UNIVERSITY OF GHANA
COLLEGE OF HUMANITIES

ENVIRONMENTAL RISK AND FOREIGN DIRECT INVESTMENT: THE ROLE OF FINANCIAL SECTOR DEVELOPMENT AND TAX POLICIES

BY

ERIC BOACHIE YIADOM

THIS THESIS IS SUBMITTED TO THE UNIVERSITY OF GHANA, LEGON IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF PHD FINANCE DEGREE

DEPARTMENT OF FINANCE
JULY 2022

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DECLARATION

I hereby declare that this thesis is my work produced from research I carried out under supervision. This thesis has not been presented by anyone for any academic award, in this or any other institution. All references made to work done by other people have been duly acknowledged. I am solely responsible for any shortcomings in this work.

01/08/2023

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CERTIFICATION

We hereby certify that this thesis was supervised in accordance with the procedures laid down by the University of Ghana.

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PROF. GODFRED ALUFAR BOKPIN DATE

(CO-SUPERVISOR)

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DEDICATION

This work is dedicated to:

God Most High.

My Supervisor, Professor Lord Mensah, for believing in me and inspiring me to come this far.

ABSTRACT

Responding to climate change is at the forefront of policy and research at this crucial moment of the earth's history. A two-pronged approach has emerged: mitigation and adaptation. This study relates to both the climate mitigation and adaptation strategies to resolving climate change. Specifically, the thesis contributes to the literature by (i) examining the moderating role of financial sector development on the effect of foreign direct investment (FDI) on environmental risk, (ii) decomposing financial sector development into its subcomponents: access, depth and efficiency, and examining the extent to which they aid or prevent foreign direct investment from harming the environment, (iii) exploring whether countries with 'weak' or better still low tax rate attract 'dirty' FDI to deteriorate their environment, (iv) investigating the impact of carbon tax adoption on foreign direct investment. The study employs standard approaches namely the generalized method of moments (GMM), dynamic panel threshold models, fixed effects, random effects, sample splitting, and partial effects computations to examine the linkages.

The results from the various estimation strategies show that, the unmitigated effect of FDI on environmental risk is detrimental. However, FDI conditioned on the local financial sector development minimizes environmental risk. This means that countries that have a well-developed financial sector is able to channel FDI into green projects that improve the quality of the environment. Further, the dynamic panel threshold model reveals that financial development increases environmental risk at low regimes of the threshold but high regimes of financial development have the ability to reduce it. This means that the level of financial sector development matters in accounting for its impact on environmental risk. Therefore, assuming a linear relationship between the two variables could be problematic. This brings clarity to the literature

on why some studies report positive effect of financial development on environmental risk and others show negative effect.

We further decomposed financial development into its subcomponents to help examine their behaviours and recommend specific policy directions. The findings reveal that financial deepening and efficiency reduce environmental risk and can overturn the negative impact of FDI on the environment. However, financial access worsens environmental risk especially at lower levels and cannot make the FDI – environment nexus any better. But then again, high levels of financial access has the ability to reduce environmental risk.

Also, after splitting the dataset into high and low financially developed economies, we report that FDI is more environmentally depressive among low financially developed economies. Third, on the effect of tax policies on the FDI-environmental risk nexus, the study finds support that the tax channel is the main medium through which FDI worsens environmental risk. By discomposing tax policy into low and high regimes, the study reports that countries that deliberately reform tax policy to bait FDI have higher environmental risk. Therefore, using tax policy to lure FDI amount to short-changing capital risk for environmental risk. Finally, We set up the Dynamic Stochastic General Equilibrium (DSGE) model to estimate the effect of carbon tax adoption on FDI. The findings from this exercise show that the direct effect of the carbon tax on FDI is repressive. However, if the revenue from the carbon tax is recycled into the economy, the carbon tax will have a significant positive effect on FDI. Hence, the study corroborates the double dividend theory. The findings further suggest that a carbon tax of around US$8.5/ton is reasonable to enhance inward FDI but a carbon tax either above US$25/ton or below US$3/ton will be detrimental to the African

region. Also, the entrenched negative relationship between FDI and taxes is worsened if the additional carbon tax is levied among high tax regime countries than their counterparts.

The findings of this thesis churn out several contributions to knowledge and literature. The African context in the environmental economics and carbon tax policies are marginalized in the existing literature. This study opens up the frontiers to the discussions on the implications of carbon tax introduction on the free movement of international capital. As a forerunner on the subject of carbon tax's effect on FDI in both Africa and the globe, this study offers reasons why many countries have not implemented a carbon tax despite the numerous benefits associated with it.

This study also leads the way in advancing that the finance and the tax channels are the yet-to-be-explored factors that account for the impact of FDI on the environment. The existing literature associates the negative effect of FDI on the environment with institutional quality. However, institutional quality is broad and encompasses almost everything in the administration of a country. This leaves policymakers helpless as the specific aspect of institutions that can mitigate the harmful environmental effects of FDI. This thesis brings finality to this policy debacle and recommends that retooling tax policies and enhancing financial deepening and efficiency could improve the effect of FDI on the environment.

Keywords: environmental risk, foreign direct investment, financial sector development, carbon tax, tax policies, and generalized method of moment.

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LIST OF ABBREVIATIONS

ARDL	Autoregressive Distributed Lag
APEC	Asia Pacific Economic Cooperation
BRIC	Brazil, Russia, India and China
CGM	Computable General Equilibrium
CO_2	Carbon Dioxide
CUP-FM	Continuously Updated Full Modified
CUP-BC	Continuously Updated Bias-Corrected
DOL	Dynamic Ordinary Least Square
DSGE	Dynamic Stochastic General Equilibrium
EKC	Environmental Kuznet Curve
FDI	Foreign Direct Investment
FEP	Foreign Equity Portfolio
FE	Fixed Effects
FMOLS	Fully Modified Ordinary Least Square
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GMM	Generalized Method of Moment
HIPC	Highly Indebted Poor Countries
IMF	International Monetary Fund
IV-GMM	Instrumental Variable Generalized Method of Moment
MBI	Market Based Instruments
MNC	Multinational Corporation
NARDL	Nonlinear Autoregressive Distributed Lag
NASA	National Aeronautics and Space Administration
OBOR	Belt and Road Initiative
ODA	Official Development Assistance
OECD	Organisation for Economic Co-operation and Development

OLS	Ordinary Least Squares
OPEC	Organization of the Petroleum Exporting Countries
PHH	Pollution haven hypothesis
PMG	Pooled Means Group
PNDC	Provisional National Defence Council
RE	Random Effect
RTB	Race-To-the-Bottom
SSA	Sub Saharan Africa
UNCTAD	United Nations Conference on Trade and Development
UNFCCC	United Nations Framework Convention on Climate Change
US	United States
VECM	Vector Error-Corrected Model
WDI	World Development Indicators
2SLS	Two-Stage Least Square

CHAPTER ONE

INTRODUCTION

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

"We are currently way off track to meeting either the 1.5° C or 2° C targets that the Paris Agreement calls for. We need to reduce greenhouse gas emissions by 45% from 2010 levels by 2030 and reach net zero emissions by 2050. And for that, we need ***political will*** *and* ***urgent action*** *to set a* ***different path****."* [Anthónio Guterres (2020), Secretary-General of the United Nations]

The problem of climate change and in this case environmental risk has become an albatross on the neck of the local and international communities and may not be out of the economic discussions anytime soon. The last five years have been the warmest half-decade in human history with unprecedented earth temperature exceeding 1.0° C. This sudden upshoot in earth temperature is wreaking havoc on human lives. The hurricanes, wildfires, pandemics and other life-threatening diseases in recent times, have been attributed to the changing patterns in the climate (World Meteorological Organization, 2020). The World Economic Forum (2019) has labelled climate change as the greatest threat to the world today. The Intergovernmental Panel on Climate Change (2019) on the other hand has indicated that the worst impacts of climate change could be irreversible by 2030. The earth is almost on a collision course and investigating the causes of climate change and offering solutions to mitigate them at this point is imperative. Moreover, Scientists have advanced that in this Anthropocene era, the rising earth temperature is more social, than natural (NASA, 2019). This means that climate change and its effects are more anthropogenic than an act of God. Hence, we cannot continue to blame the sufferings from extreme weather events on divinity when human activities are the primary cause.

Additionally, the anthropogenic nature of climate change makes it appropriate to examine those human activities in the economy that is reducing precipitation on earth. The probability that a particular human activity may hurt the environment is termed an environmental risk (Liverman, 2001). Xu and Liu (2009) further explain environmental risk as the risk that an organization's (human) activities may emit toxic gasses or deplete resources in such a way that it will bring actual or potential negative effects on the ecological system. One human activity identified as a major cause of environmental risk is economic growth (Stern, 2002; Dasgupta, Laplante, Wang, & Wheeler, 2002; World Commission on Environment and Development, 1987). The environmental impact of economic activities is popularized by Grossman and Krueger (1991) in their Environmental Kuznet Curve (EKC) hypothesis. They empirically showed that economic activities reduce air quality in 42 countries and concluded that an increase in per capita income worsens environmental risk. Panayotou (1993) expounded on this frontier to show how the various stages of economic development deteriorate the environment.

Furthermore, there is a strong relationship between economic activities and capital availability; thus, countries with more capital resources grow faster. Studies such as McKinnon (2010); Borensztein, De Gregorio and Lee (1998); Khan and Reinhart (1990) affirm that the extent of economic development in a country indeed hinges on capital resource accessibility. So, it is almost the case that the richer a country, the greater the economic activities and the higher the level of emissions which worsen the environmental risk. This perception is supported by the fact that developed nations emit more Green House Gases (GHGs) than developing countries. Capital resources are almost becoming bad for the climate, especially in the post-industrial era. This is the more reason why the empirical literature is tilting toward investigating the effect of capital

resources on environmental risk (Frutos-Bencze, & Kulvanich, 2017; Zheng & Sheng, 2017; Zhu, Duan, Guo, & Yu, 2016; Acharyya, 2009; Jorgenson, Dick, & Mahutga, 2007).

Undoubtedly, Africa lacks the capital to finance its desired growth agenda (Sachs et al, 2004; Collier and Dollar, 2002; Burnside and Dollar, 2000). The capital constraints in Africa translate into fewer economic activities which subsequently account for the low emission of greenhouse gases (Panayotou, 1993). It can be inferred that Africa's lack of capital is the main reason for the low greenhouse gas emissions and therefore if the capital constraints are removed, Africa like any other global region may increase its greenhouse gas emissions. However, it is estimated that a capital investment of at least US$1 trillion can help achieve Africa's industrialization dream (Leke & Signé, 2019). This capital target is anticipated to turn the region from an exporter of primary products into a global manufacturing hub.

Nevertheless, raising the US$1 trillion is a major challenge in Africa. Domestic revenue mobilization is not enough to cover the financing deficit. The total domestic revenue in the region has averaged 21% of GDP in the last five years (Boly, Nandelenga, & Oduor, 2020). Foreign capital may augment the poor performance of domestic revenue collection but certainly not through borrowing. External borrowing in Africa is rising speedily at an annual average rate of 5.3% in the last decade and may return to the pre-HIPC debt levels soon. Data from the International Debt Statistics shows that the external debt to the region stood at US$702.41 billion as of 2020, indicating a 208% increase since 2011 (World Bank, 2021). The rising debt levels coupled with high interest rates are badly affecting the region and exploiting other forms of foreign

capital is a necessity. Foreign equity portfolio (FEP) and foreign direct investment (FDI) are the other two components of foreign capital Africa is tapping into to fill its investment deficit. The annual contribution of FEP to Africa's growth has been sluggish, accounting for less than 0.5% of GDP in the last 10 years as compared to 4% of FDI (World Bank, 2021). The contribution of FDI to Africa's economic growth has been well researched with favourable conclusions (Sunde, 2017; Agbloyor, et. al., 2014; Alfaro et al., 2004; Durham, 2004; Li & Liu, 2005; Borensztein et. al., 1998). FDI is different from the other forms of foreign capital in several ways. First, unlike debt and other official development assistance, FDI does not come with immediate repayment conditions on the central government. Second, there are no prior open stringent requirements to meet before hosting FDI. Third, there are also no third parties to review and approve a country's economic performance before FDI is granted. Fourth, FDI comes with more flexibility relative to the other forms of foreign capital. Although, FDI is not free capital it brings mutual benefits to both the home and the host economy.

Li and Liu (2005) assert that even in cases where FDI does not result in explicit capital financing, it influences positively the host nation's technological transfer, managerial competencies, raw materials availability, and production processes, among others. FDI forms a significant part of Africa's economic growth. In 2019 alone, the region recorded an 11% increase in FDI despite the global downturn in inward FDI (UNCTAD, 2019). The relevance of FDI in Africa's growth struggles is evidenced in the region's attempt to restructure its taxes, trade laws, governance, infrastructure, and human capital, among others to be a key host to inward FDI (Odusola, 2016).

Despite the numerous positive spillovers from FDI to host nations, concerns have been raised about the effect of inward FDI on environmental risk. Some studies attribute the rise in carbon emission to the rise in FDI inflows; hence, making the Africa a "pollution haven" for multinational

enterprises (MNE) who want to pay less for damaging the environment (Nepal, et. al., 2021; Frutos-Bencze, K., & Kulvanich, 2017; Zheng & Sheng, 2017; Bokpin, 2017; Omri, Nguyen, & Rault, 2014; Sbia, Shahbaz, & Hamdi, 2014; Acharyya, 2009; Jorgenson, Dick, & Mahutga, 2007; Antweiler et al., 2001). Contrarily, a section of the literature believes that FDI improves the host nation's environment through the deployment of advanced climate-resilient technologies (Kim & Adilov, 2012; Perkins & Neumayer, 2008; Hoffmann et al., 2005; Hines & Rice, 1994). This makes the impact of FDI on the environment still a thorny question for research and policy to unravel.

Albeit, whether the effect of FDI on environmental risk is favourable or not, it is overly simplistic to study the relationship between the two without considering other interconnected economic developments (Sarkodie, Adams, & Leirvik, 2020; Bokpin, 2017). We suspect that whether FDI enhances or deteriorates the environment, it is reinforced by local factors in the host nations. Consequently, local factors within the host nations cannot be discounted in accounting for the effect of FDI on the environment.

Moreover, empirical studies have argued that for FDI to be growth-enhancing, the host nation should have access to key factors such as the level of financial sector development (Osei & Kim, 2020; Agbloyor et. al., 2013; Alfaro, Chanda, & Kalemli-Ozcan, 2004), the quality of institutions or governance (Agbloyor, 2019; Agbloyor et, al, 2016; Busse & Groizard, 2008), and the level of human development (Shahrivar & Jajri, 2012; Borensztein, De Gregorio, & Lee, 1998; De-Mello, 1997). The relevance of these local factors are not limited to ensuring that FDI promotes economic growth but also determines the extent to which FDI improves or retard environmental quality. Subsequently, Bokpin (2017) investigated the moderating role of institutional quality on the impact of FDI on the environment. Unfortunately, human development is not a catalyst for environmental

quality. Rather, there is an adverse reverse causality running from environmental risk to human development (United Nations, 2015; Chaudhry & Ruysschaert, 2008). What is left hanging in the literature is the role of financial sector development in the FDI – environmental risk nexus.

Besides financial sector development, one key local factor which influences the location of inward FDI and the likely effect of FDI on the environment is the tax policy. Mostly, countries use lucrative tax regimes to woo foreign investors into their economies. An array of tax incentives in the form of exemptions and low tax rates are often used to bait investors. For instance, in Ghana, the introduction of the Investment code (PNDC Law 116, 1985) brought a range of incentives to foreign investors. The code offers tax rebates as high as 40%. Damgaard, Elkjaer, and Johannesen, (2019) observed that FDI locates countries with favourable or weak tax regimes. It is therefore not surprising to have 10 countries in the world with the most lenient tax policies hosting more than 85% of global FDI inflows (Damgaard et al., 2019). In an attempt to receive more FDI inflows in Africa, the corporate tax rate for the past one and half decades has fallen from over 75% to less than 40% averaged (Figure 4.1). Mauritius, Namibia, Zambia, and Lesotho which host the largest bloc of FDI in Africa have a mean total corporate tax rate below 20% (World Bank, 2021).

Cole et. al. (2006) and Prakash and Potoski (2006) observed that FDI does not only move towards a conducive tax climate but also targets countries with weak environmental laws. One channel of strengthening environmental laws is through the tax system. Effective tax systems impose punitive measures to slow the rate at which businesses degrade the environment. If tax laws are not sufficiently punitive, FDI inflows may be invested in environmentally damaging sectors of the economy. It is of no surprise that a greater portion of FDI inflows to Africa is invested in oil and gas and natural resource extractions sectors (Asiedu, 2013). We acknowledge the reality of

developmental and capital deficits in Africa. However, deliberately reforming tax laws to attract more FDI could be trading one risk for the other. Hunting for more FDI through tax reforms could close the gap between capital and developmental shortfalls; but where the FDI goes matters to safeguarding sustainable development.

Meanwhile, the containment of carbon dioxide and other harmful emissions has become necessary in the attempt to reduce global warming. Several solutions have been proposed both in research and practice on how to cut down global emissions. These solutions as championed by the United Nations Framework Convention on Climate Change (UNFCCC) can be categorized into two: regulatory policies and fiscal policies (United Nations, 2021). Regulatory policies comprise government bureaucracies and legal systems that fashion specific environmental technology, standards, and laws to mitigate climate change. The United Nations Committee of Experts on International Cooperation termed these "command-and-control" instruments (United Nations, 2021).

Regulatory policies define strict pathways to achieving the desired compliance and do not consider the resource implications such rules have on the firms. They are punitive and often reactive mechanisms and do not offer incentives for climate actors to voluntarily comply with environmental standards (Lanoie et al., 2011). Regulatory instruments demand high resource investment to monitor and ensure compliance. Some studies have examined the effect of regulatory instruments on climate change mitigations and adaptations (Rhodes, Scott, & Jaccard, 2021; Goulder, Hafstead, & Williams, 2016). The general conclusions are that, although regulatory policies could be an effective tool for climate change mitigation; however, the prescriptive nature makes them too rigid for entities to choose appropriate compliance pathways. It is the more reason why Rhodes et. al. (2021) advocate for a diluted version of the prescriptive command-and-control

policies, called the flexible regulations, which allow market participants to determine how to meet the regulatory needs on their terms.

Fiscal policies, on the other hand, use taxes, subsidies, emission trading schemes, deposit refunds, and central government spending to influence climate change. Fiscal policies are part of the broad market-based instruments (MBI) that focus on reducing emissions through financing decisions (United Nations, 2021). Unlike regulatory policies, fiscal policies are two-sided that offer incentives for voluntary compliance on one hand and at the same time punish offenders through high taxes or fees. Baumol and Oates (1988) stressed that both regulatory and fiscal policies are effective at mitigating climate change; however, fiscal policies do so at a relatively cheaper social cost. Numerous tools within the fiscal policy framework are in use in various countries to mitigate carbon emissions.

But one key policy dominating the fiscal policy-emission cut debate is the carbon tax. Gaspar et. al. (2019) think that carbon tax is a climate change mitigation catalyst and estimate that its full implementation can reduce emissions by up to 32% by 2030. Lin and Li (2011) examine the effect of the carbon tax on carbon emissions on European countries that first adopted carbon tax. Their findings show that carbon tax significantly reduces emissions. In a related study, Conefrey et. al (2013) found that carbon tax has a double-dividend effect on the domestic economy by reducing emissions and increasing economic growth, especially if the revenue from the carbon tax is recycled.

According to Gaspar and Amaglobeli (2021), the carbon tax is the most powerful and efficient means to address rising earth temperatures. Recent empirical evidence confirms the existing findings that indeed carbon tax reduces emissions (Fu et. al., 2021; Tiwari et. al., 2021; Sun, et al., 2021; Jia & Lin, 2020). Despite the glowing tributes to the carbon tax, only 30 countries have

implemented it as of 2020 ((Metcalf, 2021). Meanwhile, two-thirds of all submitted Nationally Determined Contributions (around 100 countries) to the UNFCCC consider the use of carbon tax to achieving their emission reduction targets (United Nations, 2021). Gaspar et. al. (2019) bemoan that even countries that have implemented carbon taxes largely shy away from the recommended rates. Currently, the average global carbon tax is just US$3 per ton which is not near the 2015 Paris Agreement recommendation of US$50 and US$25 per ton for developed and developing countries respectively (United Nations, 2021). The slow pace in the adoption of the carbon tax and its related emission reduction policies require further interrogation. The big question is why are countries reluctant in implementing a policy that can mitigate emissions and at the same time mobilize revenue for economic growth? Perhaps, carbon tax implications are more complex than the current focus and need to be thought through thoroughly.

Again, advanced countries are introducing various environmental policies to make carbon emissions expensive and undesirable ventures. Very soon polluting firms in these economies may relocate into jurisdictions that have minimal to zero environmental policies. The implementation of the carbon tax is worse in Africa which makes the sub-region a potential haven for dirty industries. So far, it is only South Africa that has implemented a carbon tax at the rate of $8 per ton as of 2019 (Gaspar et. al., 2019). The lack of enthusiasm among policymakers in Africa towards the introduction of carbon taxes raises concern and the need to holistically assess the wholesale recommendation of the carbon tax. Several factors account for the slow implementation of carbon tax adoption in Africa. Although corporate taxes have fallen in the last decade, they are high relative to global averages. The African region is still home to countries with high corporate taxes. The informal nature of economies in the region narrows the tax bracket to only a few formal sector taxpayers. As a result, firms in the region pay high corporate taxes to make up for non-

taxpayers. For instance, Africa houses nine of the twenty countries in the world with the highest corporate taxes and has the highest average corporate tax rate of 28.5% (OECD, 2021). Introducing additional tax in the form of the carbon tax on the already burdened taxpayer has complex implications.

To this end this thesis explores the financial sector developments and tax channels used by FDI to worsen environmental risk and investigates why recommended mitigating factors such as carbon taxes are not being implemented especially in Africa.

1.2 Problem Statement

The financial sector is the first entry point that receives, distributes, and directs FDI into the various sectors of the economy (Alfaro, Chanda, & Kalemli-Ozcan, 2004). Where the FDI goes matters in influencing economic activities and environmental risk. Schumpeterians argue that a well-developed financial sector facilitates capital accumulation and advanced technologies to spur economic activities. Thus, the financial sector plays an intermediary (moderator) role between FDI and the environment. In the natural sense, a weak moderator can easily be compromised. Therefore, a weak financial sector mimics the type of FDI received; hence, if the FDI is toxic it will adversely affect the environment. On the contrary, if the level of financial sector development is robust, it corrects market failures and the impact of FDI on the environment may no longer be hurtful.

Several studies have investigated either the relationship between FDI and the environment (Bokpin, 2017; Omri, Nguyen, & Rault, 2014; Sbia, Shahbaz, & Hamdi, 2014; Acharyya, 2009; Jorgenson, Dick, & Mahutga, 2007; Antweiler et al., 2001) or financial sector development and the environment (Ntow-Gyamfi, et. al., 2020; Osei & Kim, 2020; Acheampong, 2019; Shahbaz, Nasir, & Roubaud, 2018; Riti, Shu, Song, & Kamah, 2017; Shahbaz, et. al., 2016; Tamazian,

Chousa, & Vadlamanna, 2009) with disjointed conclusions. The first two empirical chapters of this thesis consolidate the fragmented literature by examining the role of financial sector development in the relationship between FDI and environmental risk in Africa. Our study is different in several ways.

First, we correct the misconception in the literature that the effect of FDI on the quality of the environment is isolated from the financial sector that carries it (Ntow-Gyamfi, Bokpin, & Aboagye, 2020; Acheampong, 2019; Shahbaz et. al., 2016). Second, the present study shows that the level of financial sector development matters in accounting for the impact of FDI on the environment. This has been largely ignored by the existing studies (Shahbaz, Nasir, & Roubaud, 2018; Riti, Shu, Song, & Kamah, 2017; Tamazian, Chousa, & Vadlamanna, 2009). Particularly, our study posits that at low levels of financial sector development, FDI can 'bulldoze' its way to deteriorate the quality of the environment; however, the results may be different in a highly developed financial sector. Third, the measurement of financial sector development in the available literature is highly contentious and, in most cases, the measurements used are inappropriate to capture the full complexity and efficacy of the financial system.

In the existing literature, financial sector development has been narrowly measured with domestic credit to the private sector, stock market value traded, the ratio of deposit money to bank assets, stock market turnover and broad money (Ntow-Gyamfi, et. al., 2020; Osei & Kim, 2020; Acheampong, 2019; Shahbaz, Nasir, & Roubaud, 2018; Riti, et. al., 2017; Shahbaz, et. al., 2016; Tamazian, Chousa, & Vadlamanna, 2009). A careful examination of these variables show that they are largely financial depth measurements and do not reflect the whole financial system as evidenced in Sahay et al. (2015). Suffice it to say that earlier studies only considered financial depth to represent the entire financial system in their analysis, their variables are still inadequate

to capture the full complements of the financial depth. This is because Sahay et al. (2015) explained that the domestic credit to private sector variable often used in the literature represents less than 25% of the overall composition of the financial depth itself (see Table 3.5 in the Appendix). In rare cases, a few studies have constructed principal component analysis to determine financial development measurements. An evaluation of their variables shows that financial access is crudely missing (Xing et al., 2017; Shahbaz, et. al., 2016). This study departs from the current trend and employs a more robust and comprehensive measurement for financial sector development. The study uniquely adopt the IMF's financial index data compiled by Sahay et al. (2015) to examine the relationship among the research constructs.

Furthermore, this study measures the behaviour of FDI in the presence of the three determinents of financial sector development – access, depth and efficiency. By decomposing the financial sector development index into its subcomponents, the study can address which particular aspect of the financial development indicators drive environmental risk or can mitigate the negative effect of FDI on the environment. Subsequently, this research avoids the wholesale recommendations on financial sector development in the existing literature.

Additionally, Shahbaz et al. (2016) and Sehrawat et al. (2015) investigated the effect of financial sector development on carbon dioxide emissions and conclude that a highly developed financial sector increases emissions. Again, their financial development variables which are domestic credit to the private sector, stock market value traded and the ratio of deposit money to bank assets are mainly financial deepening indicators. It is therefore problematic to generalize that the whole financial sector worsens carbon emissions. We correct this distortion in the literature by examining

the separate effect of the three components (access, depth and efficiency) of the financial sector development on environmental risk.

The third empirical chapter of the thesis examines the role of tax policies in accounting for the effect of FDI on environmental risk. The effect of FDI on environmental quality and the effect of tax policies on FDI are well documented in the literature. The main conclusions are that FDI harms the environment (Omri, et. al., 2014; Sbia, et. al., 2014; Acharyya, 2009; Jorgenson, et. al., 2007) and favourable tax policies attract more FDI (de Mooij & Ederveen, 2003; Scholes & Wolfson, 1991). The literature is, however, malnourished on the channels through which FDI affects the quality of the environment. Most part of the literature attempts to offer solutions to the FDI-environmental problem by suggesting governance or institutional quality as a panacea (Bokpin, 2017; Corfee-Morlot, et. al., 2009). However, this approach overly simplifies the menace and makes it difficult and ambiguous in offering specific policy direction.

The existing literature is skewed towards the negative effects of FDI on the environment (Omri, et. al., 2014; Acharyya, 2009; Jorgenson, et. al., 2007) without paying attention to the channels through which FDI toxifies the environment. These oversights culminate into the wholesale recommendations of most studies in this area. We fill this lacuna by introducing the tax policies of developing economies into the debate. The current study explores the tax channel as one of the main channels through which FDI influences environmental outcomes. We suggest that loosening tax policies to attract more FDI could amount to shooting the economy in the foot because FDI takes advantage of the same tax policy to harm the environment.

In Figure 5.2 we develop a simple "Toxic Taxes, Dirty FDI Model" based on the "tax haven" and "pollution haven" hypothesis (Dinda, 2004). The model shows that lenient tax regimes attract more FDI inflows. FDI, on the other hand, affects the host nation's economy in three dimensions;

technology, scale and structure (Antweiler et al., 2001). The model supports the hypothesis that tax haven economies attract pollution haven FDI. FDI takes advantage of the weak tax system to increase environmental risk. This study, therefore, uses empirical data to investigate the assertion that tax reforms may provide a convenient channel through which FDI worsens environmental risk.

In the empirical chapter four of the thesis, we examine the effect of adopting caebon tax on FDI in Africa. Carbon tax is a efficient in addressing environmental risk. But one key implication of carbon tax introduction in Africa is its effect on the competitiveness of the domestic economy. Zhang and Baranzini (2004) review the impact of the carbon tax on firm competitiveness and conclude that carbon tax can impair the international competitiveness of countries in comparative terms. The reduction in the competitive advantage according to Zhang and Baranzini (2004) is the major reason why many countries are reluctant in implementing a carbon tax. In a related study, Marron and Toder (2014) argued that carbon tax indeed rolls back international competitiveness and can increase local consumers' demand for cheaper imported goods. Although imported goods can equally be taxed at higher rates to restore the imbalances in the local economy, Marron and Toder (2014) contend that firms will find it difficult to expand in the international markets. The harsh impact of the carbon tax on the domestic economy will be minimized if there is a global consensus to implement the tax in every country and almost at the same rate. Although it is near impossible to achieve such a recommendation, the global introduction can wipe out the competitive disadvantages to the countries that have unilaterally introduced the carbon tax.

Consequently, it will minimize firm relocation. Voßwinkel and Birg (2018) study the effect of the carbon tax on the relocation decisions of firms within a two-country scenario. They report that if two countries simultaneously set carbon taxes, it reduces the chances of relocation. However, if

the carbon tax is set unilaterally or one country's marginal tax rate is higher than the counterparty, chances are that firms in the carbon tax economy will relocate to a foreign country with minimal or no carbon tax. Previous studies including Hudson (1993) and OECD (1993) lend support to these findings that unilateral imposition of the carbon tax is a recipe for firm relocation.

Additionally, the carbon tax literature is malnourished in the African context. Carbon tax introduction and its effect in the African region are almost missing in the vast literature reviewed for the present study. But Africa possesses unique characteristics in the carbon tax and climate change mitigation debate that need considerable attention. It will be interesting to know how a capital-trapped economy with a high corporate tax rate will implement a policy perceived to be damaging to the local economy.

In this chapter of the thesis, we examine the effect of carbon tax introduction on foreign direct investment in Africa. We argue that imposing a carbon tax may deter foreign investors, hence, the study recommends a pragmatic approach to the implementation of the carbon tax in Africa. The debate on the carbon tax is skewed towards its deterrent nature and the ability to cut down emissions without analyzing the implications of additional taxes on the local economies. It is surprising to note that despite the deterrent nature of carbon tax and the possibility of raising revenue for local and international governments, policymakers are hesitant in implementing it. This study thinks that if carbon tax externalities are not addressed, its implementation will continue to be stalled.

Again, foreign direct investment is critical to Africa's developmental agenda. FDI provides jobs, technology, and private capital to the region. There is a strong relationship between FDI and taxes (Gao & Liu, 2021; Xu & Wu, 2021; Damgaard, Elkjaer, & Johannesen, 2019; Oates, 1972). Damgaard, Elkjaer, and Johannesen (2019) have shown that countries with low corporate taxes

attract high FDI. Any additional taxes may deter new foreign firms from Africa and existing ones may relocate. This makes carbon tax a sensitive topic in the region. We show in this paper that, although carbon tax harms FDI; the revenue can be recycled to cut down other forms of taxes to reduce the burden on the taxpayers.

1.3 Research Objectives

The objectives of the study are to:

i. Examine the role of financial sector development on the relationship between FDI and environmental risk

ii. Assess the impact of financial depth, access and efficiency on the FDI-environment nexus.

iii. Examine the effect of tax policies on the relationship between FDI and environmental risk.

iv. Investigate the impact of carbon tax introduction on FDI in Africa.

1.4 Research Hypothesis

Subsequently, the study specifies the following null hypothesis:

i. Financial sector development has no impact on the relationship between FDI and environmental risk.

ii. Financial depth, access and efficiency have no impact on the FDI-environmental risk nexus.

iii. Tax policies are irrelevant in accounting for the effect of FDI on environmental risk.

iv. Carbon tax has no effect on FDI to Africa.

1.5 Significance of the Study

Extant studies have investigated the individual effect of FDI, financial development and tax policies on environmental quality. The interrelationships between these variables have been marginalized in the existing literature. This thesis lays theoretical and empirical foundations for the need to study these variables together. Our study opens the frontiers to the climate change discussions by offering a broader view of interrelated factors that have long been sidestepped in the existing studies.

Again, the current study introduces the 'Toxic Taxes, Dirty FDI Model' conceptual framework (Figure 5.2) into the FDI-environmental risk debate. The framework is grounded on the tax haven and pollution haven hypothesis illustrate clearly how a lenient tax regime may attract more FDI inflows and the channels through which FDI influences the quality of the environment. The introduction of this model forms the basis of new thinking that can influence future studies.

There is a policy specificity crisis in the current studies. This is because a large segment of the existing studies has proposed improvement in institutional quality as a panacea to curbing the negative effect of FDI on the environment. The definition of institutional policy in the existing studies covers administrative governance, rule of law, fiscal and monetary discipline, voice and accountability, among others. Placing all these variables into one basket and prescribing institutional quality as a solution to the FDI – environmental quality debacle leaves policymakers in a dilemma, as to which aspect of the institution influence the nexus. This study which forms part of the broad institutional literature settles the confusion by offering specific policy interventions in containing the harmful effect of FDI on the quality of the environment.

Additionally, the significance of the study lies in the value it contributes to the literature on the carbon tax. Because to the best of the authors' knowledge, it is the first study to examine the

implications of carbon tax on FDI, more especially in the African context. The recommendations from this exercise will serve as a guide to policymakers in determining the appropriate carbon tax that could maximize inward FDI and at the same time mitigate the negative effects of FDI on the environment. Again, the non-availability of carbon tax data in Africa is a hindrance to researchers who desire to explore this area. The strategy adopted in this study by the authors in constructing carbon tax data in Africa can guide future studies.

The financial sector development aspect of the thesis also provides guidelines to investors as to the direction of funding. This is helpful to investors and the policymakers in identifying funding concentration and the need to create an enabling environment in green energy sectors to be financially attractive to investors.

Also, the relevance of the study lies in its timeliness due to the urgency of climate change. As national and international leaders solicit for new ideas to contain climate change and mitigate its negative effect on lives and properties, the timing of this study could not have been better than now. To facilitate climate adaptations and mitigations, the authors have carefully explored the channels through which FDI influences the environment and propose measures to improve the effect of FDI on the environment.

1.6 Scope and Limitations of the Study

The study explores the role of financial sector development and tax policies in the relationship between FDI and environmental risk in Africa. Data availability of the tax policy variables is a key issue within this study. The data problem makes it difficult to find a standard environmental tax variable which is uniform across Africa. The authors resort to the corporate tax rate and assume that any specific environmental tax may mimic the nature of corporate tax existing in the resident country. The authors acknowledge that although the corporate tax rate is not originally designed

to regulate the effect of FDI on the environment, it can be the closest proxy given the current circumstance. Since corporate tax is used to attract inward FDI, it can also be used to direct FDI into sectors that either worsen or improve environmental quality.

Further, another challenge for this study is the non-availability of data on carbon taxes in Africa. South Africa is the only country in Africa that has implemented a carbon tax as of the end of 2021. This makes it difficult to conduct a study in this area. However, the authors overcome this challenge by constructing three different carbon taxes based on sound financial and economic assumptions.

1.7 Structure of the Thesis

Chapter One covers a general introduction to the research and identifies the problem the study seeks to address.

In Chapter Two, we discuss the broad literature that covers all the four empirical chapters of the thesis. The chapter offers a detailed review of both the theoretical and empirical literature and attempt to situate the thesis in the context of the available studies. The chapter also defines and explains key variables and their measurements.

Chapter Three contains the first empirical chapter of the study. It addresses the objective one of the theses and is entitled "Foreign Direct Investment and Environmental Risk: the role of Financial Sector Development". In this chapter, the authors examine the role of financial sector development in the relationship between FDI and environmental risk by adopting Sahey et. al. (2015) broad based measurement of financial sector development into the international capital and climate change debate. We apply the system GMM techniques to accommodate the dynamic nature of the dataset and make provisions for endogeneity and heteroskedasticity in the series.

Chapter Four addresses objective two of the thesis and is titled "Environmental Risk and Foreign Direct Investment: the role of financial deepening, access and efficiency". In this chapter, we employ a dynamic panel of 45 economies from 1982 to 2018 and decomposed the financial sector development indicator into its three key determinents (depth, access, and efficiency) to investigate whether they can help to overturn the negative impact of FDI on the environment.

Chapter Five contains the empirical chapter that addresses objective three of the thesis. In this chapter, we use various empirical models to examine the moderating efficacy of tax policy in the relationship between FDI and environmental risk. We explore whether countries with 'weak' or better still low tax rates attract 'dirty' FDI to deteriorate their environment.

Chapter Six is the empirical chapter four and addresses objective four of the thesis. In this chapter, we open up the frontiers to the discussions on the implications of carbon tax introduction on the free movement of international capital. This chapter expands the discussion on the carbon tax to question the snail-paced of its implementation in Africa. A carbon tax can deter dirty industries from polluting the environment and at the same time generate revenue to augment public funds. Despite these benefits, only South Africa has introduced a carbon tax across Africa. The lack of enthusiasm among African countries to implement carbon tax necessitated this research, perhaps, the effect of carbon tax transcends beyond emission reduction.

Finally, in Chapter Seven, we summarize the findings of this work, conclude based on the findings and provide recommendations for policy and future research.

1.8 Chapter Summary

This chapter presented an introduction to the thesis. In doing so, it provided a background to the thesis, identified the problem, stated the research questions and objectives, and explained the significance of the thesis. It also presented the scope and structure of the thesis.

CHAPTER TWO

LITERATURE REVIEW

CHAPTER TWO

LITERATURE REVIEW

2.1 Chapter Introduction

The relationship between FDI and environmental risk is well known in both the theoretical and empirical literature. In this chapter, the authors discuss the conceptual framework for the study and review topical highlights in the literature. The chapter also establishes the role of financial sector development and tax policies in accounting for the impact of FDI on environmental risk. The theoretical review focuses on the definition of key concepts and theories relating to environmental risk, FDI, financial sector development, and tax policies.

In addition, four major strands of the empirical literature are discussed. First, we examine the relationship between economic growth and environmental risk. Second the effect of FDI on environmental risk. Third, the study investigates the effect of financial sector development on environmental risk. We look at the role of financial sector development in the FDI-environmental risk nexus. Finally, the chapter reviews the literature on carbon tax and the role of tax policies on the effect of FDI on environmental risk

2.2 Environmental Risk and Economic Activities

Ustohalova (2011, p. 603) defines environmental risk as "the probability and consequence of an unwanted environmental accident". Ustohalova (2011) further elucidates that the likelihood of environmental risk occurrence is due to deficiencies in waste management, waste transport, and waste treatment and disposal, which cause serious threats to human health. Additionally, Xu and Liu (2009) explain environmental risk as the risk that an organization's (human) activities may emit toxic gasses or deplete resources in such a way that it brings actual or potential negative effects on the ecological system. According to Ustohalova (2011), the impact of environmental risk can be assessed at two levels: the global and local impacts. The global impact of environmental

risk is where carbon dioxide, methane, and other harmful gases are released into the ecosystem and their effects go beyond the borders of the emitting country. These dangerous gases contribute to the increasing threat of climate change. The local impact of environmental risk on the other hand contributes to the contamination of the immediate environment. This often occurs through the release of harmful chemicals into the soil which affects groundwater, carbon monoxide from cars, and reactive waste substances, among others. The local impact of environmental risk usually comes with immediate health and environmental complications. The existence of environmental risk in business operations has led to categorizing industries into destructive and non-destructive sectors. An industry is described as destructive if its operations lead to "over-consumption of natural resources - forests, fisheries, wetlands, rivers, etc., and causes pollution of air, water, and land" (Bazerman & Hoffman, 2000).

Largely, the environmental risk does not occur in a vacuum. Environmental risk occurs as a result of human activities, making it anthropogenic. The anthropogenic nature of environmental risk offers clues to the causes, drivers, as well as solutions to environmental risk. One human activity identified as a major driver of environmental risk is economic growth (Stern, 2002; Dasgupta, et. al., 2002; World Commission on Environment and Development, 1987).

Environmental risk is the by-product of economic growth. The environmental impact of economic growth (activities) as popularized by Grossman and Krueger (1991) in their Environmental Kuznets Curve (EKC) hypothesis suggest that economic growth reduces the quality of the environment. This is because economic growth requires expansion in economic activities which in turn place a huge demand on the factors of production. Classical economics have identified land, capital, and labour as the basic inputs of production. Land (environment) provides the physical

capital and the natural resources required for production activities. A critical attribute of land is that it is fixed in supply (Kaika & Zervas, 2013). The fixed nature of the land and in this case the environment places constraints on the absorptive capacity of the waste resulting from production. The over-accumulation of production waste trapped within the environment is what has been identified as the main cause of climate change. The likelihood that these economic activities may lead to more carbon emissions has been well articulated (Meadows et al., 1992).

2.3 The Pollution-Income-Relationship (PIR) and EKC

The relationship between pollution and income has been a thorny subject for both research and policy to settle. But it all began with the seminal work of Kuznets (1955) who postulated a quadratic relationship between economic development and income inequality. Kuznets (1955) believes that income inequality rises at the initial stage of economic development and then falls at a higher level of economic development leading to an inverted U-shape in what has been termed the Kuznets Curve. Later in 1993, Panayotou expounded on this frontier and tested the Kuznets Curve assumption within the scope of environmental degradation. Panayotou (1993) found that at the beginning stage of economic development, pollution rises and declines when economic development has exceeded a certain threshold.

Hence, developing countries will emit more pollution than developed nations. Panayotou (1993) further suggest that, unlike developing economies, developed countries can acquire advanced technologies and improved production processes that help reduce pollution. Consequently, Panayotou (1993) proposed an inverted U-shape between economic development and environmental quality. This is what is popularly known as the Environmental Kuznet Curve (EKC). It should be mentioned that the EKC was not proposed by Kuznets (1955) but it is so-called because Grossman and Krueger (1991) and Panayotou (1993) built the EKC theory within

the original assumptions of the Kuznet income-growth theory. Chronologically, Grossman and Krueger (1991) had earlier established the inverted U-shaped relationship between per capita income and pollution concentrations using samples from North American countries. Grossman and Krueger (1991) use comparable measures of three air pollutants in a cross-section of urban areas located in 42 countries to study the relationship between air quality and economic growth. The results from their empirical estimation models show different concentration levels at different levels of economic growth.

Specifically, two out of the three pollutants – sulfur dioxide and smoke recorded high emission concentrations at lower per capita GDP but the level of concentrations reduced as the level of per capita GDP increased. The inverted U-shaped of the EKC makes more sense when analyzed in the light of Maslow's theory of the pyramid of needs (Maslow 1943). At the early stage of a country's economic development, there is little motivation to protect the environment. Resources are rather channelled into achieving the basic needs of the nation which can be likened to the bottom of the Maslow's needs pyramid; hence, economic development is pursued at the expense of environmental sustainability. The concern for the environment is almost an afterthought to development. It is the reason why rich nations are more likely to show concern for the environment than poor nations (Grossman & Krueger, 1991).

Recent studies like Bandyopadhyay and Rej (2021), Destek (2020), Hasanov et. al. (2019), Isik, Ongan, and Özdemir (2019) report empirical results which are consistent with the EKC theory. Zakaria and Bibi (2019) confirm the EKC in the South Asia panel study for the period 1984-2015 by positing that a 1% increase in economic growth worsens the environment by 1.709%; however, a further increase in economic growth improves the environment by 0.104%.

Nevertheless, other studies have contended the claims put forward by the EKC. For example, Stern (2004) posits that countries do not necessarily follow the EKC trajectory of economic development and that some developing countries show more concern for the environment than developed countries. In the words of Stern (2004, p.1419) "if the EKC hypothesis were true, then rather than being a threat to the environment, economic growth would be the means to eventual environmental improvement". This point is further supported by the current data from the World Bank's World Development Indicators which suggest that developed nations continue to emit more pollution than developing countries (World Bank, 2020). The inverted 'U' shape in the EKC is not supported by the current emission data in the global regions. This cast doubt on the perceived turning point at which economic growth enhances environmental quality.

However, there is a thin line between Stern's ideologies and the EKC. The main point of departure is that Stern believes that environmental quality can be integrated at every stage of economic development rather than pushing it to the end of economic development. Postponing environmental considerations into the future may come with a very high cost of repairing the environmental damage caused by economic development. It is on this basis that the concept of sustainable development and the circular economy is founded. The concept of economic sustainability or sustainable development as introduced by the Brundtland Commission Report "Our Common Future" believes that current economic growth should not endanger the ability of future generations to meet their own needs (World Commission on Environment and Development, 1987).

On the other hand, the concept of circular economy advances the idea of a cyclical system of production where economic resources are shared, recycled, and reintroduced into the economy

(Kneese, 1988). The circular economy minimizes pollution and waste, recycling production factors, and regeneration of the environment.

Additionally, other empirical studies doubt the EKC claims and have since advocated for sustainable development. For instance, Demissew-Beyene and Kotosz (2020) study the economic growth path of 12 eastern African countries and argue that developing countries depart completely from the EKC. Demissew-Beyene and Kotosz (2020) stress that countries can grow and achieve environmental sustainability together. Gill, Viswanathan, and Hassan (2018) also think that the EKC exists in the empirical literature due to weak econometric models used in arriving at the various results and conclusions. Additionally, the EKC studies are biased by choice of countries, data quality, and mismatched time scales (Busa, 2013). Hasanov, Hunt, and Mikayilov (2021) added that the EKC could have been possible in the prior studies due to weak specifications, inappropriate indicators/variables, and lack of data.

Most importantly, it is not within the ambit of this study to point out which side of the economic growth and environmental sustainability argument is right or wrong. It is the authors' firm belief that the two extremes of the Pollution-Income-Relationship theories may be valid depending on the assumptions and constrained imposed on them. This study draws the strength from these theories to examine the role of financial sector development in the relationship between FDI and environmental risk.

2.4 Capital needs, FDI and Economic Activities in Africa

Financing economic activities to promote development has not been easy in the African region. Poor domestic revenue mobilization coupled with low private savings makes it difficult to mobilize the needed capital resources to finance economic activities. In Figure 2.1, the authors use data from the OECD to illustrate the main financing sources for Africa. In Figure 2.1, it is observed that

public revenue consist of taxes, fines, loans, grants, and others contributes about 41% to the total financing to Africa (OECD, 2021). Africa's public revenue is highly driven by loans due to low domestic revenue mobilization.

The IMF (2020b) reports that the average domestic revenue mobilization as a percentage of GDP has been 14.8% between 1990 and 2019. The bank further estimates that the post-pandemic could trigger a sharp decrease in the domestic revenue mobilization in the region. Hence, other sources of finance like foreign capital inflows are needed to fill the eminent capital gap. Moreover, foreign capital contributes at least 19% to the capital needs of Africa. One significant component of foreign capital is FDI contributing an average of 24% (see Figure 2.1). Like any other capital source, FDI plays a critical role in the economic development of Africa. In the World Bank (2020) World Development Indicators dataset, foreign direct investment is defined as the direct investment equity flows in the receiving country. It comprises ordinary share capital, reinvestment of earnings, and other capital. The World Bank (2020) expatiate that FDI is a typical cross-border investment associated with a resident in one economy having control or a significant degree of influence on the management of an enterprise that is resident in another economy. For an investment to constitute FDI, the ownership of the equity stake qualifying for voting should be 10 per cent or more.

The relevance and uniqueness of FDI to the economic fortunes of a country are summed up by Ajayi (2006):

"The benefits of FDI include serving as a source of capital, employment generation, facilitating access to foreign markets, and generating both technological and efficiency spillover to local firms. It is expected that by providing access to foreign markets, transferring technology and

generally building capacity in the host country firms, FDI will inevitably improve the integration of the host country into the global economy and foster growth".

The effect of FDI on the host nations' economies has been variously researched. The findings point out that FDI affects the economy of the receiving nation positively (Alfaro et al., 2004; Durham, 2004; Li & Liu, 2005; Borensztein et. al., 1998). And even in cases where the FDI does not bring actual cash inflows, it improves the receiving nations' technical know-how through improved managerial skills, advanced technology transfer, and enhanced production processes (Li & Liu, 2005).

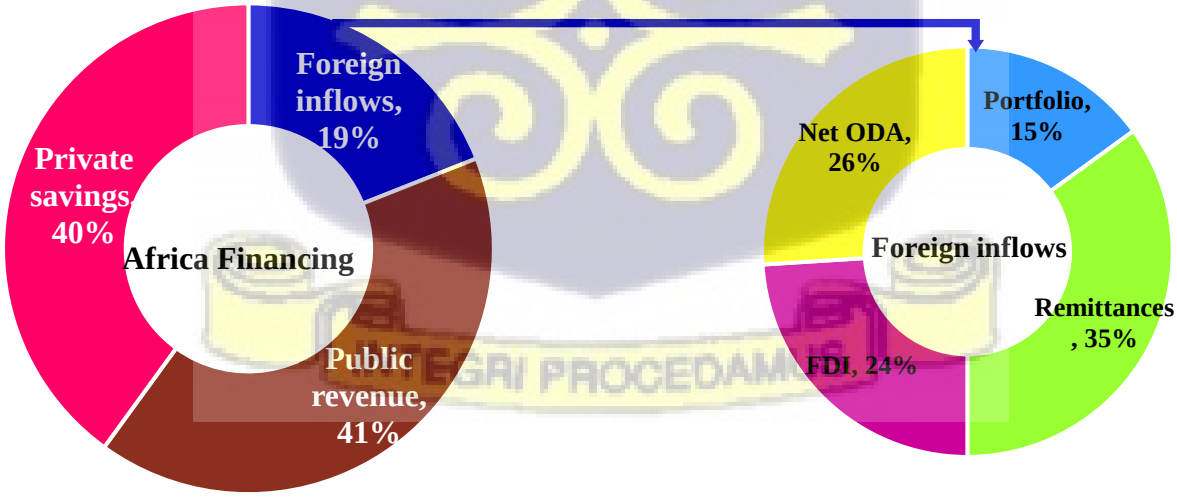
Borensztein et. al. (1998) investigates the effect of FDI on economic growth in a cross-country study of 69 developing countries over two decades. Their regression results show that "FDI is an important vehicle for the transfer of technology, contributing relatively more to growth than domestic investment". Recently, Asafo-Agyei and Kodongo (2022) built a panel of 25 countries in Sub-Saharan Africa over 23 years and used the Borensztein et. al. (1998) approach to retest the effect of FDI on economic growth. Their threshold regression which controls for nonlinearity affirmed the findings of Borensztein et. al. (1998), that FDI has an appreciable impact on economic growth.

Again, in a separate study Opoku, Ibrahim, and Sare (2019) examine the role of FDI in the economic development of Africa using the system generalized method of the moment (GMM). They found that FDI affects African growth through the various productive sectors of the economy. They further report that the agricultural sector is the main channel through which FDI influences economic growth in Africa. The sectorial channel is part of what Asafo-Agyei and Kodongo (2022) termed the FDI absorptive capacity of the economy. The existence of the absorptive capacity can

ensure that FDI minimizes income inequalities. A study by Kaulihowa and Adjasi (2018) on the relationship between FDI and income inequality reveals that with the existence of the required absorptive capacity the dividends from FDI can increase the equality in the distribution of income among African countries.

Notwithstanding, other studies believe that FDI is overhyped and does not have a direct effect on economic growth. Such studies advance that in the absence of key factors like human development, institutions, financial sector development, and natural resources, FDI may not benefit the domicile countries as reported in the literature. For example, extant empirical studies have argued that for FDI to be growth-enhancing, the host nation should have access to key factors such as the quality of institutions or governance (Agbloyor, 2019; Busse & Groizard, 2008), the level of human development (Shahrivar & Jajri, 2012; De-Mello, 1997) and the level of financial sector development (Osei & Kim, 2020; Agbloyor et. al., 2013; Alfaro et. al., 2004).

Figure 2.1: Africa's financing options



Source: Authors' construct, Data from OECD (2020).

2.5 FDI and Environmental Risk

Empirical evidence shows that economic activities among other factors are underpinned by the availability of capital resources (McKinnon, 2010; Borensztein, De Gregorio, & Lee, 1998; Khan & Reinhart, 1990). This is the reason the empirical literature is tilting towards investigating the effect of capital resources on environmental risk (Frutos-Bencze, & Kulvanich, 2017; Zheng & Sheng, 2017; Zhu, et. al., 2016; Jorgenson, et. al., 2007). Undoubtedly, Africa lacks all the capital needed to finance its economic growth (Sachs et al, 2004; Burnside & Dollar, 2000). The capital constraints in Africa translate into fewer economic activities which subsequently account for the low carbon dioxide emissions (World Bank, 2020; Panayotou, 1993). This implies that Africa's lack of capital is the main reason for low carbon dioxide emissions. Therefore, all other things being equal if the capital constraints are removed, Africa like any other global region will increase its carbon dioxide emissions.

One capital source often linked to carbon dioxide emissions is FDI. The environmental effect of FDI is of particular interest for several reasons. As advanced countries get richer, they tighten environmental laws, making it expensive for carbon-intensive firms to continue operations. These firms relocate, mostly into developing and emerging economies with less stringent environmental laws. It is the more reason why extant studies report that FDI worsens environmental risk. For example, Singhania and Saini (2021) study the relationship between FDI and environmental sustainability using a sample of 21 countries between 1990 and 2016. The results from their dynamic system GMM indicate that FDI has a significant positive effect on environmental risk. Singhania and Saini (2021) believe that FDI takes advantage of the lack of a mandatory statements of environmental disclosures to degrade the environment. They contend that the absence of strict laws to regulate the environmental reporting of FDI contributes to its negative

effect on the environment. Additionally, the effectiveness of environmental laws influences FDI relocation decisions. Multinational companies are more likely to move out from jurisdictions with strict environmental laws.

Zhang and Fu (2008) confirm this position when they investigated the stringency of environmental regulations and their effect on the choice of location for FDI among 30 provinces in China. They conclude that FDI prefers to locate in regions with relatively weak environmental regulations. Shahbaz et. al. (2018) on the other hand estimated the effect of FDI on carbon dioxide emissions in France using a 62-year time series. They find that FDI negatively influences the quality of the environment in France. In Africa, Bokpin (2017) built a panel of 24 countries to explore the impact of FDI on environmental sustainability. The empirical results show that FDI significantly increases environmental risk in Africa.

Also, Halliru et. al. (2021) study the environmental effect of FDI in Westen Africa and find results consistent with Singhania and Saini (2021), Shahbaz et. al. (2018), and Bokpin (2017). Studies such as Frutos-Bencze, and Kulvanich (2017), Zheng and Sheng (2017), Omri, et. al. (2014), Sbia, et. al. (2014), and Jorgenson et. al. (2007) has all found an adverse effect of FDI on the quality of the environment. All the studies that report that FDI toxifies the environment lean on the pollution-haven hypothesis. This suggests that, when multinational companies (MNCs) are considering setting up international branches, they locate countries with the cheapest resources in terms of land, material, and labour (Levinson & Taylor, 2008). According to the theory, this practice accounts for the reasons why developing countries with cheap resources attract carbon-intensive MNCs. Firms by nature are profit-oriented and would explore every opportunity to reduce cost; hence, MNCs will easily locate countries with lax environmental standards when the need arises. Environmental standards affect firms' margins, influence investment location decisions, and

contribute to a country's competitive advantages which are key factors in determining FDI inflows. There are also snowballing games countries play which worsen the environmental effect of FDI. In the snowballing game countries deliberately set environmental standards below their counterparts or the internally required levels to attract FDI (Millimet & Roy, 2016). The environmental cost consideration of FDI is what makes a section of the literature believe in the existence of the pollution-haven hypothesis.

Conversely, other scholars disagree with the claims put forward by the proponents of the pollution-haven hypothesis by citing several weaknesses like inappropriate measurements and weak empirical support (Kim, & Adilov, 2012; Hoffmann, et. al., 2005). Demena and Afesorgbor (2020) conduct an extensive literature review of studies that have investigated the effect of FDI on carbon dioxide emissions. They cited issues such as differences in data samples (mixing developed with developing countries), econometric techniques, diversities in environmental indicators, and a host of varying control variables as the main factors accounting for the inconsistencies in the literature.

The use of varying levels of development and emissions heightens the heterogeneity problems in the myriad of studies available, that is why the meta-analysis by Demena and Afesorgbor (2020) produce 1006 elasticities in the results. They further report that the underlying effect of FDI on environmental emissions is close to zero; however, after accounting for heterogeneity in the studies, they find that FDI significantly reduces environmental emissions. Following this, the Pollution-halo hypothesis has been suggested as an alternative theory. The Pollution-halo hypothesis suggests that FDI rather enhances the quality of the environment (Hines & Rice, 1994). Kim and Adilov (2012) argue that most FDI comes from developed countries with strict

environmental regulations, hence, they can transfer superior environmental technologies to the host nation. The dissemination of superior environmentally friendly technologies helps train the local workers in good environmental practices.

Again, MNCs are believed to transfer improved production processes which influence local firms' production process decisions (Wang, Dong, and Liu (2019). Some of these improved production processes are cheaper and more efficient than what is available locally. Locals end up copying from MNCs to neutralize competition advantages. Eventually, MNCs lead the way in promoting environmental sustainability in the host nation. Based on the pollution-halo hypothesis, Nepal, et. al. (2021) points out that, the adoption of energy-efficient techniques through FDI is important in cutting down carbon dioxide emissions. They employ a multivariate framework to investigate the role of FDI in energy use and carbon dioxide emissions in India over 39 years. Their ARDL model and VECM Granger causality tests reveal a strong long-run relationship between FDI, energy use, and carbon dioxide emission. They conclude that a 1% increase in FDI reduces energy use by 0.013% and since the energy-use granger cause output, carbon dioxide in effect will decrease.

Again, Shao (2017) use an extended cross-section of 188 countries between 1990 and 2013 to study the effect of FDI on carbon intensity. The results for the system GMM estimation process reveal that FDI hurts carbon intensity. Shao (2017) further divided the sample into three different income groupings (high-income, middle-income, and low-income countries) to retest his objectives. In all three scenarios, the findings suggest that FDI is effective in reducing carbon intensity.

Wang, Dong, and Liu (2019) study the effect of Beijing's direct investment in promoting integrated development and tackling regional environmental problems since 2014. Their results show that

Beijing's direct investment is conducive to reducing industrial pollution emissions in the host administrative units, a pollution halo effect, and a win-win situation for both Beijing and its neighbours. More also, there are green FDIs that seek to contribute to a cleaner environment. For that reason, generalizing all FDIs as bad by the pollution-haven hypothesis could be an error in the literature. In Africa, Duodu et. al. (2021) tested the FDI pollution-halo effect among 23 sub-Saharan African counties using the GMM estimation approach. The results show that FDI enhances the quality of the environment in Africa, especially in the long run. Similar findings relating to Africa have been reported by Mesagan (2021) and Ngonadi et. al. (2020).

The argument for and against the role of FDI in environmental sustainability raises questions on whether the effect of FDI on the environment is direct or indirect. But we can take lessons from the effect of FDI on the economy. Various studies have argued that the role of FDI on economic development is contingent on local factors such as the quality of institutions or governance (Agbloyor, 2019; Busse & Groizard, 2008), the level of human development (Shahrivar & Jajri, 2012; Borensztein, De Gregorio, & Lee, 1998; De-Mello, 1997) and the level of financial sector development (Osei & Kim, 2020; Agbloyor et. al., 2013). It is in the same way this present study is advancing that the effect of FDI on the environment is contingent on the same growth factors. Following this, Bokpin (2017) investigate the effect of FDI on environmental quality conditioned on domestic institutional factors. And reported that the effect of FDI is moderated by the effectiveness of institutions in the host nations. Unfortunately, human development is not a catalyst for environmental quality. Rather, there is an adverse reverse causality running from environmental risk to human development (United Nations, 2015; Chaudhry & Ruysschaert, 2008). What is hanging in the literature is the role of financial sector development in the

relationship between FDI and environmental risk. This study takes inspiration from Bokpin (2017) and extends the FDI-environment contingency to financial sector development.

The role of financial sector development in economic development is well documented. Leading studies like King and Levine (1993) and Alfaro et. al. (2004) think that the financial sector is the first entry point that receives, distributes, and directs FDI into the various sectors of the economy. Where the FDI goes matters in influencing economic activities and environmental risk. Again, Schumpeter (1911) argued that a well-developed financial sector facilitates capital accumulation and advanced technology to spur economic activities. The effectiveness of the financial system can drive the direction and impact of FDI on the environment.

2.6 Financial Sector Development (FSD) and Economic Growth

The financial system is a key player in the sourcing and disbursing of funds for economic activities. The financial health of any economy is highly influenced by the development in the financial sector. Reuttner et. al. (2012) in the 2012 Financial Development Report by the World Economic Forum defines financial development as "the factors, policies, and institutions that lead to effective financial intermediation and markets, as well as deep and broad access to capital and financial services". Alternatively, Levine (2005) describes the financial system as a complex unit of markets, institutions, and regulatory frameworks that guides financial transactions. Levine (2005) further argues that the financial system plays five fundamental roles in the economy. These include:

i. providing information ex-ante about investment and capital allocation,
ii. monitoring investment and enforcing corporate governance to ensure funds provided achieve the needed objectives,

iii. aiding trading, diversification, and risk management,

iv. mobilization and pooling savings,

v. easing the exchange of goods and services.

These functions of the financial system are traditionally at the heart of the financial intermediation theory which suggest that financial systems exist to reduce traction cost and information asymmetry (Allen & Santomero, 1997). For businesses to thrive in the real sector, economic actors must have trust and confidence that parties to transactions will deliver. But the trust and confidence are often impaired due to hidden actions and unexpected circumstances.

The financial system then becomes the third party or the intermediary to provide the trust and confidence needed in the real sector. This creates a direct link between the financial system and the real sectors of the economy. By extension, financial development focuses on reducing the cost of obtaining funds and information and facilitates contract enforcement. Thus, financial development ensures that the financial system performs the five functions efficiently and effectively.

It is undeniably clear in the literature that financial sector development promotes economic growth. This is because of the direct link between capital accumulation and economic activities. Schumpeter (1912) draws a relationship between financial development and innovation by advancing that a well-developed financial system locates entrepreneurs that have the best chances of bringing innovative products that will excel. Bagehot (1873), and Hicks (1969) have long argued that England's industrial revolution was ignited by the developments in the financial sector that facilitated capital mobilization. Levine (1997) also reviewed a series of cross-country, case-

study, industry-level, and firm-level studies, and conclude that financial development critically influences the speed and pattern of economic growth. Different studies have identified various channels through which financial development leads to economic growth. King and Levine (1993) tested the finance-growth nexus using a panel of 80 countries between 1960 and 1989 and report that financial development promotes economic developments by enhancing physical capital accumulation and efficient allocation of resources. In a similar study, Benhabib and Spiegel (2000) argue that financial development boosts investments to enhance economic growth. In recent times, Xu and Tan (2020) and Yang (2019) report findings that support the earlier studies that financial development contributes significantly to economic growth through the channels of physical capital stock and total factor productivity.

Again, in a sample of developing, emerging, and advanced economies Botev, Égert, and Jawadi (2019) argue that 'too much finance' does not hurt economic growth. In the African context, Muyambiri and Odhiambo (2018), Ibrahim and Alagidede (2018), and Bist (2018) posit that economic growth is underpinned by the level of physical capital which in turn depends on financial development. Moreover, technological progress is another important channel through which financial development enhances economic outcomes (Ibrahim & Alagidede, 2018; Han & Shen, 2015). Again, the link between financial development and economic growth is reinforced by two extreme theories of growth: the neoclassical and endogenous growth theories (Eggoh & Villieu, 2014; Adu, Marbuah, & Mensah, 2013).

If financial development is treated as an exogenous factor by the neoclassical theory, it will result in technological progress to augment labour and capital. But if financial development is endogenized it plays the role of resource mobilizer and efficient allocator of resources within the production chain.

There are, however, some limitations that have been levelled against the idea that financial development promotes economic outcomes. Researchers like Lucas (1988) and Arcand, Berkes and Panizza (2015) are of the view that the role of financial development in economic growth is over-stressed. Arcand et. al. (2015) argue that financial development hurts economic growth and that there is a vanishing effect if an economy has 'too much finance'. Law and Singh (2014) add that the positive effect of financial development is only up to a tipping point and beyond that point, further financial development reverses economic growth. Zhu, Asimakopoulos and Kim (2020) raise four limitations of financial development:

i. expansion in the financial sector would hurt innovation and innovation-led growth.
ii. countries with a higher level of financial development have a lower rate of innovation.
iii. the vanishing effect between finance and innovation transmits to innovation-led growth.
iv. effect of innovation on growth becomes smaller with a developed financial sector.

2.7 Financial Sector Development and Foreign Direct Investment

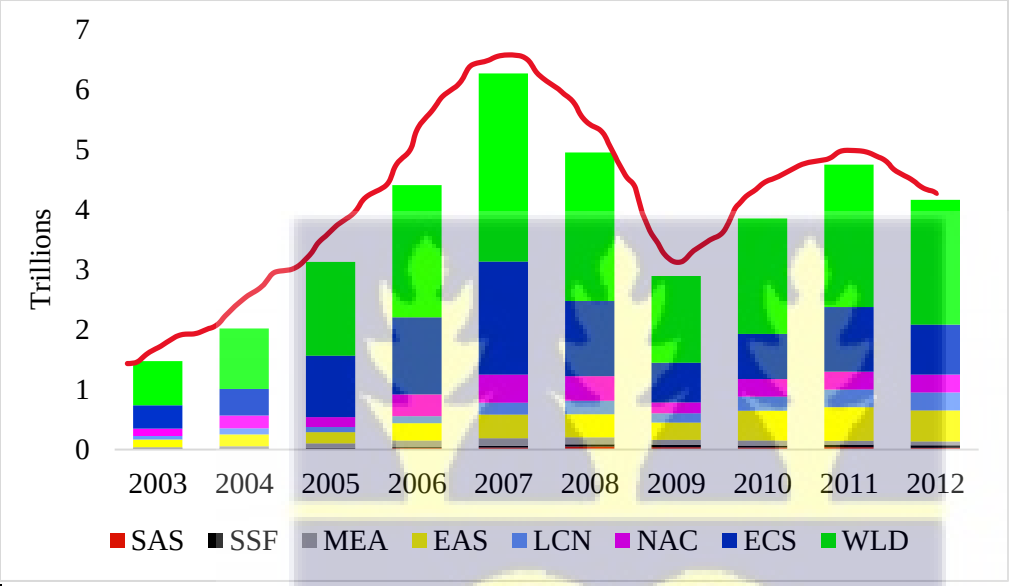
The economic benefits of foreign direct investment have spewed volumes of studies interrogating local factors required in attracting it. Factors such as corporate tax rates, natural resource endowments, labour market, culture, institutional quality, and market size have been identified as favourable conditions for attracting FDI (Uddin et al., 2019; Bokpin et al., 2015; Eicher, Helfman, & Lenkoski, 2012). Certainly, the financial sector development cannot be ruled out of these factors (Islam et. al., 2020; Desbordes & Wei, 2017). Yao, Chen, and Zhang (2021) attribute the increase in China's FDI post World Trade Organization (WTO) admission to the development of the financial systems. They argue that a 1% improvement in financial sector development raises FDI by 3.77%.

Financial development can influence FDI direction in four ways. First, the existence of a well-developed financial system enables foreign firms to borrow locally to finance subsidiaries. Financing subsidiaries with locally sourced funding reduces the foreign investors' exposure to interest rates and exchange rate volatilities (Desbordes & Wei, 2017). The financial system further provides the avenue for repatriating profit made in the local economy. Second, the existence of a financial system reduces information asymmetry usually faced by foreign firms. Where the financial system is less developed, the uncertainties about the business environment are high and this has been identified as part of the reasons why foreign firms fail (Dunning, & Lundan, 2008). But in a developed financial system, the local lenders volunteer information to foreign firms, especially because they have an interest in the survival of multinational firms. Third, Nkoa (2018) argues that the existence of insurance companies within the financial system provides assurance and security to the investment of foreign firms. Lastly, cost reduction is pivotal to financial sector development (World Bank, 2013).

The reduction in the cost of financial services lessens the operational cost for both local and foreign firms. The relevance of financial development in accounting for FDI flows became louder in the wake of the 2007/2008 financial crisis. The UNCTAD (2010) report on World Investment Report attributes the rise and fall in the global FDI to the disruption in the financial system. This assertion is further reaffirmed by Figure 2.2 of this study. Before the disruption in the financial sector, global FDI flows were growing steadily at an average rate of 24% per annum between 2003 and 2007 but the crisis brought the growth to a halt. The post-2007/2008 financial crisis saw FDI taking a nose dive until 2010 (see Figure 2.2). Again, the externalities of the 2007/2008 financial crisis which originated in the United States of America affected FDI supplies across all global regional blocs.

The non-monotonic pattern of the global FDI flows runs through all the seven (7) regional groupings as illustraded in Figure 2.2: South Asia (SAS), Sub-Saharan Africa (SSF), Middle East & North Africa (MEA), East Asia & Pacific (EAS), Latin America & Caribbean (LCN), North America (NAC), and Europe & Central Asia (ECS).

Figure 2.2: Global Regions' share of FDI (pre-post 2007)



Percentage Growth in Global FDI

2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
-2%	27%	35%	29%	30%	-27%	-71%	25%	19%	-14%

Source: Authors' construct, Data from World Bank (2020).

Albeit the extent to which the local financial system is integrated into the international markets influences the level of FDI receipts. The recent developments in Africa's financial system are deepening financial integration with the international financial markets. This is making the region a preferred destination for foreign direct investment (UNCTAD, 2019). Studies within the African context have produced results consistent in the wider literature. For instance, Nkoa (2018) uses the dynamic panel model technique to examine the impact of financial development on FDI in 52

African economies between 1995 and 2015. They report that all the different measures of financial development in, namely, money and quasi-money, banking credit to the private sector, and interest rate liberalization play a positive role in FDI inflows. Agbloyor et al. (2013) employing a two-stage least squares panel instrumental variable approach to obviate simultaneous causality bias with annual data from 1970 to 2007 found that the level of development in the financial system is a precursor to the quantum of FDI inflows to Africa. Adam and Tweneboah (2009) study the finance-FDI nexus using the multivariate cointegration and error correction modelling with quarterly data from 1991 to 2006. Their study reports a long-run relationship between the financial development proxy (stock market development), and the FDI.

Other strands of studies argue that financial sector development does not only aid in attracting FDI but also determine whether the host country profit from it. Studies including Osei and Kim (2020), Agbloyor et al. (2013), Sghaier and Abida (2013), and Alfaro et al. (2004) share the view that the financial sector development is a gatekeeper both to the entrance of and exit of FDI. Thus, the financial sector development influence where the FDI goes. This point is well articulated by the allocative efficiency function of the financial system. The financial system channels the FDI into the most productive sectors of the economy which can make profitable use of it. The financial system then becomes the conduit through which FDI influences economic outcomes. However, inefficiencies in the financial system compromise its allocative abilities and may divert financial resources from deserving firms. A weak or inefficient financial system heightens information asymmetry and distorts investment decisions. The impairment of the fundamental functions of the financial system rolls back the expected gains from both local and foreign funds and does not augur well for the overall economy. It is the more reason why a section of the literature thinks that the

effect of FDI on economic developments hinges on the absorptive capacity of the local financial system. Sghaier and Abida (2013) examine the effect of FDI on economic growth in a panel of 4 countries in North Africa (Tunisia, Morocco, Algeria, and Egypt) from 1980 to 2011. The paper concludes that the effect of FDI is contingent on the absorptive capacity of host countries, with particular respect to the development of the domestic financial system. Alfaro et al. (2004) examine channels through which FDI affects economic growth using panel data from 1975 to 1995 and find that the role of FDI in accounting for economic growth becomes ambiguous when financial development is omitted.

However, countries with well-developed financial markets gain significantly from FDI. Alfaro et al. (2010) re-examined the moderating role of local financial markets in the FDI-growth nexus and confirm that an increase in the share of FDI leads to higher additional growth in financially developed economies relative to financially under-developed ones. Sirag, SidAhmed, and Ali (2018) analyze the contingency effect of financial sector development on the effect of FDI on economic growth in Sudan between 1970 and 2014 using the fully modified ordinary least squares and the dynamic ordinary least squares techniques. The findings reveal that FDI leads to better economic performance through financial development.

2.8 The role of FSD in the relationship between FDI and Environmental Risk

Having established the relationship between financial sector development and FDI, it is important to discuss the two in the context of environmental risk. The literature can be categorized into two: the effect of FDI on environmental risk and the effect of financial sector development on environmental risk. The former has been well articulated in the previous sections of this thesis; hence, this part of the study focuses on the effect of financial sector development on environmental

risk. More importantly, the authors extend the argument beyond the mere direct impact of FDI and financial sector development on environmental risk.

The literature on the effect of financial sector development on environmental risk has produced contentious results leading to a blur policy direction. For example, Saud et. al. (2020) investigates the role of financial development on environmental quality among selected 44 countries that are part of the One-Belt-One-Road program using the ecological footprint accounting system approach over the 1990-2014 period. The results from the pooled-mean-group estimation technique show that the ecological footprint measuring environmental degradation increases due to upsurges in financial development in 30 countries. They report opposite results for the remaining 14 countries. This makes it difficult to recommend the exact impact of financial sector development on environmental risk. The empirics in this area can be categorized into two positive and negative effect of FSD on environmental risk.

2.8.1 Positive effect of FSD on Environmental Risk

Extant empirical studies argue that the effect of financial sector development on environmental risk is positive and direct. Jalil and Feridun (2011) investigate the impact of financial development, economic growth, and energy consumption on environmental pollution in China from 1953 to 2006 using the Autoregressive Distributed Lag (ARDL). The results from their empirical strategy show a negative sign for the coefficient of the financial development, indicating that financial sector development in China has not taken place at the expense of environmental pollution. Zaidi et. al. (2019) determines the dynamic linkages between globalization, financial development, and carbon emissions in Asia Pacific countries under the framework of the EKC using panel data from 1990 to 2016. Their cointegration approach shows that financial development significantly reduces carbon emissions. Tamazian et. al. (2009) investigates the linkage between financial development

and environmental quality in panel data over the period 1992–2004 and find that financial development is effective at decreasing the environmental degradation in BRIC economies. Shahbaz et. al. (2013a) question whether financial development reduces carbon dioxide emissions or not in the case of Malaysia. Their empirical results show that financial development reduces CO_2 emissions. Yuxiang and Chen (2011) examine the capitalization, technology, income, and regulation effects of financial sector development and its impact on the environment using the provincial panel data of China. The econometric analysis from their study shows that financial development significantly improves environmental quality.

Shahbaz et. al. (2018) explores the determinants of carbon emissions in France by accounting for the significant role of financial development in influencing carbon dioxide emissions using bootstrapping bounds testing approach. The findings from their study show that financial development lowers carbon emissions, thereby improving the French environmental quality.

Moreover, Kirikkaleli, Güngör, and Adebayo (2022) investigate the effect of financial development on consumption-based carbon dioxide emissions in Chile using autoregressive distributed lag (ARDL) bounds with Kripfganz and Schneider's (2018) approximations, fully modified ordinary least square (FMOLS), and dynamic ordinary least square (DOLS) techniques. The findings from their empirical models reveal that financial development reduces the consumption-based carbon dioxide emissions in Chile. Acheampong, Amponsah, and Boateng (2020) use a comprehensive panel dataset of 83 countries over the period 1980–2015 to investigate the impact of financial market development on carbon emission intensity, taking into account the various stages of financial development among countries. The results from their instrumental

variable generalized method of moment approach show that the overall financial market development and its sub-measures (depth and efficiency) reduce carbon emission intensity in the developed and emerging financial economies. Khan and Ozturk (2021) test both the direct and indirect effects of financial development on environmental pollution using the Environmental Kuznets Curve (EKC) framework among 88 developing countries during the 2000–2014 period. The outcome of their differenced and system generalized method of moments models show that financial sector development supports the pollution inhibiting role of financial development for the selected countries. And indirectly, financial development can reduce the adverse effects of income, trade openness, and FDI on pollution emissions.

2.8.2 Negative effect of FSD on Environmental Risk

A section of the literature reports an adverse effect of financial sector development on environmental risk. Zakaria and Bibi (2019) investigate the effect of financial development and institutional quality on the environment in South Asia for the period 1984-2015 and estimate that a 1% increase in financial development deteriorates the environment by 0.147%. They contend that in the absence of institutional quality, financial sector development is grievous to the environment.

Shahbaz et. al. (2016) examine the asymmetric impact of financial development on environmental quality in Pakistan using quarterly data for the period 1985Q1 to 2014Q4 and find that financial sector development impedes the quality of the environment. Shahbaz et. al. (2016) attribute the environmental harms of financial sector development to the high volume of credit that goes into the energy sector. They conclude that increasing financial access has consequences: investors increase investment in the energy sector and households increase consumption of pollution-intensive commodities. Again, Shahbaz et. al. (2013b) examine the linkages among economic

growth, energy consumption, financial development, trade openness, and carbon dioxide emissions from 1975 to 2011 in the case of Indonesia. The results from their vector error-corrected model (VECM) suggest that financial sector development Granger causes carbon dioxide emissions and recommend that financial development can be retooled to improve the environmental quality.

In a separate study, Shah, Yasmeen, and Padda (2019) argue that financial development is important for the growth of a country but indirectly affects the environment adversely through industrialization. In the same way Boutabba (2014) examines the long-run equilibrium and the existence of a causal relationship between carbon emissions and financial development in India and finds a long-run positive impact of financial development on carbon emissions. Boutabba (2014) further suggests that the long-run relationship is a unidirectional running from financial development to carbon emissions.

Zhang (2011) uses various econometric techniques, including cointegration theory, Granger causality test, and variance decomposition, to explore the influence of financial development on carbon emissions in China. The results indicate that China's financial development acts as an important driver for carbon emissions increase, which should be taken into account when carbon emissions demand is projected.

Jian and Ma (2019) examine the relationship between financial development and carbon emissions based on the system generalized method of moments using data of 155 countries, sub-groups into developed countries, and emerging market and developing countries. The empirical results indicate that from a global perspective, financial development significantly increases carbon emissions, and the analysis of the emerging market and developing countries reached the same conclusion; however, for developed countries, the effect of financial development on carbon emissions is

insignificant. Omri, Kahia, and Kahouli (2021) use the dynamic ordinary least squares (DOLS) to examine the ability of good governance in moderating the negative effect of financial development on environmental quality in Saudi Arabia over the period 1996–to 2016 and argue that the unmitigated effect of financial development on the environment is detrimental but the development of the financial sector reduces carbon emissions if it is accompanied by good institutional and political governance

2.8.3 Can FSD moderates the effect of FDI on Environmental Risk?

The literature shows evidence of both positive and negative effects of financial sector development on environmental quality. The same is reported for the FDI-environment nexus. Given the theoretical linkages between FDI-financial development-environmental quality, this study put forward two arguments. First, the financial sector (development) is a medium that connects financial resources/services to the real sectors of the economy and may not have a direct effect on the environment. Therefore, the effect of the financial sector on the environment at best may replicate the type of funds injected into it.

The financial sector plays an intermediary role between financial resources and the environment. However, its efficiency or otherwise matters in allocating financial resources. In the natural sense, a weak moderator is easily influenced. Therefore, a weak financial sector will mimic the type of funds received, and, if the funds are pollution-intensive, it will adversely affect the environment. On the contrary, if the level of the financial sector is well-developed and robust, it corrects market failure, and pollution-intensive funds' impact on the environment may no longer be direct. So, in this study, the authors test the effect of financial sector development on the FDI-environment nexus and further examine the level of financial sector development on the relationship.

Second, FDI can have a direct effect on the environment in the same way it does on economic growth without necessarily passing through any specific media. However, the literature is clear that the unmitigated effect of FDI on the economy and the environment is exploitive (Saini, 2021; Shahbaz et. al., 2018; Bokpin, 2017; Frutos-Bencze & Kulvanich, 2017; Zheng & Sheng, 2017; Omri et. al., 2014; Sbia, et. al., 2014; Jorgenson et. al., 2007). Hence, this study advocates that the level of financial sector development can moderate the effect of FDI on the environment.

The financial sector is selected for this study based on the advice of the literature. Institutional quality, human development, and financial development are three main factors that moderate the effect of FDI on economic outcomes (Agbloyor, 2019; Osei & Kim, 2020; Agbloyor et. al., 2013; Shahrivar & Jajri, 2012; Busse & Groizard, 2008; Alfaro et. al., 2004; De-Mello, 1997). These three factors may also determine the effect of FDI on the environment. That is why Bokpin (2017) examined the moderating effect of institutional quality on the FDI-environment nexus. The United Nations (2015), and Chaudhry and Ruysschaert (2008) examine human development and environmental risk and report adverse reverse causality running from the latter to the former. What has been marginalized in the literature is the role of financial sector development in the relationship between FDI and environmental risk.

Additionally, FDI may be less sympathetic to the environment, especially in cases where there is no direct or immediate cost for deteriorating the environment. On that basis, Zheng and Sheng (2017), Omri et al. (2014), and Sbia et al. (2014) investigated the effect of FDI on the quality of the environment. They report that FDI is bad for the environment. Due to this, the responsibility is on the local financial system to minimize the extent to which foreign direct investment freely

deteriorates the environment. Ntow-Gyamfi et. al. (2020), Acheampong (2019), Shahbaz et. al. (2018), and Riti et. al. (2017) believe that the level of financial sector development could be a panacea to the rising environmental risk. The findings from these studies have concluded that the level of financial sector development influences the direction of economic activities and subsequently the volume of carbon dioxide emission.

Shahbaz et. al. (2018) investigated the interrelationship between FDI, financial development, and energy innovation (energy consumption and energy research). They tested the effect of the three factors on carbon dioxide emissions. Their study shares some commonalities with this present research concerning the main constructs (FDI, FSD, and carbon emissions). However, the present study is different in several ways. Shahbaz et. al. (2018) only examine the individual effect of FDI and FSD on the environment. But the present study makes a case that the effect of FDI on the environment may not be direct as suggested by Shahbaz et. al. (2018), and thus influences the environment through some channels. Bokpin (2017) agrees with this assertion and has examined the institutional channels through which FDI affects the environment. This study has shown in the earlier sections that the channel yet to be explored is the FSD channel. Therefore, unlike Shahbaz et. al. (2018) the current study test the effect of FDI on environmental risk by conditioning the FDI on the level of FSD.

Besides, Shahbaz et. al. (2018) data sample is a time series drawn from France but this study uses Sub-Saharan Africa. It is obvious that the economic and environmental characteristics of the two samples are different and may result in varied conclusions. Again, the choice of variables to measure the main constructs are far apart. For example, this study uses the Sahay et. al. (2015) dataset on financial sector development which is considered to be more comprehensive to capture the full dynamics of FSD than the ones used by Shahbaz et. al. (2018) and other scholars.

2.9 Measurement of Environmental Risk and Financial Sector Development

The measurement of financial sector development and environmental risk is a contentious subject in the literature. There is no doubt that how research constructs are measured determines the methods and the eventual outcome of the study. This section explores the literature on the measurement of environmental risk and financial sector development and justifies the choice of measurement and the data for the current study.

Environment, environmental quality, environmental performance, environmental degradation, environmental pollution, ecological footprint, carbon footprint, emissions, carbon dioxide emissions, and carbon intensity are the different terminologies used in the literature to represent environmental risk.

The vast literature available is not divided on the measurement of environmental risk. The per capita CO_2 emission is widely used to proxy for environmental risk (see Table 2.1). The anthropogenic components of greenhouse gases are contributed by carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and other gasses like hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride. Carbon dioxide emissions from the burning of fossil fuels and the manufacture of cement, iron, and steel contribute the largest to the global greenhouse gas emissions (see Figure 2.3). It is of no surprise that the literature is almost concluding that the most appropriate measure of environmental risk is carbon dioxide emissions.

Again, this study has defined environmental risk as the risk that an organization's (human) activities may emit toxic gasses or deplete resources in such a way that it will bring actual or potential negative effects on the ecological system. The anthropogenic nature of carbon dioxide emissions best fits this definition; hence, this study uses carbon emissions to proxy environmental risk.

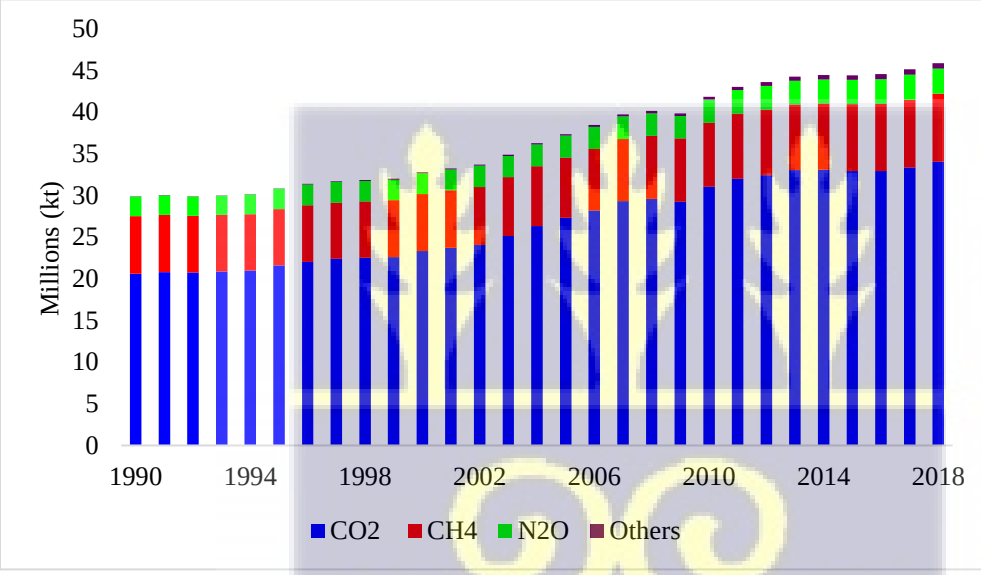
The measurement of financial sector development is highly contentious in the body of studies available. The lack of a standardized proxy for financial development is contributing to the contradictory findings in the empirical literature. In Table 2.1, the study presents an array of leading studies in the literature on how they measured financial development, and their findings. The diversity in the findings is revealed by the differences in the choice of financial development indicators.

The studies of Khan and Ozturk (2021), and Acheampong et. al. (2020) present a classical case of confusion in the literature. The two separate studies investigate the impact of financial development on carbon dioxide emissions using large samples and the same modelling techniques – the GMM. The two studies report contrasting results which echo the need for a standardized measurement for financial development. Whereas the study of Khan and Ozturk (2021) finds that financial development increases carbon dioxide emissions; Acheampong et. al. (2020) on the other hand find that financial market development and its sub-measures reduce carbon emission intensity.

Sahay et. al. (2015) argue that financial sectors have evolved across the globe and modern financial systems have become multifaceted, therefore multiple indicators are needed to measure them. They contend that the existing proxies for financial development are inappropriate to capture all the components and functions of the financial system. Many studies have narrowly used domestic credit to the private sector, stock market value traded, the ratio of deposit money to bank assets, stock market turnover, and broad money to measure financial development (see Table 2.1). An assessment of these variables reveals that they are largely financial depth indicators, hence, unable to capture the complexity of the modern-day financial systems. A good proxy for financial development according to Sahay et. al. (2015) should encapsulate a combination of depth (size

and liquidity of markets), access (the ability of individuals to access financial services), and efficiency (ability of institutions to provide financial services at low cost and with sustainable revenues, and the level of activity of capital markets). It is on this basis this study adopts the IMF data on financial development compiled by Sahay et. al. (2015). In Table 3.5 of the Appendix, the comprehensive variables used by Sahay et. al. (2015) in computing the financial development index is included.

Figure 2.3: Components of greenhouse gas



Authors' construct, Data from World Bank (2020).

Table 2.1: Measurement of Financial Sector Development and Environmental Risk in the Empirical Literature

No.	Reference	Study period	Study sample/Country	FD Variables	Environmental Risk Variables	Methods	Main findings
1	Kirikkaleli et. al. (2022)	1990-2017	Chile	IMF financial development index	CO_2 emission per capita	ARDL, FMOLS, DOLS	financial development reduces the consumption-based CO_2 emissions
2	Omri et. al. (2021)	1996–2016	Saudi Arabia	domestic credit to the private sector, private credit by deposit money banks and other financial institutions	per capita CO_2 emission	Dynamic Ordinary Least Squares (DOLS)	Financial development increases CO_2 emissions
3	Khan and Ozturk (2021)	2000–2014	88 countries	Financial system deposits to GDP; Domestic credit provided by the financial sector, Domestic credit to the private sector, Total Bank deposits to GDP, Liquid liabilities (M3)	per capita CO_2 emission	difference and system generalized method of moments	Financial development increases CO_2 emissions.
4	Acheampong et. al. (2020)	1980–2015	83 countries.	IMF financial development index	CO_2 intensity	instrumental variable generalized method of moment (IV-GMM)	financial market development and its sub-measures reduce carbon emission intensity
5	Saud et. al. (2020).	1990-2014	49 OBOR-initiative countries	domestic credit provided by the financial sector	ecological footprint, carbon footprint, CO_2 emission per capita	Pooled Means Group (PMG), Westerlund panel cointegration test	Financial development increases CO_2 emissions.
6	Zakaria and Bibi (2019)	1984 - 2015	5 South Asian countries	ratio of domestic credit to private	per capita CO_2 emission,	Two-Stage Least Square (2SLS)	Financial development degrades the environment

7	Acheampong (2019)	2000–2015	46 Sub-Saharan African countries	domestic credit to the private sector, domestic credit to private sector by banks, domestic credit to private sector by financial sector, broad money, liquid liabilities (M3)	carbon emissions measured in kiloton (kt)	(System-GMM)	FD increases carbon emission
8	Zaidi et. al. (2019).	1990-2016	17 Asia Pacific Economic Cooperation (APEC) countries	domestic credit issued to Private sector	CO_2 in Metric Tons	continuously updated full modified (CUP-FM), continuously updated bias-corrected (CUP-BC)	financial development reduce carbon emissions
9	Jiang and Ma (2019)	1990-2014	155 countries: 35 developed countries and 120 emerging market and developing countries	Domestic credit to the private sector, Domestic credit provided by the financial sector, Domestic credit to the private sector by banks, Total value of traded stocks, Market capitalization of listed domestic companies	per capita CO_2 emission	system GMM	Financial development increases CO_2 emissions
10	Shah et. al. (2019)	1995-2017.	101 countries	domestic credit to private sector % of GDP	electricity production from oil, gas, and coal sources	fully modified ordinary least square (FMOLS)	Financial development increases CO_2 emissions.
11	Shahbaz et. al. (2018)	1955–2016	France	real domestic credit to the private sector	CO_2 emission per capita	e bootstrapping ARDL cointegration	Financial development lowers carbon emissions
12	Abid (2016)	1996–2010	25 Sub Saharan Africa	domestic credit to the private sector	CO_2 emission per capita	Random Effect (RE), Fixed Effects (FE), GMM	financial development reduces CO_2 emissions

13	Hao et al. (2016)	1995–2012	29 China provinces	The ratio of loans and deposits to GDP (FD), Ratio of loans to deposit (FE)	CO_2 emission per capita	GMM	Financial depth increases carbon emissions while financial efficiency decreases carbon emissions.
14	Shahbaz et. al. (2016)	1985Q1-2014Q4	Pakistan	domestic credit to the private sector; money and quasi money; liquid liabilities; stock market capitalization; stock market traded value; and stock market turnover	per capita CO_2 emission,	A Nonlinear Autoregressive Distributed Lag (NARDL)	Financial development degrades the environment
15	Dogan and Turkey (2016)	1960–2010	USA	Domestic credit to the private sector	CO_2 emission per capita	ARDL	No causal relationship between financial development and carbon emissions
16	Omri et al. (2015) Feedback nexus between GD	(1990–2011)	12 MENA countries	Ratio of credit to the private sector to GDP	CO2 emission per capita	GMM	No relationship existed between financial development and carbon emissions
17	Boutabba (2014)	1971-2008	India	DC	per capita CO_2 emission	ARDL, VECM	Financial development increases CO_2 emissions
18	Shahbaz et. al. (2013)	1975Q1–2011Q4	Indonesia	real domestic credit to private sector per capita	per capita CO_2 emission	ARDL, VECM, Granger causality	Financial development increases CO_2 emissions.
19	Shahbaz et. al. (2013).	1965–2008.	South Africa	domestic credit to private sector as a share of GDP	coal consumption	ARDL bounds testing	financial development reduces energy emissions

20	Shahbaz et. al. (2013)	1971–2011	Malaysia	real domestic credit to private sector per capita	per capita CO_2 emission	ARDL	financial development reduces CO_2 emissions.
21	Yuxian and Chen (2011).	1999-2006	provincial panel data of China	the ratio of bank loans to GDP, ratio of the private loans to GDP, non-private loans divided by GDP	industrial wastewater discharges, sulfur dioxide	system generalized method of moments (GMM)	financial development improves the environment
22	Jalil and Feridun (2011)	1953-2006	China	the ratio of liquid liabilities, private sector loans	per capita CO_2 emission,	Autoregressive Distributed Lag (ARDL)	financial development improves the environment
23	Zhang (2011).	1980-2009	China	ratio of loans to GDP, ratio of loans to township enterprises, ratio of stock market capitalization to the GDP, ratio of stock market turnover to GDP	per capita CO_2 emission	vector error correction model (VECM)	Financial development increases CO_2 emissions
24	Tamazian et. al. (2010)	1993–2004	24 Transitional economies	Financial liberalization dummy	CO_2 emission per capita	Random effect model and GMM	Financial development reduces carbon emissions.
25	Tamazian et. al. (2009)	1992-2004	4 BRIC countries	stock market value, ratio of deposit money to GDP, capital account convertibility, financial liberalization dummy	per capita CO_2 emission	random-effect	financial development reduce carbon emissions

(Source: Authors' compilations)

2.10 The role of Access, Depth and Efficiency in the FDI-Environment nexus

Figure 2.4 shows the trends in the financial development score and its sub-components in sub-Saharan Africa. There is an upward surge in the overall financial sector development as well as the sub-components. This is good for the region since the upward trend in financial development is expected to improve capital accumulation and subsequently economic growth (Nazmi, 2005). Financial depth stands tall among the three dimensions of financial development in the region. Financial depth measures the size and liquidity of the financial institutions and markets within the economy. Thus, financial deepening increases the size of the financial sector in terms of value and volume and promotes market liquidity.

According to Sahay et. al. (2015), financial depth is predominantly measured by nine (9) main proxies. These include private-sector credit, pension fund assets, mutual fund assets, insurance premiums (life and non-life), stock market capitalization, stocks traded, international debt securities of government, total debt securities of nonfinancial corporations, and total debt securities of financial corporations. These indicators of financial depth primarily influence capital accumulation, availability and investment. It is of no surprise that it constitutes a significant proportion of the overall financial sector development. It also means that financial depth influences economic outcomes more than access and efficiency. Given the positive relationship between finance and economic growth; financial depth inadvertently can increase environmental risk. This point is well articulated by Omri et. al. (2021), Khan and Ozturk (2021), Saud et. al. (2020), Zakaria and Bibi (2019) and Shahbaz et. al. (2016).

It can also be argued that financial deepening may not necessarily spur environmental risk depending on the sectors of the economy the capital resources are invested in. But it is clear in the literature that the choice of variables for financial development greatly influences the research

outcomes. For example, studies that measure financial development using financial depth indicators tend to find a negative relationship between financial development and environmental quality (Omri et. al., 2021; Khan & Ozturk, 2021; Saud et. al., 2020; Zakaria & Bibi, 2019; Shahbaz et. al., 2016).

Another classical confusion in the empirics is the opposite findings reported by Acheampong (2019) and Acheampong et. al. (2020). Acheampong (2019) employ the generalized method of moments (GMM) technique and use financial depth driven variables to investigate the effect of financial development on carbon dioxide emissions and find that financial development is bad for the environment. A year on, the same author uses the same GMM estimating technique to study the relationship between financial development and carbon dioxide emissions but changed the choice of the financial development variables to the IMF financial development index and argue that financial development and its sub-measures rather improve the quality of the environment (Acheampong et. al., 2020). Kirikkaleli et. al. (2022) also uses the IMF financial development index and find similar results that affirm the study of Acheampong et. al. (2020).

Again, some studies argue that financial development worsens environmental quality (Shahbaz et al., 2016; Sehrawat et al., 2015; Boutabba, 2014). They contend that financial sector development promotes financial access which in turn increases economic activities thereby worsening environmental risk. But these studies fail to recognize that an increase in financial access does not necessarily translate into environmental risk but rather it depends on the direction of the financial access. Financial access is measured by the number of bank branches, automatic teller machines (ATM) to the number of adults, account ownership, and the total number of issuers of debt. These variables are the same as financial inclusion variables (Sahay et. al., 2015). Financial inclusion influences savings, investment and consumption (Yiadom, Dziwornu, & Yalley, 2021). Therefore,

it is true that financial access may cause an upward surge in economic activities, it is, however, unclear that every economic activity aggravates environmental risk. This is because, there are chances that, the increase in financial access could spill over into climate-resilient economic activities.

Unfortunately, financial access in the sub-Saharan Africa region is low relative to the financial deepening and efficiency components of financial development (see Figure 2.4). Two implications can be deduced from the low financial access. One, chances are that majority of the people in the region do not have access to funds which can influence savings and consumption patterns. And obviously, savings and consumption affect economic activities and environmental quality. Finally, low financial access can lead to financial concentration among few people. Over-concentration of funds among a few people makes it easy for them to determine what is produced and consumed; hence, influencing environmental outcomes becomes easy. This may not be healthy for the environment if the few people with financial access do not have concern for the environment.

Sahay et. al. (2015) acknowledge that the development of the financial sector does not only increases financial deepening and access but also promotes financial efficiency. Sahay et. al. (2015) further explain that financial efficiency is the ability of institutions to provide financial services at low cost and with sustainable revenues, and the level of activity of capital markets. Financial efficiency is measured by net interest margin. lending-deposits spread, non-interest income to total income, overhead costs to total assets, return on assets, return on equity, and stock market turnover. These indicators of financial efficiency can be categorized into two: cost and profitability. When the financial system is efficient, funds are allocated at a lower cost to economic sectors that offer higher returns. Greater financial efficiency is likely to promote the quality of the environment. This is because, as the cost of funding declines, climate-resilient ventures that were

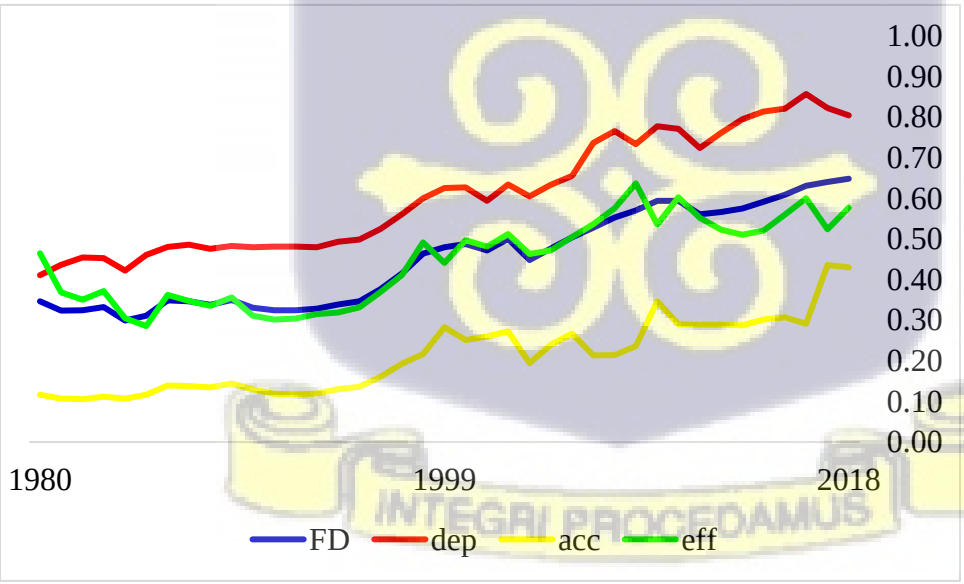
not lucrative to FDI will begin to be profitable thereby receiving equal attention from investors. The sub-Saharan African economy is overly concentrated in the extractive 'destructive' sectors (UNCTAD, 2020). However, a strong financial sector development encourages diversification and the spreading of funds to non-traditional areas. A well-developed financial sector promotes economy-wide growth and firm efficiency thereby reducing overconcentration in one particular sector.

Largely, financial deepening influences production, financial access influences consumption and financial efficiency influence the direction of investment. These three dimensions of financial development work together to deliver a sound financial sector that promotes economic growth and environmental health. It is therefore important to measure their effect on economic and environmental outcomes. This makes the literature incomplete since the available studies ignore both financial access and efficiency.

To a large extent, FDI forms part of the larger financial sector. FDI contributes to capital accumulation and investment. This means that FDI increases the financial depth of a country. If financial depth negatively influences the environment (Omri et. al., 2021; Saud et. al., 2020; Shahbaz et. al., 2016), then it is of no surprise that FDI also worsens the quality of the environment (Singhania & Saini, 2021; Shahbaz et. al., 2018; Zheng & Sheng, 2017; Omri, et. al., 2014; Sbia, et. al., 2014). Again, FDI is profit-oriented funding and will move into economic sectors that offer higher returns. If the profit sectors of the economy are environmentally destructive, FDI will end up destroying the environment and vice versa. Levine (2005) argues that the financial system assists the real sectors of the economy by providing information ex-ante about investment and capital allocation, monitoring investment and enforcing corporate governance, aiding trading, diversification, and risk management, mobilization and pooling savings, and easing the exchange

of goods and services. The efficient provision of information about investment opportunities minimizes the over-concentration of funds in a few areas. If the financial system is developed to improve information efficiency in sub-Saharan Africa, the amount of FDI that goes into environmentally destructive sectors will be minimized. The World Bank's 2020 report on climate-smart investment opportunities around the globe estimates the potential of the sub-Saharan Africa region to be $1.5 trillion over ten years and is expected to increase further. The absence or inadequate information about the existence of climate-smart investment opportunities is contributing to the low investment in those sectors by FDI. For an economy to reap the full benefit of FDI and also assess its environmental impacts, a comprehensive measure of financial development should be employed. This forms the basis why this study uses the IMF financial development index in this study. Most importantly, examining the role of the three indices of financial development will improve policy prescriptions on effect of FDI-environment nexus.

Figure 2.4: Trends in Financial Development Indicators in sub-Saharan Africa



FD = financial development; dep = financial depth; acc = financial access; eff = financial access

(Author's computation with data from IMF, 2020)

2.11 Taxation

"And it came to pass in those days, that there went out a decree from Caesar Augustus, that all the world should be ***taxed.*** *(*And *this taxing was first made when Cyrenius was governor of Syria.). And all went to be taxed, everyone into his own city."* (Luke, n.d.)

Taxation has been around for a long time and is a major source of government revenue. The role of taxation in the modern-day economy transcends beyond revenue mobilization. Taxation is a critical component of central government fiscal policies which is used in controlling consumption and savings, promoting equity, redistributing income and addressing social and economic concerns in the economy. In tax administration, it is critical to answer the question of who is taxed, what is taxed, and how much is taxed. Smith's (1791) canons of taxation are the guiding light in answering these questions. The principles of equality (taxation should be based on the ability to pay), certainty (taxation should not be arbitrary), convenience (the time and manner of the tax collection should suit the nature of the taxpayer) and economy (cost of administrating taxation should not exceed the tax revenue). These four canons of a good tax system help in achieving the objectives of taxation.

Newman (1952) categorizes the objectives of taxation into four. The foremost of these objectives is raising revenue for the government. The second is the regulatory objective. Under this objective, taxation is used in regulating production, consumption, imports and exports, as well as moderating the effect of inflation and depression on the economy. The third objective is the promotion of development. This objective is achieved through capital formation, encouraging full employment and promoting economic development. The final objective of taxation is the reduction of inequalities. Inequalities in the form of economic disparities, and income and regional imbalance can be resolved through taxation. The overarching goal of the four objectives is to promote

economic growth. However, most of the empirical studies on the relationship between taxation and economic growth reveal that taxes are bad for the economy and that the more taxes are levied, the lower the rate of economic growth. For example, Ferede and Dahlby (2019) study the impact of tax cuts on the economic growth of Canadian provinces between 1977 and 2006 and argue that reducing corporate income tax by 1 percentage point raises annual economic growth by 0.1 to 0.2 percentage points. Mertens and Ravn (2019) also investigate the dynamic effects of personal and corporate income tax changes in the United States after World War two. The results from their empirical modelling show that a 1 percentage point reduction in the average personal income tax rate raises real GDP per capita by 1.4 per cent in the first quarter and by up to 1.8 per cent after three quarters. Also, a 1 percentage point cut in the average corporate income tax rate raises real GDP per capita by 0.4 per cent in the first quarter and by 0.6 per cent after one year. The findings of Mertens and Ravn (2012) are related to Barro and Redlick (2011) in several ways. Barro and Redlick (2011) use a long dataset spanning from 1912 to 2006 in the United States to posit that a cut in the average marginal tax rate of 1 percentage point raises next year's per capita GDP by around 0.5%.

In two separate studies, Gemmell, Kneller, and Sanz (2011), and Arnold et. al. (2011) use data for 17 and 21 OECD countries respectively from the 1970 to 2004 period to examine the effect of corporate and personal taxes on economic growth. The two studies conclude that personal and corporate taxes are damaging to the economy. In a large sample of 96 developed and developing countries for the period 1976 to 2014, de Almeida and de Mendonça (2019) confirm that indeed taxation is not a tool capable of stimulating growth.

Conversely, the literature does not advocate for a wholesale abolishment of taxes but the general concerns are that taxation is economically productive if it is lowered. Alinaghi and Reed (2021),

Zidar (2019) and Cloyne et al. (2018) estimate that 1 percentage-point tax cut increases economic growth by 0.2%, 6.6% and 2% respectively. Other tax cut studies by Nguyen et. al. (2021) and Mertens and Montiel-Olea (2018) report similar conclusions.

The idea that tax cut drives economic growth is underpinned by the neoclassical view of taxation. Which argues that the creation of income and wealth should precede their consumption, therefore taxing capital and labour unsettles the wealth creation process (Barro & Redlick, 2011). Certainly, tax is a disincentive to work and investment. Progressively taxing capital defeats capital accumulation and risk-taking and high-income earners will not be motivated to undertake entrepreneurial initiatives. Again, taxing labour more will eventually reduce labour hours and production will also be affected negatively. It is against this backdrop that reducing tax rates can improve production and growth. Nevertheless, taxation is needful to promote the production of social goods and services.

2.12 Taxation and FDI

FDI is critical to the economic growth of both the developing and developed economies. It promotes economic development by augmenting domestic capital, technological transfer, managerial competencies, raw materials availability, production processes and other forms of total factor productivity (Li & Liu, 2005; Alfaro et al., 2004; Durham, 2004; Borensztein et. al., 1998). Although FDI is foreign capital but contributes to local capital accumulation to influence the level of investment and growth. Therefore, the negative effect of tax on capital affects FDI as well. Taxation has become a major tool for influencing both the direction and quantum of inward FDI as observed by Scholes and Wolfson (1991). Damgaard et. al. (2019) examines the relationship

between corporate tax rate and inward FDI across the world and argue that FDI locates countries with low tax rates. They further report that the top 10 economies with the lowest average corporate tax regime like Luxembourg, the Netherlands, Hong Kong, the British Virgin Islands, Bermuda, Singapore, the Cayman Islands, Switzerland, Ireland, and Mauritius host more than 85% of the global FDI. In Africa, data from the World Bank's World Development Indicators in 2020 reveal that the average corporate tax rate has fallen from 75% to 40% between 2005 and 2018. Also, Mauritius, Namibia, Zambia, and Lesotho have a mean total corporate tax rate below 20% which makes them a good destination for inward FDI.

Additionally, the effect of taxation on FDI is underpinned by the theory of international tax competition which suggests that governments as a matter of regulation use taxes to encourage the inflow of economic resources and discourage their relocation (Keen & Konrad, 2013; Oates, 1972). Gao and Liu, (2021) investigate the relationship between tax burden and FDI. Their fixed effect empirical model reveal a negative relationship between the two. Xu and Wu (2021) also use the system GMM estimation techniques to confirm that corporate tax drives away FDI. The sensitivity of FDI to tax rate is even higher among developing countries (Shafiq, et. al., 2021; OECD, 2008). Again, marginal tax rate variations within an economic block contribute to the direction of inward FDI (Xu & Wu, 2021). In 2017 the OECD investigated factors that drive inward FDI. The tax environment was ranked high among the five key determinants. Boly et. al. (2020) examined the effect of tax policy on inward FDI and report that a cut in corporate taxes indeed increases the net inflow of FDI and can influence the FDI receipts of neighbouring countries in the short and long term.

Naturally, tax increases operational costs and subsequently cut down profit. Hence, tax policies are critical in competing for inward FDI.

2.13 The role of Taxation on the relationship between FDI and the Environment

Tax does not only raise revenue for the government but also use in influencing the behaviour of individuals and corporate bodies. The government regulates the consumption behaviours of households by either increasing or decreasing the tax rate. In the same way, taxes are used by governments to direct or moderate investments. If a government desires to encourage investment in a certain sector of the economy, tax cuts or incentives are offered to investors. In the same way, tax can moderate the effect of FDI on the environment. Taxes are not only used in attracting FDI into the domestic economy but can also direct where the FDI goes. Cole et. al. (2006), and Prakash and Potoski (2006) observe that FDI does not only move towards countries with low corporate tax rate but also targets those with weak environmental laws. One channel of strengthening environmental laws is through the tax system.

Effective tax systems put in place punitive measures to curb the rate at which firms deteriorate the environment. If tax laws are not biting enough, FDI inflows may be invested in environmentally destructive sectors of the economy. It is of no surprise that a greater proportion of FDI inflows to Africa is invested in oil and gas and natural resource extractions (Asiedu, 2013). We acknowledge the reality of developmental and capital deficits in Africa. However, deliberately reforming tax laws to attract more FDI could be trading one risk for the other. Hunting for more FDI through tax reforms could close the gap between capital and developmental shortfalls; but where the FDI goes matters in safeguarding sustainable development.

We have discussed in the previous sections of this thesis the controversies on the relationship between FDI on the environment. But most of the literature argues that FDI deteriorates the environment. Therefore, if FDI harms the environment (Omri, et. al., 2014; Sbia, et. al., 2014; Acharyya, 2009; Jorgenson, et. al., 2007) and tax policies influence FDI receipts (de Mooij &

Ederveen, 2003; Scholes & Wolfson, 1991), then tax policies can guard both the front and back door to FDI. Thus, tax policies do not only influence inward FDI but also determine whether the FDI improves or retard environmental quality.

Tax policy is crucial in regulating the patterns of production and consumption in a free economy. It therefore, has explicit control over where the FDI goes. King, Tarbush and Teytelboym (2019); Lin and Li (2011); Davis and Kilian (2011); Bruvoll and Larsen (2004) investigate the effect of tax policy on environmental risk. They use specific tax policy (carbon tax) to show that tax policy has a significant and negative effect on per capita carbon emission. However, they (Lin & Li 2011; Davis & Kilian 2011; Bruvoll & Larsen, 2004) found environmental tax exemption policies to be a worrying trend in the fight against environmental

pollution. Lin and Li (2011) estimate that by introducing environmental taxes, carbon emission per capita is reduced by 1.69%. The full benefit of tax policy should be exploited so that even if tax is reformed to woo foreign investors, it should at the same time moderate the direction of the investment. King et. al. (2019) report that designing tax policies for specific sectors of the economy have high elasticity and can effectively reduce aggregate emissions.

2.14 The effect of a Carbon Tax on the FDI-Environmental nexus

A carbon tax is a specific tax "levied on coal, oil products, and natural gas in proportion to their carbon content, can be collected from fuel suppliers" (Parry, 2019). Although suppliers can push the carbon tax down to consumers in the form of price increases but do not rule out the idea that carbon tax can modify consumption behaviour from carbon-intensive products to renewable energies which are not harmful to the environment. Moreover, several climate mitigations and

adaptation measures like regulations, subsidies, emission trading schemes, deposit refunds, debt-for-nature swaps, green bonds, and blue bonds are in use in various countries to curb rising carbon dioxide emissions. But carbon tax stands tall among these measures for several reasons. Gaspar et. al. (2019) argue that carbon tax is a climate change mitigation catalyst and estimate that its full implementation can reduce emissions by up to 32% by 2030. A carbon tax does not only deter polluters but also serves as an avenue for raising revenue to augment public funds. The use of carbon tax as a carbon emission mitigation tool is reinforced by the 'polluter pays principle'. The polluter pays principle attempts to place the environmental responsibility of carbon emissions at the doorstep of the primary emitters and those who benefit from it.

In the absence of a polluter pays policy, market failure is entrenched and the least emitters of harmful gases become the most affected. The polluters pay policy as originated by Pigou (1952) and adopted by the OECD in 1971 was not intended that firms can pay and pollute the environment but rather to deter polluters. Therefore, the deterrent nature of carbon tax fully addresses the requirement of the polluter pays principle. More also, it has been confirmed in the literature that carbon tax is effective at reducing carbon emissions (Fu et. al., 2021; Tiwari et. al., 2021; Sun, et al., 2021; Jia & Lin, 2020; Zhang et. al., 2016; Meng, Siriwardana, & McNeill, 2013). However, it is feared that the carbon tax could reverse domestic economic developments (Evans, et. al, 2021; Xu & Wu, 2021; Voßwinkel & Birg, 2018; Marron & Toder; 2014; Zhao, 2011; Zhang & Baranzini, 2004; Hudson, 1993).

The perceived negative effect of the carbon tax on the local economy is stalling its global adoption. For instance, Meng et. al. (2013) examined the impact of the carbon tax on the Australian environment and economy using the computable general equilibrium modelling (CGE). Their

simulation results reveal that, although the carbon tax reduces carbon emissions, it will cause economic contractions in Australia.

Lin and Li (2011) examined the effect of the carbon tax on carbon emissions among European countries that first adopted carbon tax. Their findings show that carbon tax significantly reduces emissions. In a related study, Conefrey et. al (2013) found that carbon tax has a double-dividend effect on the domestic economy by reducing emissions and increasing economic growth, especially if the revenue from the carbon tax is recycled. According to Gaspar and Amaglobeli (2021), the carbon tax is the most powerful and efficient means to address rising earth temperatures. Recent empirical evidence confirms the existing findings that indeed carbon tax reduces emissions (Fu et. al., 2021; Tiwari et. al., 2021; Sun, et al., 2021; Jia & Lin, 2020). There is therefore no debate about the efficacy of carbon tax in reducing carbon emissions. What is missing in the literature is the effect of carbon tax on foreign direct investment and this thesis presents empirical findings to fill the void.

2.15 Chapter Summary

This chapter presented a discussion on the broad literature that covers all the four empirical chapters of the thesis. The chapter offered a detailed review of both the theoretical and empirical literature and placed the thesis in the context of the available studies. The chapter defined and explained the key variables and their measurements.

CHAPTER THREE

FOREIGN DIRECT INVESTMENT AND ENVIRONMENTAL RISK: THE ROLE OF FINANCIAL SECTOR DEVELOPMENT

CHAPTER THREE

FOREIGN DIRECT INVESTMENT AND ENVIRONMENTAL RISK: THE ROLE OF FINANCIAL SECTOR DEVELOPMENT

Abstract

The study examines the role of financial sector development in the relationship between FDI and environmental risk by introducing a new measurement of financial sector development into the international capital and climate change debate. The study set up a panel dataset to cover 45 Sub-Saharan African economies from 1982 to 2018. The study applies the system GMM technique and the dynamic panel threshold models to accommodate the dynamic nature of the dataset and make provisions for endogeneity and heteroskedasticity in the series. The findings suggest that the unmitigated effect of FDI on environmental risk is detrimental. However, FDI conditioned on the local financial sector development minimizes environmental risk. Again, the findings suggest that countries with low financial sector development indicator scores reported worse environmental risk than their counterparts. Our results from dynamic panel threshold regression reveals that financial development increases environmental risk at low regimes of the threshold but high regimes of financial development have the ability to reduce it.

Based on the findings the study recommends a concerted effort at the country level to ensure comprehensive development in the broad components of the financial system to reduce environmental risk.

Keywords: climate change, financial development, Foreign Direct Investment, environmental risk, General Method of Moment, CO_2 emissions

3.1 Introduction

The results of the empirical investigation on the effect of foreign direct investment (FDI) on environmental risk are inconclusive. A strand of the literature argues that FDI toxifies the environment (Frutos-Bencze, K., & Kulvanich, 2017; Zheng & Sheng, 2017; Omri, et. al., 2014; Sbia, et. al., 2014; Jorgenson, Dick, & Mahutga, 2007). Whereas other studies contend that FDI improves the quality of the host nation's environment through the deployment of advanced climate-resilient technologies (Kim & Adilov, 2012; Perkins & Neumayer, 2008; Hoffmann et al., 2005; Hines & Rice, 1994). This makes the impact of FDI on the environment still a thorny question for research and policy to unravel. This study attempts to offer answers to the reasons accounting for the sharp contradictions in the literature by examining financial sector development as a key moderator to the FDI-environmental risk. The question of whether FDI impairs or repairs the quality of the environment may not arise without interrogating local factors within the host nation. This is because FDI remotely affects the environment through economic activities (Acheampong, 2019). Therefore, regardless of the effect of FDI on the environment; it is too simplistic to examine the relationship between the two without considering the underlying local factors (Sarkodie, Adams, & Leirvik, 2020; Bokpin, 2017).

Additionally, the empirical studies have argued that for FDI to be growth-enhancing, the host nation should have access to key factors such as the quality of institutions or governance (Agbloyor, 2019; Busse & Groizard, 2008), the level of human development (Shahrivar & Jajri, 2012; Borensztein, De Gregorio, & Lee, 1998; De-Mello, 1997) and the level of financial sector development (Osei & Kim, 2020; Agbloyor et. al., 2013; Alfaro, Chanda, & Kalemli-Ozcan, 2004). Based on the foregoing, the present study argues that whether FDI is environmentally destructive or constructive depends on these same local factors. Subsequently, Bokpin (2017)

investigated the moderating role of institutional quality on the impact of FDI on the quality of the environment and reported that in the absence of good institutions, FDI degrades the environment. Unfortunately, human development is not a catalyst for environmental quality. Rather, there is adverse reverse causality running from environmental risk to human development (United Nations, 2015; Chaudhry & Ruysschaert, 2008). What is hanging in the literature is the role of financial sector development in the relationship between FDI and environmental risk.

Although the empirical evidence on FDI and environmental risk is ambiguous, the relationship between financial sector development and environmental risk has been studied extensively and findings have reached a more favourable supposition. They suggest that a well-developed financial sector reduces environmental risk (Ntow-Gyamfi, Bokpin, & Aboagye, 2020; Acheampong, 2019; Shahbaz, Nasir, & Roubaud, 2018; Riti, Shu, Song, & Kamah, 2017; Tamazian, Chousa, & Vadlamanna, 2009). What is missing in the literature is whether financial sector development can moderate the effect of FDI on the quality of the environment.

Whereas it seems logical to reason that FDI has a direct impact on the environment without necessarily passing through a moderator, a country may control its spillovers by improving the quality of local institutions. The current study takes advice from the recent emphasis on the role of institutional quality in the climate change literature. And suggest that the degree of development of the local financial institutions can moderate the impact of FDI on environmental risk and if possible, prevent its negative spillovers from reversing the quality of the environment. Besides, the financial sector is the first entry point that receives, distributes, and directs FDI into the various sectors of the economy (Alfaro, Chanda, & Kalemli-Ozcan, 2004). Where the FDI goes matters in influencing economic activities and environmental risk. Schumpeterian argues that a well-

developed financial sector facilitates capital accumulation and advanced technology to spur economic activities. In the same way, financial sector development can play an intermediary (moderator) role between FDI and the environment. In the natural sense, a weak moderator is easily influenced. Therefore, a weak financial sector will mimic the type of FDI received, hence, if the FDI is toxic it will adversely affect the environment and vice versa. On the contrary, if the level of financial sector development is robust, it corrects market failure and FDI impact on the environment may no longer be direct.

Also, several studies have investigated either the relationship between FDI and the environment or the financial sector development and the environment with disjointed conclusions. But this present study consolidates the fragmented literature by examining the role of financial sector development in the relationship between FDI and environmental risk in Africa. Our study is different in several ways. First, we correct the misconception that the effect of FDI on the quality of the environment is isolated from the financial sector that carries it (Boachie-Yiadom & Mensah, 2021; Ntow-Gyamfi, Bokpin, & Aboagye, 2020; Acheampong, 2019; Shahbaz, Shahzad, Ahmad, & Alam, 2016).

The present study solves this misconception by testing the moderating role of financial sector development in the FDI – environmental risk nexus. Second, the present study shows that the level of financial sector development matters in accounting for the impact of FDI on the environment. Particularly, the study posits that at low levels of financial sector development, FDI can 'bulldoze' its way to deteriorate the quality of the environment, however, the results may be different in a highly developed financial sector.

Third, the measurement of financial sector development is highly contentious in the existing literature, and in most cases, the measurements used are inappropriate to capture the full efficacy

of the financial system. Financial sector development has been narrowly measured with domestic credit to the private sector, stock market value traded, the ratio of deposit money to bank assets, stock market turnover, and broad money (Ntow-Gyamfi, et. al., 2020; Osei & Kim, 2020; Acheampong, 2019; Shahbaz, Nasir, & Roubaud, 2018; Riti, Shu, Song, & Kamah, 2017; Shahbaz, et. al., 2016; Tamazian, Chousa, & Vadlamanna, 2009).

A careful examination of these variables shows that they are largely financial depth measurements and do not reflect the whole financial system as evidenced in Sahay et al. (2015). Suffice it to say that earlier studies only considered financial depth to represent the entire financial system in their analysis, their variables are still inadequate to capture the full complement of the financial depth components of financial development. This is because Sahay et al. (2015) explained that the domestic credit to private sector variable often used in the literature represents less than 25% of the overall composition of the financial depth itself (refer to Table 3.5 in the Appendix). In rare cases, a few studies have constructed principal component analysis to determine financial development measurements. An evaluation of these variables shows that financial access is crudely missing (Xing et al., 2017; Shahbaz, et. al., 2016). This study departs from the current trend and for the first time employs a more robust and comprehensive measurement for financial sector development. The study uniquely introduces the IMF's financial index data compiled by Sahay et al. (2015) into the empirical discussion.

Additionally, studies on environmental risk have focussed on environmental risk assessment at the firm level only (Ak, Yucesan, & Gul, 2022; Kaikkonen, et. al., 2021; Kaikkonen, et. al., 2018; Hood & Nicholl, 2002). The relevance of the micro-level analysis of environmental risk cannot be marginalized, but grossly ignoring the aggregated environmental risk in an economy creates a

policy gap. In the existing literature, environmental risk is often discussed at the micro-level without scaling it up to the macro level. The macro analysis of environmental risk will give a broader picture and inform policy direction. For example, there can be a law that sets the ceiling for firms' carbon dioxide emissions. Such laws may not necessarily help in reducing a country's carbon dioxide emissions if the number of new firms entering the carbon-intensive sectors keeps increasing. The emission cut law may help reduce individual firms' carbon dioxide emissions but the new firms will be adding up to the overall country's carbon emissions. For this reason, it is necessary to examine environmental risk at the country level to facilitate macro policies. Specifically, this study examines the role of financial sector development on the relationship between FDI and environmental risk.

The remaining sections of the study are as follow. Section two gives a brief overview of the existing literature. Sections three and four explain the empirical strategy and the findings respectively. Conclusions and recommendations are included in section five.

3.2 Brief Literature Review

Ustohalova (2011, p. 603) defines environmental risk as "the probability and consequence of an unwanted accident". He elucidates that the likelihood of environmental risk occurrence is due to deficiencies in waste management, waste transport, and waste treatment and disposal, several pollutants are released into the environment, which cause serious threats to human health along the way. Additionally, Xu and Liu (2009) explain environmental risk as the risk that an organization's (human) activities may emit toxic gasses or deplete resources in such a way that it will bring actual or potential negative effects on the ecological system. According to Ustohalova (2011) the impact of environmental risk can be assessed at two levels: the global and local impact. The global impact of environmental risk is where carbon dioxide, methane, and other harmful

gases are released into the ecosystem. These dangerous gases contribute to the increasing threat of climate change. The local impact of environmental risk on the other hand contributes to the contamination of the immediate environment. This often occurs through the release of harmful chemicals into the soil which affects groundwater, carbon monoxide from cars, and reactive waste substances, among others. The local impact of environmental risk usually comes with immediate health and environmental complications.

Largely, the environmental risk does not occur in a vacuum. Environmental risk occurs as a result of human activities, making it anthropogenic. The anthropogenic nature of environmental risk offers clues to the causes, drivers, as well as solutions to climate change. One human activity identified as a major driver of environmental risk is economic growth (Stern, 2002; Dasgupta, et. al., 2002; World Commission on Environment and Development, 1987). Environmental risk is the by-product of economic growth. The environmental impact of economic growth (activities) as popularized by Grossman and Krueger (1991) in their Environmental Kuznets Curve (EKC) hypothesis suggest that economic growth reduces the quality of the environment. This is because economic growth requires expansion in economic activities which in turn place a huge demand on factors of production. Classical economics have identified land, capital, and labour as the basic inputs of production. Land (environment) provides the physical capital and natural resources required for production activities. A critical attribute of land is that it is fixed in supply (Kaika & Zervas, 2013). The fixed nature of the land and in this case the environment places constraints on the absorptive capacity of the waste resulting from production. The over-accumulation of production waste trapped within the environment is what has been identified as the main cause of climate change.

Similarly, empirical evidence shows that economic activities among other factors are underpinned by the availability of capital resources (McKinnon, 2010; Borensztein, De Gregorio, & Lee, 1998; Khan & Reinhart, 1990). This is the reason the empirical literature is tilting toward investigating the effect of capital resources on environmental risk (Frutos-Bencze, & Kulvanich, 2017; Zheng & Sheng, 2017; Zhu, et. al., 2016; Jorgenson, Dick, & Mahutga, 2007). For example, Grossman and Krueger (1991) find out that low-income countries emit less carbon compared to middle-income countries. This means that the higher the income of a country, the greater the emissions. Undoubtedly, Africa lacks all the capital to finance its desired growth agenda (Sachs et al, 2004; Burnside & Dollar, 2000). The capital constraints in Africa translate into fewer economic activities which subsequently account for the low emission of its carbon dioxide emission (World Bank, 2020; Panayotou, 1993). This implies that Africa's lack of capital is the main reason for low carbon dioxide emissions. Therefore, all other things being equal if the capital constraints are removed, Africa like any other global region will increase its greenhouse gas emissions.

Additionally, the financial system is a key player in the sourcing and disbursing of funds for economic activities. The recent developments in Africa's financial system have enabled the region to successfully integrate its financial system into international financial markets. This is making the region a preferred destination for foreign direct investment (UNCTAD, 2019). International investors may be less sympathetic to the environment, especially in cases where there is no direct or immediate cost for deteriorating the environment. On that basis, Zheng and Sheng (2017), Omri et al. (2014), and Sbia et al. (2014) investigated the effect of FDI on the quality of the environment. They reported that FDI is bad for the environment. Due to this, the responsibility is on the local financial system to minimize the extent to which foreign direct investment freely deteriorates the

environment. Ntow-Gyamfi et. al. (2020), Acheampong (2019), Shahbaz et. al. (2018), and Riti et. al. (2017) believe that the level of financial sector development could be a panacea to the rising environmental risk. The findings from these studies have concluded that the level of financial sector development influences the direction of economic activities and subsequently the volume of carbon dioxide emission. Furthermore, two contrasting theories – the pollution halo and pollution haven hypothesis – have argued for and against the effect of FDI on the quality of the environment respectively. This study agrees with earlier studies such as Boachie-Yiadom and Mensah (2021), Bokpin (2017), Agbloyor et. al. (2013), and Alfaro et. al. (2004), and posits that the effect of FDI on the environment is highly contingent on the local factors and may not be direct. For instance, Boachie-Yiadom and Mensah (2021) report that when local taxes are controlled, FDI improves the quality of the environment. Bokpin (2017) further stresses that the effect of FDI on the quality of the environment depends on the effectiveness of the domestic institutions.

It is on this basis the current study empirically examined the role of financial sector development in the relationship between FDI and environmental risk.

3.3 Methodology

3.3.1 A Case for GMM

The type of empirical strategy used in explaining the relationship between the research constructs goes a long way to influence the outcomes and recommendations. To this end, the literature is still divided into the appropriate estimation strategies that 'best fit' environment and finance nexus. Singhania and Saini (2021), Acheampong (2019), Shahbaz, et. al (2016), and Stern (2004) together have reviewed and chronicled the methodological dispositions of 79 studies in this area. Their conclusions are in two strands. Whereas time-series studies largely favour ARDL and the granger causality approach, panel studies are undecided between the fixed/random effect and the

generalized method of moment (GMM). A panel study like ours favours the GMM approach, particularly the instrumental variable system GMM, due to several reasons. First, the GMM allows for the inclusion of the lagged dependent variable as a regressor.

In economic and financial modelling, 'history matters', and therefore the current value of environmental risk does not only depend on some exogenous variables but also on the previous value of the environmental risk. In any case, the present study is a modified version of the EKC hypothesis. The EKC on the other hand is linked to the economic convergence theory, i.e. inverted 'U' shapes the relationship between economic growth and environmental risk (Barro, 2016; Barro & Sala-i-Martin, 2004). On the convergence theory, Barro (2016) believes that the per capita incomes of poorer economies will grow at a rate faster than rich economies and for that matter, the lagged dependent per capita growth rate is a key variable in the analysis of economic growth among nations.

On that basis, higher economic growth will then translate into higher emissions – EKC (Grossman & Krueger, 1991). Hence, models that fail to incorporate the lagged dependent variable in the relationship between environmental risk and finance may be less efficient (Singhania & Saini, 2021; Acheampong, 2019; Omri, Nguyen, & Rault, 2014). Having built a case for the inclusion of the lagged dependent variable in the modelling of the relationship between environmental risk and finance implies that the conventional fixed/random effect models will yield biased and inconsistent estimates of the coefficient of the parameters (Allison, Williams, & Moral-Benito, 2017; Roodman, 2009). This is because at the heart of the fixed/random effect models is the assumption that the regressors are contemporaneously uncorrelated with the error terms (Verbeek, 2017). However, Verbeek (2017) contends that the presence of the lagged dependent variable may lead

to an endogeneity problem, hence the OLS no longer yields a consistent estimator for the parameters in the regression.

Verbeek (2017) further proposes that the instrumental variable GMM approach can correct this problem by allowing additional instruments to be introduced into the model. The inclusion of more instruments can improve the efficiency of the model. The instrumental variable technique originally introduced by Arellano and Bond (1991) into Holtz-Eakin, Newey, and Rosen's GMM estimation can solve other estimation problems in the traditional OLS such as unobserved heterogeneity, omitted variable bias, and measurement errors.

Moreover, there are inherent problems with the GMM estimation approach as pointed out by Allison, Williams and Moral-Benito (2017). The key weakness in the GMM is the uncertainty about the choice of instruments appropriate for a particular model. The uncertainty in the selection of the instrument gives room for the inclusion of too many or too few instrumental variables, leading to weak instruments and small-sample bias (Roodman 2009). However, the Hansen/Sargan test for over-identification restriction can be used to assess the validity of the instruments used. Furthermore, Roodman (2009) posits that if the number of cross-sections is more than the periods, the GMM model should be preferred over the fixed/random effect models.

The two variants of the GMM are the differenced GMM and the system GMM. The differenced GMM takes the first difference of the regressors in the equation and therefore, fails to control for country-fixed (because of the first difference of $\Delta\mu_i = 0$). On the other hand, the system GMM uses an alternative approach to estimating the coefficients which preserve the individual country-fixed.

Notwithstanding the justification for the use of GMM, the study uses the Bond, Hoeffler, and Temple (2001) model acceptance criteria to select the appropriate model. The criteria require estimating the model first with the pooled OLS and the panel fixed effect. Bond, et. al. (2001) suggest that estimating the dynamic model with the pooled OLS will lead to dynamic panel upward bias due to the positive correlation between the lagged dependent variable and the error term. Thus, the coefficient of the autoregressive term will be inflated.

Conversely, estimating the dynamic model with the panel fixed effect does not improve its efficiency due to the negative correlation between the autoregressive term and the error term. This makes the coefficient of the lagged dependent variable to be downward biased. For the GMM to be the appropriate model, the coefficient of the autoregressive term in the dynamic model should be symmetrical to the pooled OLS and the panel fixed effect's estimates. Further, the choice between system GMM and difference GMM depends on the estimation technique that improves the dynamic stability of the coefficient of the lagged dependent variable. Thus, if the estimates from the system GMM of the coefficient of the lagged dependent variable lies outside the upper bound (pooled OLS) and the lower bound (panel fixed effect), the difference GMM is appropriate and vice versa (Roodman, 2009). Also, the moment conditions introduced into the GMM improve the estimates of the predictors but too much of it can lead to instrument proliferation making the model overfit. The Hansen test for overidentification restriction has been used to check the presence of excessive moment conditions.

In addition, to ensure that the errors are serially uncorrected in their levels and achieve validity of the GMM estimates, the first and second-order autocorrelation test is performed. The choice

between one-step and two-step GMM is settled by Bond and Windmeijer (2005) favouring the latter because the two-step is asymptotically efficient. To further fortify the robustness of the empirical model, we employ the three Andrews-Lu information selection criteria (AIC, BIC, and HQIC) to choose the appropriate model that best fits the nature of the data at hand.

This chapter of the study favours the system GMM. The selection criteria are following the approach described in the preceding paragraph is used and the results are included in Table 3.6 in the Appendix.

3.3.2 Empirical Models, Data, Variables, and Measurements

The study covers 45 Sub-Saharan African economies over 37 years from 1982 to 2018. The study period and countries were selected purely on the basis of data availability. Data on financial development is sourced from the International Monetary Fund (FD Index database). Additional data on financial development which are used as alternative proxies are collected from the World Bank's World Development Indicators (WDI), as well as all other cross-country variables used in the study.

The empirical models for the study are specified below:

$$ENVTR_{it} = \alpha ENVTR_{it-1} + \zeta FDI_{it} + \gamma FD_{it} + \varphi FD_{it}^{2} + \tau(FD \times FDI)_{it} + \phi highFD_{it} + \sum_{J=4}^{N} \omega_J X_{it} + v_i + \varepsilon_{it} \ldots\ldots\ldots\ldots\ldots (3.1)$$

$$\varepsilon_{it} = \gamma_i + \mu_t + v_{it}$$

Where '*it'* represents country i, at time *t*. *ENVTR* is environmental risk proxied by carbon dioxide emissions (% of GDP). $ENVTR_{it-1}$is the lagged of the *ENVTR* to capture environmental risk convergence. FDI represents net inflows of foreign direct investment (% of GDP). FD is the

financial sector development. This is an index ranging from -1 to 1. The FD^2 is the squared term of the financial sector development variable which tests the reaction of the environmental risk to doubling or increasing the level of financial sector development. FD × FDI is the interaction term between financial sector development and FDI. The interaction term tests the moderating effect of FD on the relationship between environmental risk and the FDI. highFD is a dummy variable used in classifying the sample into two – high and low financial development. To classify the sample, we first use a simple quartile analysis to locate the median FD index and represented countries with high FD with a value of 1 and 0 otherwise.

The purpose of this strategy is to examine whether countries with FD index above the median value may have their environmental risk reduced relative to their counterpart. The *X* represents a set of four control variables that are often used in the literature (Boachie-Yiadom & Mensah, 2021; Ntow-Gyamfi, Bokpin, & Aboagye, 2020; Acheampong, 2019; Shahbaz, Shahzad, Ahmad, & Alam, 2016). The four control variables include Financial regulation (FR), GDP per capita growth rate (GDP), growth rate of the Urban population (URBAN), and the growth rate in domestic investment (DINV).

Also, the study employs alternative measurement for financial sector development which is used regularly in the literature (Ntow-Gyamfi, Bokpin, & Aboagye, 2020; Osei & Kim, 2020; Riti, Shu, Song, & Kamah, 2017; Shahbaz, Shahzad, Ahmad, & Alam, 2016; Tamazian, Chousa, & Vadlamanna, 2009). These variables include Domestic credit to the private sector (% of GDP) (DCREDIT), Domestic credit provided by the financial sector (% of GDP) (DCREDITFC); Broad money (% of GDP) (M2), and Stocks traded, total value (% of GDP) (STTV). To use of the

alternative measures of financial sector development is to test the robustness of the results from the study.

Further explanation of the variables is included in Table 3.1.

ε_{it} is mean zero scalars; decomposes into $\varepsilon_{it} = \gamma_i + \mu_t + v_{it}$. Where γ_i is the country-specific fixed effects; μ_t is the time-invariant effect and v_{it} captures all other white noise in the specified model.

Interpreting the coefficient of the interaction variable could be elusive since the true intrinsic values of the two variables are hardly known. The study specifies equation (3.2) and constructs a partial derivative concerning FD and FDI in equations (3.3) and (3.4) respectively.

$$ENVTR_{it} = \alpha ENVTR_{it-1} + \zeta FDI_{it} + \gamma FD_{it} + \tau(FD \times FDI)_{it} + \sum_{J=4}^{N} \omega_J X_{it} + \varepsilon_{it} \ldots\ldots (3.2)$$

The net effect of FD: $\frac{\partial ENVTR_{it}}{\partial FD_{it}} = \gamma + \tau FDI_{it}$ ……(3.3)

The net effect of FDI: $\frac{\partial ENVTR_{it}}{\partial FDI_{it}} = \zeta + \tau FD_{it}$ ……(3.4)

With the thinking of Boachie-Yiadom and Mensah (2021) and Alfaro et. al. (2004), we compute the net effect of FD and FDI using the formula $\gamma\delta_{CO2} + (\tau \times mean_{FDI} \times \delta_{CO2})$ and $\zeta\delta_{CO2} + (\tau \times mean_{FD} \times \delta_{CO2})$ respectively.

Additionally, the inclusion of the squared term of the FD requires the estimation of the threshold point at which FD may reduce or increase environmental risk. The threshold point is estimated by differencing equation (3.1) concerning FD and equating it to zero. The results of this exercise are presented in equations (3.5), (3.6), and (3.7).

$$ENVTR_{it} = \alpha ENVTR_{it-1} + \zeta FDI_{it} + \gamma FD_{it} + \varphi FD_{it}^2 + \sum_{J=4}^{N} \omega_J X_{it} + \varepsilon_{it} \dots\dots\dots\dots\dots (3.5)$$

$$\frac{\partial ENVTR_{it}}{\partial FD_{it}} = \gamma + 2\varphi FD_{it} \dots\dots\dots\dots\dots\dots\dots (3.6)$$

If FD is normalized to 1, the turning point (TP) is derived by simplifying equation (3.6).

$$TP = \frac{\gamma}{2\varphi} \dots\dots\dots\dots (3.7)$$

Table 3.1: Variables Description and Sources

Variable	Description	Source
ENVTR	Carbon dioxide emissions (% of GDP). The cost of damage due to carbon dioxide emissions from fossil fuel use and the manufacture of cement is estimated to be US$30 per ton of CO2 (the unit damage in 2014 US dollars for CO2 emitted in 2015) times the number of tons of CO2 emitted.	WDI data
FDI	Foreign direct investment, net inflows (% of GDP)	WDI data
FD	Financial Development Index (-1=low to 1=high)	IMF data
highFD	Dummy variable that categorizes FD into high and low. High FD	Computed with WDI data
DCREDIT	Domestic credit to the private sector (% of GDP)	WDI data
DCREDITFC	Domestic credit provided by the financial sector (% of GDP)	WDI data
M2	Broad money (% of GDP)	WDI data
STTV	Stocks traded, total value (% of GDP)	WDI data
FR	Financial sector regulation index. It assesses the structure of the financial sector and the policies and regulations that affect it. (1=low to 6=high)	WDI data

GDP	GDP per capita growth rate (annual %)	WDI data
URBAN	The growth rate of the Urban population refers to people living in urban	WDI data
DINV	The growth rate in domestic investment	WDI data

(Source: Authors' Compilation)

3.3.3 Panel Threshold Estimation

The threshold effect of financial development on environmental risk has been largely ignored in the existing literature. Conventionally, the available studies assu me a linear relationship between financial development and environmental risk. However, given the inverted 'U' shape assumption of the EKC curve it is imminent to test whether the relationship is monotonic. Against the background that the impact of financial sector development on environmental risk amy not be constant all the time, we specify the following dynamic panel threshold regression model as follows:

$$ENVTR_{it} = \varphi X_{it} + \begin{cases} \propto_i + \beta_1 ENVTR_{it-1} + \theta_1 FD_{it} + \mu_{it} & FD_{it} < \gamma \\ \propto_i + \beta_2 ENVTR_{it-1} + \theta_2 FD_{it} + \mu_{it} & FD_{it} \geq \gamma \end{cases} \ldots\ldots\ldots\ldots\ldots (3.8)$$

Where '*it'* represents country i, at time *t*. *ENVTR* is environmental risk proxied by carbon dioxide emissions (% of GDP). $ENVTR_{it-1}$ is the lagged of the *ENVTR* to capture environmental risk convergence and also demonstrate the dynamic nature of the model. FD is the financial sector development index. $\propto_i$ is the country-specific fixed effects, and μ_{it} is a zero mean, finite variance error term. The X_{it} represents a host of control variables. Further, the financial development index FD_{it} is the regime-switching or threshold variable that is used in splitting our data into two sample groups while γ is the threshold value. More also, β_1 and θ_1 represents the coefficients of the lag

dependent variable and the FD index at low regimes respectively, while β_2 and θ_2 are high regime coefficients.

The orthodox technique of including quadratic terms and cubic terms in a model to capture threshold is subjective and may not be efficient. The imposition of the quadratic or cubic terms on the model force threshold to be determine exogenously. Although we use this conventional technique in estimating the original model in equation 3.1, we are aware of its limitations. Therefore, the dynamic panel threshold specified in equation 3.8 is estimated following the technique suggested by Seo et al. (2019) and Seo and Shin (2016). The Seo et al. (2019) and Seo and Shin (2016) threshold estimation technique splits the data by itself and enables the threshold to be determined endogenously.

Again, the threshold technique uses the bootstapping replications that allow a number of alterations to split the data sample and estimate the coefficients for both the ligh and low regimes. This process ensures that the threshold value is computed independently and endogenously under a normal distribution assumption. In this study 2,000 bootstrapping replications are used under a 15% trimming percentage, and 100 grid numbers to test the existence of thresholds.

3.4 Results and Discussions

3.4.1 Summary Statistics

Table 3.2 provides summary statistics. The summary statistics offer insights into the nature and the distribution of the data. Generally, the descriptive statistics and the correlation matrix do not give rise to any serious concern that may impair the consistency and efficiency of our model in estimating the coefficients of the regressors. Except that some of the variables included as an alternative measure for financial sector development exhibit high correlation at some point in the

correlation matrix presented in 2b of Table 3.2. To avoid possible multicollinearity issues, the study does not include all of these variables in a single regression model. Each variable is placed in different models.

Additionally, there are a few highlights from the descriptive statistics in 2a of Table 3.2, which are worthy of emphasis. The environmental risk measured by the CO_2 emission recorded a mean value of 1.08% and a standard deviation of 1.20% appears to be volatile in Africa and there are high tendencies that many countries may cross the mean CO_2 emission soon. The standard deviation of FDI of 0.09% shows marginal stability in the FDI flows and the region share in the global FDI may not dwindle anytime soon. Concerning the financial sector development variables, the overall index (FD) recorded a mean value of 0.12 confirming the porous nature of the financial sector development in Africa.

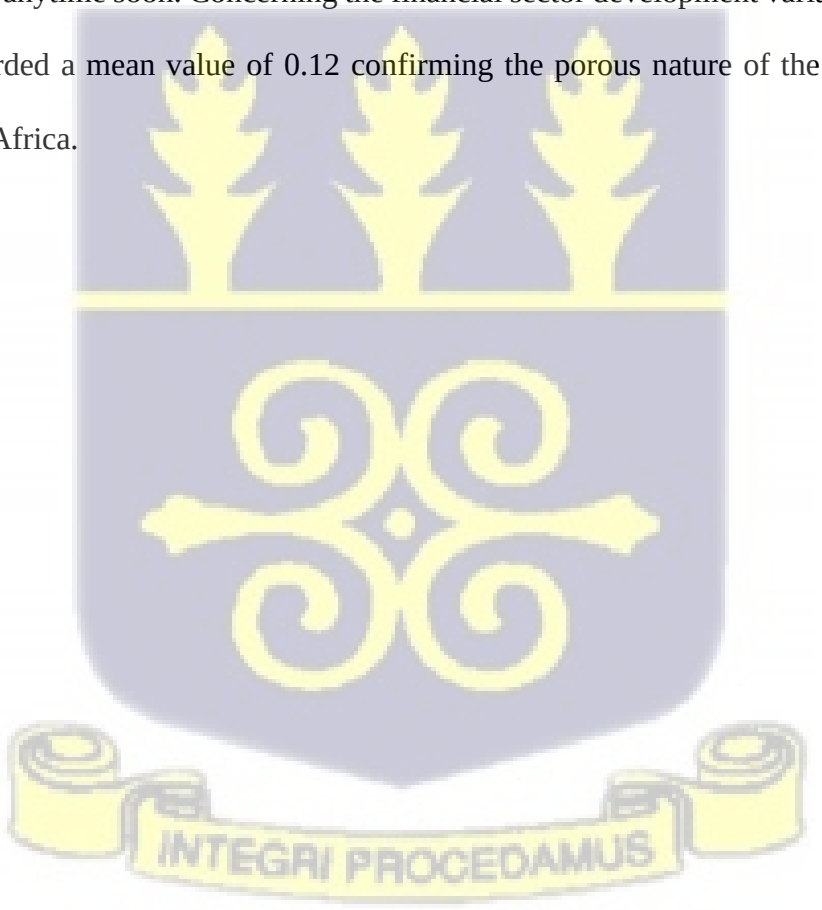


Table 3.2: Summary Statistics

2a: Descriptive Statistics

	envtr	fdi	fd	dcredit	dcreditfc	m2	sttv_	fr	urban	gdp	dinv
Mean	1.08	0.04	0.12	20.02	69.25	28.30	24.02	0.88	36.80	4.16	7.18
Median	0.71	0.01	0.10	14.66	69.23	22.19	13.70	0.00	37.00	4.45	8.33
Maximum	10.88	1.03	0.65	147.47	106.23	145.71	92.48	4.00	89.37	149.97	11.17
Minimum	0.01	-0.27	0.00	0.68	13.59	2.86	0.25	0.00	5.34	-50.25	0.00
Std. Dev.	1.20	0.09	0.09	20.17	21.12	20.55	26.10	1.39	16.08	6.91	3.14
Skewness	2.79	5.83	2.16	3.06	-0.23	2.61	1.44	1.01	0.33	5.61	-1.51
Kurtosis	12.01	50.51	9.87	15.09	2.26	11.06	3.92	2.19	2.85	134.17	4.02
Observations	1665	1665	1665	1665	1665	1665	1665	1665	1665	1665	1665

2b: Correlation Matrix

envtr	1										
fdi	0.106***	1									
fd	-0.0175	0.104***	1								
dcredit	-0.0285	0.0672**	0.139***	1							
dcreditfc	0.164***	0.143***	-0.0911***	0.249***	1						
m2	-0.0636**	0.0683**	0.0108	0.619***	0.109***	1					
sttv	-0.125***	-0.0203	0.196***	0.0436	0.0570*	-0.0546*	1				
fr	-0.0248	0.273***	0.0637**	0.0633**	0.0172	0.167***	0.0576*	1			
urban	0.137***	-0.0108	0.0901***	-0.0224	-0.147***	0.223***	0.137***	-0.0460	1		
gdp	0.0215	-0.0353	-0.0389	-0.0763**	0.000706	-0.0307	0.0168	-0.0157	0.0258	1	
dinv	0.0848***	-0.00917	-0.167***	-0.0681**	-0.157***	0.0509*	-0.732***	0.00873	-0.00824	0.0299	1

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

(Source: Authors' computations)

3.4.2 Empirical Results and Discussions

The study follows Roodman (2007) and Bond et. al. (2001) to settle on the use of the system GMM estimation techniques for this study. The results in Table 3.6 in the Appendix show that the lag of the dependend variable reported by the system GMM is symmetrical to both the pooled OLS (upper bound) and the Fixed effect (lower bounds) models. Again the system GMM results report the lowest values for the Akaike Information Creteria, Bayesian Information Creteria, and Hannan-Quinn Information Creteria as suggested by the Andrews-Lu model and moment selection criteria creteria.

Table 3.3 contains the results for the baseline model.

A common problem that affects GMM is heteroskedasticity and serial correlation especially due to the inclusion of the lagged dependent variable. We conducted the Breusch-Pagan / Cook-Weisberg test for heteroscedasticity and the Levin-Lin-Chu unit-root test results to detect patterns in the disturbance term and serial correlation in the lags respectively. The results in Table 3.7 in the Appendix show presence of heteroscedasticity in the errors. And this is solved using robust standard errors as recommended by Verbeek (2017) and Driscoll and Kraay (1998). The outcome of the Levin-Lin-Chu unit-root test shown in Table 3.8 in the Appendix does not give concern for serial correlation in the regressors.

Table 3.3: Results for the Composite Index for Financial Sector Development

Variables	(1) envtr	(2) envtr	(3) envtr	(4) envtr	(5) envtr	(6) envtr
l.envtr	0.905***	0.915***	0.910***	0.949***	0.917***	0.909***
	(0.0299)	(0.0279)	(0.0287)	(0.0331)	(0.0284)	(0.0286)
fr	-0.0154	0.0620***	0.0545***	0.00831	0.0521***	0.0540***
	(0.0330)	(0.0150)	(0.0151)	(0.0254)	(0.0150)	(0.0150)
gdp	0.0916***	0.0756***	0.0808***	0.0687***	0.0789***	0.0788***
	(0.0252)	(0.0228)	(0.0235)	(0.0237)	(0.0234)	(0.0232)
urban	0.0706***	0.0804***	0.0811***	0.0615***	0.0791***	0.0799***
	(0.0134)	(0.0122)	(0.0122)	(0.0148)	(0.0123)	(0.0120)
dinvt	-0.00375	-0.00834	-0.00855	-0.0573**	-0.00622	-0.00687
	(0.00663)	(0.00618)	(0.00631)	(0.0226)	(0.00627)	(0.00627)
fdi	3.884**		0.475*	-1.214	2.422***	0.510**
	(1.559)		(0.253)	(0.792)	(0.630)	(0.252)
fd		-0.948***	-0.988***	27.69**	-0.519*	-0.621**
		(0.285)	(0.293)	(12.77)	(0.281)	(0.301)
fd×fdi				-12.60***		
				(3.493)		
fd^2					-64.67**	
					(28.80)	
highfd						-0.111**
						(0.0490)
constant	-2.990***	-3.067***	-3.113***	-3.917***	-3.118***	-3.065***
	(0.510)	(0.450)	(0.453)	(0.571)	(0.465)	(0.444)
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1665	1665	1665	1665	1665	1665
F Statistics	73.06	73.88	49.17	47.70	59.09	43.01
Groups/instruments	45/38	45/38	45/37	45/38	45/38	45/38
AR (2)	0.870	0.907	0.896	0.883	0.906	0.815
Hansen Statistics	0.320	0.227	0.494	0.661	0.564	0.537
Turning point (TP)	n/a	n/a	n/a	n/a	0.004[1]	n/a

*Standard errors in parentheses. ***, **, * are statistical significance at the 1%, 5% and 10% levels respectively. P-values reported for AR (2) show the absence of second-order autocorrelation. The Hansen statistics indicate instruments are strictly valid and the model is not weakened by many instruments. TP = (-0.519)/(2×(-64.67)=0.004*

(Source: Authors' computations)

Models (1) to (6) of Table 3.3 present the full sample results for the baseline regression in equation 3.1, where the study tests the effect of the composite index of the financial sector development

variables on the relationship between FDI and environmental risk. From model (7) to (18) of Table 3.5, the study followed the existing literature and used the regular financial sector development variables as alternative proxies to check for the robustness of the baseline model. The Hansen statistics in all the 18 models are affirming the validity of the chosen instruments for the system GMM model. Additionally, AR (2) reject the presence of second-order serial correlation in the error terms. The F-statistics, on the other hand, support the overall fitness of the model.

The lagged of the environmental risk is statistically significant at conventional levels in all the models presented in the baseline results and all the other results. The positive coefficients imply that previous environmental risk aggravates the current levels. This lends support to the argument in the literature that, the current level of CO_2 emissions strongly depends on previous emissions (Acheampong, 2019; Tamazian, Chousa, & Vadlamanna, 2009). Again, the significance of the lagged dependent variable affirms the suspicions of the study that the economic growth convergence theory as advanced by Barro and Sala-i-Martin (2004) is also persistent in the climate change debate.

Model (1) tests the effect of FDI on environmental risk in the absence of Financial sector development (FD). The results presented in model (1) show that FDI has a significant positive effect on environmental risk in Africa. These findings support the existing opinion in the literature that the unguided effect of FDI on the environment is depressive (Boachie-Yiadom & Mensah, 2021; Singhania & Saini, 2021; Shahbaz, et. al., 2018; Bokpin, 2017; Zheng & Sheng, 2017; Omri, et. al., 2014). Studies such as Nepal, et. al. (2021), Demena and Afesorgbor (2020) as well as Hille, Shahbaz, and Moosa (2019) disagree with this finding because FDI follows the pollution halo hypothesis. The disparities in the two streams of findings can largely be attributed to the cross-sectional fixed effect in the sample, such as the location of the FDI. Whereas some countries may

have strong regulations to moderate FDI inflows, others like Africa lack these local factors. The studies of Nepal, et. al. (2021), Demena and Afesorgbor (2020), and Hille et. al. (2019) focused on India, Korea, and meta-analysis of prior studies respectively. Hence, the jurisdiction may account for the differences in the findings.

Model (2) tests the unilateral effect of financial sector development on environmental risk. The results show that financial sector development reduces environmental risk. The significant negative coefficient suggests that a percentage increase in the FD index will reduce environmental risk in Africa by 0.948%. Shahbaz et. al. (2018) report a similar finding that the long-run effect of FD on CO_2 emissions is negative.

On the contrary, Ntow-Gyamfi et. al. (2020), Acheampong (2019), and Shahbaz, et. al. (2016) rules out the potency of FD to reduce environmental risk, especially in the linear form. The three studies reported zero to a positive statistically significant relationship between FD and CO_2 emissions. These studies advanced claims that FD increases financial access which boosts households and firms' income to purchase high-ticket energy-consuming appliances and equipment. There are fundamental issues Ntow-Gyamfi et. al. (2020), Acheampong (2019), and Shahbaz, et. al. (2016) failed to acknowledge. The assertion that a rise in financial access increases the demand for pollutant goods is overly simplistic. Although, it may sound logical to argue that financial access worsens environmental risk, however, there is less empirical evidence to conclude that an increase in financial access automatically actually triggers CO_2 emissions (Riti, et. al, 2017).

Intuitively, an increase in financial access could also spread to other sectors of the economy which hitherto were neglected by investors, like the energy-efficient sectors. Additionally, a careful examination of the variables used to proxy FD by the proponents who claim no or positive

relationship between FD and CO_2 emissions reveals biasedness in the choice of variables. These variables do not reflect the whole of the financial sector as observed by Sahay et. al. (2015). For instance, the FD variables used by Ntow-Gyamfi et. al. (2020), Acheampong (2019), and Shahbaz, et. al. (2016) include the domestic credit to the private sector, domestic credit to the private sector by financial institutions, broad money, stock market capitalization, and the stock market traded value measure only financial deepening (see Table 3.5 in the Appendix). The skewness in the choice of the FD variables by these studies cast doubt on the generalization of their findings.

Financial inclusion influences savings, investment and consumption (Yiadom, Dziwornu, & Yalley, 2021). Therefore, it is true that financial access may cause an upward surge in economic activities, it is, however, unclear that every economic activity aggravates environmental risk. This is because, there are chances that, the increase in financial access could spill over into climate-resilient economic activities.

Finally, low financial access can lead to financial concentration among a few people. Over-concentration of funds among a few people makes it easy for them to determine what is produced and consumed; hence, influencing environmental outcomes becomes easy. This may not be healthy for the environment if a few people do not have concern for the environment.

Model (3) of Table 3.3 tests the effect of FDI on environmental risk when controlled for FD. The results show a persistent positive coefficient, indicating that FDI is still harmful to the environment. However, the coefficient of the FDI reduced significantly from 3.884% to 0.475%. The lesson here is that the harmful effect of FDI on environmental risk is minimized when controlling for financial sector development. This finding is unique to the present study, this is because, the existing literature considered the separate effect of either the FDI or the FD on the

environment (Boachie-Yiadom & Mensah, 2021; Singhania & Saini, 2021; Nepal, et. al., 2021; Demena & Afesorgbor, 2020; Acheampong, 2019; Shahbaz, et. al., 2018; Tamazian, et. al., 2009).

Again, in model (4) of Table 3.3, the study introduced the interaction term to test the moderation effect of FD on the relationship between FDI and environmental risk. The interaction term recorded a negative coefficient of -12.6%, suggesting that, the FD is a potent moderator that can overturn the negative effect of FDI on environmental risk. Although this finding is new to the existing empirical studies, there are enough related studies that support the position of this study.

Osei and Kim (2020), Agbloyor et. al. (2013), and Alfaro et. al. (2004) together holds the view that financial sector development can moderate the negative effect of FDI on economic growth and that whether FDI is growth-enhancing or destructive depends on the level of local FD. Economic growth, on the other hand, has long been linked to environmental risk (Dasgupta et. al., 2002; Grossman & Krueger, 1991). Hence, it makes sense to infer that if FDI conditioned on local financial sector development propels growth, then the same moderator (financial sector development) can play a significant role in the impact of FDI on the environment. Also, financial sector development captures direct and indirect regulations within the financial system and therefore falls within the ambit of the overall institutional framework (Sahay et. al., 2015; Alfaro et. al., 2004). If institutions can overturn the negative effect of FDI on the environment as suggested by Bokpin (2017), then the present study makes no error in reporting that FD moderates the effect of FDI on environmental risk.

The key finding in Table 3.3 is that financial development moderates the FDI-environmental nexus. It is critical to demonstrate the practical implication of this finding in order to guide policy in terms of what exactly is within the financial sector development that could reduce the negative impact of FDI on the environment. The practical implications of the findings are in two parts. First,

financial development plays a causal role in the economy by directing domestic and foreign investment into various sectors. More financial sector development can allow for more financing at lower costs, including investment in environmental projects. It can also be reasoned that high financial development can equally attract dirty investment to destroy the environment. Hence, greater financial development may lead to a zero-sum game.

So, how does an economy ensure that the rise in financial development reduces the environmentally destructive investment? A direct government intervention is required. Financial regulations are at the heart of financial development and it gives central government the opportunity to design and implement policies that healthy to the economy and the environment. Governments through the central banks can development policies to restrict credit to firms in destructive sectors and at same time reduce the cost of capital for firms engaged in environmentally friendly activities.

Second, financial development promotes efficient capital allocation. That means greater development in the financial sector will require firms to be properly govern to attract local and foreign investors. Good corporate governance practices ensure that the triple bottom line (profit, people, and planet) is effectively balanced. Corporate governance reduces the opportunity cost of profit over the environment. As a result, environmental considerations can be incorporated into firm-level investment decisions, which can reduce the flow of dirty FDI into the economy.

3.4.3 The Marginal effect and Turning Point analysis of Financial Sector Development

Furthermore, it is clear from the results presented in the model (1), (2), and (3) that the negative coefficient of the interaction term is driven by the FD. To be sure of this claim, the study computed the net effect or the partial derivative of the FD and the FDI variables using equations 3.4 and 3.5. The net effect of FD and FDI is computed using the formula $\gamma\delta_{CO2} + (\tau \times mean_{FDI} \times \delta_{CO2})$ and $\zeta\delta_{CO2} + (\tau \times mean_{FD} \times \delta_{CO2})$ respectively. The results of this exercise produced a partial effect of 33.8% and 3.3% for FD and FDI respectively. This confirms that the negative coefficient of the interaction terms is heavily driven by financial sector development.

Moreover, the study introduced the squared term of the FD into the model (5) to test for two things. First, the presence of non-linearity between the financial sector development and environmental risk, and second, the effect of doubling FD on the environmental risk. The results show a negative coefficient of 0.519% and 64.67% for the linear and the squared term of the FD respectively. This finding suggests the absence of an inverted 'U' shaped relationship between financial sector development and environmental risk and hence, our conclusions are opposite to that of Ntow-Gyamfi et. al. (2020).

Again, the negative coefficient of the FD squared suggests that doubling the current level of FD will continue to promote low environmental risk in Africa. This calls for enhanced action to deepen the financial sector. A well-developed financial sector strengthens financial depth, access, and efficiency. The widening of the financial sector brings into the mainstream neglected sectors like climate-resilient entrepreneurs. Lack of capital is a major hindrance among entrepreneurs in Africa especially those that intend to go into non-traditional areas. However, as the financial sector develops, access to cheaper funds makes it easier for entrepreneurs to take the initiative. Climate-

resilient sectors such as energy-efficient equipment are underfinanced in Africa and the study believes that the widening of the financial sector will reduce the financial challenges in these sectors.

3.4.4 The Effect of High Levels of Financial Sector Development on the FDI and Environmental Risk nexus

Additionally, because FD cannot be increased indefinitely, the study computed the turning point at which the negative effect of FD on the environmental risk may change and the gains made could be reversed. The results in model (5) show a value of 0.4%. This suggests that although more financial development is needed to reduce the environmental risk, there is, however, a slippery and elusive threshold that can easily be exceeded.

Model (6) of Table 3.3 grouped the dataset into two – high and low financial sector development countries. A simple quartile analysis was used to locate the median FD value and a dummy variable was used to capture the high and low FD. The idea behind this exercise is to find whether countries with high FD may reduce their level of environmental risk. The results show that on average, holding all other factors constant, the environmental risk of a country is expected to be 0.11% less if a country has a high level of financial sector development. This confirms the suspicions of the researchers that developing the African financial sector will inure to the benefit of the environment.

3.4.5 Control Variables

The control variables were selected following the thinking of Singhania and Saini (2021), Nepal et. al. (2021), Demena and Afesorgbor (2020), and Acheampong (2019), Shahbaz et. al. (2018), and Tamazian et. al. (2009). The financial regulation (fr) variable is used to control for another aspect of regulations that are not captured in the FD variables entered into models (2), (3), (5), and (6) of Table 3.3 at levels. It recorded a significant positive coefficient of about 0.05% for all the models which are opposite to our expectations. One reason that can be attributed to this finding is

that there are generally weak regulations across Africa (with a mean score of 0.88 on a scale of 0 to 6, refer to Table 3.2) and in some cases self-destructive.

Economic growth measured by gdp is significant in all 6 models of the baseline results in Table 3.3. The results suggest that economic growth aggravates environmental risk. This finding lends support to the literature (Boachie-Yiadom & Mensah, 2021; Singhania & Saini, 2021; Nepal, et. al., 2021; Stern, 2004; Dasgupta et. al., 2002; Grossman & Krueger, 1991). Again, the growth rate of the urban population (urban) has been used variously in the literature (Boachie-Yiadom & Mensah, 2021; Ntow-Gyamfi et. al., 2020; Bokpin, 2017). In all the 6 models in Table 3.3, the results echo the findings in the empirical studies that urbanization is a threat to the environment.

Also, to disassociate local investment from foreign, the study controlled for this using the growth rate in domestic investment (dinvt). Although the local investment variable maintained the expected sign of negative throughout all the 6 models in Table 3.3, it was, however, significant only in the model (4). This suggests that local investment is less destructive to the environment. Intuitively, this makes sense because local investors are likely to be more sympathetic to the environment than foreign investors. Furthermore, all the control variables are shown in models (7) to (18) of Table 3.4 recorded findings which are parallel to the results discussed in the model (1) to (6) of Table 3.3.

3.4.6 The Dynamic Panel Threshold Regression Analysis

In model (5) of Table 3.3 we examine non-linearity of the relationship between financial development and environmental risk by imposing a quadratic variable fd^2 on the equation. This approach which is largely use in the literature exogenizes the non-linearity assumption and could be subjective in determining the threshold value. We employ the dynamic panel threshold approach recommended by Seo et al. (2019) and Seo and Shin (2016) to retest the non-

monotonicity of the relationship between financial development and environmental risk. We first test for the existence of the threshold in the dataset. The threshold test is conducted under a null hypothesis that the relationship between financial sector development and environmental risk is linear (i.e. $\theta_1 = \theta_2$). Alternatively, we hypothesize a threshold relationship where $\theta_1 \neq \theta_2$. The results for the test for threshold presented in Table 3.9 in the Appendix recorded LM-test statistic of 13.23 with a bootstrap p-value less than 1%. This indicates the existence of threshold and that the relationship between the financial sector development and environmental risk is non-linear. The implication of this findings suggests the splitting of the dataset into two distinct regimes, where one side is above a calculated threshold value and the other below it.

Further, the findings in Table 3.9 indicate that the impact of financial development on environmental risk depends on the level of development in the financial sector. Hence, two different regimes will impact environmental risk differently. We then proceed to estimate the dynamic panel threshold regression following the recommendation by Seo et al. (2019) and Seo and Shin (2016) and present the results in Table 3.10 of the Appendix. The findings show a calculated threshold value of 0.27 for financial development. In Table 3.10 we present the results for low and high regimes in models (2) and (3) respectively and the system GMM results are shown in model (1) for comparative purposes. In model (2) the financial development variable (fd) recorded a positive and significant coefficient of 0.16. This suggest that low levels of financial sector development worsen environmental risk.

A possible reason accounting for this finding is that low levels of financial sector development led to overconcentration of funds in few sectors of the economy. And given the nature of the African economy, extractive sectors which are environmentally destructive are more likely to receive

funding than the other sectors. On the other hand, the results in model (3) of Table 3.10 reveal contrasting findings. Financial development recorded a negative coefficient of 0.205 at 10% significant levels above the threshold value of 0.27. This means that high regimes' financial sector development has the ability to reduce environmental risk. This finding make sense because higher levels of financial development promote financial deepening, financial access and efficiency. Which means that entrepreneurs can assess funding at relatively lower cost thereby encouraging innovation and investment into environmental resilient activities.

The highlight from the threshold analysis is that the level of financial sector development matters in accounting of its impact on environmental risk. Therefore, assuming a linear relationship between the two variables is problematic. Further, the findings in models (2) and (3) bring clarity to the literature on why some studies report positive effect of financial development on environmental risk and others show negative effect.

3.4.7 Robustness checks: The Traditional Measurement of Financial Sector Development

The empirical studies have used variables such as domestic credit to the private sector as a percentage of gdp (dcredit); domestic credit provided by the financial sector as a percentage of gdp (dcreditfc); broad money as a percentage of gdp (m2); stocks traded, total value as a percentage of gdp (sttv) to measure financial sector development (Ntow-Gyamfi, et. al., 2020; Acheampong, 2019; Shahbaz, et. al., 2018; Riti, et. al., 2017; Tamazian, et. al., 2009). The present study has argued that these traditional variables are inadequate, weak, biased, and also inefficient to capture the recent developments in the wider financial sector. The study proceeded to introduce a more robust and comprehensive dataset compiled by Sahay et. al. (2015) to proxy the level of financial sector development.

Notwithstanding, in the model (7) to (18) of Table 3.4, the current study retests its assumptions using these same traditional variables. This is because the underline objective of the present study is to examine the effect of financial sector development on the relationship between FDI and environmental risk which is novel in the existing literature. The existing studies narrowly examined either the effect of FDI on the environment (Nepal, et. al., 2021; Zheng & Sheng, 2017; Sbia, et. al., 2014; Jorgenson, et. al., 2007) or the effect of financial sector development on the environment (Ntow-Gyamfi, et. al., 2020; Acheampong, 2019; Shahbaz, et. al., 2018; Riti, et. al., 2017; Tamazian, et. al., 2009). Again, this study makes a case that the FD and FDI are intertwined, hence, their interaction may have different outcomes on the environment.

Model (7) to (18) of Table 3.4 measures the direct and indirect effect of FDI on the environmental risk in the presence of the traditional FD variables. The results reaffirm the mixed findings in the literature. Whereas domestic credit to the private sector (dcredit) and domestic credit provided by the financial sector (dcreditfc) worsen environmental risk; broad money (m2) and stocks traded (sttv) on the other hand, reduce environmental risk in the linear, non-linear and the interaction form. We sum up that whether FD promotes or hinders environmental quality depends on the variables used in proxying financial sector development as evidenced in Acheampong (2019); Riti, et. al. (2017); Shahbaz et al. (2016); Sehrawat et al. (2015) and Boutabba (2014). This finding settles the raging contentions on the effect of financial sector development on environmental risk. The disagreement in the empirical literature is due to the skewness in the choice of the FD variables.

Additionally, in models (15), (16), (17) and (18) of Table 3.4, the interaction term between the two domestic credit variables (dcredit and dcreditfc) collaborate with FDI to hurt the environment as expected. Conversely, broad money (m2) and stocks traded (sttv) interacts with the FDI to

reduce environmental risk. Strangely enough, all these four variables variously used in the literature are categorized under financial deepening, yet they produce inconsistent results (refer to Table 3.5 in the Appendix). The present study has provided a unique solution to this ambiguity and thereby settling the debate.

Table 3.4: Alternative Measures of Financial Sector Development

Variables	(7) envtr	(8) envtr	(9) envtr	(10) envtr	(11) envtr	(12) envtr	(13) envtr	(14) envtr	(15) envtr	(16) envtr	(17) envtr	(18) envtr
l.envtr	0.966***	0.855***	0.935***	0.887***	0.893***	0.883***	0.934***	0.905***	0.951***	0.867***	0.935***	0.802***
	(0.0231)	(0.0285)	(0.0283)	(0.0265)	(0.0264)	(0.0286)	(0.0282)	(0.0255)	(0.0250)	(0.0299)	(0.0290)	(0.0270)
fr	0.0340**	0.0480***	0.0937***	0.0936***	0.0296*	0.0476***	0.0725*	0.0760***	0.0467***	0.0492***	0.0669*	0.0114
	(0.0135)	(0.0130)	(0.0356)	(0.0167)	(0.0154)	(0.0139)	(0.0378)	(0.0169)	(0.0153)	(0.0138)	(0.0377)	(0.0140)
gdp	0.0743***	0.0596***	0.0800***	0.0677***	0.0627***	0.0726***	0.0793***	0.0528**	0.0798***	0.0686***	0.0682***	0.0475**
	(0.0225)	(0.0215)	(0.0230)	(0.0221)	(0.0226)	(0.0225)	(0.0229)	(0.0213)	(0.0233)	(0.0225)	(0.0240)	(0.0189)
urban	0.0515***	0.0665***	0.0516***	0.0723***	0.0352***	0.0811***	0.0548***	0.0341**	0.0591***	0.0729***	0.0419***	0.0252**
	(0.00869)	(0.00863)	(0.00918)	(0.00928)	(0.0102)	(0.0103)	(0.00935)	(0.0166)	(0.00972)	(0.00946)	(0.0100)	(0.0100)
dinvt	-0.00498	0.0342***	0.00255	-0.268***	-0.0299***	-0.0755***	-0.00585	-0.240***	-0.0118*	0.0295***	0.0046	-0.045***
	(0.00596)	(0.00896)	(0.00801)	(0.0472)	(0.00737)	(0.0221)	(0.00954)	(0.0452)	(0.00711)	(0.00932)	(0.00824)	(0.0148)
fdi	0.249	-0.792***	0.519*	-0.249	-0.284	-0.0942	0.475*	-0.649**	-0.759	17.83***	8.181***	0.407*
	(0.233)	(0.293)	(0.271)	(0.253)	(0.291)	(0.243)	(0.271)	(0.278)	(0.674)	(3.803)	(2.783)	(0.245)
dcredit	0.0028***				-0.0958***				-0.0131			
	(0.00108)				(0.0174)				(0.00820)			
dcreditfc		0.0329***				0.127***				0.0318***		
		(0.00564)				(0.0326)				(0.00636)		
m2			-0.0246*				-0.0481**				-0.00411	
			(0.0144)				(0.0205)				(0.0165)	
sttv				-0.044***				-0.166***				-0.007***
				(0.00787)				(0.0460)				(0.00232)
$dcredit^2$					0.00089***							
					(0.00017)							
$dcreditfc^2$						-0.0009***						
						(0.00024)						
$m2^2$							0.000311					
							(0.00019)					
$sttv^2$								0.00127***				
								(0.00047)				
dcredit×fdi									0.0551*			
									(0.0327)			
dcreditfc×fdi										-0.229***		
										(0.0493)		
m2×fdi											-0.259***	
											(0.0937)	

sttv×fdi												-0.00389 (0.00942)
Constant	-2.231*** (0.366)	-5.078*** (0.590)	-1.592*** (0.547)	0.0847 (0.553)	-0.0474 (0.554)	-6.840*** (1.102)	-1.339** (0.568)	2.693** (1.098)	-2.174*** (0.382)	-5.300*** (0.700)	-1.736*** (0.563)	-0.453 (0.283)
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1665	1665	1665	1665	1665	1665	1665	1665	1665	1665	1665	1665
F Statistics	99.55	45.88	89.34	66.24	112.76	38.29	75.85	20.73	79.92	78.92	162.42	44.75
Groups/instruments	45/38	45/39	45/38	45/38	45/38	45/38	45/39	45/38	45/38	45/39	45/38	45/38
AR (2)	0.635	0.594	0.782	0.532	0.314	0.726	0.797	0.165	0.800	0.585	0.501	0.182
Hansen Statistics	0.486	0.515	0.492	0.554	0.565	0.486	0.423	0.391	0.429	0.506	0.533	0.464
Turning point (TP)	n/a	n/a	n/a	n/a	-53.820	-70.556	-77.331	-65.354	n/a	n/a	n/a	n/a

*Standard errors in parentheses. ***, **, * are statistical significance at the 1%, 5% and 10% levels respectively. P-values reported for AR (2) show the absence of second-order autocorrelation. The Hansen statistics indicate instruments are strictly valid and the model is not weakened by many instruments.*

(Source: Authors' computations)

3.5 Conclusions and Policy Implications

The present study examines the role of financial sector development in the relationship between FDI and environmental risk by introducing a new measurement of financial sector development into the international capital and climate change debate. The study set up a panel dataset that covers 45 Sub-Saharan African economies over 36 years from 1982 to 2018. The study applies the system GMM technique to accommodate the dynamic nature of the dataset and make provisions for endogeneity and heteroskedasticity in the series.

A review of the existing empirical literature shows that variables such as domestic credit to the private sector, domestic credit provided by the financial sector, broad money, and stocks traded are used in measuring financial sector development. However, these variables fail to address the complexity of the modern financial sector. The present study employed a new dataset by Sahay et. al. (2015) to proxy financial sector development. Again, the findings from the earlier studies show a little understanding that the financial sector is the entry point and a carrier of FDI. That answers the question of why several studies have only investigated either the relationship between FDI and the environment or the financial sector development and the environment with disjointed conclusions. The approach of this study corrects the misconception that the effect of FDI on the quality of the environment is isolated from the financial sector.

On the findings, from our baseline models, we conclude that the unmitigated effect of FDI on environmental risk is still detrimental. However, the extent to which the FDI harms the environment is minimized in the presence of financial sector development indicators. To test this further, the study forcefully conditioned FDI on financial sector development by treating the FD variable as a moderator. We found that financial sector development can overturn the negative effect of FDI on the environment into a positive one. Thus, FDI conditioned on the level of

financial sector development can reduce environmental risk. Although this finding is unique to this study in the area of environmental quality, it is, however, not new in the FDI, financial sector development, and economic growth literature. Our results from dynamic panel threshold regression reveals that financial development increases environmental risk at low regimes of the threshold but high regimes of financial sector development have the ability to reduce it.

We also conclude that countries with a high level of financial sector development reduce their environmental risk more than countries with low financial sector development scores. The study also used the traditional variables use in the literature to proxy financial sector development to settle the confusion in the literature as to whether FD promotes or hinders environmental quality. We sum up that whether FD promotes or hinders environmental quality depends on the variables used in proxying financial sector development. Based on the findings the study recommends a concerted effort at the country level to ensure comprehensive development in the broad components of the financial sector.

3.6 Chapter Summary

This chapter contains the first empirical chapter of the study. It has addressed the objective one of the thesis and is entitled "Foreign Direct Investment and Environmental Risk: the role of Financial Sector Development". We justified the need for this chapter in the introduction section and situated it in the context of the current debate at the literature section. The estimation approach, data and choice of variables were included in the methodological section. The key takeaway from the discussion section is that, the unmitigated effect of FDI on environmental risk is detrimental. However, FDI conditioned on the local financial sector development minimizes environmental risk. Again, the findings suggest that countries with low financial sector development indicator scores reported worse environmental risk than their counterparts.

3.7 Appendix

Table 3.5: Variables in the FD Index Computation (Adapted from Sahay et al., 2015)

	FINANCIAL INSTITUTIONS	FINANCIAL MARKETS	SUMMARY
DEPTH	1. Private-sector credit (% of GDP) 2. Pension fund assets (% of GDP) 3. Mutual fund assets (% of GDP) 4. Insurance premiums, life and non-life (% of GDP)	1. Stock market capitalization to GDP 2. Stocks traded to GDP 3. International debt securities government (% of GDP) 4. Total debt securities of nonfinancial corporations (% of GDP) 5. Total debt securities of financial corporations (% of GDP)	**DEPTH** 1. Private-sector credit (% of GDP) 2. Pension fund assets (% of GDP) 3. Mutual fund assets (% of GDP) 4. Insurance premiums, life and non-life (% of GDP) 5. Stock market capitalization to GDP 6. Stocks traded to GDP 7. International debt securities government (% of GDP) 8. Total debt securities of nonfinancial corporations (% of GDP) 9. Total debt securities of financial corporations (% of GDP)
ACCESS	1. Branches (commercial banks) per 100,000 adults 2. ATMs per 100,000 adults	1. Percent of market capitalization outside of top 10 largest companies 2. Total number of issuers of debt (domestic and external, nonfinancial corporations, and financial corporations)	**ACCESS** 1. Branches (commercial banks) per 100,000 adults 2. ATMs per 100,000 adults 3. Percent of market capitalization outside of the top 10 largest companies 4. Total number of issuers of debt (domestic and external, nonfinancial corporations, and financial corporations)
EFFICIENCY	1. Net interest margin 2. Lending-deposits spread 3. Non-interest income to total income 4. Overhead costs to total assets 5. Return on assets 6. Return on equity	1. Stock market turnover ratio (stocks traded/capitalization	**EFFICIENCY** 1. Net interest margin 2. Lending deposits spread 3. Non-interest income to total income 4. Overhead costs to total assets 5. Return on assets 6. Return on equity 1. Stock market turnover ratio (stocks traded/capitalization

(Source: Authors' Compilation)

Table 3.6: Results of Roodman (2009) and Bond et. al. (2001) GMM selection Criteria

	(1)	(2)	(3)	(4)
VARIABLES	Pooled OLS: Upper Bound	Fixed Effect: Lower Bound	Baseline results: Two-Step System GMM	Two-Step Difference GMM
l.envtr	0.976***	0.758***	0.910***	0.710***
	(0.0118)	(0.0163)	(0.0287)	(0.0071)
fr	-0.00814	-0.0131	0.0545***	-0.0161***
	(0.0103)	(0.0111)	(0.0151)	(0.0047)
gdp	0.00127	-0.00016	0.0808***	0.0448***
	(0.0020)	(0.0021)	(0.0235)	(0.0022)
urban	0.00133	0.0022*	0.0811***	0.0256***
	(0.0009)	(0.0013)	(0.0122)	(0.0018)
dinvt	0.00198	-0.0385***	-0.0086	-0.281***
	(0.0045)	(0.0127)	(0.0063)	(0.0159)
fdi	0.206	-0.0378	0.475*	0.425***
	(0.169)	(0.192)	(0.253)	(0.149)
fd	0.0705	0.190	-0.988***	1.230**
	(0.156)	(0.337)	(0.293)	(0.546)
Constant	0.0536	0.448***	-3.113***	
	(0.0532)	(0.103)	(0.453)	
Observations	1665	1665	1665	1,591
Groups/instruments	45	45	45/38	45/38
AR (2)			0.896	0.852
Hansen Statistics			0.494	0.352
R-squared	0.125	0.585	-	-
Andrews-Lu model and moment selection criteria (MMSC):				
Akaike (AIC)			**-0.0036**	-0.0024
Bayesian (BIC)			**-0.0065**	-0.0051
Hannan-Quinn (HQIC)			**-0.0048**	-0.0034

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
(Source: Authors' Computation)

Table 3.7: Breusch-Pagan / Cook-Weisberg test for heteroskedasticity

Ho: Constant variance
Variables: envtr fr gdp urban dinv fdi fd
F(7 , 1313) = 8.14
Prob > F = 0.0000

(Source: Authors' Computation)

Table 3.8.D: Levin-Lin-Chu unit-root test

Ho: Panels contain unit roots — Number of panels = 45
Ha: Panels are stationary — Number of periods = 37

AR parameter: Common — Asymptotics: N/T -> 0
Panel means: Included
ADF regressions: 1 lag
LR variance: Bartlett kernel, 10.00 lags average (chosen by LLC)

Variable	Statistics Unadjusted	Adjusted	p-value
envtr	-15.4951	-6.2078	0.2458
fr	-4.9712	2.4223	0.9923
gdp	-21.9258	-10.9421	0.5762
urban	-5.4842	0.2261	0.5894
dinv	-17.6410	-8.6422	0.8795
fdi	-6.4971	0.9732	0.8348
fd	-7.8321	0.6334	0.7464

(Source: Authors' Computation)

Table 3.9: Test for Threshold existence

	FD Index
LM-test for no Threshold	13.23
Bootsrap p-value	0.000
No. of bootstrap replication	2000
Trimming percentage	0.15

(Source: Authors' Computation)

Table 3.10: Dynamic Panel Regression Results

Variables	(1) Overall GMM	(2) Low regime	(3) High regime
		<0.2700	>0.2700
l.envtr	0.910***	0.769***	-0.181***
	(0.0287)	(0.0759)	(0.0381)
fr	0.0545***	18.58*	-19.49***
	(0.0151)	(11.14)	(4.424)
gdp	0.0808***	0.187***	-0.192*
	(0.0235)	(0.0683)	(0.110)
urban	0.0811***	0.0286**	-0.0339***
	(0.0122)	(0.0118)	(0.0088)
dinvt	-0.0086	0.0309**	-0.0169*
	(0.0063)	(0.0121)	(0.00936)
fdi	0.475*	-0.0794	-0.123***
	(0.253)	(0.0601)	(0.0412)
fd	-0.988***	0.160***	-0.205***
	(0.293)	(0.0157)	(0.0533)
constant	-3.113***	2.198***	0.0700
	(0.453)	(0.591)	(0.0935)
Observations	1,634	1,634	1,634
No. of countries	45	45	45
Threshold value		0.2700	0.2700
F-Stats		602.69	602.69
Prob > F		0.000	0.000

(Source: Authors' Computation)

CHAPTER FOUR

ENVIRONMENTAL RISK AND FOREIGN DIRECT INVESTMENT: THE ROLE OF FINANCIAL DEEPENING, ACCESS AND EFFICIENCY

CHAPTER FOUR

ENVIRONMENTAL RISK AND FOREIGN DIRECT INVESTMENT: THE ROLE OF FINANCIAL DEEPENING, ACCESS AND EFFICIENCY

Abstract

We employ a dynamic panel of 45 economies from 1982 to 2018 and decomposed financial development into its three key components: depth, access, and efficiency. Foreign direct investment (FDI) augments local capital to promote economic growth, especially among financially cursed economies. The growth effect of FDI is often at the cost of the environment. In this study, we employ a dynamic panel of 45 economies from 1982 to 2018 and decomposed financial development into its three key components (depth, access, and efficiency) to investigate whether they can help to overturn the negative impact of FDI on the environment. The study adopts the system GMM and the dynamic panel threshold regressions approach to address the research gaps. The results from the various estimation strategies conclude that financial deepening and efficiency reduce environmental risk and can overturn the negative impact of FDI on the environment. Further, the low level of financial access in the sample promotes environmentally destructive activities and therefore cannot make the FDI – environment nexus any better. However, high levels of financial access has the ability to reduce environmental risk. Also after splitting the dataset into high and low financially developed economies, we report that FDI is more environmentally depressive among low financially developed economies. The level of financial sector development contributes to the extent to which foreign direct investment influences environmental quality. The better the financial development indicators, the more robust it can moderate the relationship between foreign direct investment and the quality of the environment.

Keywords: climate change, depth, access, efficiency, FDI, environmental risk.

4.1 Introduction

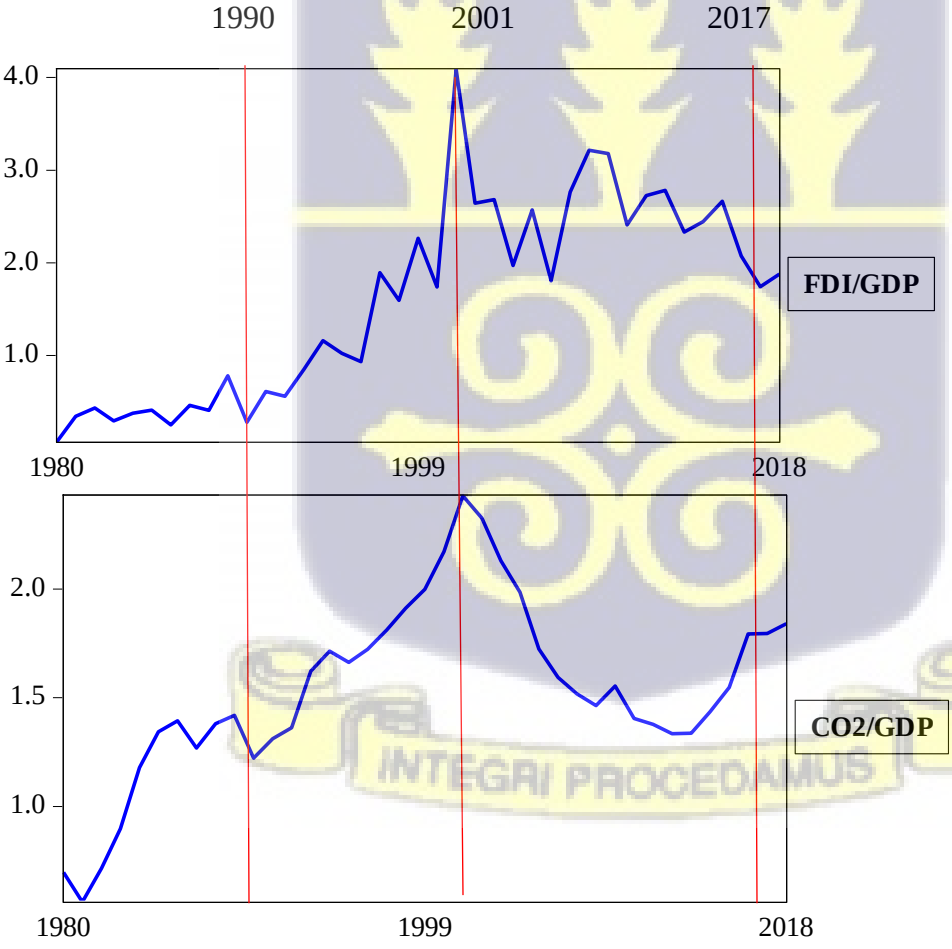
Scientists believe that economic activities are the main drivers of climate change. This is the main reason why advanced economies deteriorate the environment more than developing economies (Dasgupta, et. al, 2002). Ironically, the consequences of climate change and in this case environmental risk is that there is a high-level market failure which makes the least emitters of greenhouse gases to be the most affected (Sonwa, 2018). Of course, Africa contributes less than 4% to the annual global greenhouse gas emission but it is the worst affected by climate change (Ritchie, 2019). Shephard (2019) reports that Africa is a climate change hotspot and every addition to the greenhouse gas emission increases the region's environmental risk in the form of heatwaves, droughts, crop failures, and food insecurities, among others.

Meanwhile, Africa's low greenhouse gas emission is changing in recent times partly to the enhancement in the hunt for more or new capital (see Figure 4.1). The level of greenhouse gas emissions from Africa is expected to go up further as it continues to mobilize more capital. Leke and Signé (2019) suggest that Africa requires a capital investment of US$1 trillion to be fully industrialized and become the world's next great manufacturing hub. This proposed capital requirement can hardly be financed from domestic revenue (Sachs et al, 2004; Burnside and Dollar, 2000). As a result, the need for foreign capital especially Foreign Direct Investment (FDI) has become eminent.

Although, there are other forms of foreign capital the region is tapping into, however, FDI inflow stands out and is becoming a major talking point in Africa's international capital debate. FDI is different in several ways. First, unlike government borrowing and other official development assistance, FDI does not come with immediate repayment conditions. Second, there are no prior open stringent requirements to meet before hosting FDI. Third, there are also no third parties to

review and approve a country's economic performance before FDI is granted. Fourth, FDI comes with more flexibility relative to the other forms of foreign capital. Although FDI is not free capital, it brings mutual benefits to both the home and the host economy. FDI forms a significant part of Africa's economic growth. For instance, in the past decade, the average annual FDI flow to Africa as a percentage of GDP is above 2.5% (see Figure 4.1). In 2019 alone, the region recorded an 11% increase in FDI despite the global downturn in inward FDI (UNCTAD, 2019). The relevance of FDI in Africa's growth struggles is evidenced in the region's attempt to restructure its taxes, trade laws, governance, infrastructure, and human capital, among others to be a key host to inward FDI (Boachie-Yiadom & Mensah, 2021; Odusola, 2016).

Figure 4.1: Trends in FDI and CO_2 Emission in Africa



(Source: Authors' computations)

Notwithstanding, FDI has received a backlash as being a major contributor to environmental risk contagion in Africa and other parts of the world (Bokpin, 2017; Zheng & Sheng, 2017; Omri, et. al., 2014). The trend analysis between FDI and carbon dioxide emission in Figure 4.1 confirms the earlier suspicions of research. Although too early in this study to establish a causal effect from FDI to CO_2, Figure 4.1 shows that the two variables slope upwards over time; and therefore, a likely positive relationship between the two. Figure 4.1 is further supported by theory and empirical studies that conclude that an upshoot in the capital (FDI) increases economic activities and subsequently aggravates environmental risk (Boachie-Yiadom & Mensah, 2021; Singhania & Saini, 2021; Shahbaz, et. al., 2018; Grossman & Krueger, 1991).

The question research is still attempting to answer is how to correct the negative impact of FDI on the quality of the environment. In the past Boachie-Yiadom and Mensah (2021) and Bokpin (2017) proposed tax policies and institutions respectively as intervening variables to overturn the negative effect of FDI on the environment. Additionally, extant research on environmental quality believes that the level of financial development can directly reduce environmental risk (Ntow-Gyamfi, et. al., 2020; Acheampong, 2019; Shahbaz, et. al., 2018; Riti, et. al., 2017). Other empirical studies have also drawn a strong relationship between financial development and FDI (Osei & Kim, 2020; Agbloyor et. al., 2013; Alfaro, et. al., 2004).

Based on the linkages reasoned by earlier researchers, the present study believes that financial development can moderate the effect of FDI on the quality of the environment. Financial development as represented by financial markets and institutions is the channel that distributes capital resources to the various sectors of the economy. As a distribution channel, financial markets and institutions indirectly determine the economic activities that may improve or destroy the environment.

Moreover, this study set itself apart from existing studies in this area. This study introduces a comprehensive measure of the financial development index from Sahay et, al. (2015) and decomposes it into three sub-units: financial deepening, access and efficiency. This offers the current study the opportunity to investigate first-hand how FDI affects the quality of the environment in the presence of the decomposed financial development indicators. By decomposing the financial sector development index into its subcomponents, the study can address which particular aspect of the financial development indicators drive environmental risk or can mitigate the negative effect of FDI on the environment. Subsequently, this research avoids the wholesale recommendations on financial sector development in the existing literature.

Furthermore, the numerous studies on financial sector development and environmental risk largely use one aspect of financial sector development – mostly financial deepening variables – such as private-sector credit; pension fund assets; mutual fund assets and stocks traded (Osei & Kim, 2020; Riti, et. al., 2017; Shahbaz, et. al., 2016; Tamazian, et. al., 2009). Since these variables do not fully represent the majority of the indicators for financial sector development, findings and recommendations from such studies could be biased and misleading. The lack of a comprehensive measure for financial development has led to some studies even suggesting that a highly developed financial sector will automatically harm the environment due to an increase in financial access (Shahbaz et al., 2016; Sehrawat et al., 2015). We correct this distortion in the literature by examining the separate effect of the three components (access, depth and efficiency) of financial development on the relationship between FDI and environmental risk. The study specifically tests whether the decomposed financial development indicators make the nexus any better. The specific objectives of the study are:

i. To examine the individual effect of the three dimensions of financial development on environmental risk.

ii. To examine the moderating effect of the three dimensions of financial development on the FDI-environmental risk nexus.

iii. To test whether 'too much finance' harm the environment.

iv. To investigate how environmental risk responds to financial depth, access efficiency, and FDI in high and low financially developed countries.

The remaining sections of the study are as follow. Section two gives a brief overview of the existing literature. Sections three and four explain the empirical strategy and the findings respectively. Conclusions and recommendations are included in section five.

4.2 Brief Literature Review

The rush for international capital is making the race-to-the-bottom (RTB) theory more profound among developing countries. Countries are deregulating the business environments, cutting down taxes and relaxing environmental laws to attract more foreign investors (Singhania & Saini, 2021; Shahbaz, et. al., 2018; Grossman & Krueger, 1991). It is the reason that 85% of the global FDI is hosted by the top 10 countries with the lowest corporate tax rates (Damgaard et al., 2019). The RTB is reinforced by the pollution haven hypothesis (PHH). As long as countries relax business policies and environmental laws to attract more foreign capital, those countries will end up becoming a destination for toxic multinational companies who want to avoid the cost of damaging the environment. Bokpin (2017) believes that countries that have weak environmental governance will attract dirty firms that will deteriorate the quality of the environment. Boachie-Yiadom and Mensah (2021) on the other hand investigated the pollution haven hypothesis through tax policies. They conclude that countries that deliberately relax tax policies to attract more FDI will have their

environment destroyed by the same FDI. The practicality of the negative effect of the RTB and the PHH can both be mitigated by a sound financial system.

The financial system is a key player in sourcing and disbursing funds for economic activities. The financial sector is the mediator between capital resources and the investment sectors of an economy. So, whether capital will be invested in environmentally destructive sectors or not depends on the eco-friendliness of the financial sector. A novel work by Schumpeter reveals that a well-developed financial sector facilitates capital accumulation and advanced technology to spur economic activities. Thus, the financial sector plays an intermediary (mediator) role between capital and the environment. Climate financing is critical in mitigating emissions and building resilience in the ecosystem to minimize climate change impact vulnerabilities. Without adequate financing the much talked about climate change mitigation and adaptation will only remain academic jargon. FDI can step up to fill the fiscal gap in local economies, especially in developing countries.

However, whether FDI will serve the climate financing purpose or not depends on prevailing local factors. Even for FDI to be growth-enhancing, local factors like institutions, financial markets, human developments, and infrastructure among others must come to play (Agbloyor, 2019; Agbloyor, et. al., 2016; Agbloyor, et. al., 2013). In the same way, this study believes that for FDI to facilitate climate resilience, these same factors must be present and strong in the domestic economy. We are particularly interested in how the subcomponents of financial developments are helping redirect FDI into efficient climate financing.

Financial development is the conduit that carries the financial resources (FDI) to the various sectors of the economy and therefore can influence the location of the funds. A weak financial

development leads to inefficient financial allocation (Alfaro, et. al., 2010; Alfaro, et. al., 2004). Some studies have proceeded to test the direct effect of financial development on the environment and report favourable outcomes (Acheampong, 2019; Shahbaz, et. al., 2018; Riti, et. al., 2017). We build on the findings of these studies to hypothesize that different aspects of financial development influence the FD – environment nexus differently.

4.3 Methodology

The study investigates the direct, indirect and nonlinearity effect of the three dimensions of financial development on the FDI – environmental risk nexus using a dataset of 45 sub-Saharan African countries over the 1982-2018 period. We suspect that not only the decomposed financial development is crucial in accounting for environmental risk but also the various components will influence the nexus differently. The study follows Acheampong (2019) and Tamazian et. al. (2009) to estimate a dynamic panel model where the current CO_2 emissions (*ENVTR*) are a function of the foreign direct investment (*FDI*), financial developments components (*COMP*), squared of the components of the financial development ($COMP^2$), and other control variables (X) consistent with the literature (Boachie-Yiadom & Mensah, 2021; Acheampong, 2019; Shahbaz, et. al., 2016; Tamazian et. al., 2009). The control variables include the financial sector regulation index (*FR*), gdp per capita growth rate (*GDP*), the growth rate of the urban population (*URBAN*) and the growth rate in domestic investment (*DINV*).

The financial development components are made up of financial depth (*DEP*), financial access (*ACC*) and financial efficiency (*EFF*). These variables are highly correlated; therefore, they are placed in the models separately.

The use of the dynamic model estimator as proposed by Arellano and Bond (1991) is not only widely used in the literature but also helps in addressing issues of autocorrelation, endogeneity,

and heteroskedasticity. Additionally, the study justifies the consistency of the model and the validity of the exogenous instruments using the Sagan and Hansen tests of over-identification restrictions and the Arellano and Bond test for second-order serial correlation. The dynamic model estimator also provides the most efficient results for our dataset since the period of 36 years is smaller than the 45 countries. The financial development data is compiled by Sahay et. al. (2015) and hosted by the International Monetary Fund. All other cross-country variables were collected from the World Bank's World Development Indicators (WDI). Except for the measurement of the financial development variables which is new to the literature, all other variables are purely inspired by existing studies (Ntow-Gyamfi, et. al., 2020; Osei & Kim, 2020; Riti, et. al., 2017; Shahbaz, et. al., 2016; Tamazian, et. al., 2009). The Sahay et. al. (2015) measurement of financial development although rare, however, it is the most comprehensive dataset source that captures the wider financial system.

$$ENVTR_{it} = \beta ENVTR_{it-1} + \zeta FDI_{it} + \eta COMP_{it} + \theta COMP_{it}^{2} + \gamma \mathrm{FR}_{\mathrm{it}} + \varphi GDP_{\mathrm{it}} + \tau \mathrm{URBAN}_{\mathrm{it}} + \rho \mathrm{DINV}_{\mathrm{it}} + \varepsilon_{it} \ldots\ldots\ldots (4.1)$$

$$\varepsilon_{it} = \gamma_i + \mu_t + v_{it}$$

$$for\ i = 1 \ldots 45\ and\ t = 1982 \ldots 2018 \ldots$$

ε_{it} is mean zero scalars; decomposes into $\varepsilon_{it} = \gamma_i + \mu_t + v_{it}$. Where γ_i is the country-specific fixed effects; μ_t is the time-invariant effect and v_{it} captures all other white noise in the specified model.

The squared term of the financial development components ($COMP^2$) tests the reaction of the environmental risk to doubling or increasing the level of each component. The introduction of the squared term also helps in testing the 'too much finance' hypotheses. Due to the quadratic nature of the squared term, it offers insight into its curvature which allows computing the turning point of the financial development. The turning point tells the exact threshold at which the effect of financial development on environmental risk changes and can be computed by taking the first differentiation of equation 4.1 concerning $COMP$ and setting it to zero as shown in equation 4.2.

$$\frac{\partial ENVTR_{it}}{\partial COMP_{it}} = \eta + 2\theta COMP_{it} \text{ ……..……(4.2)}$$

$$Turning\ Point\ (TP) = -\frac{\eta}{2\theta} \text{ … … …. . (4.3)}$$

To explain the indirect effect of the decomposed financial development on the environmental risk, the study includes the interaction term ($COMP \times FDI$) between each of the components of the financial development and the foreign direct investment into the linear form of equation 4.1.

$$ENVTR_{it} = \beta ENVTR_{it-1} + \zeta FDI_{it} + \eta COMP_{it} + \varpi (COMP \times FDI)_{it} + \gamma \mathrm{FR_{it}} + \varphi GDP_{\mathrm{it}} + \tau \mathrm{URBAN_{it}} + \rho \mathrm{DINV_{it}} + \varepsilon_{it} \text{ … … … … (4.4)}$$

$for\ i = 1 \ldots 45\ and\ t = 1982 \ldots 2018$

Additionally, due to the complexity associated with the interpretation of the coefficient of the interaction term (ϖ), the study follows the recommendations by Ntow-Gyamfi et. al. (2020) and Alfaro et. al. (2004) to estimate the net effect of each component of financial development on the environmental risk as shown in equation 4.4.

$$\frac{\partial ENVTR_{it}}{\partial COMP_{it}} = \eta + \varpi FDI_{it} \text{ ……..……(4.5)}$$

The net effect of the components of the financial development is computed at their mean values. However, to incorporate the standard deviations (δ) into the marginal effect computation, we followed Alfaro et. al. (2004) to modify equation 4.5 to estimate the final marginal effect of both the components of the financial development and the FDI as follows:

$$\text{The marginal effect of FD components} = \eta\delta_{ENVTR} + (\varpi \times mean_{FDI} \times \delta_{ENVTR}) \quad \ldots\ldots\ldots\ldots(4.6)$$

$$\text{The marginal effect of FDI} = \zeta\delta_{ENVTR} + (\varpi \times mean_{COMP} \times \delta_{ENVTR}) \quad \ldots\ldots\ldots\ldots\ldots\ldots(4.7)$$

3.3.3 Panel Threshold Estimation

In equation 4.1, we include both the linear and the quadratic term of the components of financial development in the regression. The idea is to test non-linearity on the relationship between the financial development components (depth, access and efficiency) and environmental risk. This approach is a conventional practice in the literature to capture non-linearity (Boachie-Yiadom & Mensah, 2021; Singhania & Saini, 2021; Shahbaz, et. al., 2018; Bokpin, 2017; Zheng & Sheng, 2017; Omri, et. al., 2014). The technique of including quadratic terms and cubic terms in a model to capture threshold is subjective and may not be efficient. The imposition of the quadratic or cubic terms on the model forces the non-linearity to be determine exogenously. In order to allow the threshold to be determined endogenously and independently, we follow the recommendations by Seo et al. (2019) and Seo and Shin (2016) to specify a dynamic panel threshold regression.

dynamic panel threshold regression model as follows:

$$ENVTR_{it} = \varphi X_{it} + \begin{cases} \propto_i + \beta_1 ENVTR_{it-1} + \theta_1 COMP_{it} + \mu_{it} & COMP_{it} < \gamma \\ \propto_i + \beta_2 ENVTR_{it-1} + \theta_2 COMP_{it} + \mu_{it} & COMP_{it} \geq \gamma \end{cases} \ldots\ldots\ldots\ldots\ldots(4.8)$$

Where '*it*' represents country i, at time *t*. *ENVTR* is environmental risk proxied by carbon dioxide emissions (% of GDP). $ENVTR_{it-1}$is the lagged of the *ENVTR* to capture environmental risk

convergence and also demonstrate the dynamic nature of the model. COMP represents the three components of financial sector development (depth, access and efficiency). These three indicators are included in their separate models due to their high correlation. $\propto_i$ is the country-specific fixed effects, and μ_{it} is a zero mean, finite variance error term. The X_{it} represents a host of control variables.

Further, the financial development index $COMP_{it}$ is the regime-switching or threshold variable that is used in splitting our dataset into two sample groups while γ is the threshold value. More also, β_1 and θ_1 represents the coefficients of the lag dependent variable and the COMP index at low regimes respectively, while β_2 and θ_2 are high regime coefficients. The Seo et al. (2019) and Seo and Shin (2016) threshold estimation technique splits the data by itself and enables the threshold to be determined endogenously. Again, the threshold technique uses the bootstapping replications that allow a number of alterations to split the data sample and estimate the coefficients for both the ligh and low regimes. This process ensures that the threshold value is computed independently and endogenously under a normal distribution assumption. In this study 2,000 bootstrapping replications are used under a 15% trimming percentage, and 100 grid numbers to test the existence of thresholds.

4.4 Results and Discussions

4.4.1 Summary Statistics

Table 4.1 presents the descriptive statistics of the data. The reported standard deviation, skewness and kurtosis of the data justify the usage of the dynamic model used in estimating the empirical model. There is no serious concern in the descriptive statistics that needs special attention. Table 4.2 provides the results of the correlation matrix. The numerical strength of the association among the datasets is within acceptable thresholds (less than 0.5); hence, there is the absence of

multicollinearity. To further dissolve any appearance of multicollinearity problem, financial depth (dep), access (acc) and efficiency (eff) which recorded relatively high correlation values are not included in the same model. Rather, each of the financial development indicators is placed in a separate model.

Table 4.1: Descriptive Statistics

	envtr	fdi	dep	acc	eff	fr	urban	gdp	dinv
Mean	1.08	0.04	0.07	0.05	0.25	0.88	36.80	4.16	7.18
Median	0.71	0.01	0.04	0.02	0.26	0.00	37.00	4.45	8.33
Maximum	10.88	1.03	0.86	0.65	0.82	4.00	89.37	149.97	11.17
Minimum	0.01	-0.27	0.00	0.00	0.00	0.00	5.34	-50.25	0.00
Std. Dev.	1.20	0.09	0.11	0.10	0.11	1.39	16.08	6.91	3.14
Skewness	2.79	5.83	3.71	2.74	-0.26	1.01	0.33	5.61	-1.51
Kurtosis	12.01	50.51	19.75	10.12	3.55	2.19	2.85	134.17	4.02
Observations	1665	1665	1665	1665	1665	1665	1665	1665	1665

(Source: Authors' computations)

Table 4.2: Correlation Matrix

	envtr	fdi	dep	acc	eff	fr	urban	gdp	dinv
envtr	1								
fdi	0.106***	1							
dep	-0.102***	-0.0254	1						
acc	0.112***	0.216***	0.473***	1					
eff	-0.0245	0.0881***	0.451***	0.391***	1				
fr	-0.0248	0.273***	0.0110	0.0255	0.124***	1			
urban	0.137***	-0.0108	0.143***	-0.0495*	0.107***	-0.0460	1		
gdp	0.0215	-0.0353	-0.0138	-0.0248	-0.0565*	-0.0157	0.0258	1	
dinv	0.0848***	-0.00917	-0.245***	-0.0223	-0.103***	0.000873	-0.00824	0.0299	1

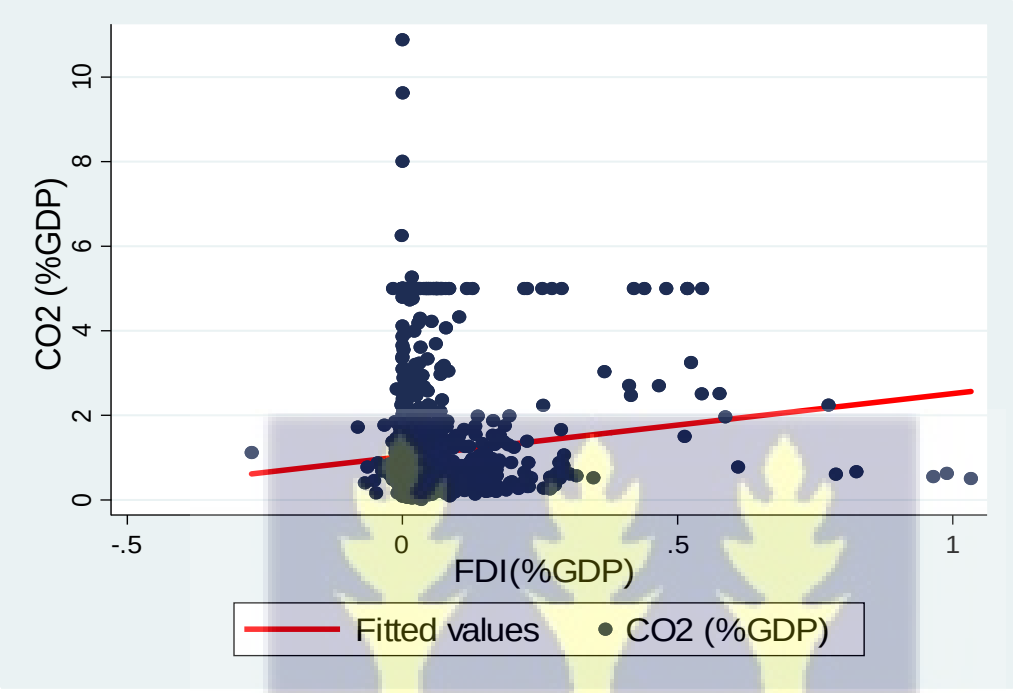
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

(Source: Authors' computations)

Figures 4.2, 4.3 and 4.4 offer more insight into the nature of the dataset and give pictorial evidence in support of the correlation matrix. The correlation matrix in Table 4.2 shows a positive relationship between FDI and environmental risk. This confirms our earlier suspicions demonstrated in the trend analysis in Figure 4.1. To interrogate this relationship further, we plot a bivariate relationship between FDI and CO_2 in Figure 4.2. Figure 4.2 depicts that the line of best

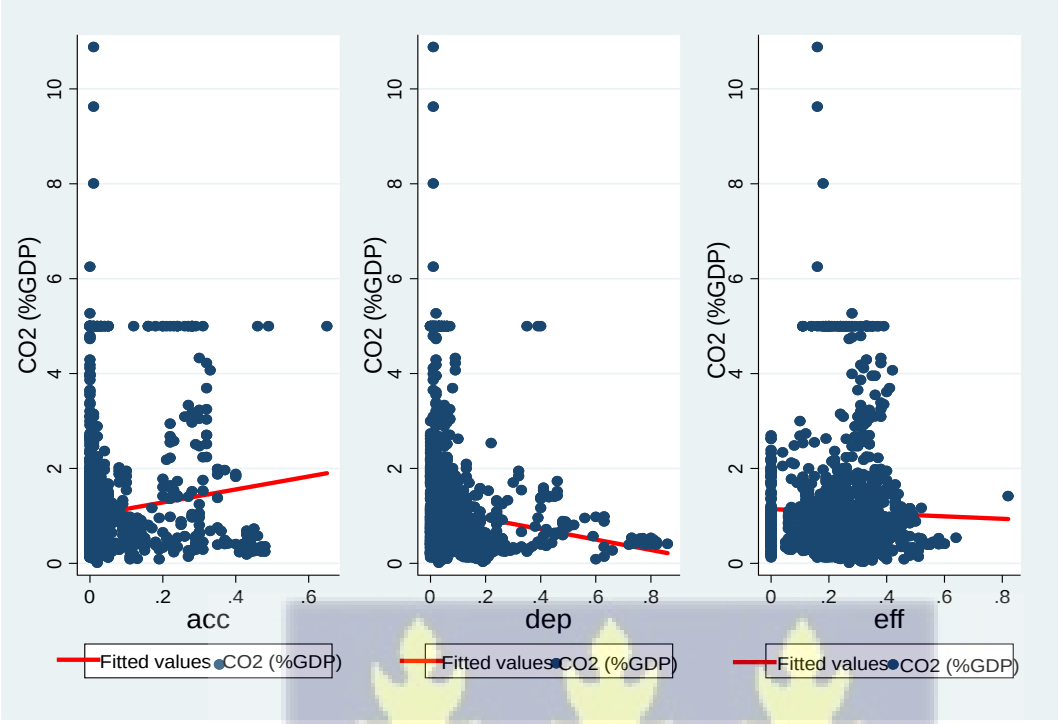
fits steeply slopes upwards indicating that the bivariate relationship between the FDI and CO_2 is strong and positive.

Figure 4.2: Bivariate relationship between CO_2 and FDI



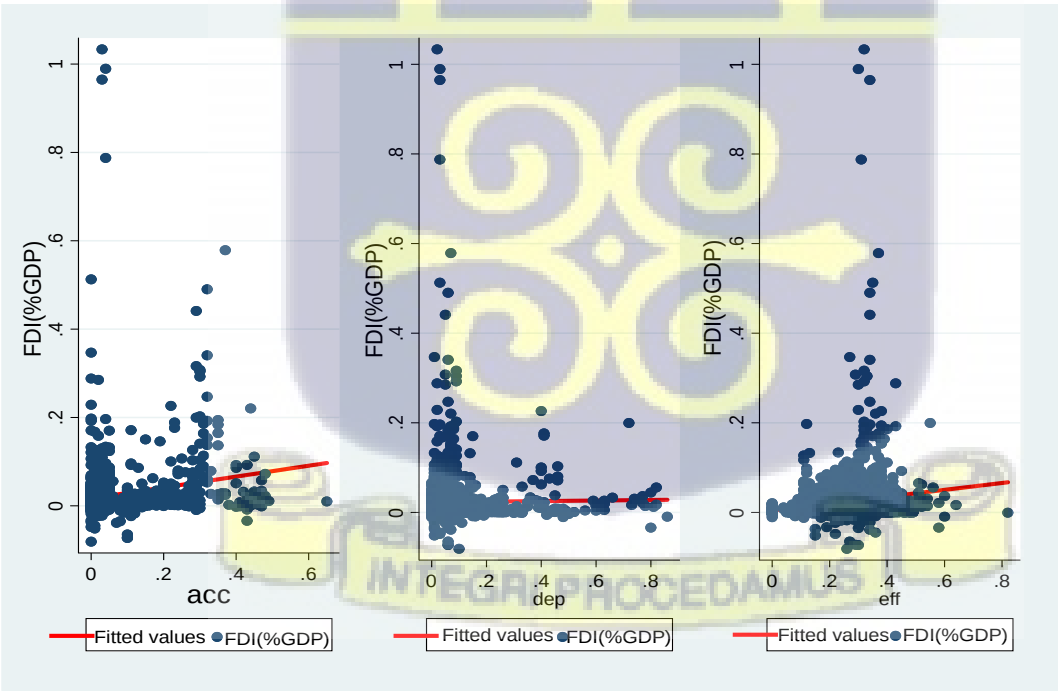
Source: Authors' construct, Data from World Bank (2020).

Figure 4.3: Bivariate relationship between CO_2 and access, depth and efficiency



Source: Authors' construct, Data from OECD (2020).

Figure 4.4: Bivariate relationship between FDI and access, depth and efficiency



Source: Authors' construct, Data from OECD (2020).

Figure 4.3 demonstrates the bivariate relationship between the environmental risk (CO_2) and the three components of the financial development indicators. Figure 4.3 suggest a strong positive relationship between CO_2 and financial access. However, a negative relationship is depicted between CO_2 and financial depth and a weak negative bivariate relationship between CO_2 and financial efficiency. This can also be seen in the correlation coefficient of 0.112, -0.102 and -0.0245 for financial access, depth and efficiency respectively in Table 4.2. It follows that the three components of financial development relate differently to environmental risk. It can therefore be inferred that depending on the choice of financial development indicator, a study may report either a positive or negative relationship with the environmental risk. Hence, this oversight in the existing literature is the more reason why earlier studies reported contradicting and biased results (Ntow-Gyamfi, et. al., 2020; Acheampong, 2019; Shahbaz, et. al., 2018; Riti, et. al., 2017; Tamazian, et. al., 2009).

Again, Figure 4.4 shows a bivariate relationship between FDI and the three components of financial development indicators. The FDI although has a strong positive relationship with financial access and efficiency; however, has a weak and negative association with financial depth.

Taking Figures 4.2, 4.3 and 4.4 together offer support for investigating the impact of the three components of financial development on the relationship between FDI and environmental risk. Moreover, the components of the financial development have improved significantly in the last 39 years in Africa (see Figure 4.5 in the Appendix). The improvement in the level of financial development may either improve or worsen the FDI – environmental risk in Africa.

4.4.2 Can Financial Depth, Access and Efficiency improve the impact of FDI on Environmental Risk?

The bivariate relationships are shown in Figures 4.2, 4.3 and 4.4 and the correlation matrix does not imply a causal effect, we present the results from the empirical model estimations in Tables 4.3, 4.4, and 4.5.

A common problem that may affect dynamic models like ours is heteroskedasticity and serial correlation, especially for the inclusion of the lagged regressors in the models (Baum et., 2003). We conducted the Breusch-Pagan / Cook-Weisberg test for heteroscedasticity and the Levin-Lin-Chu unit-root test results to detect patterns in the disturbance term and serial correlation in the lags respectively.

The results presented in Table 4.7 of the Appendix show the presence of heteroscedasticity in the errors. We solve this problem by resorting to robust standard errors as recommended by Verbeek (2017) and Driscoll and Kraay (1998). The outcome of the Levin-Lin-Chu unit-root test shown in Table 4.8 of the Appendix does not give any concern for serial correlation in the regressors. The study also presents the model selection strategy in Table 4.9 of the Appendix. The model selection strategy follows the advise of Roodman (2009), Bond et. al. (2001) and the Andrews-Lu model and moment selection criteria.

First, we estimate the pooled OLS (upper bound) and the Fixed Effect (lower bound) models for the three components of financial sector development. According to Bond et. al. (2001) estimating equation 4.1 with the pooled OLS will create a positive correlation between the lag of the dependent variable and the error causing an upward bias. On the other hand, estimating equation 4.1 with the Fixed Effect (FE) creates a negative correlation between the lag of the dependent variable and the error term causing an downward bias.

Second, we estimate equation 4.1 using both the system GMM and the differenced GMM. The choice between the models depends on the one which lies between the upper bound (OLS) and the lower bound (FE). In our case, the results in Table 4.9 shows that the system GMM results is symmetrical to both the upper and lower bounds.

Further, we use the Akaike (AIC), Bayesian (BIC), Hannan-Quinn (HQIC) information criteria to choose between the system GMM and the differenced GMM based on the model with the lowest values of the criteria. All three components of financial sector development, the Andrews-Lu model and moment selection criteria criteria selected the system GMM model as the most appropriate model for estimating equation 4.1.

The baseline results for the study are presented in columns (1) to (9) of Table 4.3. In columns (1), (2) and (3), we test the unilateral effect of the decomposed financial development on the environmental risk. The results in column (1) show that financial depth has a negative and significant effect on environmental risk. The findings suggest that as financial deepening increases, the level of environmental degradation will fall marginally.

A similar result is reported for financial efficiency in column (3). But access to finance is a major worry to the environment. This is because the results in column (2) show that financial access has a positive and significant effect on environmental risk; implying that as people get more access to finance, environmental degradation is worsened. Sahay et. al. (2015) description of financial development provides insight into the disparities in the effect of the decomposed financial development indicators on the environment. They explained that financial development is a "combination of depth (size and liquidity of markets), access (the ability of individuals to access financial services), and efficiency (ability of institutions to provide financial services at low cost

and with sustainable revenues, and the level of activity of capital markets)". As the size of the market expands and becomes highly liquid (financial depth), the investment choice of investors increases and can reduce over-concentration in one particular sector. Investment in the African economy is skewed towards the primary extractive sectors which by far worsens environmental risk (UNCTAD, 2020). In a separate report, the UNCTAD (2022) expressed concern that only US$39 billion of the total value of US$83 billion FDI flows to Africa in 2022 were invested in greenfield projects. This translate into 53% of FDI is still invested in projects that worsens the environment. Sahay et. al. (2015) believe that financial depth diffuses investment over-concentration in a few sectors of the economy. This is the more reason why financial depth reduces environmental risk. A similar finding is reported by Shahbaz et. al. (2018), Tamazian et. al. (2009) and Riti et. al. (2017) who used a subcomponent of financial depth – domestic credit to the private sector – to measure the effect of financial development on carbon emission.

Additionally, financial access increases environmental risk as reported in column (2) of Table 4.3. This is not surprising because access to financial services increases the number of households in the mainstream financial system which enables them to have access to funds. The financial access then provides the ability to pay for high tickets for environmental degrading goods. Stated differently, access to funds increases consumption and consequently stimulates economic activities and environmental risk.

This study is not advocating that financial access should be curtailed but rather given the African case where an increase in financial access finds its way to destroying the environment, appropriate financial depth and efficiency should be instituted to direct the funds into climate-resilient sectors. Column (3) of Table 4.3, shows that financial efficiency is a good catalyst for environmental quality. This is affirmed by Acheampong (2019) that the low cost of funds enables climate-resilient

and energy-efficient sectors which hitherto were less profitable to investors will start receiving appropriate investment attention. One major cause of the lack of investment in climate-resilient sectors like clean energy is the high cost of finance, hence, an increase in financial efficiency to reduce the cost of funding can reduce environmentally degrading activities.

Column (4), (5) and (6) of Table 4.3 presents the results of the quadratic relationship between financial development and environmental risk and their turning points as well. The squared term of financial depth and efficiency failed to enter into the models at conventional levels. However, financial access recorded a negative coefficient at a 5% level of significance, implying that if the level of financial access is doubled, environmental risk will be reduced by 41.01%. To this end, we have made a case that financial access in the linear form is environmentally destructive because of its skewness to the primary extractive sectors.

However, if financial access is enhanced enough, the neglected sectors in Africa which are often non-destructive to the environment will be financed appropriately to overturn the environmental deficit. Also, the linear and non-linear coefficients of the financial efficiency presented in the Column (5) of Table 4.3 mimic a classical financial development Environmental Kuznet Curve (EKC) as reported by Ntow-Gyamfi et. al. (2020), Dasgupta et. al. (2002) and Grossman and Krueger (1991). Additionally, the financial access turning point of 16.1% reported in Column (5) of Table 4.3 provides caution that if financial access is promoted beyond the estimated threshold the negative effect of financial access on environmental risk will be overturned.

Furthermore, FDI continues to exert a positive effect on environmental risk in all the baseline models except for Columns (2) and (8) where it fails to enter into the empirical models at conventional levels. These findings are not new to the literature (Boachie-Yiadom & Mensah,

2021; Singhania & Saini, 2021; Shahbaz, et. al., 2018; Bokpin, 2017; Zheng & Sheng, 2017; Omri, et. al., 2014). The vacuum this study seeks to fill is to investigate the moderating effect of the decomposed financial development indicators on the relationship between FDI and environmental risk. FDI is a necessary evil in Africa's development story, hence, there is a need to find innovative means to overturn if possible its negative effect on the environment. In line with institutional economics, we suspect the decomposed financial development indicators could do the magic.

In Columns (7), (8) and (9) of Table 4.3 we test whether financial depth, access and efficiency make the FDI – environmental risk nexus better by introducing the interaction terms into the models.

The results show that financial depth and efficiency are significant and negative at conventional levels. This means that depth and efficiency are two good channels that can overturn the negative impact of FDI on the environment. This finding is possible and consistent throughout this study. This is because the study has justified the bivariate relationship between financial development (depth and efficiency) and environmental risk as well as FDI in Figures 4.3 and 4.4 and the correlation matrix in Table 4.2. If financial development (depth and efficiency) correlates negatively with environmental risk and also reduces the environmental risk [see Columns (1) and (3) in Table 4.3] then it can influence the FDI – environment nexus.

However, the interaction terms of depth and efficiency could be deceptive when explaining them, hence, we compute their marginal effects following Alfaro et. al. (2004) strategy and present the results in Columns (7) and (9) of Table 4.3. The marginal effect coefficient of -1.192 and -1.49 is reported for depth and efficiency respectively. This means that depth and efficiency consistently improve the FDI and environmental risk nexus. Although this finding is still under-researched in

the literature, it finds support from the larger institutional economies studies which suggest that institutional quality overturns the negative effect of FDI on the environment (Bokpin, 2017).

4.4.3 The Dynamic Panel Threshold Regression Analysis

In Columns (4), (5) and (6) of Table 4.3, we examine non-linearity of the relationship between financial depth, access and efficiency, and environmental risk. We did so by imposing a quadratic term on the equation. This approach although regularly used in the literature have justification problems. The imposition of the quadratic term on the regression in Table 4.3 makes the non-linearity to be subjectively determined instead of allowing the data to find it own threshold. Therefore, we employ the dynamic panel threshold approach as an alternative to test the non-monotonicity of the relationship between financial development and environmental risk (Seo et al., 2019; Seo & Shin, 2016).

We first test for the existence of the threshold in the dataset. The threshold test is conducted under a null hypothesis that the relationship between the financial development components and environmental risk is linear (i.e. $\theta_1 = \theta_2$). Alternatively, we hypothesized a non-linear relationship where $\theta_1 \neq \theta_2$. The results of the test for the existence of threshold are presented in Table 4.10 in the Appendix. The results reveal that the LM-test statistic for depth, access and efficiency are 18.43, 12.02 and 30.15 respectively. The p-values for all the three components are significant at conventional levels. These results confirm the existence of threshold and that the relationship between the financial sector development and environmental risk is non-linear. The implications of these findings suggest the splitting of the dataset into two distinct regimes, where one regime is above a calculated threshold value and the other below it.

The dynamic panel threshold results are presented in Table 4.11 in the Appendix. The study reports a calculated threshold value of 0.19, 0.25 and 0.15 for depth, access and efficiency respectively.

For the financial depth index, we report a positve coefficient of 3.378 and a negative of 0.3217 at 1% significant level for both the low and the high regimes respectively. The financial access component recorded a positive coefficient (0.983) below the threshold value and a negative coefficient (0.912) above the threshold. The coefficient at the opposite sides of the threshold were all significant at 1% level. Further, the study reports a negative coefficient (3.834) for the financial efficiency index at the lower end of the threshold. But at high regimes of the threshold, financial efficiency failed to enter into the model at conventional levels of significance.

The findings in column (2) of Table 4.11 indicate that the impact of financial deepening on environmental risk depends on the level of depth of the financial sector. Hence, two different regimes of depth will impact environmental risk differently. Low regimes of financial depth worsen environmental risk. A possible reason accounting for this finding is that low levels of financial depth allocate funds to few sectors of the economy. And given the nature of the African economy, extractive sectors which are environmentally destructive are more likely to receive funding than the other sectors.

However, if financial deepening exceeds the 0.19 threshold, its impact on environmental risk becomes negative thereby reducing environmental degradation. Financial deepening measures the extent of funding to investors. It captures investment indicators such as private sector credit, stock market capitalization, debt securities, mutual and pensions funds, among others. This means that as financial deepening increases investment into environmental resilient and energy efficient activities which hitherto were neglected become possible.

Further, the findings on financial access index reveals an inverted 'U' shape between access and environmental risk. This means that whereas lower levels of financial access aggravate

environmental risk, higher levels of access can reduce it. There are two reasons accounting for this finding.

First, at low levels of financial access, investors concentrate their investment into few profitable sectors. Low levels of financial also imply that the cost of funding is high due to the competing needs for the funds. Given the investment landscape in Africa, profit-seeking investors are more likely to invest in the extractive sectors which worsens environmental risk.

Second, high levels of financial access reduce environmental risk due to the widening of the financial nets to capture a variety of previously neglected sectors. An increase in financial access also means that research and development into environmentally resilient technologies can be undertaken. One of the major hindrances to the adoption of clean production technology is cost, and financial access empower entrepreneurs to scale-over the cost barrier (United Nations, 2021, United Nations, 2010). These results serve as a robustness check on the results presented in Column (2) and (5) of Table 4.3 where the linear term and quadratic term of access recorded positive and negative coefficients respectively. It clearly shows that increasing financial access is good for the environment.

The findings on financial efficiency show that the environment benefits from it even at lower regimes of the threshold, although we cannot say same at higher regimes. Financial efficiency help in reducing the cost of funding and thereby increasing profitability in the financial system. Just like explained in the financial access section, the reduction in cost enables climate-resilient and energy efficient sectors which hitherto were neglected to receive considerable attention from investors.

4.4.4 Robustness checks, Control Variables and Validity of the Results

To check the robustness of the findings of the study, we split the dataset into high and low-financially developed countries and presented the results in Tables 4.4 and 4.5. The data splitting was done using a simple quartile analysis to locate the median financial development indicator and countries above the median were separated and classified as high financially developed countries. We followed the same approach to classify the low financially developed countries.

The results presented from Column (10), through to Column (18) of Table 4.4 replicate the baseline regression results in Table 4.3 in terms of the expected signs and the level of significance of the variables of interest. For instance, the interaction term between financial depth and FDI recorded a coefficient of -18.44% at a 5% significant level. This finding confirms the baseline results that financial depth indeed overturns the negative impact of FDI on the quality of the environment, especially among high financially developed countries. Column (18) of Table 4.4 presents a similar result for financial efficiency and FDI. Notwithstanding, Column (19), through to (27) presents the results for the low financially developed countries. Our variables of interest: financial depth, access, and efficiency together with their squared terms as well as interactions failed to enter into the empirical models at conventional levels, except for the squared of financial access in column (23).

The results imply that financial development indicators are ineffective in either improving environmental risk by themselves or correcting the negative effect of FDI on the environment. Thus, weak financial developments do not matter in explaining environmental risk even at the linear levels (see Columns 19 to 21). Also, non of the financial development components is significant in explaining the effect of FDI on environmental risk (see columns 25 to 27).

Taking the regression results in Tables 4.4 and 4.5 together gives further evidence that financial depth, access and efficiency are key determinants in accounting for the effect of FDI on environmental risk. Weak or low financial development fails to protect the environment from being deteriorated by FDI.

Additionally, the results of the control variables presented in the baseline regression in Table 4.3 maintain their expected signs which are consistent in the literature (Boachie-Yiadom & Mensah, 2021; Singhania & Saini, 2021; Nepal, et. al., 2021; Stern, 2004; Dasgupta et. al., 2002; Grossman & Krueger, 1991). For instance, economic growth (gdp) and urbanization (urban) recorded a positive and significant coefficient in columns (1) through to (9) implying that the two variables worsen environmental quality. Domestic investment (dinvt) reduces environmental risk (see columns 1, 4 and 7). This means that local investors are more environmentally considerate than foreign investors. Financial regulation (fr) was significant in columns (8) and (9) and reveals that the current states of financial regulations in Africa are environmentally depressive.

The post estimation statistics reported by the Hansen test and the AR (2) in Tables 4.4, 4.5 and 4.6 show that the instruments are justifiable and no second-order autocorrelation among the errors. The F-statistics confirm the overall fitness of the models used for the study.

Table 4.3: System GMM Results – full sample

Variables	(1) envtr	(2) envtr	(3) envtr	(4) envtr	(5) envtr	(6) envtr	(7) envtr	(8) envtr	(9) envtr
l.envtr	0.894***	0.801***	0.895***	0.890***	0.936***	0.865***	0.894***	0.914***	0.911***
	(0.0308)	(0.0270)	(0.0311)	(0.0314)	(0.0292)	(0.0400)	(0.0312)	(0.0285)	(0.0285)
fr	-0.0163	0.00208	-0.00185	-0.0121	-0.0483	0.0465	-0.00567	0.0742**	0.0567***
	(0.0329)	(0.0136)	(0.0333)	(0.0328)	(0.0335)	(0.0490)	(0.0394)	(0.0315)	(0.0155)
gdp	0.0912***	0.0445**	0.0921***	0.0919***	0.0792***	0.105***	0.0892***	0.0729***	0.0802***
	(0.0251)	(0.0189)	(0.0254)	(0.0251)	(0.0249)	(0.0293)	(0.0251)	(0.0237)	(0.0234)
urban	0.0714***	0.0243**	0.0741***	0.0727***	0.0591***	0.0915***	0.0729***	0.0811***	0.0756***
	(0.0132)	(0.0123)	(0.0138)	(0.0130)	(0.0135)	(0.0192)	(0.0135)	(0.0125)	(0.0114)
dinvt	-0.0130*	0.0019	-0.0078	-0.0158**	0.0028	-0.0126	-0.0141*	-0.0026	-0.0046
	(0.0068)	(0.0050)	(0.0066)	(0.0071)	(0.0071)	(0.0080)	(0.0075)	(0.0068)	(0.0063)
fdi	4.007**	0.293	3.990**	3.820**	3.067*	5.122***	5.235*	-1.124	6.602***
	(1.555)	(0.194)	(1.571)	(1.554)	(1.611)	(1.893)	(2.978)	(3.005)	(1.376)
dep	-1.126***			-1.612***			-0.491		
	(0.295)			(0.554)			(0.836)		
acc		0.592***			13.23**			1.357***	
		(0.206)			(5.834)			(0.495)	
eff			-1.278***			-11.95*			-0.442
			(0.344)			(7.158)			(0.301)
dep^2				0.219					
				(0.749)					
acc^2					-41.01**				
					(16.56)				
eff^2						19.75			
						(13.23)			
dep×fdi							-37.11*		
							(22.38)		
acc×fdi								-0.837	
								(10.97)	
eff×fdi									-20.42***

									(4.310)
Constant	-2.861***	-0.924*	-2.782***	-2.853***	-2.740***	-2.316***	-2.911***	-3.272***	-2.975***
	(0.481)	(0.500)	(0.478)	(0.453)	(0.488)	(0.613)	(0.453)	(0.530)	(0.433)
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1665	1665	1665	1665	1665	1665	1665	1665	1665
F Statistics	62.15	68.02	63.15	72.56	67.28	59.53	58.24	62.86	64.86
Groups/instruments	45/29	45/28	45/28	45/29	45/29	45/28	45/30	45/30	45/31
AR (2)	0.365	0.464	0.382	0.392	0.352	0.386	0625	0685	0.615
Hansen Statistics	0.286	0.276	0.257	0.286	0.276	0.261	0.326	0.313	0.356
Turning point (TP)	n/a	n/a	n/a		0.161		n/a	n/a	n/a
Marginal effect:									
FD Comp.	n/a	n/a	n/a	n/a	n/a	n/a	-1.192*	n/a	-1.49***
FDI	n/a	n/a	n/a	n/a	n/a	n/a	9.4*	n/a	1.8***

*Standard errors in parentheses. ***, **, * are statistical significance at the 1%, 5% and 10% levels respectively. P-values reported for AR (2) show the absence of second-order autocorrelation. The Hansen statistics indicate instruments are strictly valid and the model is not weakened by many instruments. The marginal effect is computed for financial development components (FD Comp) and the FDI on the assumption that the mean values of the dataset are the expected values. The marginal effect is estimated only where the interaction term is significant. The Turning Point is estimated where the squared terms are significant*

(Source: Authors' computations)

Table 4.4: System GMM Results – high FD nations

Variables	(10) envtr	(11) envtr	(12) envtr	(13) envtr	(14) envtr	(15) envtr	(16) envtr	(17) envtr	(18) envtr
l.envtr	0.651***	0.594***	0.639***	0.590***	0.642***	0.605***	0.569***	0.723***	0.653***
	(0.0653)	(0.0494)	(0.0705)	(0.0689)	(0.0664)	(0.0786)	(0.0715)	(0.0593)	(0.0717)
fr	-0.087***	-0.056***	-0.092***	-0.093***	-0.116***	-0.089***	-0.109***	-0.042*	-0.038**
	(0.0262)	(0.0145)	(0.0272)	(0.0268)	(0.0275)	(0.0289)	(0.0279)	(0.0241)	(0.0191)
gdp	-0.0032	0.0052	0.0021	-0.00052	0.0112	0.0046	0.0014	-0.0183	0.0171
	(0.0233)	(0.0171)	(0.0234)	(0.0238)	(0.0235)	(0.0249)	(0.0243)	(0.0206)	(0.0229)
urban	0.115***	0.00527	0.120***	0.126***	0.109***	0.131***	0.127***	0.0879***	0.110***
	(0.0183)	(0.0146)	(0.0200)	(0.0180)	(0.0201)	(0.0227)	(0.0182)	(0.0141)	(0.0180)
dinvt	0.0753***	0.0102	0.0838***	0.0594***	0.0936***	0.0963***	0.0619***	0.0678***	0.0849***
	(0.0142)	(0.0117)	(0.0156)	(0.0112)	(0.0162)	(0.0188)	(0.0111)	(0.0128)	(0.0156)
fdi	1.018	0.587***	1.055	0.837	0.550	1.052	2.536**	0.804	9.962***
	(0.742)	(0.196)	(0.758)	(0.761)	(0.760)	(0.805)	(1.262)	(1.466)	(2.287)
dep	-0.528**			-2.244***			-1.614***		
	(0.213)			(0.618)			(0.491)		
acc		0.858**			13.21***			2.521***	
		(0.339)			(2.471)			(0.506)	
eff			-1.303**			-14.02			0.195
			(0.587)			(9.011)			(0.606)
dep^2				0.127					
				(0.707)					
acc^2					-35.59***				
					(6.365)				
eff^2						16.84			
						(11.90)			
dep×fdi							-18.44**		
							(8.876)		
acc×fdi								-6.200	
								(5.426)	
eff×fdi									-31.29***

									(7.025)
Constant	-4.451***	0.0599	-4.344***	-4.491***	-4.818***	-2.596*	-4.585***	-3.681***	-4.558***
	(0.712)	(0.637)	(0.721)	(0.630)	(0.788)	(1.453)	(0.647)	(0.611)	(0.768)
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	962	962	962	962	962	962	962	962	962
F Statistics	42.15	43.56	48.25	44.27	52.26	51.78	38.47	39.25	34.58
Groups/instruments	26/12	26/12	26/13	26/15	26/15	26/15	26/14	26/14	26/16
AR (2)	0.624	0.684	0.678	0.586	0612	0.576	0.624	0.489	0.594
Hansen Statistics	0.324	0.342	0.368	0.425	0.428	0.412	0.452	0.467	0.489
Turning point (TP)	n/a	n/a	n/a	n/a	0.186	n/a	n/a	n/a	n/a
Marginal effect:									
FD Comp.	n/a	n/a	n/a	n/a	n/a	n/a	-1.051***	n/a	-1.268***
FDI	n/a	n/a	n/a	n/a	n/a	n/a	1.494***	n/a	2.567***

*Standard errors in parentheses. ***, **, * are statistical significance at the 1%, 5% and 10% levels respectively. P-values reported for AR (2) show the absence of second-order autocorrelation. The Hansen statistics indicate instruments are strictly valid and the model is not weakened by many instruments. The marginal effect is computed for financial development components (FD Comp) and the FDI on the assumption that the mean values of the dataset are the expected values. The marginal effect is estimated only where the interaction term is significant.*

(Source: Authors' computations)

Table 4.5: System GMM Results – Low FD nations

Variables	(19) envtr	(20) envtr	(21) envtr	(22) envtr	(23) envtr	(24) envtr	(25) envtr	(26) envtr	(27) envtr
l.envtr	1.094***	0.844***	1.093***	1.093***	1.025***	1.088***	1.105***	1.084***	1.096***
	(0.0278)	(0.0511)	(0.0277)	(0.0277)	(0.0351)	(0.0292)	(0.0298)	(0.0302)	(0.0275)
fr	-0.113**	-0.0061	-0.103*	-0.120**	-0.230***	-0.103*	-0.0508	0.0003	-0.0100
	(0.0573)	(0.0226)	(0.0604)	(0.0577)	(0.0685)	(0.0629)	(0.0403)	(0.0402)	(0.0250)
gdp	-0.0200	-0.0508**	-0.0212	-0.0184	-0.0406	-0.0264	-0.0200	-0.0237	-0.0227
	(0.0244)	(0.0244)	(0.0246)	(0.0242)	(0.0260)	(0.0259)	(0.0243)	(0.0244)	(0.0242)
urban	0.0228	-0.0113	0.0257*	0.0226	0.0223	0.0297*	0.0243*	0.0299**	0.0262*
	(0.0141)	(0.0155)	(0.0147)	(0.0141)	(0.0142)	(0.0157)	(0.0140)	(0.0141)	(0.0146)
dinvt	-0.0175	0.0195	-0.0199	-0.0189	0.0114	-0.0163	-0.0339**	-0.0303**	-0.0288*
	(0.0179)	(0.0169)	(0.0172)	(0.0177)	(0.0180)	(0.0181)	(0.0163)	(0.0148)	(0.0162)
fdi	11.27**	-0.532	11.03**	11.73**	3.490	11.33**	9.561	-0.634	1.752
	(4.944)	(1.470)	(4.976)	(4.881)	(5.598)	(5.183)	(6.624)	(7.125)	(1.903)
dep	-0.746			-1.874			0.902		
	(2.813)			(2.389)			(5.083)		
acc		-0.625			45.16***			-3.240	
		(1.888)			(13.92)			(7.155)	
eff			-0.274			10.59			-0.555
			(0.454)			(8.882)			(0.497)
dep^2				-18.26					
				(19.40)					
acc^2					-1.764***				
					(513.9)				
eff^2						-41.08			
						(33.53)			
dep×fdi							-191.9		
							(180.9)		
acc×fdi								168.2	
								(304.3)	
eff×fdi									5.503

									(8.420)
Constant	-0.899*	0.687	-0.953**	-0.864*	-0.841*	-1.429**	-0.783*	-0.851	-0.714
	(0.469)	(0.553)	(0.480)	(0.467)	(0.492)	(0.632)	(0.466)	(0.527)	(0.462)
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	703	703	703	703	703	703	703	703	703
F Statistics	72.56	67.28	59.53	58.24	62.86	64.86	62.15	68.02	63.15
Groups/instruments	19/12	19/12	19/11	19/12	19/12	19/10	19/12	19/10	19/12
AR (2)	0.392	0.352	0.386	0625	0685	0.615	0.365	0.464	0.382
Hansen Statistics	0.286	0.276	0.261	0.326	0.313	0.356	0.286	0.276	0.257
Turning point (TP)	n/a	n/a	n/a	n/a	12.800	n/a	n/a	n/a	n/a
Marginal effect:									
FD Comp.	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
FDI	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

*Standard errors in parentheses. ***, **, * are statistical significance at the 1%, 5% and 10% levels respectively. P-values reported for AR (2) show the absence of second-order autocorrelation. The Hansen statistics indicate instruments are strictly valid and the model is not weakened by many instruments. The marginal effect is computed for financial development components (FD Comp) and the FDI on the assumption that the mean values of the dataset are the expected values. The marginal effect is estimated only where the interaction term is significant.*

(Source: Authors' computations)

4.5 Conclusions and Policy Implications

The contribution of FDI to economic growth especially among financially cursed economies has been well researched. However, recent studies show that although FDI improves economic outcomes at the same time reverses environmental quality. Since FDI is almost a necessity for Africa's development, there is a need to explore channels that can overturn the negative effect of FDI on the environment.

Many studies have advocated for strong institutions to moderate FDI. However, institutions are almost everything in the administration of a country and therefore the 'institutional wholesale' recommendations leave policymakers still asking questions on which aspect of institutions can directly influence FDI – environment nexus.

This study dissolves this doubt by exploring how financial development can play a good catalyst role in the nexus. To this end little is known about the moderating effect of financial development in this all-important nexus. Therefore, we decomposed financial development into its three key components to investigate whether they can help reduce the negative impact of FDI on the environment. The study is underpinned by institutional economies and the Environmental Kuznet Curve hypothesis to test our assumptions.

The results from the various estimations conclude that financial deepening and efficiency reduce environmental risk and can overturn the negative impact of FDI on the environment.

The study recommends that direct policies should be tailored towards strengthening financial deepening and efficiency, especially among countries with weak financial developments. The study was constraint by data in the measurement of the carbon dioxide emissions. The study could not find carbon emissions that are directly resulting from FDI. The use of the overall country level carbon emissions although have been widely used in the literature may exaggerate envrionmental

risk resulting from FDI. Future studies may find alternative methods to capture the exact carbon emissions from FDI. At best future studies should test the effect of FDI on sectorial carbon emissions to improve policy specififfity.

4.6 Chapter Summary

This chapter addresses objective two of the thesis and is titled "Environmental Risk and Foreign Direct Investment: the role of financial deepening, access and efficiency". In this chapter, we employed a dynamic panel of 45 economies from 1982 to 2018 and decomposed the financial sector development indicator into its three key determinants (depth, access, and efficiency) to investigate whether they can help to overturn the negative impact of FDI on the environment.

The key finding from this chapter is that financial deepening and efficiency reduce environmental risk and can overturn the negative impact of FDI on the environment. Further, the low level of financial access in the sample promotes environmentally destructive activities and therefore cannot make the FDI – environment nexus any better. However, high levels of financial access have the ability to reduce environmental risk.

4.7 Appendix

Table 4.6: Variables in the FD Index Computation

DEPTH	ACCESS	EFFICIENCY
1. Private-sector credit (% of GDP) 2. Pension fund assets (% of GDP) 3. Mutual fund assets (% of GDP) 4. Insurance premiums, life and non-life (% of GDP) 5. Stock market capitalization to GDP 6. Stocks traded to GDP 7. International debt securities government (% of GDP) 8. Total debt securities of nonfinancial corporations (% of GDP) 9. Total debt securities of financial corporations (% of GDP)	1. Branches (commercial banks) per 100,000 adults 2. ATMs per 100,000 adults 3. Percent of market capitalization outside of top 10 largest companies 4. Total number of issuers of debt (domestic and external, nonfinancial corporations, and financial corporations)	1. Net interest margin 2. Lending-deposits spread 3. Non-interest income to total income 4. Overhead costs to total assets 5. Return on assets 6. Return on equity 7. Stock market turnover ratio (stocks traded/capitalization

Adapted from Sahay, et al. (2015)

Table 4.7: Breusch-Pagan / Cook-Weisberg test for heteroskedasticity

Ho: Constant variance
Variables: envtr fr gdp urban dinv fdi dep acc eff
F(7 , 1626) = 12.67
Prob > F = 0.0000

(Source: Authors' Computation)

Table 4.8: Levin-Lin-Chu unit-root test

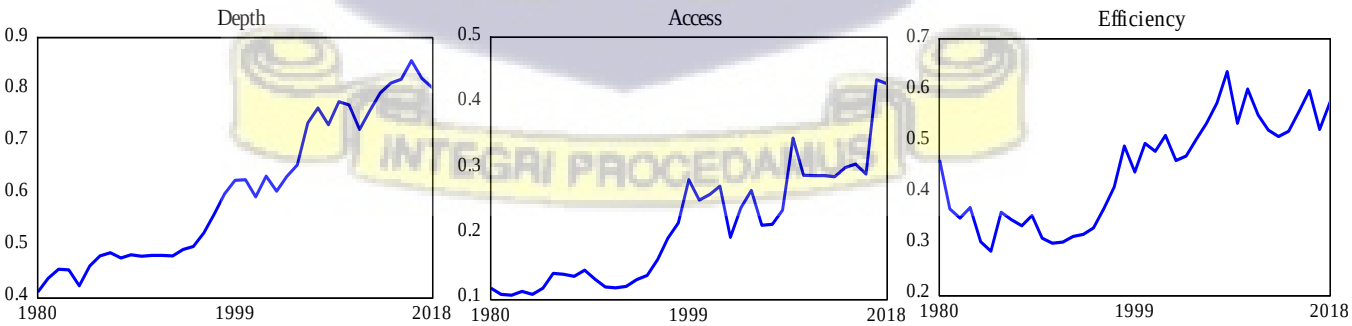
Ho: Panels contain unit roots — Number of panels = 45
Ha: Panels are stationary — Number of periods = 37

AR parameter: Common — Asymptotics: N/T -> 0
Panel means: Included
ADF regressions: 1 lag
LR variance: Bartlett kernel, 10.00 lags average (chosen by LLC)

Variable	Statistics Unadjusted	Adjusted	p-value
envtr	-15.4951	-6.2078	0.2458
fr	-4.9712	2.4223	0.9923
gdp	-21.9258	-10.9421	0.5762
urban	-5.4842	0.2261	0.5894
dinv	-17.6410	-8.6422	0.8795
fdi	-6.4971	0.9732	0.8348
dep	-6.4610	0.3678	0.6435
acc	-0.9651	6.4523	0.9831
eff	-8.2048	-1.0239	0.1529

(Source: Authors' Computation)

Figure 4.5: Trends in Financial Development Components



Source: Authors' construct, Data from OECD (2020).

Table 4.9: Results of Roodman (2009) and Bond et. al. (2001) GMM selection criteria

VARIABLES	Financial Depth				Financial Access				Financial efficiency			
	Pooled OLS: Upper Bound	Fixed Effect: Lower Bound	Baseline results: Two-Step System GMM	Two-Step Difference GMM	Pooled OLS: Upper Bound	Fixed Effect: Lower Bound	Baseline results: Two-Step System GMM	Two-Step Difference GMM	Pooled OLS: Upper Bound	Fixed Effect: Lower Bound	Baseline results: Two-Step System GMM	Two-Step Difference GMM
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
l.envtr	0.975***	0.757***	**0.894*** **	0.735***	0.874***	0.758***	**0.801*** **	0.892***	0.946***	0.758***	**0.895*** **	0.724***
	(0.0118)	(0.0163)	(0.0308)	(0.0814)	(0.0118)	(0.0163)	(0.0270)	(0.0695)	(0.0118)	(0.0163)	(0.0311)	(0.0889)
fr	-0.00782	-0.0130	-0.0163	-0.0987	-0.00734	-0.00976	0.00208	-0.00813	-0.00843	-0.0130	-0.00185	-0.0500
	(0.0103)	(0.0109)	(0.0329)	(0.0905)	(0.0103)	(0.0113)	(0.0136)	(0.0487)	(0.0104)	(0.0109)	(0.0333)	(0.123)
gdp	0.00123	-0.000174	0.0912***	0.108**	0.00131	-0.000225	0.0445**	0.0495	0.00129	-0.000170	0.0921***	0.0787
	(0.00201)	(0.00206)	(0.0251)	(0.0521)	(0.00200)	(0.00206)	(0.0189)	(0.0469)	(0.00201)	(0.00206)	(0.0254)	(0.0528)
urban	0.00147*	0.00218*	0.0714***	0.0448**	0.00147*	0.00213	0.0243**	0.0591**	0.00133	0.00210	0.0741***	0.0553
	(0.000877)	(0.00130)	(0.0132)	(0.0215)	(0.000867)	(0.00131)	(0.0123)	(0.0254)	(0.000872)	(0.00131)	(0.0138)	(0.0353)
dinvt	0.000869	-0.038***	-0.0130*	-0.0902	0.00188	-0.041***	0.0019	0.0225	0.00182	-0.039***	-0.0078	-0.00800
	(0.00455)	(0.0127)	(0.0068)	(0.0825)	(0.00442)	(0.0128)	(0.0050)	(0.0493)	(0.00444)	(0.0127)	(0.0066)	(0.0450)
fdi	0.211	-0.0369	4.007**	8.321	0.153	0.00613	0.293	1.880	0.209	-0.0314	3.990**	6.000
	(0.168)	(0.192)	(1.555)	(5.669)	(0.172)	(0.194)	(0.194)	(2.275)	(0.168)	(0.191)	(1.571)	(5.553)
dep	-0.0947	0.266	-1.126***	-8.532								
	(0.129)	(0.321)	(0.295)	(7.407)								
acc					0.245*	-0.537	0.592***	2.968				
					(0.146)	(0.484)	(0.206)	(5.228)				
eff									0.0520	0.143	-1.278***	-2.129
									(0.125)	(0.183)	(0.344)	(6.442)
Constant	0.0727	0.450***	-2.861***		0.0483	0.456***	-0.924*		0.0505	0.441***	-2.782***	
	(0.0507)	(0.100)	(0.481)		(0.0497)	(0.104)	(0.500)		(0.0574)	(0.103)	(0.478)	
Observations	1665	1665	1665	1665	1665	1665	1665	1665	1665	1665	1665	1665
R-squared	0.251	0.586	-	-	0.185	0.586	-	-	0.124	0.586	-	-
Groups/instruments	-	-	45/29	45/25	-	-	45/28	45/25	-	-	45/28	45/24
AR (2)	-	-	0.365	0.376	-	-	0.464	0.521	-	-	0.382	0.415
Hansen Statistics	-	-	0.286	0.214	-	-	0.276	0.224	-	-	0.257	0.276

Andrews-Lu model and moment selection criteria (MMSC):												
Akaike (AIC)	-	-	**-0.0068**	-0.0048	-	-	**-0.0047**	-0.0034	-	-	**-0.0074**	-0.0061
Bayesian (BIC)	-	-	**-0.0081**	-0.0062	-	-	**-0.0055**	-0.0048	-	-	**-0.0078**	-0.0065
Hannan-Quinn (HQIC)	-	-	**-0.0086**	-0.0068	-	-	**-0.0064**	-0.0052	-	-	**-0.0081**	-0.0072

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1
(Source: Authors' Computation)

Table 4.10 Test for the existence of threshold

	Depth	Access	Efficiency
LM-test for no Threshold	18.43	12.02	30.15
Bootsrap p-value	0.000	0.067	0.000
No. of bootstrap replication	2000	2000	2000
Trimming percentage	0.15	0.15	0.15

(Source: Authors' Computation)

Table 4.11 Dynamic Panel Threshold Regression Results

	Depth			Access			Efficiency		
	Overall (1)	Low (2)	High (3)	Overall (4)	Low (5)	High (6)	Overall (7)	Low (8)	High (9)
l.envtr	0.894***	0.442***	-0.313***	0.801***	0.800***	-0.673***	0.895***	0.588*	-0.925***
	(0.0308)	(0.0603)	(0.0629)	(0.0270)	(0.154)	(0.116)	(0.0311)	(0.303)	(0.268)
fr	-0.0163	-7.038**	7.173**	0.0021	1.455	-2.769*	-0.0019	-1.152	2.595
	(0.0329)	(3.555)	(3.157)	(0.0136)	(1.396)	(1.526)	(0.0333)	(2.153)	(3.126)
gdp	0.0912***	-0.754**	0.931***	0.0445**	0.516***	0.186	0.0921***	-0.0494	0.0229
	(0.0251)	(0.344)	(0.256)	(0.0189)	(0.107)	(0.238)	(0.0254)	(0.0755)	(0.172)
urban	0.0714***	0.0248***	-0.022***	0.0243**	-0.0169**	0.0060	0.0741***	0.0084	0.0005
	(0.0132)	(0.0049)	(0.0047)	(0.0123)	(0.0083)	(0.0096)	(0.0138)	(0.0109)	(0.0139)
dinvt	-0.0130*	0.0207*	-0.0133	0.0019	0.0109	-0.0010	-0.0078	-0.0002	0.0291**
	(0.0068)	(0.0117)	(0.0114)	(0.0050)	(0.0079)	(0.0162)	(0.0066)	(0.0105)	(0.0124)
fdi	4.007**	-0.136**	0.170**	0.293	0.0466	-0.178	3.990**	-0.106**	0.0630
	(1.555)	(0.0671)	(0.0722)	(0.194)	(0.0511)	(0.116)	(1.571)	(0.0481)	(0.0478)
dep	-1.126***	3.378***	-0.3217***						
	(0.295)	(0.885)	(0.0843)						
acc				0.592***	0.983***	-0.912***			
				(0.206)	(0.339)	(0.348)			
eff							-1.278***	-3.834***	2.532
							(0.344)	(1.032)	(2.495)
Constant	-2.861***	-0.178	0.010	-0.924*	2.234*	0.0101	-2.782***	-1.371	0.261***
	(0.481)	(0.850)	(0.0439)	(0.500)	(1.236)	(0.0348)	(0.478)	(0.890)	(0.0486)
Observations	1,634	1,634	1,634	1,634	1,634	1,634	1,634	1,634	1,634
No. of countries	45	45	45	45	45	45	45	45	45
Threshold value		0.19	0.19		0.25	0.25		0.15	0.15
F-Stats			2.78	2.78	2.80	2.80		2.72	2.72
Prob > F		0.000	0.000		0.000	0.000		0.000	0.000

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

(Source: Authors' Computation)

CHAPTER FIVE

ENVIRONMENTAL RISK, FDI AND TAX REFORMS: SHOULD WE WORRY?

CHAPTER FIVE

ENVIRONMENTAL RISK, FOREIGN DIRECT INVESTMENT AND TAX POLICIES: SHOULD WE WORRY?

Abstract

In this paper, we use empirical models to examine the main channel through which foreign direct investment escalates environmental risk. We explore whether countries with 'weak' or better still low tax rates attract 'dirty' FDI to deteriorate their environment. The analysis uses a 30-year panel to show that FDI and tax policy matter in accounting for cross-country environmental risk. Our sample finds support that the tax channel is the main medium through which FDI worsens environmental risk. By discomposing tax policy into low and high regimes, we report that countries that deliberately reform tax policy to bait FDI have higher environmental risk. A useful lesson from here is that using tax policy to lure FDI amount to short-changing capital risk for environmental risk.

Keywords: environmental risk, FDI, tax rate, CO_2, tax policy

5.1 Introduction

The growing concern about global warming leaves much to be desired on the financing decisions of countries. Global warming has resurrected the sustainability debate and the need to reconsider the extent to which economic growth financing affects the quality of the environment. The concept of economic sustainability or sustainable development as introduced by the Brundtland Commission report "Our Common Future" believes that current economic growth should not endanger the ability of future generations to meet their own needs. Most often, countries in an attempt to propel economic growth, deplete resources beyond acceptable levels. Sustainability, therefore, cautions today's generation to be more circumspect in their use of resources.

However, financing economic growth has not been easy, especially in Africa. The region is exploring both domestic and foreign avenues to raise cheaper capital to finance growth. Domestic financing has not helped much due to poor savings and low tax mobilization in the region; hence, the overreliance on foreign capital flows (Uneze, 2013; Fosu, 1996; Chenery & Strout, 1966). One key external funding flooding the African economy is Foreign Direct Investment (FDI). There is consensus between researchers and policymakers that FDI raises economic growth levels by augmenting total factor productivity and capital formation of host countries (Alfaro et al., 2004; Durham, 2004; Li & Liu, 2005; Borensztein et. al., 1998). FDI is relatively cheaper than other forms of external capital like aid and external debt. Li and Liu (2005) assert that even in cases where FDI does not result in explicit capital financing, it influences positively the host nation's technological transfer, managerial competencies, raw materials availability, and production processes, among others. FDI to Africa in the past three decades has been marginal but better than

the global mean as shown in Figure 5.1 in the Appendix and constitutes a significant proportion of Africa's GDP.

To attract more FDI, countries in Africa and most parts of the world extensively use lucrative tax regimes to woo foreign investors into their economies. An array of tax incentives in the form of exemptions and low tax rates are often used to bait investors. For instance, in Ghana, the introduction of the Investment code (PNDC Law 116, 1985) brought a range of incentives to foreign investors. The code offers tax rebates as high as 40%. Damgaard, Elkjaer, and Johannesen, (2019) observed that FDI locates countries with favourable or weak tax regimes. Weak tax policies create breeding spaces for tax avoidance through thin capitalization, transfer pricing, royalties as well as management fee payments. It is therefore not surprising to have 10 countries with the most lenient tax policies hosting more than 85% of global FDI inflows (Damgaard et al., 2019). In an attempt to receive more FDI inflows in Africa, the corporate tax rate for the past one and half decades has fallen from over 75% to less than 40% averaged (Figure 5.1 in the Appendix). Mauritius, Namibia, Zambia, and Lesotho have a mean total corporate tax rate below 20% (World Bank, 2019). Tax policies are crucial in determining the direction of FDI inflows as observed by Scholes and Wolfson (1991).

At the same time, the quality of the environment in Africa is becoming a concern. In Figure 5.1, the level of carbon dioxide emission looks stable for Africa in the last decade but still higher than the global average. Meanwhile, pockets of studies attribute the rise in carbon emission to the rise in FDI inflows; hence, making the region a "pollution haven" for multinational enterprises (MNE) who want to pay less for damaging the environment (Bokpin, 2017; Omri, Nguyen, & Rault, 2014; Sbia, Shahbaz, & Hamdi, 2014; Acharyya, 2009; Jorgenson, Dick, & Mahutga, 2007; Antweiler et al., 2001).

FDI does not only move toward a conducive tax climate but also targets countries with weak environmental laws (Cole et. al., 2006; Prakash & Potoski, 2006). One channel of strengthening environmental laws is through the tax system. Effective tax systems impose punitive measures to slow the rate at which businesses degrade the environment. If tax laws are not sufficiently punitive, FDI inflows may be invested in environmentally damaging sectors of the economy. It is of no surprise that a greater portion of FDI inflows to Africa is invested in oil and gas and natural resource extractions (Asiedu, 2013). We acknowledge the reality of developmental and capital deficits in Africa.

However, deliberately reforming tax laws to attract more FDI could be trading one risk for the other. Hunting for more FDI through tax reforms could close the gap between capital and developmental shortfalls; but where the FDI goes matters to safeguarding sustainable development. In Figure 5.2 we develop a simple "Toxic Taxes, Dirty FDI Model" based on the "tax haven" and "pollution haven" hypothesis (Dinda, 2004). The model shows that the lenient tax regime attracts more FDI inflows. FDI, on the other hand, affects the host nation's economy in three dimensions; technology, scale and structure (Antweiler et al., 2001). The model supports the hypothesis that tax haven economies attract pollution haven FDI. FDI take advantage of the weak tax system to increase environmental risk. This study, therefore, uses empirical data to investigate the assertion that tax reforms may provide a convenient channel through which FDI worsens environmental risk.

Moreover, the effect of FDI on environmental quality and the effect of tax policies on FDI are well documented in the literature. The main conclusions are that FDI harms the environment (Omri, et. al., 2014; Sbia, et. al., 2014; Acharyya, 2009; Jorgenson, et. al., 2007) and favourable tax policies attract more FDI (de Mooij & Ederveen, 2003; Scholes & Wolfson, 1991). The literature is,

however, malnourished on the channels through which FDI affects the quality of the environment. Most of the literature that attempts to offer a solution to the FDI-environmental problem, largely suggests governance or institutional quality as a panacea (Bokpin, 2017; Corfee-Morlot, et. al., 2009). However, this approach overly simplifies the menace and makes it difficult and ambiguous in offering specific policy direction.

The existing literature is skewed toward the negative effects of FDI on the environment (Omri, et. al., 2014; Acharyya, 2009; Jorgenson, et. al., 2007) without paying attention to the channels through which FDI toxifies the climate. This oversight distorts the wholesale recommendations of most studies in this area. We fill this lacuna by introducing the tax policies of developing economies into the debate. The current study explores the tax channel as one of the main mediums through which FDI affects the environment. We suggest that loosening tax policies to attract more FDI could amount to shooting the economy in the foot because FDI takes advantage of the same tax policy to harm the environment.

The study is organized as follows: in section one, we introduced the study by giving a detailed background; in section two we set up both theoretical and empirical foundation for the study; in section three, we discuss the research designs by building an empirical model for estimation; the regression results are discussed in section four; and finally, in section five, we draw conclusions from the results and offer recommendations for policy consideration.

5.2 Brief Literature Review

It is not new in the literature that FDI has a positive effect on local capital formation, technical efficiency and economic growth. However, there are divided views on the effect of FDI on the quality of the environmental quality. Two strands of the debate have emerged based on two conflicting hypotheses. These are the “pollution haven hypothesis and “pollution halo hypothesis”.

The former suggests that firms by nature are profit-oriented and would explore every opportunity to reduce cost; hence, MNC will easily locate countries with lax environmental standards when the need arises. Studies that stem from this theory conclude that FDI is bad for the environment (Zheng & Sheng, 2017; Omri, et. al., 2014; Sbia, et. al., 2014; Acharyya, 2009; Baek & Koo, 2008; Jorgenson, et. al., 2007). The pollution halo hypothesis, on the other hand, holds the view that FDI is rather environment enhancing (Kim, & Adilov, 2012; Hoffmann, et. al., 2005; Hines & Rice, 1994) since most FDI come from developed countries with strict environmental regulations, it can transfer superior externalities to host nation.

We suspect that whether FDI enhances or deteriorates the environment is reinforced by local factors in host nations. Even if the two arguments hold in their respective circumstances, we argue that FDI tends to replicate the disposition of the host country. Thus, what matters in determining the impact of FDI on the environment is the channel(s) underpinning the receipt and deployment of FDI. In the best-case scenario where FDI brings superior technologies to reduce environmental risk, MNC will revert to the status quo in the long run if there are weak environmental fundamentals in the local country. Largely because in reality, not too many firms would do more than the required to protect the environment, especially profit-maximizing firms. It is against this background we introduce tax reforms into the debate.

Although several channels may account for the effect of FDI on the environment, the tax channel stands out. Not only does it capture the regularity quality of the host nation but also guides both the front and back door to FDI as illustrated in Figure 5.2. In our "toxic taxes/dirty FDI model, we expand the tax haven hypothesis (Hines & Rice, 1994) and pollution 'haven/halo' hypothesis (Antweiler et al., 2001; Grossman & Krueger, 1991). In a provocative paper, Hines and Rice (1994) show that FDI locates in countries with low tax rates. Scholes and Wolfson (1991) hold a

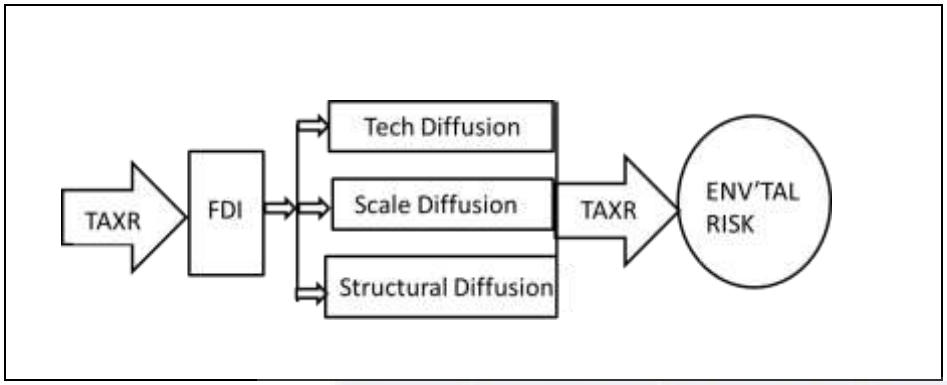
similar view. This makes tax policy a handy tool for countries, especially capital-trapped economies to regulate the 'back' door for FDI. Although our conceptual framework in Figure 5.2 agrees with earlier authors (Hines & Rice, 1994) that indeed tax attracts FDI, we, however, hold the view that the same tax policy determines the extent to which FDI degrades the environment.

Antweiler et al., (2001) and Grossman and Krueger (1991) observe that FDI affect the host economy at three levels: technological, scale and structural. FDI can diffuse new technology into the production process that may improve or harm the environment. FDI may increase the size of the economy due to an increase in productive activities. This is termed FDI scale diffusion. Scale diffusion may worsen environmental risk if the necessary steps are not taken to address the expansion of the economy. The structural diffusion, on the other hand, triggers a change in the industrial cycle due to a possible shift in the economic activity patterns. Whether all three FDI effect would be helpful or hurtful to the environment depend on domestic tax policy which controls the 'front' door to FDI diffusion. Tax policy is a crucial component of regulation that directs patterns of production and consumption in a free economy. It, therefore, has explicit control over where FDI goes. King, Tarbush and Teytelboym (2019); Lin and Li (2011); Davis and Kilian (2011); Bruvoll and Larsen (2004) investigate the effect of tax policy on environmental risk. They use specific tax policy (carbon tax) to show that tax policy has a significant and negative effect on per capita carbon emission. However, they (Lin & Li 2011; Davis & Kilian 2011; Bruvoll & Larsen, 2004) found environmental tax exemption policies to be worrying about the fight against pollution.

Lin and Li (2011) estimate that by introducing environmental taxes, carbon emission per capita is reduced by 1.69%. The full benefit of tax policy should be exploited so that even if tax is reformed to woo foreign investors, it should at the same time moderate the direction of the investment. King

et. al. (2019) report that designing tax policies for specific sectors of the economy have high elasticity and can effectively reduce aggregate emissions.

Figure 5.2: Toxic Taxes, Dirty FDI Model



Authors' conceptual framework

In addition, the lack of strict environmental tax policy is making MNC use developing countries as a dumping site for developed countries. Evidence has shown that developed countries in the name of recycling build plants in developing countries and export their waste (Basel Action Network, 2018).

Moreover, He (2006) explores the pollution haven hypothesis and environmental impacts of foreign direct investment in China; the evidence he uncovers shows that an increase in FDI will lead to a decline in environmental quality with specific emphasis on SO_2 and CO_2 emissions. His study establishes grounds for the existence of the "pollution haven hypothesis". In a recent study, Zheng and Sheng (2017) confirm the findings of He (2006) that FDI directly promotes China's CO_2 emissions. Using Johansen's co-integration analysis and vector error-correction (VEC) model, Baek and Koo (2008) examines the possible relationship between FDI and Environmental quality. The results show that FDI inflow plays a pivotal role in determining the short and long-run movement of economic growth through capital accumulation and technical spillovers. However,

they report that FDI inflow still has a detrimental effect on environmental quality. More also, Ajide and Adeniyi (2010), as well as Baek and Choi (2017), report a long-run causal link between CO_2 per capita and FDI.

5.3 Methodology

The research data cover 36 African economies over 40 years from 1979 to 2018. Data on environmental risk proxied by CO_2 emission and Natural Resource Depletion (NRD), Foreign Direct Investment (FDI), GDP per capita growth rate (GDP), Rule of Law (LAW), urbanization (URBAN), and domestic investment (DINV) are from World Development Indicators (WDI). We expand Antweiler et al. (2001) and Grossman and Krueger's (1991) model to include FDI and Tax Reforms. To test the effect of FDI on environmental risk in the presence of weak or low tax policy, we construct two empirical models shown in equations (5.1) and (5.2) below:

$$\mathrm{ENVR}_{it} = \alpha_0 + \zeta \mathrm{TAXR}_{it} + \gamma \mathrm{FDI}_{it} + \tau(\mathrm{TAXR} * \mathrm{FDI})_{it} + \varphi(\mathrm{FDI}^2 * \mathrm{TAXR})_{it} + \sum_{\omega=4}^{n} \omega \, \mathrm{X}_{it} + \varepsilon_{it} \quad \ldots\ldots\ldots\ldots(5.1)$$

$$\mathrm{ENVR}_{it} = \alpha_0 + \zeta \mathrm{TAXR}_{it} + \gamma \mathrm{FDI}_{it} + \alpha \mathrm{TAXDUMMY}_{it} + \tau(\mathrm{TAXDUMMY} * \mathrm{FDI})_{it} + \sum_{\omega=4}^{n} \omega \, \mathrm{X}_{it} + \varepsilon_{it} \quad \ldots\ldots\ldots\ldots(5.2)$$

Where '*it*' is the country '*i*' at time '*t*'. The dependent variable ENVR is the environmental risk. Environmental risk refers to the risk that economic activities by economic agents especially firms pose danger to the environment. This is proxied by carbon dioxide (CO_2) emission as a percentage of GDP. CO_2 emission shows the extent of damage to the environment; hence, the lower the better. As part of the robustness check, we used Natural Resource Depletion (NRD) as an alternative measure of environmental risk. To explore the channels through which FDI deteriorates the environment, we include an interaction term ($\mathrm{TAXR} * \mathrm{FDI}$) between tax rate and FDI in the regression. The interaction is based on the modified hypothesis that tax haven attracts dirty FDI

and FDI consequently degrades the environment through the same tax avenue (Damgaard et al., 2019; Antweiler et al.; 2001; Grossman & Krueger, 1991). The use of interaction terms to examine channels through which a regressor influences the dependent variable in a linear model is justified in the empirical literature (Alfaro et al., 2004; Borensztein et al., 1998; Okada & Samreth, 2014). The interaction term $FDI^2 * TAXR$ represents the square term of FDI and tax rate. This examines whether high FDI accumulation still uses the tax policy window to exploit the environment.

$\sum_{\omega=4}^{n} \omega X_{it}$ represents additional exogenous factors which are included as control variables. These variables are widely used in the literature and they include per capita growth rate (GDP), rule of law (LAW); urbanization (URBAN), and domestic investment (DINV).

In equation 5.2, we employ quantile analysis to determine the median of the tax data and group countries into low and high tax rate economies. We introduced a tax dummy (TAXDUMMY). Low tax rate countries have a score of 1 and 0 otherwise. An additional variable TAXDUMMY*FDI captures the interaction between tax dummy and FDI. We make the same case that countries intentionally lower tax rate to attract more FDI and the FDI in return take advantage of the low tax policy to deteriorate the environment. A low tax rate offers lesser punishment for environmental degradation activities and therefore creates fertile grounds for dirty FDI inflows.

ε_{it} is mean zero scalars; decomposes into $\varepsilon_{it} = \gamma_i + \mu_t + v_{it}$. Where γ_i is the country-specific fixed effect, μ_t is the time-invariant effect and v_{it} captures other white noise in the specified model. A brief description of all variables is shown in Table 5.1.

Table 5.1: Description of Variables and Sources

Variable	Description	Source
ENVR (CO_2)	Carbon dioxide emissions (% of GDP). This is a proxy of environmental risk	WDI data
TAXR	The total tax rate measures the amount of taxes and mandatory contributions payable by businesses	WDI data
FDI	Foreign direct investment, net inflows (% of GDP)	WDI data
FDI^2	Computed by squaring the FDI, Net Inflow	Computed with WDI data
FDI^2*TAXR	An interaction term between FDI^2 and TAXR	Computed with WDI data
TAXR*FDI	Computed by multiplying TAXR and the FDI	Computed with WDI data
RULE	property rights and rule-based governance rating (1=low to 6=high)	WDI data
NRD (ENVR)	The natural log of Natural resource depletion is the sum of net forest depletion, energy depletion, and mineral depletion. It is an alternative proxy for environmental risk	WDI data
GDP	GDP per capita growth rate (annual %)	WDI data
GDP^2	Computed by squaring the GDP per capita growth variable	Computed with WDI data
URBAN	The growth rate of the Urban population refers to people living in urban	WDI data
DINV	The growth rate in domestic investment	WDI data
TAXDUMMY	Dummy variable that separates countries with low tax rates from the high tax rate. Low tax rate countries have a score of 1 and zero otherwise.	Authors' computation
TAXDUMMY*FDI	An interaction between the tax dummy and FDI	Authors' computation

(Source: Authors' Compilation)

5.4 Empirical Results

5.4.1 Summary Results

The empirical model is first estimated with OLS. The Breusch and Pagan Lagrangian Multiplier test for Random Effects is then used to choose between OLS and Random Effect model. The results of the test are shown in Appendix 5.A favours the Random Effect model. We compare the Random Effect model to the Fixed Effect model using the Hausman specification test. The test results failed to uphold the null hypothesis that Random Effect is appropriate (see Appendix 5.B). Our choice of the Fixed Effect model is not strange in the literature (Bokpiin, 2017; Zhu, Duan, Guo, & Yu, 2016). The flexibility in the Fixed Effect model to allow additional intercept that varies over time across observations makes it more appropriate for panel datasets since heterogeneity is a common feature of cross-country studies. Verbeek (2017, p.388) is of the view that the use of the Fixed Effect model will not lead to underestimation of the coefficient where the panel has a large 't' like ours. However, a common problem associated with most Fixed Effect models is heteroskedasticity and serial correlation. We, therefore, performed the Modified Wald test for Groupwise heteroskedasticity and Pesaran's test for serial correlation. The test results as included in Appendix 5.C and 5.D affirm the presence of heteroskedasticity and serial correlation respectively. Consequently, we resort to robust standard error Fixed Effect regression to resolve the heteroskedasticity and serial correlation problems (Verbeek, 2017; Driscoll & Kraay, 1998). Although the discussion of the results is based on the Fixed Effect regression, the Random Effect and in one case the OLS model results are included for comparative analysis purposes.

Table 5.1 presents the descriptive statistics for CO_2 emission (ENVR) Natural Resource Depletion (NRD), Foreign Direct Investment (FDI), Per Capita Growth Rate (GDP), Rule of Law (LAW), urbanization (URBAN), and Domestic Investment (DINVEST). There is considerable variation in the share of CO_2 in GDP across countries, ranging from 0.19% in Chad to 5.0% in Sudan within

the 1989-2018 period. Tax rate trends are on the decline globally. Africa is featured in the global downward tax spiral. However, some countries still have high tax rates. For instance, Benin, Cameroon, D.R Congo and Cote d'Ivoire have an average tax rate above 50% within the 1989-2018 period. Four countries at the top of lower tax rates include Botswana (25.1), Mauritius (22.1), Namibia (20.7), and Zambia (15.6). These statistics suggest a wide variation in tax rates across countries. FDI as a share of GDP shows variations ranging from a low of 0.032 to a peak at 7.3%. Lastly, the GDP per capita growth rate shows developmental diversity in the region.

Table 5.2: Descriptive Statistics

Variable	Obs	Mean	Std.Dev.	Min	Max
CO_2	1440	1.122	0.973	.19	5.0
TAXR	1440	39.98	10.896	15.6	63.5
FDI	1440	2.787	1.686	0.032	7.299
RULE	1440	2.636	.659	.895	4.314
GDP	1440	4.832	.997	2.368	6.92
URBAN	1440	36.262	15.833	5.342	89.37
DINV	1440	8.36	1.265	5.136	11.167
NRD	1440	6.309	4.371	.037	40.816

(Source: Authors' Computation)

Table 5.3 presents the correlation matrix results. The two main take-homes are that there is no indication of multicollinearity among our regressors. Also, the positive sign between CO_2 emission and the two main variables of interest (TAXR and FDI) could preempt our expectation; albeit, concluding here would be too early.

Table 5.3: Matrix of correlations

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) CO_2	1.000							
(2) TAXR	0.066	1.000						
(3) FDI	0.022	-0.301	1.000					
(4) RULE	-0.294	-0.095	-0.068	1.000				
(5) GDP	-0.366	0.056	-0.004	0.135	1.000			
(6) URBAN	0.133	-0.091	0.301	-0.266	0.134	1.000		
(7) DINV	-0.080	-0.198	0.325	-0.157	0.211	0.200	1.000	
(8) NRD	-0.118	0.099	-0.130	-0.037	0.073	-0.251	-0.015	1.000

(Source: Authors' Computation)

5.4.2 Environmental Risk: Does FDI and Tax Policy matter?

The objective of the study is to investigate the tax policy channel as a window through which FDI increases environmental risk. As a starting point, we analyze the individual roles of FDI and tax policy in our empirical model using three distinct estimation techniques. Table 5.4 presents the results for Fixed Effect (FE), OLS and Random Effect (RE) in columns (1), (2) and (3) respectively. Our measure of environmental risk – CO_2 emission as a share of GDP is computed as the cost of damage to the environment due to carbon dioxide emissions from fossil fuel use and the manufacture of cement, estimated to be US$30 per ton of CO_2 multiplied by the number of tons of CO_2 emitted (World Bank, 2019). Since it shows an inverse measure of environmental quality, variables with a positive coefficient worsen environmental risk and vice versa. In all three models, FDI is seen to be bad for the environment. This is not surprising in the empirical literature (Bokpin, 2017; Omri, et. al., 2014; Sbia, et. al., 2014; Acharyya, 2009); because most FDI to SSA goes into the extraction of natural resources such as oil, gas, gold, timber, among others and these activities degrade the environment.

The FE and RE results presented in Table 5.4 reveal that tax policy standalone increases environmental risk. This makes it susceptible to being used by other economic growth pollutants to afflict the environment the more. Tax policy is expected to be a watchdog over the environment

by serving as a punitive measure. But if tax policy itself is environmentally unfriendly it opens the greater door to FDI and other environmental degradation activities.

Table 5.4: Environmental Risk: Does FDI and Tax Policy matter? Dependent Variable: CO_2

VARIABLES	FE	OLS	RE
FDI	0.0263***	0.0376***	0.0267***
	(0.00183)	(0.00185)	(0.00183)
TAXR	0.00149**	0.000344	0.00183***
	(0.000654)	(0.000404)	(0.000604)
GDP	1.033***	-0.251***	-0.0186
	(0.165)	(0.0292)	(0.0817)
URBAN	-0.0148***	0.00975***	0.00634
	(0.00550)	(0.00176)	(0.00389)
DINV	-0.00877	0.0252	-0.0103
	(0.0249)	(0.0225)	(0.0246)
RULE	-0.289**	-0.297***	-0.336***
	(0.113)	(0.0431)	(0.0895)
Constant	-2.849***	2.263***	1.635***
	(0.780)	(0.268)	(0.491)
Observations	1,410	1,440	1,440
R-squared	0.154	0.393	0.164
Number of i	47	48	48

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
(Source: Authors' Computation)

5.4.3 Environmental Risk and FDI: Tax Policy as a channel

The theoretical framework of the study suggests that tax haven economies are more likely to attract dirty FDI into sectors that pollute the environment. Table 5.5 presents the results of the effect of FDI on environmental risk through the tax channel. In column (1) we introduced an interaction term between FDI and tax rate. The results indicate that although the tax rate failed to enter the model at conventional levels, the interaction term is positive and significant at 1% levels. Suggesting that the tax channel is a strong avenue for FDI to harm the environment. Meanwhile,

interaction terms in empirical models could be deceptive since one cannot tell from the absolute values which of the variables within the interaction is driving the change in the dependent variable. Also, the ambiguity is high in our study since both FDI and tax rate are seen to worsen environmental risk as shown in Table 5.4. To solve this problem, we proceed further to decompose the interaction term by computing the net effect of FDI on environmental risk. We take the partial derivative of CO_2 concerning FDI and follow Alfaro et. al (2004) to estimate how much a standard deviation increase in FDI escalates environmental risk. We use the same procedure to compute the net effect of the tax rate as well for comparative purposes. This is given as:

$$\mathrm{ENVR_{it}} = \alpha_0 + \zeta \mathrm{TAXR_{it}} + \gamma \mathrm{FDI_{it}} + \tau(\mathrm{TAXR} * \mathrm{FDI})_{\mathrm{it}} + \sum_{\omega=4}^{n} \omega \, \mathrm{X_{it}} + \varepsilon_{\mathrm{it}} \quad \ldots\ldots\ldots\ldots (5.3)$$

The net effect of FDI:

$$\frac{\partial \mathrm{ENVR_{it}}}{\partial \mathrm{FDI}} = \gamma + \tau \mathrm{TAXR_{it}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5.4)$$

The net effect of tax rate:

$$\frac{\partial \mathrm{ENVR_{it}}}{\partial \mathrm{TAXR}} = \zeta + \tau \mathrm{FDI_{it}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5.5)$$

Assuming a country receives the mean FDI, how much does one standard deviation increase in FDI affects environmental risk. This is measured by $\gamma\delta_{CO2} + (\tau \times mean_{TAXR} \times \delta_{CO2})$. The measurement produces a net effect FDI of 0.018%. The outcome of the net effect of the tax rate as measured by $\zeta\delta_{CO2} + (\tau \times mean_{FDI} \times \delta_{CO2})$ is 0.000723%. This beautifully sums up the gap in the literature. Empirically, there are grounds to believe that FDI deteriorates the environment. However, the channel through which FDI achieve this is missing. This study fills the gap by establishing that FDI drives greater change in environmental risk through the host nation's tax policy. The weak tax policy across the sample space is impotent to mitigate or withstand the shocks from FDI. One explanation for the existence of weak tax policy could be that SSA countries are

starting to loosen tax rates and tax laws in an attempt to attract more FDI. A useful lesson from here is that using tax policy to lure FDI amount to short-changing capital risk for environmental risk.

In column (3) we include the square term of FDI and interact the same with TAXR. We have two objectives here. First to test possible non-linearity and second to find out whether tax channels can help reduce environmental risk. The former is upheld at a 1% significant level.

However, the interaction term in column (3) rejects the validity that tax policy can transmit the environmental enhancing effect from the squared FDI. The key reason is that higher FDI by itself could reduce environmental risk because at certain levels of development, economic activities are shifted from primary destructive extractions to other areas and therefore FDI may be forced to invest in environmentally friendly sectors of the economy.

But if the tax system is not healthy enough, FDI will still locate economic activities that harm the environment. Taking together, this reaffirms the results in Table 5.5 column (1) that at high or low FDI inflows, current tax policies in SSA are not robust enough to ensure a reduction in environmental risk. In column (5) we retest our hypothesis that tax policy is a channel through which FDI heightens environmental risk by using the log of natural resource depletion as an alternative measure for environmental risk. Again, the interaction term FDI*TAXR is significant at 5% levels and positive. The results reecho the point that the tax channel is indeed a good conductor of dirty FDI that harms the environment.

Table 5.5: FE Results. Environmental Risk and FDI: Tax Policy as a channel. Dependent Variable: CO_2

VARIABLES	(1) CO_2 (ENVR)	(2) CO_2 (ENVR)	(3) CO_2 (ENVR)	(4) CO_2 (ENVR)	(5) NRD (ENVR)
FDI	0.0181***	0.0489***	0.0412***	0.0265***	0.00739
	(0.00296)	(0.00352)	(0.00388)	(0.00182)	(0.00556)
TAXR	0.000718	0.00170***	0.000842	0.00166**	0.0125
	(0.000686)	(0.000595)	(0.000659)	(0.000652)	(0.0050)
FDI*TAXR	0.000905***				0.00151**
	(0.0000257)				(0.000643)
GDP	0.940***	-0.0140	0.846***	-0.874*	-3.266***
	(0.166)	(0.0813)	(0.165)	(0.508)	(0.492)
URBAN	-0.0142***	0.00420	-0.0143***	-0.0188***	0.0841***
	(0.00548)	(0.00385)	(0.00540)	(0.00556)	(0.0167)
DINV	-0.00898	-0.00241	-0.00375	-0.0108	0.211***
	(0.0248)	(0.0242)	(0.0244)	(0.0248)	(0.0746)
RULE	-0.282**	-0.318***	-0.253**	-0.353***	-0.0370
	(0.113)	(0.0884)	(0.111)	(0.114)	(0.338)
FDI^2		-0.000311***	-0.000332***		
		(0.0000423)	(0.0000438)		
FDI^2*TAXR			0.000015***		
			(0.00000449)		
GDP^2				0.214***	
				(0.0538)	
Constant	-2.384***	1.515***	-2.106***	1.487	17.15***
	(0.788)	(0.486)	(0.779)	(1.341)	(2.330)
F(46, 1356)	28.11	28.10	23.21	18.08	73.44
Prob>F	0.0000	0.0000	0.0000	0.0000	0.000
Observations	1,410	1,440	1,410	1,410	1,410
R-squared	0.161	0.172	0.189	0.163	0.144
Number of i	48	48	48	48	48

Robust Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
(Source: Authors' Computation)

5.4.4 Environmental Risk: Does Tax rate levels matter?

One can easily see from the descriptive statistics shown in Table 5.1 that tax rate levels are at wide variation among African countries. The mean tax rate of 39.98% is still high compared with other global sub-regions. This raises questions as to the claim that Africa is reducing the tax rate to receive more FDI. To disperse this doubt and ambiguity, we introduce a dummy variable to capture

the level of the tax rate. First, a simple quantile analysis is used to locate the median tax rate in the series and group countries into low and high tax rates. Low tax rate countries are scored 1 and 0 otherwise. The strategy of using low tax rates to represent tax haven countries with weak or flexible tax reforms is not unique to this study (Hines & Rice, 1994). The results of this exercise are shown in Table 5.6. Running a Fixed effect model with a time-invariant variable like TAXDUMMY will certainly be omitted therefore we include results from the Random Effect model for comparison. From the FE results in column (1), the interaction between tax dummy and FDI is positive and significant at 1%. This shows that low tax rate matters in environmental risk and FDI nexus. The low tax rate could be less punitive to multinational enterprises that engage in environmentally destructive businesses; hence, creating space for FDI to worsen the environmental risk. The low tax rate has long been established as a catalyst for FDI inflows (Scholes & Wolfson, 1991). Albeit, freefall in tax rate will consequently trigger environmental exploitation.

Table 5.6: Environmental Risk: Does the level of Tax rate matter? Dependent Variable: CO_2

VARIABLES	(1) FE	(2) RE
TAX	0.00118*	0.00172***
	(0.000665)	(0.000639)
FDI	-0.136***	-0.113***
	(0.0299)	(0.0288)
RULE	-0.305***	-0.350***
	(0.115)	(0.0956)
GDP	1.092***	0.0521
	(0.169)	(0.0938)
URBAN	-0.00959	0.00862*
	(0.00587)	(0.00450)
DINV	-0.00686	-0.00840
	(0.0253)	(0.0251)
TAXDUMMY	-	0.0567
		(0.264)
TAXDUMMY*FDI	0.0304***	0.0294***
	(0.00235)	(0.00233)
Constant	-2.170***	2.135***
	(0.791)	(0.584)
Observations	1,410	1,440
R-squared	0.132	
Number of i	47	48

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
(Source: Authors' Computation)

Other determinants of environmental risk include economic growth proxied by GDP, urbanization, domestic investment and rule of law. Table 5.5, column (4) shows results for GDP and GDP squared. Both variables are significant at various levels. But whereas GDP is negative, the latter is positive indicating a possible 'U' shaped relationship between economic growth and environmental risk. The results find no support for the existence of the Environmental Kuznets Curve given the study's sample space. Also, urbanization strangely reduces environmental risk as shown in Table 5.5, columns (1), (3) and (4). One possible reason accounting for this phenomenon could be that SSA is not largely urbanized because a greater part of its population still lives in

villages without access to basic utilities. Domestic investment failed to enter all of our primary models except in column (5) of Table 5.5 where the study uses the net forest depletion (NRD) as a proxy for environmental risk. Domestic investment recorded a positive coefficient of 0.21 at 1% level of significance; suggesting that local investment increases environmental risk just as FDI. This finding although worrying for the environment but not surprising within the African context. In Africa priority is given to expansion in economic activities rather than a concern for the environment leading to rising levels of pollution. To control the negative effect of both domestic and foreign investment on the environment; levying of environmental taxes should not be restricted to FDI but all forms of capital.

Lastly, our measure of regulatory quality – rule of law is significant at various levels in all our models. The results indicate that the rule of law reduces environmental risk.

5.5 Conclusions

In this paper, we set out to use empirical models to test the effect of FDI on environmental risk in the presence of tax policies. The existing literature is blind to the channels through which FDI worsens the quality of the environment. We bridge this gap by advancing that tax policies matter in this all-important discussion. We use various estimation models including the OLS, fixed effect, random effect and quantile analysis to achieve our objectives. Our main model which is the fixed effect forms the basis for our claims.

Given the nature of our panel dataset, we believe that the flexibility in the fixed effect model which allows the inclusion of additional intercepts to vary over time across observations makes it more appropriate to capture country-specific heterogeneity. Also, the study data which covers 36 African economies over 40 years from 1979 to 2018 is large enough for generalization.

Our results indicate that FDI and tax policy matter in accounting for the level of environmental risk. A key consideration from our findings is that reforms in tax policy to lure FDI eventually harms the environment. We record a positive net effect of FDI on environmental risk above 90% to point out that tax policy is a good transmitter of toxics from FDI to the environment.

These findings deviate from earlier studies that advocate for wholesale FDI targeting through tax policies (Damgaard et al., 2019). We expand the argument for a holistic review of both the receipt and use of the FDI. Asiedu (2013) reports that a greater portion of FDI inflows to Africa is invested in oil and gas and natural resource extractions. These areas are conductors of environmental risk. Our results provide the reasons why FDI will locate these sectors.

We also discompose tax policy into low and high regimes to drive home that deliberately reducing the tax rate to get FDI attention is poisonous to the environment. We employ quantile analysis to divide our sample into high and low tax rate regimes. This strategy which is supported by Hines and Rice (1994) reports that low tax economies will suffer more FDI-related environmental risk than their counterparts. This is because a low tax rate is less punitive to FDIs that engage in climate destructive activities. A related study to this finding is Scholes and Wolfson (1991).

Based on the results of our studies the following recommendations are made to mitigate FDI-related environmental risk. First, we have established that using tax policy to lure FDI amount to short-changing capital risk for environmental risk. Hence, the overreliance on tax for FDI is not helping environmental risk. Second, the existing tax rate or tax laws is not punitive enough to deter FDI from aggravating environmental risk. Designing specific tax laws used in advanced economies like carbon taxes can minimize the rate at which FDI is harming Africa's environment.

The main policy implication from our findings is that strengthening tax policy could prevent FDI from deteriorating the environment.

5.6 Chapter Summary

This chapter has answered the research question three of the thesis. We have used various empirical models to examine the moderating efficacy of tax policy in the relationship between FDI and environmental risk. The analysis of the results find support that the tax channel is the main medium through which FDI worsens environmental risk. By discomposing tax policy into low and high regimes, we report that countries that deliberately reform tax policy to bait FDI have higher environmental risk.

5.7 Appendix

Appendix 5.A: Breusch and Pagan LM Test

Breusch and Pagan Lagrangian multiplier test for random effects

CO_2 [i,t] = Xb + u[i] + e[i,t]

Estimated results:

	Var	sd = sqrt(Var)
CO_2	1.598359	1.264262
e	.5715065	.7559805
u	.362094	.6017425

Test: Var(u) = 0

chibar2(01) = 2556.75

Prob > chibar2 = 0.0000

(Source: Authors' Computation)

Appendix 5.B: Hausman Specification Test

	---- Coefficients ----			
	(b)	(B)	(b-B)	sqrt(diag(V_b-V_B))
	fe	re	Difference	S.E.
TAXR	.0017222	.0022286	-.0005065	.0002314
FDI	-.0166335	-.0118822	-.0047512	.0078053
RULE	-.3114843	-.3741769	.0626927	.0666073
GDP	.7870431	-.094587	.8816301	.1453618
URBAN	-.0188344	.000544	-.0193784	.0039288
DINV	-.0192467	-.0227565	.0035098	.0044228

b = consistent under Ho and Ha; obtained from xtreg

B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic

chi2(6) = (b-B)'[(V_b-V_B)^(-1)](b-B)

= 42.74

Prob>chi2 = 0.0000

(V_b-V_B is not positive definite)

(Source: Authors' Computation)

Appendix 5.C: Modified Wald test for groupwise heteroskedasticity

Modified Wald test for groupwise heteroskedasticity
in fixed effect regression model

H0: sigma(i)^2 = sigma^2 for all i

chi2 (47) = 1.7e+05
Prob>chi2 = 0.0000

(Source: Authors' Computation)

Appendix 5.D: Test for Serial Correlation

Pesaran's test of cross sectional independence = 3.470, Pr = 0.0005

(Source: Authors' Computation)

Appendix 5.E: Test for Stationarity

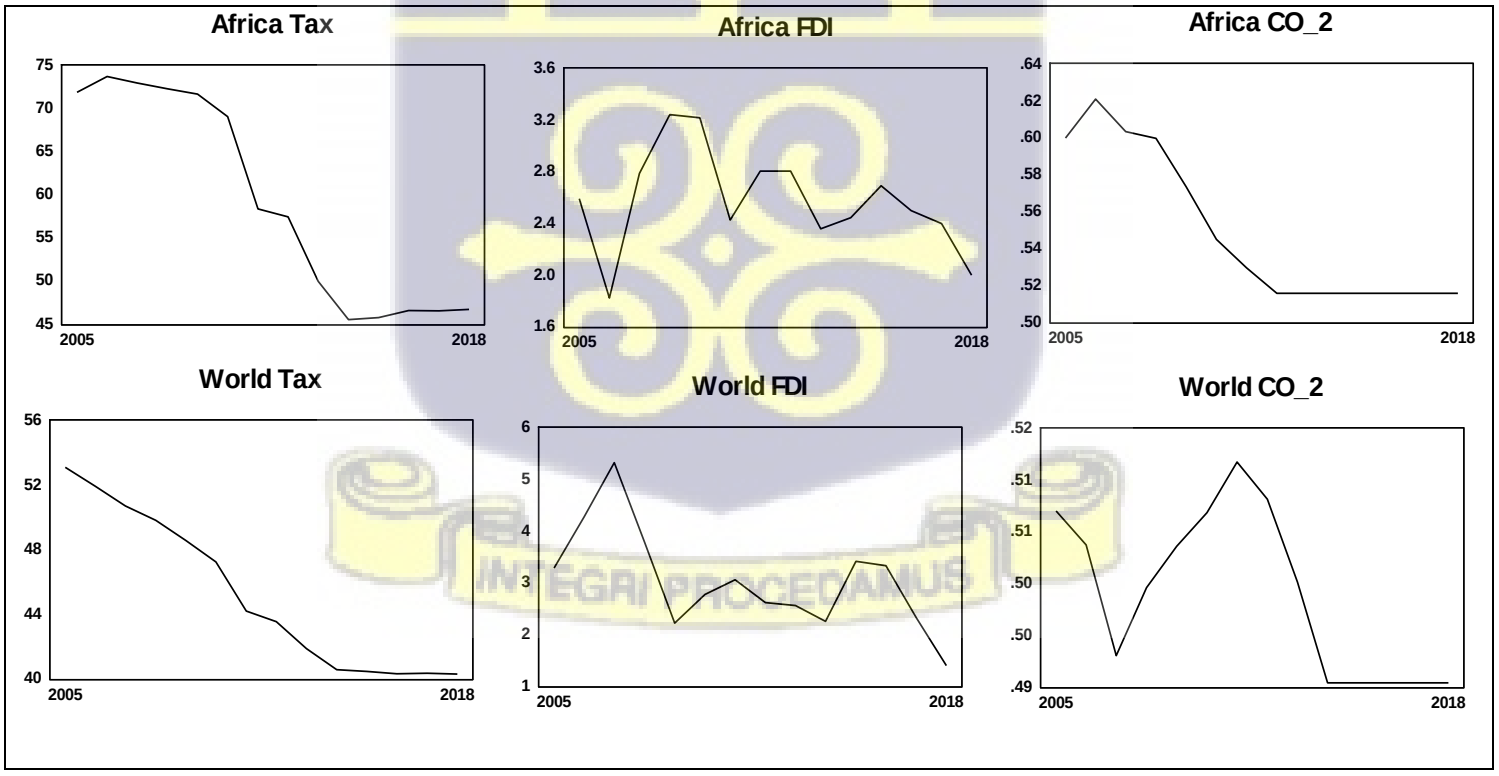
Levin-Lin-Chu unit-root test

Ho: Panels contain unit roots — Number of panels = 48
Ha: Panels are stationary — Number of periods = 30
AR parameter: Common — Asymptotics: N/T -> 0
Panel means: Included
Time trend: Not included
ADF regressions: 1 lag
LR variance: Bartlett kernel, 9.00 lags average (chosen by LLC)

	Statistic		p-value
	Unadjusted t	Adjusted t*	
CO2	-60.1554	-59.1286	0.00000
FDI	-14.6039	-6.1139	0.00000
TAXR	-7.0707	-2.8969	0.00190
GDP	-22.1247	-12.1856	0.00000
URBAN	-34.2894	-22.707	0.00000
DINV	-35.2126	-24.6683	0.00000
RULE	-11.5242	-2.7015	0.00350
NRD	-16.0054	-2.5422	0.00550

(Source: Authors' Computation)

Figure 5.1: Trend in the Tax rate, FDI and CO_2 emission in Africa and the World



Authors' computations with data from World Bank, 2019

CHAPTER SIX

ASSESSING THE IMPACT OF CARBON TAX ADOPTION ON FOREIGN DIRECT INVESTMENT

CHAPTER SIX

ASSESSING THE IMPACT OF CARBON TAX ADOPTION ON FOREIGN DIRECT INVESTMENT

Abstract

This study opens the frontiers to the discussions on the implications of carbon tax introduction on the free movement of international capital. A carbon tax can deter dirty industries from polluting the environment and at the same time generate revenue to augment public funds. Despite these benefits, few countries have adopted carbon tax. The lack of enthusiasm among countries to implement carbon tax has necessitated this research, perhaps, the effect of carbon tax transcends beyond carbon emission reduction.

This study investigates the impact of carbon tax adoption on foreign direct investment in Africa. We set up the Dynamic Stochastic General Equilibrium (DSGE) model and estimate it with the differenced GMM techniques. The findings from this exercise show that the unmitigated effect of the carbon tax on FDI is repressive. However, if the revenue from the carbon tax is recycled into the economy, the carbon tax will have a significant positive effect on FDI. Hence, the study corroborates the double dividend theory.

The findings further suggest that a carbon tax of around US$8.5/ton is reasonable to enhance inward FDI but a carbon tax either above US$25/ton or below US$3/ton will be detrimental to the African region. Also, the entrenched negative relationship between FDI and taxes is worsened if the additional carbon tax is levied among high tax regimes countries than their counterparts. The practical contribution of the study is that the negative effect of the carbon tax on foreign direct investment can be overturned by efficiently ploughing back the carbon tax revenue into the economy.

Keywords: carbon tax revenue, carbon dioxide, Dynamic Stochastic General Equilibrium, double dividend theory, polluter pay principle, generalized method of the moment.

6.1 Introduction

A carbon tax is one of the most efficient means of addressing the rising earth's temperature and can reduce carbon emissions by up to 32% by 2030 (Gaspar & Amaglobeli, 2021, Gaspar et. al., 2019). Carbon tax just like any other form of tax is often feared to hurt the economy. But a cross-sectional examination of the effect of a carbon tax on carbon emissions and economic growth reveals that a carbon tax is effective at reducing carbon emissions and enhancing economic growth (Conefrey et. al, 2013; Lin & Li, 2011). For instance, Sweden which levies the highest carbon tax of US$127 per ton, has reduced carbon emissions by 25% whiles expanding the economy by 75% since 1995 when its first introduced the carbon tax (Gaspar et. al., 2019). On other the hand, South Africa recently introduced a carbon tax and accumulated US$175 million in 2020 alone and is projected to mobilize US$1.87 trillion to augment government revenue for developmental projects (World Bank, 2020). Recent empirical evidence confirms the existing findings that indeed carbon tax reduces carbon emissions (Fu et. al., 2021; Tiwari et. al., 2021; Sun, et al., 2021; Jia & Lin, 2020). There is therefore no debate about the efficacy of carbon tax in reducing carbon emissions.

Despite the glowing tributes to the carbon tax, only 30 countries have implemented it as of 2020 (Metcalf, 2021). Meanwhile, two-thirds of all submitted Nationally Determined Contributions (around 100 countries) to the UNFCCC consider the use of carbon tax to achieve their carbon emission reduction targets (United Nations, 2021). Gaspar et. al. (2019) bemoans that even countries that have implemented carbon taxes largely shy away from the recommended rates. Currently, the average global carbon tax is just $3 per ton which is not near the 2015 Paris

Agreement recommendation of $50 and $25 per ton for developed and developing countries respectively (United Nations, 2021). The slow pace in the adoption of the carbon tax and its related carbon emission reduction policies require further interrogation. The big question is why are countries reluctant in implementing a policy that can mitigate carbon emissions and at the same time mobilize revenue to promote economic growth? Perhaps, carbon tax implications are more complex than the current focus and need to be thought through thoroughly.

Furthermore, the implementation of the carbon tax is worse in Africa which makes the sub-region a potential haven for dirty industries. So far, it is only South Africa that has implemented a carbon tax at the rate of $8 per ton as of 2019 (Gaspar et. al., 2019). The lack of enthusiasm among policymakers in Africa towards the introduction of carbon tax raises concern and the need to holistically assess the wholesale recommendation of the carbon tax. Several factors account for the slow implementation of carbon taxes in Africa. The region is home to countries with high corporate taxes (OECD, 2021). The informal nature of economies in the region narrows the tax bracket to only a few formal sector taxpayers. As a result, firms in the region pay high corporate taxes to make up for non-taxpayers. For instance, Africa houses nine of the twenty countries in the world with the highest corporate taxes with an average corporate tax rate of 28.5% (OECD, 2021). Introducing additional tax in the form of the carbon tax on the already burdened taxpayer has complex implications.

Again, one key implication of carbon tax introduction in Africa is the competitiveness of the domestic economy. Zhang and Baranzini (2004) reviewed the impact of the carbon tax on firm competitiveness and concluded that the domestic carbon tax can impair the international competitiveness of countries in comparative terms. The reduction in the competitive advantage according to Zhang and Baranzini (2004) is the major reason why many countries are reluctant in

implementing a carbon tax. In a related study, Marron and Toder (2014) argued that carbon tax indeed rolls back international competitiveness and can increase local consumers' demand for cheaper imported goods. Although imported goods can equally be taxed at higher rates to restore the imbalances in the local economy, Marron and Toder (2014) contend that firms will find it difficult to expand into the international markets. The harsh impact of the carbon tax on the domestic economy will be minimized if there is a global consensus to implement the carbon tax in every country and almost at the same rate.

However, it is almost impossible to achieve such a recommendation due to the sovereignty of nations. Voßwinkel and Birg (2018) studied the effect of the carbon tax on the relocation decisions of firms within a two-country scenario. They report that if two countries simultaneously set carbon taxes, it reduces the chances of relocation. However, if the carbon tax is set unilaterally or one country's marginal tax rate is higher than the counterparty, there are higher chances that firms in the carbon tax economy will relocate to a foreign country with minimal or no carbon tax. Previous studies including Hudson (1993) and OECD (1993) lend support to these findings that unilateral imposition of the carbon tax is a recipe for firm relocation. The possibility that a firm will relocate due to tax discrepancies among countries is rooted in the theory of international tax competition. Keen and Konrad (2013) and Oates (1972) investigated the role of international tax competition and foreign direct investment (FDI). Their findings revealed that tax policies are the key determinants in accounting for FDI.

Additionally, Xu and Wu (2021) and Boly, Coulibaly, and Kéré (2020) examined the effect of tax policy on inward FDI and report that a cut in corporate taxes indeed increases the net inflow of FDI and can influence the FDI receipts of neighbouring countries in the short and long term.

Although no study has specifically examined the relationship between the carbon tax and FDI, this present study relies on the international tax competition theory and posits that carbon tax adoption could dwindle FDI in the host country. We make this claim based on the strong relationship between FDI and taxes (Gao & Liu, 2021; Xu & Wu, 2021; Damgaard, Elkjaer, & Johannesen, 2019; Oates, 1972). Damgaard et. al. (2019) have shown that countries with low corporate taxes attract high FDI and that foreign firms in particular are sensitive to additional taxes. Subsequently, this study suspects a similar behavior between FDI and carbon tax.

The relevance of this study is not only because it is the first to examine the impact of the carbon tax on FDI but also contributes to the malnourished literature in the African context. Carbon tax introduction and its effect in the African region are almost missing in the vast literature reviewed for the present study. But Africa possesses unique characteristics in the carbon tax and climate change mitigation debate that need considerable attention. Africa's unique characteristics are in the three forms. First, the region lacks the needed capital and FDI inflows augment the deficit. It will be interesting to know how a capital-trapped economy with a high corporate tax rate will implement a policy perceived to be damaging to the local economy and may deter foreign capital as well. Second, Africa may become a pollution haven for western firms who wants to relocate as a result of increasing environmental cost in Europe. This will increase the pollution rate in the continent. Third, the revenue from the carbon tax could contribute to additional source of funding to public fiscal deficit balance.

In this paper, we examine the effect of carbon tax introduction on foreign direct investment in Africa. We argue that imposing a carbon tax may deter foreign investors, hence, the study recommends a pragmatic approach of reinvesting the carbon tax revenue efficiently into the economy. The carbon tax reinvestment assumption hinges on the double dividend theory as

suggested by Pearce (1991) Yang, Jiang, and Pan (2020), Freire-González and Ho (2019) and Radulescu et. al (2017) empirically verified the double dividend theory and concluded that ploughing back carbon tax revenue minimizes the negative effect of the carbon tax on the economy.

In addition, this study fills the carbon tax and international capital omission in the literature. The debate on the carbon tax is skewed towards its deterrent nature and the ability to cut down carbon emissions without analyzing the implications of additional taxes on the local economies. It is surprising to note that despite the deterrent nature of carbon tax and the possibility of raising revenue for local and international governments, policymakers are hesitant to implement it. This study thinks that if carbon tax externalities are not addressed, its implementation will continue to be stalled.

The objective of this study is twofold grounded on the international tax competition theory and the double dividend theory. First, we examine the impact of the carbon tax on FDI. Secondly, we investigate the existence of the double dividend theory by introducing carbon tax revenue into the relationship between the carbon tax and FDI.

The paper is grouped into five sections. Section 1 introduced the study by discussing carbon tax as a means of mitigating carbon emissions. It also gives insights into why countries are sceptical about implementing a carbon tax. Sections two and three provide the literature foundation and the empirical modelling for the study. In section four, the results from the empirical models are discussed and conclusions and recommendations are included in section five.

6.2 Brief Literature Review

The use of carbon tax as a carbon emission mitigation tool is reinforced by the 'polluter pays principle'. The polluter pays principle attempts to place the environmental responsibility of carbon

emissions at the doorstep of the primary emitters and those who benefit from it. In the absence of a polluter pays policy, market failure is entrenched and the least emitters of harmful gases become the most affected. The polluters pay policy as originated by Pigou (1952) and adopted by the OECD in 1971 was not intended that firms can pay and pollute the environment but rather to deter polluters.

Therefore, the deterrent nature of carbon tax fully addresses the requirement of the polluter pays principle. More also, it has been confirmed in the literature that carbon tax is effective at reducing carbon emissions (Fu et. al., 2021; Tiwari et. al., 2021; Sun, et al., 2021; Jia & Lin, 2020; Zhang et. al., 2016; Meng, Siriwardana, & McNeill, 2013). However, it is feared that the carbon tax could reverse domestic economic developments (Evans, et. al, 2021; Xu & Wu, 2021; Voßwinkel & Birg, 2018; Marron & Toder; 2014; Zhao, 2011; Zhang & Baranzini, 2004; Hudson, 1993). The perceived negative effect of the carbon tax on the local economy is stalling its global adoption. For instance, Meng et. al. (2013) examined the impact of the carbon tax on the Australian environment and economy using the computable general equilibrium modelling (CGE). Their simulation results reveal that, although the carbon tax reduces carbon emissions, it will cause economic contractions in Australia.

Additionally, Zhang et. al. (2016) conducted a similar study in three selected provincial economies in China - Henan, Fujian, and Chongqing, using the same methodology. They confirmed that the carbon tax hurts the economies of the selected Chinese provinces. The argument that carbon tax reverses the economic fortunes of a country is based on the effect of tax on business operations. Tax naturally increases operational costs and subsequently cut down profit. This culminates in low capital for reinvestment. It is against this backdrop that Conefrey et. al. (2013) believe that the greater incidence of carbon tax falls on capital than on labour. Even within the same country, it

has been evidenced that unequal levying of a carbon tax can retard sectoral competitiveness and make firms less productive (Xie, et. al., 2018; Wang, Li, & Zhang, 2011). Like it or not, the perceived negative effect of the carbon tax on industrial competitiveness accounted for the reasons why the United States refused to sign the Kyoto Protocol (Zhao, 2011) and their subsequent withdrawal from the Paris Agreement (Zhang, et. al., 2017).

A carbon tax can influence the productivity of local firms and how they compete both within and outside the borders of the domestic economy (Evans, et. al, 2021; Marron & Toder; 2014). In immediate terms, carbon tax affects the competitiveness of firms at three levels: technological, scale, and structural. Carbon tax introduction will require firms to invest in new clean energy technologies. It will also influence economies of scale in the short run due to the possible changes in the cost of production. At the structural level, a carbon tax can change the industrial cycle by altering the patterns in economic activities. The aggregated effect of these significant adjustments on the economy depends on how the transitions are managed and a deliberate government policy is pivotal.

Prior studies have extensively researched the effect of the carbon tax on various economic indicators. But the effect of the carbon tax on FDI is missing in the available literature. The importance of FDI in accounting for economic developments cannot be marginalized and therefore examining the impact of the carbon tax on FDI is critical (Xu & Wu, 2021; Shafiq, et. al., 2021; Sbia, et. al., 2014). More also, capital pays a greater part of the carbon tax than labour as evidenced by Conefrey et. al. (2013); hence, this study enriches the literature by examining how foreign capital (FDI) reacts to carbon taxes.

Additionally, the effect of the carbon tax on the domestic economy is underpinned by the theory of international tax competition which suggests that governments as a matter of regulation use taxes encourage the inflows of economic resources and discourage their relocation (Keen & Konrad, 2013; Oates, 1972).

Gao and Liu, (2021) investigated the relationship between tax burden and FDI. Their fixed effect empirical model revealed a negative relationship between the two. Xu and Wu (2021) also used the system GMM estimation techniques to confirm that corporate tax drives away FDI. The sensitivity of FDI to tax rate is even higher among developing countries (Shafiq, et. al., 2021; OECD, 2008). The negative effect of taxes on FDI is the reason why FDI locate in countries with lower tax rates (Damgaard, Elkjaer, & Johannesen, 2019).

Again, marginal tax rate variations within an economic block contribute to the direction of inward FDI (Xu & Wu, 2021). In 2017 the OECD investigated factors that drive inward FDI. The tax environment was ranked high among the five key determinants. Boly et. al. (2020) examined the effect of tax policy on inward FDI and report that a cut in corporate taxes indeed increases the net inflow of FDI and can influence the FDI receipts of neighbouring countries in the short and long term.

Although prior studies largely focused on the effect of corporate tax on FDI, it will be important to investigate the relationship between the carbon tax and FDI as well. The present study is different from the existing studies in several ways. Whereas the existing literature focused on the impact of corporate income tax on FDI, this present study narrows the argument on the carbon tax. Corporate income tax and carbon tax may have some similarities but the latter has environmental implications. The environmental implications of carbon tax make its design and administration unique relative to other forms of taxes. The carbon tax is a specific tax intended to stop pollution

but can generally affect the economic outlook of a country and subsequently deter FDI due to the free movement of capital. This is the more reason why a holistic assessment of the impact of carbon taxes is needed and remedial measures instituted.

Moreover, another omission in the available studies is the African context. Despite the unique characteristics of Africa, there is yet to be a study that examines carbon tax dynamics in the region. African countries rely on foreign capital to finance developmental programs and FDI is a key source of capital for the region (Agbloyor, et. al., 2016). Ignoring the effect of the carbon tax on FDI in Africa may not help policy formulation. Again, although the region is the least emitter of carbon dioxide among the global regions, it has the potential to become one of the highest emitters if capital constraints are removed (Ritchie, 2019).

The level of carbon emission in a country depends on economic activities and economic activities also depend on resource (capital) availability. Leke and Signé (2019) estimate that about US$1 trillion in capital investment in Africa can transform the region into a full manufacturing hub. This will have implications for carbon emissions. Most African countries are capital trapped and may not be able to raise the needed capital from the domestic economy. Therefore, FDI may fill the capital gap. We have shown in the literature that FDI is sensitive to the general tax environment. Hence, examining the relationship between the carbon tax and FDI will be informative in moderating the level of FDI receipts and how the FDI contributes to carbon emissions.

Furthermore, other strands of empirical work are exploring innovative strategies to curtail the possible negative effect of the carbon tax on the economy (Yang, Jiang, & Pan, 2020; Freire-González & Ho, 2019; Marron & Toder, 2014; Mathur & Morris, 2012). These studies advocate that to achieve the full benefits of the carbon tax, other complementary policies must be implemented alongside. Policies such as tax cuts and reliefs can be pursued to minimize the impact

of carbon taxes on the economy. Also, the revenue from carbon taxes can be recycled into strategic sectors of the economy. Marron and Toder (2014) acknowledge that designing a real-world carbon tax that will deter emitters and promote macroeconomic development is indeed a difficult task. They stress that the three key policies that need to be considered in designing carbon tax include: the tax rate, the collection, and how the revenue is used. Climate economists anticipate that carbon taxes, in the long run, will be passed on to the consumer in the form of higher prices and the low-income household will be greatly affected due to the regressive nature of carbon tax (Mathur & Morris, 2012). To offset this harsh impact on the poor, Marron and Toder (2014) recommend a complete restructuring of the tax system to give tax credits or payroll tax cuts. Firms can also be supported through the reduction in corporate income tax and subsidies. The loss in government revenue as a result of the tax cut could be augmented with the carbon tax revenue. Again, carbon tax revenue can be used to create an alternative source of livelihood for households that will be disproportionately affected.

The use of carbon tax revenue to offset the negative impact on the economy is supported by the double dividend theory. The effectiveness and practicality of double dividend spillover from carbon tax have been confirmed in both theoretical and empirical studies (Yang, Jiang, & Pan, 2020; Freire-González & Ho, 2019; Radulescu, et. al, 2017; Repetto, Dower, & Geoghegan, 1992; Pearce, 1991).

Yang, Jiang, and Pan (2020) use the Difference-in-Differences model and the Ordinary Least Squares method to test the existence of the double dividend theory between the carbon tax and employment in China. Their findings indicate that an 'employment double dividend' exists and that the introduction of a carbon tax could scale up employment if carbon tax revenues are recycled. Freire-González and Ho (2019) on the other hand studied the spillover effect of the

carbon tax on CO_2 emissions and production factors. Their simulation exercises confirm that recycling carbon tax in the form of cutting taxes on labour, capital, and value addition can reduce the cost of implementing a carbon tax and also mitigate CO_2 emissions. However, they report high carbon tax costs to the economy where revenue is not recycled.

6.3 Method and Data

6.3.1 Estimation Strategy

The structural dynamic stochastic general equilibrium (DSGE) approach has been used variously in determining shocks within macroeconomic frameworks due to its inherent opportunities (King et al., 1988; Blanchard & Watson, 1986; Bernanke, 1986). The DSGE expands the standard neoclassical growth model to capture frictions between macroeconomic factors (Ramey, 2016; Blanchard & Perotti, 2002) and check invertibility problems in theoretical models (Ramey, 2016). Another common feature of macroeconomic studies is business cycles and Chari et al. (2008) confirm that the DSGE approach is efficient in accounting for real business cycles. Macroeconomic decisions assume preferences, regime changes, and resource constraints, and the DSGE can incorporate these assumptions into empirical models by solving intertemporal optimization problems (Fernández-Villaverde, Rubio-Ramírez, and Schorfheide, 2016).

Fernández-Villaverde, Rubio-Ramírez, and Schorfheide (2016) further suggest that the DSGE is appropriate for policy experimentations due to its flexibility to accurately track and forecast macroeconomic dynamics over a period. Given the opportunities within the DSGE, the study employs it to examine the effect of carbon tax imposition on FDI and local output.

We start building the empirical model by considering a Cobb-Douglas production function grounded on Leeper et. al. (2013).

$Y_t = A_t K_t^{\alpha} L_t^{1-\alpha}$……(6.1)

Where; 'Y' is output, 'K' is capital, 'L' is labour, and, α and $(1-\alpha)$ are shares of capital and labour in output respectively. For simplicity, we write this function in intensive form and normalize technology (A_t), leading to (2).

$y_t = k_t^{\alpha}$……(6.2)

We assume that the government charges carbon taxes at $'\tau'$ per ton of carbon emitted. The effect of a carbon tax on the economy can be viewed from two points. It can be pushed forward to affect output prices. Given that household income is constant, there will be a cut in demand and output will be affected. Conversely, the carbon tax can be pushed back to the factors of production: capital and labour (labour is omitted for convenience). We can estimate carbon tax shock $'\varepsilon_{\tau,t}'$ first on capital and then output. Based on the Cobb-Douglas function, Ramey (2016) deduced the capital accumulation rule as:

$k_t = \alpha k_{t-1} + \varepsilon_{\tau,t}$ … … … (6.3)

Where $\varepsilon_{\tau,t}$ is the carbon tax shock. (3) can be substituted into (2) to examine carbon tax shock on output

$y_t = (\alpha k_{t-1} + \varepsilon_{\tau,t})^{\alpha}$……(6.4)

Our empirical model is estimated based on (3) with few modifications. In (3), capital is reduced to FDI to examine the effect of a carbon tax on FDI. In (4) we introduce the lag of the dependent variable y_{t-1} following Barro and Salai-Martin's (2003) convergence hypothesis. The share of capital and labour in output sums up to 1. Therefore, we use human development proxied by

secondary school enrollment to control for labour in the empirical model to normalize the share of capital and labour to 1. This gives rise to (5).

$$y_t = y_{t-1} + \alpha k_{t-1} + \varepsilon_{\tau,t} \dots\dots\dots (6.5)$$

If the carbon tax shock $\varepsilon_{\tau,t}$ is anticipated, its lags $\varepsilon_{\tau,t-1}$ can be included in the model up to the number of periods anticipated. Carbon taxes are usually announced before their period of implementation and this allows economic activities to take measures to embrace the shock. Hence, the current behaviour of output or capital will be influenced by both the present shock and the previous information (lag) about the shock. Including lags into the DSGE is supported by Fernández-Villaverde, Rubio-Ramírez, and Schorfheide (2016), and Ramey (2016) and Blanchard and Perotti (2002). Arellano and Bonds' GMM is employed to estimate the DSGE models.

Fernández-Villaverde, Rubio-Ramírez, and Schorfheide (2016), and Ramey (2016) believe that estimating DSGE with GMM is efficient since it overcomes the endogeneity problem usually found in the usual OLS. The inclusion of additional instruments further minimizes the chances that the lags may correlate with the error terms. Consequently, the empirical model in this chapter of the study is estimated following the advice of Bond et. al. (2001). The Bond, et. al. (2001) estimation strategy for GMM is well explained in section 3.3 of Chapter 3 of this study. At the end of this exercise, the differenced GMM estimation technique was selected for this chapter of the study (see Table 6.5).

The empirical model is specified below;

$$fdi_{it} = \delta fdi_{it-1} + \gamma indexct_{it} + \omega indexctrev_{it} + \rho Control_{it} + \varepsilon_{it} \dots\dots\dots (6.6)$$

Where; *'i'* and *'t'* denote a country and time respectively. The rest of the variables are explained in Table 6.1.

fdi_{it-1} is included based on the convergence theory (Barro & Salai-Martin, 2003)

indexct based on the polluter pays hypothesis (Pigou,1952)

indexctrev based on the double dividend hypothesis (Pearce, 1991)

control is a set of exogenous variables selected based on their wide acceptance in the literature (Gao & Liu, 2021; Xu & Wu, 2021; Zhang & Baranzini, 2004).

ε_{it} is mean zero scalars; decomposes into $\varepsilon_{it} = \gamma_i + \mu_t + v_{it}$. Where γ_i is the country-specific fixed effects; μ_t is the time-invariant effect and v_{it} captures all other white noise in the specified model.

6.3.2 Measurement of the Carbon Tax and Carbon Tax Revenue

Presently, it is only South Africa that has implemented a carbon tax in Africa; Cote d'Ivoire and Senegal are considering introducing it in the future (World Bank, 2020). Therefore, data on the carbon tax is not available. But it can be estimated based on reasonable assumptions.

We assume three possible carbon tax rates that African countries can charge.

i. World Bank's minimum carbon tax recommendation of US$25/ton for developing countries. Relative to the existing global average carbon tax, there is little motivation for African countries to charge carbon tax beyond this value. Hence, the World Bank's recommended carbon tax becomes the maximum carbon tax (*maxct*)
ii. Global carbon tax average of US$3/ton (World Bank, 2020). This is assumed to be the minimum carbon tax (*minct*)
iii. South African current tax of US$8.5/ton. South Africa introduced their carbon tax in 2019 at $8/ton but increased it later to US$8.5/ton. The US$8.5/ton is the most likely carbon tax (*mlct*) African countries may desire to charge following the South African example.

All these three possible carbon taxes are examined in different models. This strategy will be instructive enough to advise policy on the implications of various carbon tax values on the dependent variables.

Further, to ensure that carbon tax is heterogeneous (varying across time and country), we assumed that each country will charge a carbon tax as a function of the corporate tax rate and the three-carbon tax values: US$25, US$3, and US$8.5. This approach also facilitates the building of the panel dataset. The carbon tax revenue is computed by multiplying the carbon tax value by the tonnes of carbon emitted.

These assumptions are the more reason why the DSGE modelling is appropriate for this study. Erceg et al. (2005) reviewed the effectiveness of DSGE to accommodate macroeconomic assumptions and observed that the DSGE can evaluate the validity of long-run restrictions often impose on macroeconomic variables by calibrating the data to see if the restrictions indeed exist.

6.3.3 Data Source and Description

The data span between 1995 to 2019 covers 43 Sub-Saharan African countries. Data is sourced from the World Bank's World Development Indicators. To standardize the data, variables that are neither in percentage terms nor index form are included at their logarithm levels (Table 6.1). GDP per capita, education, and the three measures of carbon tax revenue are all in logarithm terms. Table 6.2 contains the summary statistics and Figure 6.1 shows the trends in some of the key variables of the study.

Table 6.1: Variable Definitions and Computations

Variable	Indicator Name	Source/Computation
fdi	Foreign direct investment, the value of net inflows calculated as a % of GDP)	WDI
gdp	GDP per capita (log)	WDI
trade	Trade (value of net trade calculated as a % of GDP)	WDI
edu	Education: number of secondary school enrollment, (log)	WDI
inv	Domestic investment (calculated as a % of GDP)	WDI
maxct	Maximum carbon tax	Tax rate multiplied by US$25/ton
minct	minimum carbon tax	Tax rate multiplied by US$3/ton
mltct	most likely carbon tax	Tax rate multiplied by US$8.5/ton
indexct	Index of carbon	Generated using principal component analysis (PCA) from the three proxies of the carbon tax (maxct, minct, mlct).
maxctrev	Maximum carbon tax revenue (log)	Maxct multiplied by CO2 emission
mlctrev	Minimum carbon tax revenue (log)	Minct multiplied by CO2 emission
minctrev	Most likely carbon tax revenue (log)	Mltct multiplied by CO2 emission
indexctrev	Index of carbon tax revenue	Generated using principal component analysis (PCA) from the three proxies of carbon tax revenue.

(Source: Authors' Compilation)

6.4 Results and Discussions

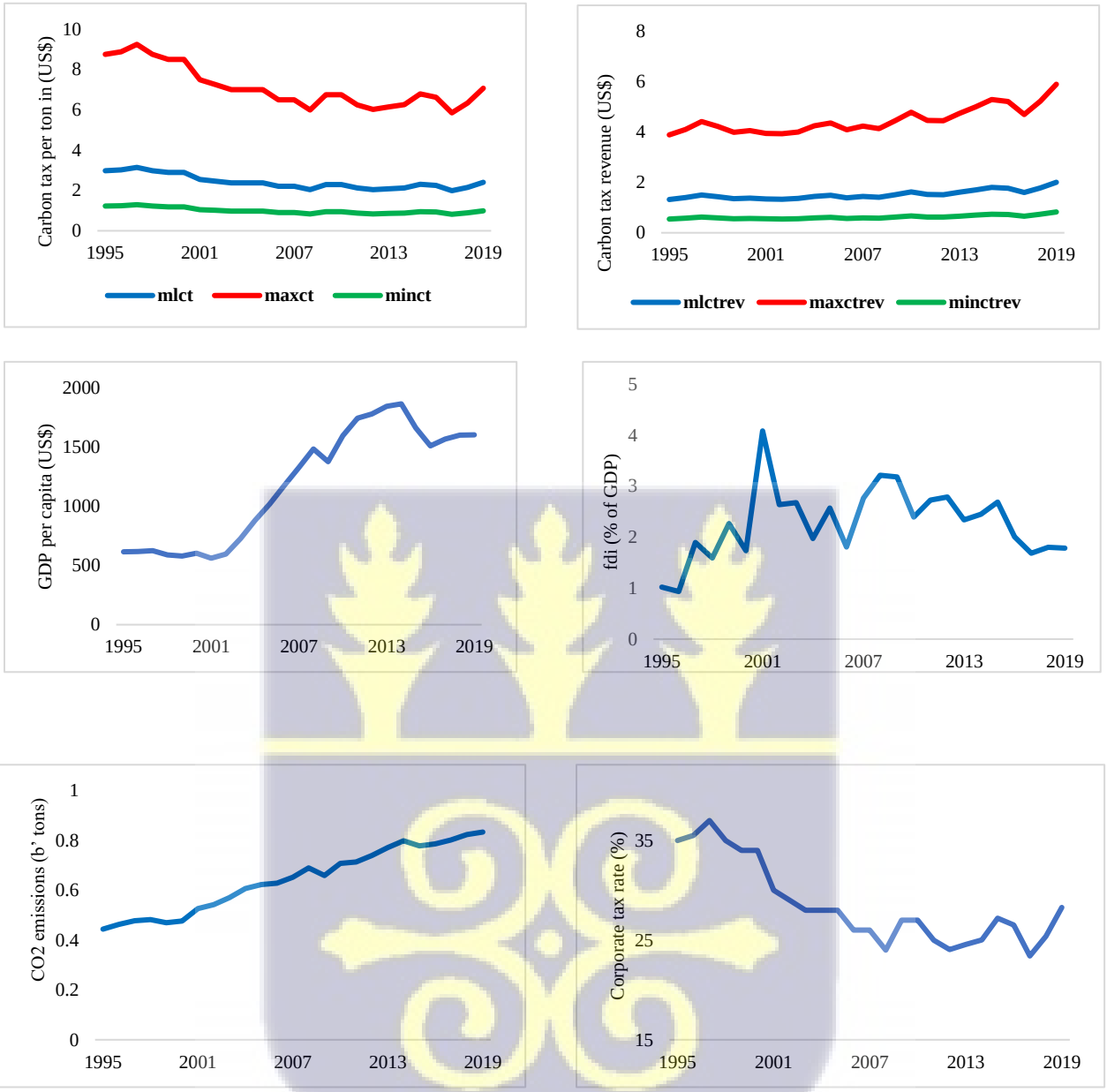
6.4.1 Summary Statistics

Estimating the empirical model in equation 6.6 with GMM requires some preliminary checks to ensure the robustness of the results. First, the residuals of the series were tested for heteroscedasticity using the Breusch-Pagan / Cook-Weisberg test. The results in Table 6.3 show

the presence of heteroscedasticity in the errors. The Levin-Lin-Chu unit-root test results in Table 6.4 on the other hand show evidence of serial correlation in the series. The effect of heteroscedasticity and serial correlation on the estimates are corrected using robust standard errors (Verbeek, 2017). The GMM approach is particularly useful to this study because the number of panel units exceeds the period (Arellano & Bonds, 1993). Also, the GMM estimation technique is robust enough to deal with the endogeneity problem which is usually associated with macroeconomic variables (FDI, GDP, trade, investment, etc.), especially when estimated with static models (Bond & Windmeijer, 2005).

But the issue of moment condition proliferation is a concern for GMM estimates. The Hansen test for overidentifying restrictions is used to validate the number of instruments employed in this study (see Table 6.5). Further, the use of lags as regressors in the GMM estimations can entrench the serial correlation problem identified by the Levin-Lin-Chu unit-root test. The study uses the Arellano and Bonds test for second-order serial correlation in the GMM estimates. The second-order autocorrelation (AR2) results presented in Table 6.5 show that the estimates are free from serial correlation.

Figure 6.1: Trends in Key Variables



Source: Authors' construct, Data from World Bank (2020).

Table 6.2: Summary Statics

Variable	Obs	Mean	Std. Dev.	Min	Max
fdi	1075	3.98	8.264	-11.625	51.824
gdp	1075	4.65	7.165	-8.392	20.973
trade	1075	1.798	0.199	1.316	2.352
edu	1075	32.613	18.26	2.767	90.544
rule	1075	2.684	0.69	1.00	4.75
inv	1075	22.239	9.734	-2.424	77.89
indexct	1075	0.9	1.732	3.52	5.878
mlct	1075	1.874	0.85	0.147	4.759
maxct	1075	5.512	2.5	0.432	13.996
minct	1075	0.441	0.2	0.035	1.12
indexctrev	1075	1.5	1.732	4.213	7.045
mlctrev	1075	8.226	1.84	3.75	14.65
maxctrev	1075	9.305	1.84	4.83	15.73
minctrev	1075	6.779	1.84	2.3	13.2

(Source: Authors' Computation)

The results from the empirical estimations are included in Tables 6.5 and 6.6. Table 6.5 examines the effect of the carbon tax and carbon tax revenue on FDI. Table 6.5 also contains the results of the model selection processes. Based on the recommendations of Bond, Hoeffler, and Temple (2001), the two-step differenced GMM shown in column (4) of Table 6.5 is selected as the most efficient model in estimating the empirical models. The lagged dependent variable l.fdi in column (4) lies in between the upper and lower bounds and also has the lowest values of the Akaike (AIC), Bayesian (BIC), and Hannan-Quinn (HQIC) as per the Andrews-Lu model and moment selection criteria. Again, the differenced GMM estimates produce efficient gains with relatively small

standard errors as compared to the results from the pooled OLS, the fixed effect, and the system GMM (Table 6.5, column 6.4).

Table 6.3: Breusch-Pagan / Cook-Weisberg test for heteroskedasticity

Dependent variable	Assumption	F.statistics	p-value
fdi	Constant variance	21.40	0.0000

(Source: Authors' Computation)

Table 6.4: Levin-Lin-Chu unit-root test

Variable	Statistics		**p-value**
	Unadjusted	Adjusted	
fdi	-14.7709	-7.2305	0.0000
gdp	-19.0461	-8.7226	0.0000
l.fdi	-14.6870	-7.3529	0.0000
l.gdp	-19.0035	-8.8871	0.0000
indexct	-0.0909	0.0385	0.4846
indexctrev	-6.7437	-3.2833	0.0005
trade	-9.1467	-1.2629	0.1033
edu	0.3144	0.3428	0.6341
rule	-7.7e+03	-8.4e+03	0.0000
inv	-9.2828	-2.1475	0.0159
mlct	0.3551	0.4739	0.6822
maxct	0.2026	0.2325	0.5919
minct	0.1567	0.1778	0.5706
mlctrev	-6.7749	-3.3206	0.0004
maxctrev	-6.7433	-3.2757	0.0005
minctrev	-6.7128	-3.2485	0.0006

(Source: Authors' Computation)

6.4.2 The effect of Carbon Tax and Carbon Tax Revenue of FDI

In Table 6.5, we proxied carbon tax with the carbon tax index generated through the principal component analysis process. This helps in assessing the singular effect of the carbon tax on FDI. In Table 6.6, the carbon tax is decomposed into three different classifications and introduced into the empirical model separately. This approach offers the opportunity to examine the impact of different carbon tax policies on FDI.

Column (4) of Table 6.5 shows that the unmitigated effect of the carbon tax on FDI is repressive. This finding is new due to the scarcity of studies in this area. However, there is compelling evidence that FDI responds negatively to the general tax environment in the host economy (Gao & Liu, 2021; Xu & Wu, 2021; Shafiq, et. al., 2021; OECD, 2008). The negative effect of taxes on FDI is the reason why FDI locate in countries with lower tax rates (Damgaard, Elkjaer, & Johannesen, 2019). It is of no surprise that the introduction of additional taxes like carbon tax can also drive away foreign investors if a tax mitigating policy is not implemented alongside. One such policy is the recycling of the carbon tax revenue into the economy. There are various channels through which carbon tax revenue can be recycled as advanced by the double dividend hypothesis (Repetto, Dower, & Geoghegan, 1992; Pearce, 1991).

But the use of carbon tax revenue to offset payroll taxes and/or corporate taxes are the two channels that stand out (Yang, Jiang, & Pan, 2020; Freire-González & Ho, 2019; Radulescu, Sinisi, et. al, 2017). The use of carbon tax revenue to reduce corporate tax will be directly beneficial to foreign investors as compared to payroll tax cuts. This insight is highlighted in our results in column (5) of Table 6.5. The effect of the carbon tax on FDI changed from negative to positive after the introduction of the carbon tax revenue into column (5). The carbon tax revenue (indexctrev) can absorb the negative shock from the carbon tax even to the extent that the tax now becomes a positive driver for FDI.

This situation intuitively makes sense because the carbon tax is a specific tax levied to regulate carbon emissions and not every firm will be obliged to pay. But if the carbon tax revenue is recycled into the economy (say through a corporate tax cut), it will benefit every firm and thereby influencing FDI positively. These findings corroborate Yang, Jiang, and Pan (2020) and Freire-González and Ho (2019) that carbon tax revenue indeed mediates the negative effect of the carbon

tax on macro variables, hence, affirming the presence of the double dividend theory. Taking the results in column (4) and (5) together minimize the fears of African economies about the carbon tax spillover on international capital. But factors such as rule of law (rule), human capital development (edu), and sustained domestic investment (inv) are crucial in ensuring that the revenue from carbon taxes is used judiciously to advert the negative effect of carbon taxes (see column 5).

Table 6.5: Effect of Carbon Tax Index and Carbon Tax Revenue Index on FDI

VARIABLES	(1) Pooled OLS: Upper Bound	(2) Fixed Effect: Lower Bound	(3) Two-Step System GMM	(4) Baseline Two-Step Difference GMM	(5) Baseline With Carbon tax revenue
l.fdi	0.471***	0.312***	0.173***	0.342***	0.344***
	(0.032)	(0.034)	(0.0495)	(0.017)	(0.0209)
indexct	-0.0767	0.0165	-3.148*	-0.377**	0.581*
	(0.0874)	(0.193)	(1.664)	(0.164)	(0.307)
gdp	0.0129	0.0195	0.171***	0.036***	0.00202
	(0.0367)	(0.0379)	(0.0501)	(0.011)	(0.0162)
trade	1.869	-2.118	28.28	-1.005	1.724
	(1.294)	(2.566)	(23.95)	(1.581)	(1.956)
edu	0.00480	0.100***	-0.101	0.0796***	0.132**
	(0.0127)	(0.0349)	(0.102)	(0.023)	(0.0595)
rule	0.514	1.121*	7.604**	1.079***	1.280***
	(0.349)	(0.643)	(3.422)	(0.268)	(0.412)
inv	0.120***	0.194***	0.202**	0.160***	0.196***
	(0.0255)	(0.0357)	(0.100)	(0.016)	(0.0207)
indexctrev					-2.893***
					(0.630)
Constant	-6.006**	-6.232	-70.00	-	-
	(2.556)	(5.684)	(48.66)	-	-
Year dummies	yes	yes	yes	yes	Yes
Observations	1,032	1,032	1,032	1,032	1,032
Number of Countries	43	43	43	43	43
Number of Intruments	-		24	24	26
R-squared	0.347	0.288	-	-	-
AR(1)	-	-	0.062	0.024	0.208
AR(2)	-	-	0.427	0.481	0.405
Hansen	-	-	0.224	0.371	0.385

Andrews-Lu model and moment selection criteria			
Akaike (AIC)	-0.0012	-0.0018	-
Bayesian (BIC)	-0.0025	-0.0033	-
Hannan-Quinn (HQIC)	-0.0017	-0.0024	-

Robust Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
(Source: Authors' Computation)

The results from the decomposition of the carbon tax into most likely (mlct), maximum (maxct), and minimum (minct) are presented in Table 6.6. The results in column (6), (8), and (10) shows that all three variants of carbon taxes significantly hurt FDI. This implies that any amount of additional taxes in the form of the carbon tax will hurt FDI. These findings again affirm the deep-rooted negative relationship between taxes and FDI.

The OECD (2021) has pointed out that Africa has the highest average corporate tax rate as compared to the rest of the world; based on the high-level corporate taxes in the region, it is only expected that foreign investment will roll back at the introduction of additional taxes. The fact that carbon tax may deter inward FDI does not imply that it should not be introduced at all. Given the devasting effect of FDI on the environment as highlighted in the past by Boachie-Yiadom and Mensah (2021), Omri et al. (2014), and Sbia et al. (2014) necessitate carbon tax to reinforce the pollute pay policy. To ensure that FDI pays for destroying the environment and at the same encourages inward FDI in the presence of carbon tax, complementary policies are needed. The results in column (7) reveal that if the most likely carbon tax of $8.5 is introduced, the carbon tax will significantly increase inward FDI.

But the positive effect running from the carbon tax can only be achieved if the revenue from the taxes is plough back into the economy. This is because, without the plough back of the carbon tax

revenue, the carbon tax will unilaterally have a significant negative effect on the FDI as shown in column (6). The recycling of the carbon tax revenue sounds almost automatic once revenue is mobilized it will surely be reinvested into the economy. But this automatic recycling assumption cannot be realistic given Africa's history with public funds. Public funds in Africa are occasioned with diversions from their original intentions (IMF, 2015). Moreover, the endemic nature of corruption in Africa and the use of taxes to service public debt will compete with the recycling of the revenue from the carbon taxes (Mensah, Bokpin, & Boachie-Yiadom, 2018).

Consequently, there is a need for a deliberate policy to ensure that the carbon tax revenue is invested in its intended purposes. However, To minimize the likelihood of this diversion, corporate tax cuts can be introduced alongside the carbon tax so that the carbon tax revenue cushions the reduction in the corporate tax. The results in Columns (9) and (11) show that carbon tax charged at either US$25/ton (maxct) or US$3/ton (minct) will not have any effect on the level of inward FDI to Africa even if the carbon tax revenue is recycled. There are two lessons from these findings. First, if the carbon tax is set either too high or too low, its relevance will not be missed. When the carbon tax is too high, it will drive away FDI and the revenue mobilized from the carbon tax revenue may not be able to make for the shortfall in the FDI.

Conversely, if the carbon tax is too low, carbon tax revenue will also be low and environmental costs from the FDI cannot be repaired by the carbon tax revenue. Second, the findings in columns (9) and (11) validate why South Africa introduced a carbon tax of $8.5/ton. The US$25/ton and the US$3/ton almost set cap and floor respectively for the fixing of the carbon tax for Africa and following the South African example seems rational given the results in Columns (7), (9), and (11).

Table 6.6: Effect of different Carbon Tax values on FDI

VARIABLES	(6) fdi	(7) fdi	(8) fdi	(9) fdi	(10) fdi	(11) Fdi
L.fdi	0.342***	0.344***	0.339***	0.348***	0.339***	0.349***
	(0.0167)	(0.0209)	(0.0166)	(0.0243)	(0.0165)	(0.0238)
mlct	-0.758**	1.192*				
	(0.333)	(0.621)				
mlctrev		-2.731***				
		(0.590)				
maxct			-0.231**	0.385		
			(0.0962)	(0.252)		
maxctrev				-2.409***		
				(0.560)		
minct					-2.828**	4.966
					(1.200)	(3.067)
minctrev						-2.442***
						(0.558)
gdp	0.0360***	0.00220	0.0373***	0.0139	0.0374***	0.0139
	(0.0105)	(0.0162)	(0.0101)	(0.0130)	(0.0101)	(0.0128)
trade	-1.037	1.719	-1.122	-0.893	-1.113	-0.992
	(1.583)	(1.954)	(1.618)	(2.105)	(1.618)	(2.118)
edu	0.0793***	0.133**	0.0810***	0.0787	0.0808***	0.0791
	(0.0228)	(0.0595)	(0.0241)	(0.0537)	(0.0241)	(0.0516)
rule	1.072***	1.279***	1.107***	1.606***	1.102***	1.605***
	(0.267)	(0.410)	(0.268)	(0.450)	(0.268)	(0.432)
inv	0.161***	0.196***	0.159***	0.203***	0.159***	0.203***
	(0.0158)	(0.0207)	(0.0154)	(0.0173)	(0.0155)	(0.0173)
Year dummies	yes	yes	yes	yes	yes	Yes
Observations	1,032	1,032	1,032	1,032	1,032	1,032
No. of Countries	43	43	43	43	43	43
No. of Intruments	25	28	28	28	28	28
AR(1)	0.098	0.082	0.112	0.115	0.158	0.163
AR(2)	0.549	0.519	0.465	0.548	0.510	0.564
Hansen	0.327	0.347	0.335	0.268	0.315	0.250

Robust Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
(Source: Authors' Computation)

6.4.3 Robustness Check

To ensure the consistency of the results, the study samples were divided into two and the objectives were reexamined with the new samples. To do this, the observations from the study were

reclassified into low and high tax regimes. Given the entrenched negative relationship between FDI and taxes, we do not expect carbon tax to behave in the same way in the two regimes. The results from this exercise are presented in Tables 6.7 and 6.8 in the Appendix. Table 6.7 contains the results of the effect of the carbon tax and carbon tax revenue on FDI among low tax regime economies. Results in columns (12), (14), (16), and (18) of Table 6.7 corroborate the findings in Table 6.5 and 6.6 that carbon tax has a significant and negative effect on FDI but if the revenue from the carbon tax is controlled for by recycling it into the economy, carbon tax begins to promote FDI [refer to column (13), (15), (17), and (19)].

Conversely, examining the effect of the carbon tax and carbon tax revenue among high tax regime economies produce contrasting results as presented in Table 6.8 in the Appendix. The negative significant effect of the carbon tax on FDI is persistent throughout columns (20), (21), (22), (23), (24), (25), and (26) of Table 6.8. These findings suggest that the negative effect of a carbon tax cannot be overturned by recycling carbon tax revenue. High tax regime economies are fragile for further taxes and the introduction of a carbon tax could be devastating to foreign investment. The post estimation checks confirm that the estimates in Tables 6.7 and 6.8 do not suffer from instrument proliferation and autocorrelation as confirmed by the Hansen test and the AR(2) test respectively.

6.5 Conclusions

This study opens the frontiers for more discussion on the effect of the carbon tax on macroeconomic indicators. We have examined the effect of carbon tax introduction on FDI in Africa. We were particularly alarmed by the slow pace of the introduction of the carbon tax in Africa. A carbon tax can deter dirty industries from polluting the environment and at the same time

generate revenue to augment public revenue. Despite these benefits, only South Africa has introduced a carbon tax across the sub-region. The lack of enthusiasm among African countries to implement carbon tax necessitated this research, perhaps, the effect of carbon tax transcends beyond the carbon emission reduction mantra. We set up the DSGE model and estimate it with the differenced GMM techniques.

The findings are that the unmitigated effect of the carbon tax on FDI is repressive. However, if the revenue from the carbon tax is controlled, the carbon tax will have a significant positive effect on FDI. We introduce three variants of a carbon tax: US$25/ton, US$8.5/ton, and US$3/ton. Our findings suggest that if the revenue generated from a carbon tax of US$8.5/ton is recycled, FDI will respond favourably to the introduction of the carbon tax. The study did not find justification for a carbon tax of US$25/ton and US$3/ton. Furthermore, as a robustness check, we use two different subsamples grouped into low and high tax regimes to retest our suspicions. We find support for the double dividend theory and that recycling carbon tax revenue mitigates the negative effect of the carbon tax on FDI among countries with low taxes. However, high-tax countries cannot overturn the negative spillover from the carbon tax to FDI.

The study recommends that carbon tax deter foreign investors but revenue from the carbon taxes can be reinvested efficiently to reduce its negative effect. Also, setting a carbon tax around the South African rate of US$8.5/ton is rational in achieving both the polluter pay policy and the double dividend policy. Meanwhile, the current study has a few limitations. The carbon tax has not been fully introduced in Africa, therefore data is a challenge. Although reasonable assumptions were made to generate the carbon tax data used in the study, future studies should consider using alternative measures of carbon taxes.

6.6 Chapter Summary

This is the empirical chapter four and has addressed the objective four of the thesis. In this chapter, we opened up the frontiers to the discussions on the implications of carbon tax introduction on the free movement of international capital. We justified the need for this chapter in the introduction section and situated it in the context of the current debate at the literature section. The estimation approach, data and choice of variables were included in the methodological section. The key takeaway from the discussion section is that the unmitigated effect of the carbon tax on FDI is repressive. However, if the revenue from the carbon tax is recycled into the economy, the carbon tax will have a significant positive effect on FDI.

6.7 Appendix

Table 6.7: Effect of Carbon Tax and Carbon Tax Revenue on FDI among Low tax regime countries

VARIABLES	(12) fdi	(13) fdi	(14) fdi	(15) fdi	(16) fdi	(17) fdi	(18) fdi	(19) fdi
L.fdi	0.379***	0.249***	0.379***	0.249***	0.379***	0.249***	0.379***	0.248***
	(0.00592)	(0.00608)	(0.00592)	(0.00601)	(0.00592)	(0.00610)	(0.00592)	(0.00613)
indexct	-0.423***	3.146***						
	(0.0898)	(0.412)						
indexctrev		-5.952***						
		(0.223)						
gdp	-0.0917***	-0.0680***	-0.0917***	-0.0679***	-0.0917***	-0.0683***	-0.0917***	-0.0677***
	(0.00650)	(0.00686)	(0.00650)	(0.00679)	(0.00650)	(0.00686)	(0.00650)	(0.00693)
trade	-3.024***	2.437***	-3.024***	2.444***	-3.024***	2.442***	-3.024***	2.423***
	(0.243)	(0.618)	(0.243)	(0.612)	(0.243)	(0.621)	(0.243)	(0.619)
edu	0.0855***	0.151***	0.0855***	0.151***	0.0855***	0.151***	0.0855***	0.151***
	(0.00296)	(0.0140)	(0.00296)	(0.0138)	(0.00296)	(0.0141)	(0.00296)	(0.0141)
rule	0.335***	1.076***	0.335***	1.078***	0.335***	1.076***	0.335***	1.075***
	(0.128)	(0.112)	(0.128)	(0.110)	(0.128)	(0.111)	(0.128)	(0.115)
inv	0.205***	0.281***	0.205***	0.281***	0.205***	0.281***	0.205***	0.282***
	(0.00585)	(0.0156)	(0.00585)	(0.0156)	(0.00585)	(0.0157)	(0.00585)	(0.0156)
mlct			-0.862***	6.406***				
			(0.183)	(0.831)				
mlctrev				-5.601***				
				(0.210)				
maxct					-0.293***	2.170***		
					(0.0622)	(0.285)		
maxctrev						-5.590***		
						(0.209)		
minct							-3.663***	27.41***
							(0.778)	(3.593)
minctrev								-5.615***
Year dummies	yes	yes	yes	yes	yes	yes	yes	yes
Observations	539	539	539	539	539	539	539	539
Number of i	35	35	35	35	35	35	35	35
No. of Intruments	29	30	29	30	29	30	29	30
AR(1)	0.267	0.266	0.267	0.267	0.267	0.266	0.267	0.266
AR(2)	0.318	0.333	0.318	0.333	0.318	0.332	0.318	0.332
Hansen	0.287	0.207	0.287	0.208	0.287	0.209	0.287	0.204

Robust Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

(Source: Authors' Computation)

Table 6.8: Effect of Carbon Tax and Carbon Tax Revenue on FDI among High tax regime countries

VARIABLES	(20) fdi	(21) fdi	(22) fdi	(23) fdi	(24) fdi	(25) fdi	(26) fdi	(27) fdi
L.fdi	0.228***	0.219***	0.228***	0.219***	0.228***	0.217***	0.228***	0.219***
	(0.00132)	(0.00581)	(0.00132)	(0.00581)	(0.00132)	(0.00347)	(0.00133)	(0.00584)
indexct	-0.903***	-0.927***						
	(0.00749)	(0.0248)						
indexctrev		0.113***						
		(0.0252)						
gdp	0.0253***	0.0303***	0.0252***	0.0302***	0.0252***	0.0320***	0.0254***	0.0304***
	(0.00319)	(0.00548)	(0.00317)	(0.00546)	(0.00317)	(0.00358)	(0.00321)	(0.00551)
trade	8.202***	7.765***	8.201***	7.763***	8.201***	7.749***	8.203***	7.768***
	(0.106)	(0.242)	(0.105)	(0.242)	(0.105)	(0.250)	(0.107)	(0.243)
edu	-0.0111***	-0.0153***	-0.0111***	-0.0153***	-0.0111***	-0.0153***	-0.0111***	-0.0152***
	(0.00206)	(0.00316)	(0.00206)	(0.00318)	(0.00206)	(0.00318)	(0.00205)	(0.00313)
rule	3.560***	3.665***	3.561***	3.665***	3.561***	3.669***	3.559***	3.665***
	(0.0305)	(0.0723)	(0.0306)	(0.0721)	(0.0306)	(0.0882)	(0.0304)	(0.0728)
inv	0.00987***	0.0103***	0.00987***	0.0103***	0.00987***	0.0104***	0.00987***	0.0103***
	(0.000276)	(0.000790)	(0.000275)	(0.000791)	(0.000275)	(0.000714)	(0.000278)	(0.000791)
mlct			-1.840***	-1.889***				
			(0.0153)	(0.0505)				
mlctrev				0.108***				
				(0.0237)				
maxct					-0.626***	-0.641***		
					(0.00520)	(0.0173)		
maxctrev						0.118***		
						(0.0122)		
minct							-7.817***	-8.027***
							(0.0646)	(0.216)
minctrev								0.105***
								(0.0238)
Year dummies	yes	yes	yes	yes	yes	yes	yes	yes
Observations	373	373	373	373	373	373	373	373
Number of i	30	30	30	30	30	30	30	30
No. of Intruments	29	30	29	30	29	30	29	30
AR(1)	0.119	0.120	0.119	0.120	0.119	0.120	0.119	0.120
AR(2)	0.273	0.282	0.273	0.282	0.273	0.288	0.273	0.282
Hansen	0.326	0.397	0.326	0.397	0.326	0.392	0.324	0.395

Robust Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

(Source: Authors' Computation)

CHAPTER SEVEN

SUMMARY, CONCLUSION AND RECOMMENDATIONS

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SUMMARY, CONCLUSION AND RECOMMENDATIONS

7.1 Introduction

This chapter presents a summary of the findings of the thesis from which conclusions are drawn. It also identifies the contributions of the thesis to knowledge. Based on the findings and conclusions, we make recommendations for policy and future academic research. Specifically, in Section 6.2 we present a summary of the findings of the study; Section 6.3 presents conclusions drawn from the findings, whilst Section 6.4 explains the contribution of the thesis to empirics, theory, methodology and practice (policy recommendations). Section 6.5 gives directions for future studies.

7.2 Summary of Findings and Conclusions

This thesis investigated the effect of foreign direct investment on environmental risk and the role played by financial sector development and tax policies in Africa.

In chapter one, the study laid the foundations for the thesis by giving a detailed background to the topic and highlighting the oversights in the existing literature. The study then justified the need for this thesis and stated the objectives, scope, limitations and structure of the thesis. In chapter two, the study discussed both the theoretical and the empirical literature and went ahead to situate the research objectives in the context of the ongoing debate in the literature.

Chapter two also provides a detailed discussion of both the theoretical and empirical literature. Also, the chapter discusses key variables in the literature. For example, the definitions, measurements and trends in key variables are included in chapter two.

In chapter three, the study examined the role of financial sector development on the relationship between FDI and environmental risk.

Chapter four on the other hand focused on the assessment of the impact of the subcomponents of financial sector development on the FDI-environment nexus. It is the firm belief of this thesis that financial access, deepening, and efficiency will react variously to the FDI-environment nexus and could offer clues as to curtailing the existing harmful effect of FDI on the environment.

Chapter five explores another neglected channel used by FDI to influence environmental outcomes – the tax policies channel. In chapter six, the study investigated the impact of carbon introduction on FDI in Africa.

In sum the thesis has used various approaches to answer the following four empirical questions:

i. What is the role of financial sector development on the relationship between FDI and environmental risk?
ii. What is the effect of the subcomponents of financial sector development on the FDI-environment nexus?
iii. Do tax policies matter in accounting for the effect of FDI on the environmental risk?
iv. What is the effect of carbon tax implementation in Africa on FDI?

Thematically, summaries of key findings from the four empirical chapters are presented here.

7.2.1 Foreign Direct Investment and Environmental Risk: the role of Financial Sector Development

In this empirical chapter, the study examined the role of financial sector development in the relationship between FDI and environmental risk by introducing a comprehensive measurement of financial sector development into the international capital and climate change debate. The relevance of this study lies in the fact that is a foremost study that places financial sector development at the center of FDI's impact on environmental outcomes. It also solved the

controversies about the appropriate measurement of financial sector development by adopting a dataset that measures financial development comprehensively. The study set up a panel dataset to cover 45 Sub-Saharan African economies from 1982 to 2018. The study applies the system GMM technique to accommodate the dynamic nature of the dataset and make provisions for endogeneity and heteroscedasticity in the series. The findings suggest that the unmitigated effect of FDI on environmental risk is detrimental.

However, FDI conditioned on the local financial sector development minimizes environmental risk. Again, the findings suggest that countries with low financial sector development indicator scores reported worse environmental risk than their counterparts. The highlight from the dynamic panel threshold analysis reveals that the level of financial sector development matters in accounting of its impact on environmental risk. Whereas low regime financial development increases environmental risk, high levels are able to reduce it. Therefore, increasing the broad-based measures of financial development is healthy for the environment.

7.2.2 Environmental Risk and Foreign Direct Investment: the role of Financial Deepening, Access and Efficiency

Foreign direct investment augments local capital to promote economic growth, especially among financially cursed economies. The growth effect of FDI is often at the cost of the environment. In this study, we employ a dynamic panel of 45 economies from 1982 to 2018 and decomposed financial development into its three key components: depth, access, and efficiency. We investigate firsthand how FDI affects the quality of the environment in the presence of the decomposed financial development indicators. By decomposing the financial sector development index into its subcomponents, the study can address which particular aspect of the financial development

indicators drive environmental risk or can mitigate the negative effect of FDI on the environment. Subsequently, this research avoids the wholesale recommendations on financial sector development in the existing literature.

Further, the low level of financial access in the sample promotes environmentally destructive activities and therefore cannot make the FDI – environment nexus any better. However, high levels of financial access have the ability to reduce environmental risk. Also, after splitting the dataset into high and low financially developed economies, we report that FDI is more environmentally depressive among low financially developed economies.

7.2.3 Environmental Risk, Foreign Direct Investment and Tax Policies: should we worry?

The economic benefits of FDI are enormous, especially to capital trap economies in Africa. To attract more FDI, countries in Africa and most parts of the world extensively use lucrative tax regimes to woo foreign investors into their economies. An array of tax incentives in the form of exemptions and low tax rates are often used to bait investors. It is therefore not surprising to have 10 countries with the most lenient tax policies hosting more than 85% of global FDI inflows. FDI does not only move towards a conducive tax climate but also targets countries with weak environmental laws.

In this study, we use empirical models to examine the main channels through which foreign direct investment escalates environmental risk. We explore whether countries with 'weak' or better still low tax rates attract 'dirty' FDI to deteriorate their environment. The analysis uses a 40-year panel to show that FDI and tax policy matter in accounting for cross-country environmental risk. Our sample finds support that the tax channel is the main medium through which FDI worsens environmental risk. By discomposing tax policy into low and high regimes, we report that

countries that deliberately reform tax policy to bait FDI have higher environmental risk. A useful lesson from here is that using tax policy to lure FDI amount to short-changing capital risk for environmental risk.

7.2.4 Assessing the impact of Carbon Tax Adoption on Foreign Direct Investment

This study opens the frontiers to the discussions on the implications of carbon tax introduction on the free movement of international capital. A carbon tax can deter dirty industries from polluting the environment and at the same time generate revenue to augment public funds. Despite these benefits, few countries have adopted carbon tax. The lack of enthusiasm among countries to implement carbon tax has necessitated this research, perhaps, the effect of carbon tax transcends beyond carbon emission reduction. This study investigates the impact of carbon tax adoption on foreign direct investment in Africa. We set up the Dynamic Stochastic General Equilibrium (DSGE) model and estimate it with the differenced GMM techniques. The findings from this exercise show that the unmitigated effect of the carbon tax on FDI is repressive.

However, if the revenue from the carbon tax is recycled into the economy, the carbon tax will have a significant positive effect on FDI. Hence, the study corroborates the double dividend theory. The findings further suggest that a carbon tax of around US$8.5/ton is reasonable to enhance inward FDI but a carbon tax either above US$25/ton or below US$3/ton will be detrimental to the African region. Also, the entrenched negative relationship between FDI and taxes is worsened if the additional carbon tax is levied among high tax regimes countries than their counterparts. The practical contribution of the study is that the negative effect of the carbon tax on foreign direct

investment can be overturned by efficiently ploughing back the carbon tax revenue into the economy.

7.3 Contributions to Knowledge

This study contributes to the literature in so many ways. Specifically, it makes critical value additions to empirical, theoretical and methodological contributions to the disciplines of economics and finance. We discuss each of these contributions below:

7.3.1 Contributions to Empirics

The thesis presents empirical evidence on the impacts of FDI on environmental risk and the roles play by two critical channels: financial sector development and tax policies in Africa. Extant studies have investigated the individual effect of FDI, financial development and tax policies on climate change. The interrelationships between these variables have been marginalized in the existing literature. This study has laid theoretical and empirical foundations for the need to study these variables together. Our study opens the frontiers to the climate change discussions by offering a broader view of interrelated factors that have long been sidestepped in the existing studies. The thesis leads the empirics in several ways.

First, the study is the foremost to argue that FDI conditioned on a well-developed financial sector can improve environmental outcomes. Empirical studies have separately examined the direct impact of financial developments and FDI on the environment. The literature assumes that FDI is distinct from the local financial system and not aided by the same to influence environmental outcomes has spewed disjointed findings and recommendations. We have connected the fragmented empirical studies by looking at the inter-linkages between FDI, financial developments

and environmental risk. Second, the study contributes to the empirics by decomposing financial sector development into subcomponents of access, depth and efficiency, and arguing that financial development is a multiplicity of factors and lamping them together leads to wholesale recommendations which leave policymakers confused as to which aspect needs critical attention. Third, the thesis contributes to the empirical knowledge of the tax policies, FDI and environmental risk. Up until this thesis, the literature has been biased toward the use of tax policies to attract more FDI argument capital accumulation.

But we have shown that FDI does not only gravitate towards favorable tax policies but also takes advantage of the same to exacerbate environmental risk. Finally, the discussion on carbon tax has been centered on its ability to cut down carbon dioxide emissions and raised additional revenue. Not too many countries are enthused about these benefits given the snail-pace of carbon tax adoption around the globe. In this thesis, we have used empirical data to show that carbon taxes may have a detrimental effect on foreign direct investment if the tax rate is not designed and used properly and the tax proceeds are not utilized efficiently. This thesis leads the way on the subjects of carbon tax effects on FDI both in the global dimensions and in the African context.

Largely, the thesis has attempted to highlight pockets of neglected areas of the various objectives of the study and has challenged conventional knowledge in the empirical literature.

7.3.2 Contributions to Theory

There are divided views on FDI spillover on environmental quality. Two strands of the debate have emerged based on two conflicting hypotheses. These are the "pollution haven hypothesis and "pollution halo hypothesis". The former suggests that firms by nature are profit-oriented and would explore every opportunity to reduce cost; hence, FDI will easily locate countries with lax

environmental standards when the need arises. The pollution halo hypothesis, on the other hand, holds the view that FDI is rather an environment enhancing since most FDI comes from developed countries with strict environmental regulations, it can transfer superior externalities to the host nation. We suspect that whether FDI enhances or deteriorates the environment is reinforced by local factors in host nations. Even if the two arguments hold in their respective circumstances, we argue that FDI tends to replicate the disposition of the host country. Thus, what matters in determining the impact of FDI on the environment is the channel(s) underpinning the receipt and deployment of FDI. Based on these arguments, the study introduced the 'Toxic Taxes, Dirty FDI Model' conceptual framework into the FDI – environment debate. This framework which is grounded on the tax haven and pollution haven hypothesis illustrate clearly how a lenient tax regime may attract more FDI inflows and the channels through which FDI influences the quality of the environment. The introduction of this model can form the basis of new thinking that can influence future studies.

Arguably, the Environmental Kuznet Curve (EKC) theory is the most referenced theory in the area of economics, finance and climate change. It argues that economic growth will eventually lead to environmental improvements. But real-time data shows that developed countries rather emit more than developing ones and there may not be any turning point as advanced by the EKC. The shortcoming of this theory is its attempt to simplify the effect of economic growth on environmental outcomes. We have shown in this study the complexity of the discussions and the interlinkages of variables that influence the quality of the environment. This thesis suggests modifications to this theory by advocating for the finance and tax channels through which environmental improvements can be achieved.

Further, this thesis contributes to the theoretical knowledge by showing the interconnections among existing theories and how they can be combined to achieve expected outcomes. For example, we have shown in this thesis that implementing a carbon tax as advanced by the polluter pays principle can deter foreign capital; however, adopting a complementary policy through the double dividend theory will ensure that the carbon tax revenue is recycled into the economy which offset the negative effects from the carbon tax.

Finally, some theories like the polluter pay principle and the double dividend theory have never been tested in Africa. Hence, this thesis leads the way in that regard.

7.3.3 Contributions to Methodology

The bane of studies on carbon tax in Africa has been the lack of data. Presently, it is only South Africa that has implemented a carbon tax in Africa; Cote d'Ivoire and Senegal are considering introducing it in the future. The carbon tax data on South Africa is also scanty because it was introduced in 2019. Therefore, the non-availability of data justifies neglect of the subject in the empirical literature. This thesis takes a bold step to overcome the data limitation by adopting a data estimation strategy to estimate carbon tax and carbon tax revenue within the confines of sound econometric assumptions. This thesis rekindles the discussion on data estimation and will aid future studies to venture into research areas where data availability is a major constraint.

The use of GMM to estimate the empirical models solves the endogeneity and heteroscedasticity problems which have bedevilled many empirical studies. The thesis almost provided a 'one-stop' study on GMM. This is because, we have shown step-by-step approaches, assumptions and tests that need to be performed before and after the adoption of the GMM estimation techniques.

Further, this study leads the way in employing the dynamic panel threshold approach to estimate the financial development thresholds and the extent to which they impact environmental risk.

7.3.4 Contributions to Practice (Policy Recommendations)

There is a policy specificity crisis in the current studies. This is because a large segment of studies has proposed improvement in institutional quality as a panacea to curbing the negative effect of FDI on the environment. The definition of institutional policy in the existing studies covers administrative governance, rule of law, fiscal and monetary discipline, voice and accountability, among others. Placing all these variables into one basket and prescribing institutional quality as a solution to the FDI – environmental quality debacle leaves policymakers in a dilemma, as to which aspect of the institution influence the nexus. This study which is part of the broad institutional literature settles the confusion by offering specific policy interventions in containing the harmful effect of FDI on the quality of the environment. We have advanced the tax policy and financial sector developments as the key institutional variables that can offset the negative impact of FDI on the environment.

Additionally, the significance of the study lies in the value it contributes to the literature on the carbon tax, because to the best of the authors' knowledge, it is the first to examine the implications of carbon taxes on FDI, more especially in the African context. The findings from this study show different rates of carbon taxes and their effect on FDI. The recommendations from this exercise will serve as a guide to policymakers in determining the appropriate carbon tax that could maximize inward FDI and at the same time mitigate the negative effect of FDI on the environment.

The financial development aspect of the study also provides guidelines to investors as to the direction of funding. This is helpful to investors and the government in identifying funding

concentration and the need to create an enabling environment in green energy sectors to be financially attractive to investors.

Finally, the relevance of the study lies in its timeliness due to the urgency of climate change. As national and international leaders solicit new ideas to contain climate change and mitigate its negative effect on lives and properties, the timing of this study could not have been better than now. To facilitate climate actions and mitigations, the authors have carefully explored the channels through which FDI influences the environment and propose measures to improve the effect of FDI on the environment.

7.4 Suggested Areas for Further Research

The study explores the role of financial sector development and tax policies in the relationship between FDI and environmental risk in Africa. Data availability of the tax policy variables is a key issue within this study. The data problem makes it difficult to find a standard environmental tax variable which is uniform across Africa. The authors resort to the corporate tax rate and assume that any specific environmental tax may mimic the nature of corporate tax existing in the resident country. The authors acknowledge that although the corporate tax rate is not originally designed to regulate the effect of FDI on the environment, it can be the closest proxy given the current circumstance. Since corporate tax is used to attract inward FDI, it can also be used to direct FDI into sectors that either worsen or improve environmental quality. Future studies may explore other forms of variables to measure tax policies.

Further, another challenge for this study is the non-availability of data on carbon taxes in Africa. South Africa is the only country in Africa that has implemented a carbon tax as of the close of 2021. This makes it difficult to conduct a study in this area. However, the authors overcome this

challenge by constructing three different carbon taxes based on sound financial and economic assumptions. We acknowledge that future studies should explore alternative assumptions in estimating carbon tax.

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