental quality using individual country study.

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# APPENDIX

**A: " List of West Africa countries considered for the study**

| | |
|---|---|
| Benin | Liberia |
| Burkina Faso | Mali |
| Cape Verde | Mauritania |
| Côte D'Ivoire | Niger |
| Gambia | Nigeria |
| Ghana, | Senegal |
| Guinea | Sierra Leone |
| Guinea-Bissau | Togo" |