UNIVERSITY OF CAPE COAST

ENVIRONMENTAL POLICY EFFECTIVENESS AND INDUSTRIALIZATION

SOLOMON HOPE AGBESI

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BY

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

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DECLARATION

Candidate's Declaration

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

Candidate's Signature………………………………… Date 5/2/2024……………….

Name: Solomon Hope Agbesi

Supervisor's Declaration

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

Supervisor's signature…………………………...... Date ……………….

Name: Dr William Godfred Cantah

ABSTRACT

The thesis delved into the non-linear relationship between Environmental Policy Effectiveness (EPE) and industrialization in low- and middle-income countries. The study used a dataset of 104 countries in Asia, Latin America & the Caribbean and Sub-Saharan Africa spanning 19 years and uncovers a significant negative linear association between EPE and industrialization (except for Sub-Saharan Africa, where early positive impacts result from emerging environmental regulations) until an EPE threshold of 36.2 is reached. Beyond this threshold, countries experience positive influences from stringent environmental policies (with increases in EPE having a negative impact on industrialization in SSA), validating the Porter Hypothesis. Furthermore, the study establishes the pivotal role of regulatory quality, revealing its moderating effect on reducing the adverse consequences of EPE, particularly evident in Asia but constrained in Latin America & the Caribbean and Sub-Saharan Africa due to historical economic-biased policies within regulatory frameworks. The findings emphasize the need for tailored regional policies, institutional reforms prioritizing environmental quality, international collaboration for knowledge-sharing, and capacity-building to manage environmental challenges while fostering industrial growth.

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DEDICATION

To my family

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

CO_2	Carbon Dioxide
EKC	Environmental Kuznets Curve
EPI	Environmental Performance Index
EPE	Environmental Policy Effectiveness
ERC	Emission Reduction Credits
FD	Financial Development
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
GNI	Gross National Income
GHG	Green House Gases
GMM	Generalized Method of Moments
GTFP	Green Total Factor Productivity
HDI	Human Development Index
IMF	International Monetary Fund
IND	Industrialization
IoT	Internet of Things
ISI	Import Substitution Industrialization
ISIC	International standard industrial classification
LAC	Latin America & The Caribbean
No_x	Nitrogen Oxide
OLS	Ordinary Least Squares
PHH	Pollution Haven Hypothesis
REER	Real Effective Exchange Rate
RQ	Regulatory Quality
SO_2	Sulfur Dioxide
SSA	Sub-Saharan Africa
TO	Trade Openness
WDI	World Development Indicators
WGI	World Governance Indicators

KEYWORDS

Effectiveness

Environmental Policy

Industrialization

Regulatory Quality

Developing Countries

CHAPTER ONE

INTRODUCTION

Introduction

This chapter provides the background and problem statement of the study. It outlines the purpose, specific objectives, hypotheses, and significance of the research. Additionally, it addresses the scope and limitations of the study. The chapter concludes with an overview of the organization of the subsequent chapters.

Background to the Study

Since the 18th century Industrial Revolution, industrialization has been recognized as a critical driver of economic development worldwide (Ferreira, Pessôa, & Dos Santos, 2016). According to Chang et al. (2017), with few exceptions like oil-rich countries and specialized financial zones, no nation has achieved sustained growth, development, or high living standards without significant advancements in its industrial sector. Industrialization is believed to boost economic growth by shifting resources toward more productive manufacturing activities. As a result, a country's economy transitions from being primarily agricultural to one dominated by industrial and manufacturing sectors (Kapás, 2008).

Kaldor (1967) analyzed the significant influence of industrial sector on economic growth. Kaldor highlighted the sector's unique role in driving growth, citing its high productivity, strong linkage effects, and the resulting demand, which promotes job creation and faster production growth. The manufacturing sector is seen as having greater potential for productivity improvements compared to agriculture and certain services, due its to capital accumulation ability, achievement of economies of scale and technological advancement (Szirmai, 2013). Kaldor's growth theory supports the idea that increased output in manufacturing leads to enhanced economic growth.

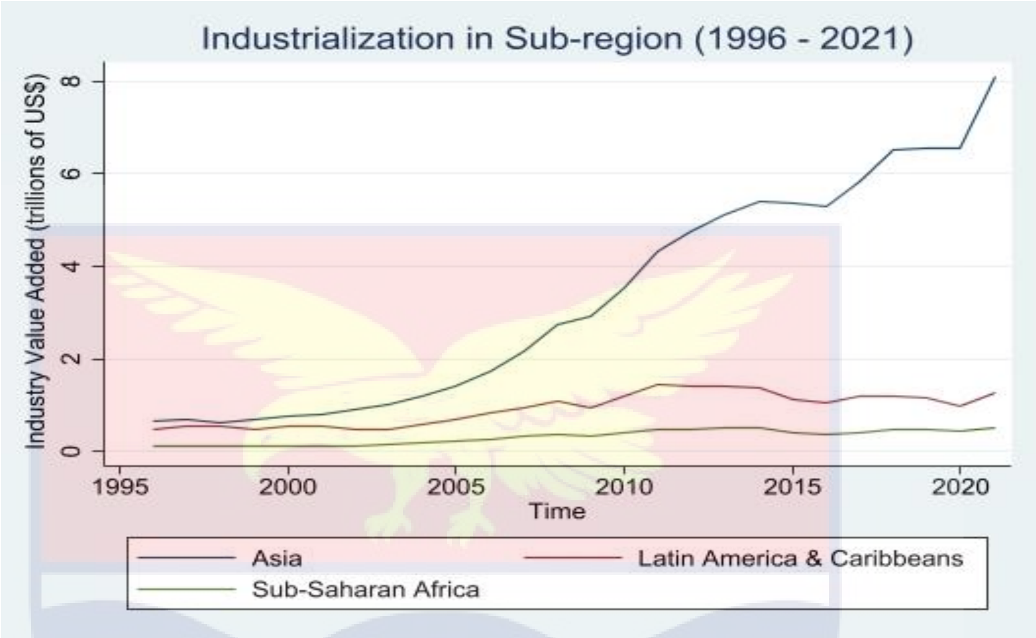

Figure 1: Trend of Industrialization in Sub-Regions (1996 -2021)

Figures 1 and 2 show the upward trend of industrialization and Gross National Income in the three Sub-regions. Studies indicate the critical role of industrialization to poverty reduction in developing countries which is also implied by the figures. Industrialization creates employment opportunities, particularly in manufacturing sectors, which frequently pay more than those in other industries, increasing household earnings. This increase in income has a direct impact on GNI, and efforts towards the elimination of poverty (Alcorta, 2015). Industrialization also promotes innovation and technical breakthroughs, which boost output and efficiency in manufacturing processes. This increase in productivity raises the general level of income among the individuals and reduces poverty (Manivannan et al., 2019).

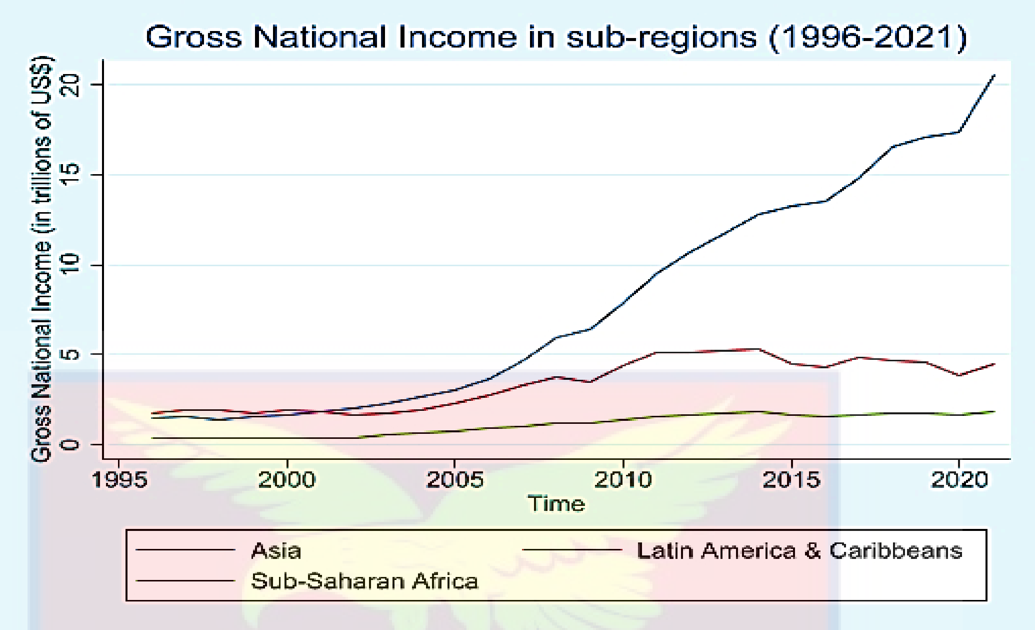

Figure 2: Trend of Gross National Income in Sub-Regions (1996 -2021)

However, there were few and reluctant steps toward industrialization in developing countries in the incipient phases of industrial revolution. Industrialization began to take off during the end of the nineteenth century in major Asian nations like India and China, and Latin American nations like Brazil, Argentina, Chile, and Mexico (Basu & Miroshnik, 2016). As shown in Figure 1, the low trend of industrialisation witnessed in SSA is because agriculture and mining are the core sources of income in developing world (Duran, Musacchio & Paolera, 2017). Over the years, persistent low incomes from agriculture and the focus on primary raw materials have resulted in marginal gains in poverty reduction in SSA.

To overturn the vicious cycle of poverty and proceed towards fulfilling Sustainable Development Goal One, which aims to eliminate poverty in all its forms by 2030, developing countries need a big push industrialization agenda. According to relative backwardness hypothesis, low-income nations can achieve a high productivity growth rate because the adoption of advanced technologies is often easier and more cost-effective than innovation in comparison to technologically advanced countries. (Barcenilla et al., 2019; Kang, 2000). This also also aligns with the convergence theory, which posits that poorer economies tend to grow more quickly over time and eventually catch up with the income levels of richer economies thus, marginal returns on investment are larger in developing economies (Quiroga, 2007).

As these countries increase their capital stock and invest in new technologies, the returns on each additional unit of investment become more significant, leading to faster growth rates (Haraguchi et al., 2017). Ahmad and Naz (2000) and Bahmani-Oskooee et al. (2018) found cases where countries such as Japan, Germany, Holland, Korea, Hong Kong, and Singapore have experienced catching-up post second world war period.

Although industrialization has greatly contributed to economic growth, development, and poverty alleviation in numerous countries, its negative environmental consequences have become increasingly evident. A major concern is its role in exacerbating climate change through the release of greenhouse gases (GHGs). As industrial activities expand, they lead to environmental degradation and increase the susceptibility of nations to natural disasters (Lin & Li, 2020). Carbon dioxide (CO2) is the prime GHG driving climate change, with its emissions largely coming from the combustion of fossil fuels like coal, oil, and natural gas for energy, transportation, and industrial applications. (United Nations, 2020). Additionally, factories generate pollutants that worsen climatic changes and damage the environment and. For example, Sun et al. (2016) establishes that some industrial processes release pollutants that contribute to air pollution, such as Sulfur Dioxide (SO_2), Nitrogen Oxides (NOx) and Carbon Dioxide (CO_2). These pollutants have both immediate and long-run effects on air quality and contribute to climate change.

Protecting the environment requires a necessary switch to cleaner, more sustainable methods in the industrialization process to address the effects of industrialization on climate change. This entails establishing stringent environmental policies to protect the environment, supporting sustainable land use, deploying renewable energy sources, enhancing energy efficiency, and making investments in green technologies and innovation (Satria, 2020). The Paris Agreement and other forms of international cooperation and agreements encourage nations to cut emissions and move toward low-carbon futures, which is an important way to mitigate climate change. This creates a dilemma for developing countries as they have to choose to either industrialize using dirty fuel to gravitate towards achieving sustainable development goal one, as was previously done by current industrialized nations, or protect the environment as stipulated by sustainable development goal 13.

The latter may initially slow the industrialization agenda because they do not have the requisite resources to invest in technologies that reduce emissions in a cost-effective manner (Chang et al., 2017). There is, therefore, the need to find a balance between the industrialization and environmental protection agenda. This balance can be achieved by effectively implementing environmental policies while pursuing the industrialisation goal. As operationalized in the study, Environmental Policy Effectiveness (EPE), is an environmental performance index - a score developed by Yale University. It assesses how well nations perform regarding environmental protection policies and how effectively they implement them.

According to Chang and Hao (2017), the EPE indicators evaluate how close a country is to achieving –a specified policy objective using a "proximity-to-target" methodology. The objective is usually a high-performance standard, primarily established by national or international policy objectives or accepted scientific thresholds. Simple arithmetic method is used to convert scores to a scale of 0-100, with 0 representing the country's worst value and 100 representing the country's best observed value (Chang & Hao, 2017). Although EPE is ideal for environment protection, it can affect the industrialization agenda of developing nations either positively or negatively. A stringent implementation can slow down the industrialisation effort due to cost of compliance or promote it over time due to innovation. That is, initially, incremental changes in EPE lead to significant industrialization gains or loss, but beyond a certain point, further increases in EPE might result in decrease or increase industrial growth.

Furthermore, regulatory quality, an essential governance indicator, is very crucial to the success of environmental policies. The quality of regulations is a key factor that greatly influence the effectiveness of environmental policies. Jagodzińska (2019) asserts that the implementation of diverse environmental measures, such as emission limits, waste management regulations, and conservation initiatives, is heavily dependent on a functional regulatory framework. When these regulatory systems are designed transparently, they tend to be more successful in achieving their objectives. This encourages industries, businesses, and individuals to comply with these regulations leading to protection for the environment (Billon et al., 2021; Marquis et al., 2011).

Moreover, by minimizing the risks of corruption or bias, industries are more likely to follow these regulations, which promote fairness in matters and attract investments. When citizens have confidence that regulations will be applied fairly, they become actively involved in shaping policies and monitoring their implementation. The transparent decision-making processes facilitated by standards foster accountability among policymakers and regulatory bodies while aligning environmental policies with sustainable development goals and public welfare. These factors play central part in moderating the negative effect of EPE on industrialization They may also promote innovation and investment in environmentally friendly technologies amongst firms to facilitate industrialization.

Statement of Problem

Studies by Yuan and Zhang (2017) and Jiang et al. (2019), indicates that effective environmental policies can support industrialization. However, contrasting findings from other studies (e.g., Satria, 2020; Yang et al., 2020; Peng et al., 2020; Chong et al., 2016; Raheem & Ogebe, 2017; and Adedoyin et al., 2021) suggests the implementation of stringent environmental policies, while increasing policy effectiveness, may hinder the industrialization efforts of developing nations. Given these mixed findings, an important question emerges: Does environmental policy effectiveness (EPE) follow a non-linear relationship with industrialization in developing countries, akin to the Environmental Kuznets Curve? Specifically, can EPE initially impede industrialization but later enhance it after surpassing a certain threshold? This potentially crucial non-linear relationship has not yet been thoroughly investigated from the perspective of low- and middle-income countries, which highlights the importance to explore the non-linear effects of EPE on industrialization in these regions.

Chang and Hao (2017) studied the connection between environmental performance, corruption, and economic growth, utilizing data from 87 countries spanning the years 2002 to 2012. The study made use of the EPI study data set used in this study. It found that environmental performance is positively affects economic growth in these countries. The study found that corruption weakened the positive impact of environmental performance on economic growth. Nevertheless, it overlooked the non-linear impact of environmental policy effectiveness (EPE) on the industrial sector, a critical consideration for developing countries. Examining this non-linear relationship could identify the threshold at which EPE either fosters or hinders industrialization in these nations. Additionally, the study failed to account for regional variations, which may affect the EPE-industrialization relationship. Disaggregating the effects by sub-region would allow for more tailored policy recommendations that align with the unique characteristics of each region.

Finally, the role of regulatory quality was not explored in this research. Hence the current study, relying on Sustainable Development Goals 1, 9, and 13, seeks to fill these gaps by explore the non-linear effect of EPE on industrialization in low and middle-income developing countries, specifically in Sub-Saharan Africa (SSA), Latin America and the Caribbean (LAC), and Asia. Furthermore, this research will assess whether regulatory quality plays a moderating role in facilitating faster achievement of the EPE threshold.

The study incorporates updated data, to provide policy recommendations tailored to the characteristics of different sub-regions, thereby contributing to the ongoing discourse on balancing environmental sustainability with industrial growth in developing countries.

Purpose of the Study

The current study seeks to examine the effect of environmental policy effectiveness on industrialization in low – and middle-income countries.

Objectives of the Study

Specifically, the research;

1. investigates the linear effect of environmental policy effectiveness on industrialization in low – and middle-income countries.
2. assesses the non-linear effect of environmental policy effectiveness on industrialization in low – and middle-income countries.
3. evaluate the role of Regulatory Quality in the relationship between environmental policy effectiveness and industrialization in low – and middle-income countries.

Hypotheses of the Study

Hypothesis 1

H_0: Environmental Policy Effectiveness does not have a significant linear effect on industrialization in low – and middle-income countries.

H_1: Environmental Policy Effectiveness has a significant linear effect on industrialization in low – and middle-income countries.

Hypothesis 2

H_0: There is no significant non-linear relationship between Environmental Policy Effectiveness and industrialization in low – and middle-income countries.

H_1: There is a significant non-linear relationship between Environmental Policy Effectiveness and industrialization in low – and middle-income countries.

Hypothesis 3

H_0: Regulatory quality does not moderate the relationship between environmental policy effectiveness and industrialization in low – and middle-income countries.

H_1: Regulatory quality moderates the relationship between environmental policy effectiveness and industrialization in low – and middle-income countries.

Significance of Study

The study gives an insight on the threshold beyond which environmental policy effectiveness hampers/promotes industrialization in developing countries in Asia, Latin America, the Caribbean and Sub-Saharan Africa. It also provides recommendations on the essence of regulatory quality in promoting the positive effects of environmental policy effectiveness on industrialization in developing countries.

Scope

The study covers a period of 2002 to 2020. Data used cover 104 developing countries drawn from Asia, Latin America and the Caribbean and Sub-Saharan Africa which are considered developing (low- and middle-income countries as classified by the world bank). The countries in the study include: Angola, Antigua and Barbuda, Argentina, Bahamas, Bangladesh, Barbados, Belize, Benin, Bhutan, Bolivia, Botswana, Brazil, Brunei Darussalam, Burkina Faso, Burundi, Cabo Verde, Cambodia, Cameroon, Central African Republic, Chad, Chile, China, Colombia, Comoros, Democratic Republic of Congo, Republic of Congo, Costa Rica, Cote d'Ivoire, Djibouti, Dominica, Dominican Republic, Ecuador, El Salvador, Republic of Equatorial Guinea, Eritrea, Eswatini, Ethiopia, Fiji, Gabon, Gambia, Ghana, Grenada, Guatemala, Guinea, Guinea-Bissau, Guyana, Haiti, Honduras, India, Indonesia, Jamaica, Japan, Kenya, Kiribati, Laos, Lesotho, Liberia, Madagascar, Malawi, Malaysia, Maldives, Mali, Marshall Islands, Mauritania, Mauritius, Mexico, Micronesia, Mongolia, Mozambique, Myanmar, Namibia, Nepal, Nicaragua, Niger, Nigeria, Pakistan, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Rwanda, Samoa, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Singapore, Solomon Islands, South Africa, Sri Lanka, Suriname, Tanzania, Thailand, Timor-Leste, Togo, Tonga, Trinidad and Tobago, Uganda, Uruguay, Vanuatu, Venezuela, Viet Nam and Zambia.

Limitations

The main limitation of the study is the availability of data for current years thus 2021 and 2022. The study did not include these years because data on the variables of interest were not readily available. Also, data on Real Effective Exchange Rate was also not up to date; hence, reducing our data points.

Additionally, due to the small number of countries within each region, the fixed effects model was used instead of the system GMM for regional analysis. A system GMM would have produced more instruments than groups, potentially leading to unreliable estimates, as indicated by the Sargan test for overidentifying restrictions consistently producing a p-value of 1.

Another limitation of this study is the decision to combine Latin America and the Caribbean into a single region for analysis, necessitated by the requirements of the system Generalized Method of Moments (GMM) approach. The small number of countries in each sub-region individually would have led to an insufficient number of groups compared to instruments, potentially causing overfitting and unreliable results. While this aggregation provides the statistical power needed for effective analysis, it may obscure important differences between the two sub-regions, which can have distinct economic structures, industrialization stages, and environmental policies. Consequently, the conclusions may not fully capture the unique dynamics of each sub-region.

Lastly, the explicit exclusion of key drivers of industrialization such infrastructure and technology could be a limitation. However, factors like Foreign Direct Investment, Gross Domestic Product, and Financial Development may indirectly reflect these elements.

Organization of the Study

The study is divided into five chapters. Chapter One details the background, problem statement and objectives as well as significance, scope, limitations, and organization of the study. Chapter Two contains the literature review which is subdivided into theoretical and empirical literature reviews as well as the conceptual framework. Chapter Three has the research design, the source of data, theoretical and empirical model specifications, measurement and justification of variables and model diagnostics. Chapter Four presents and discusses the findings and lastly, Chapter Five contains the conclusion, recommendations, and suggestions for further studies.

CHAPTER TWO

LITERATURE REVIEW

Introduction

This chapter consists of the theoretical and empirical literature review relevant to this study. The theoretical literature considers the various theories underpinning the relationship between environmental policy effectiveness and industrialization and moderating role of regulatory quality while the empirical section reviews existing studies that are related to environmental policy effectiveness, industrialization and regulatory quality, as well as other determinants of industrialization. The chapter also has a conceptual underpinning of the study.

Theoretical review

The Environmental Kuznets Curve

The Environmental Kuznets Curve (EKC) is a theoretical model that describes the relationship between economic growth and environmental degradation. This theory posits that as a nation experiences growth, environmental quality initially deteriorates. However, after reaching a certain threshold of economic development, society begins to mend its relationship with the environment, ultimately leading to a decline in environmental degradation (Grossman & Krueger, 1991). It suggests that economic growth can be conducive to environmental improvement after a certain threshold.

The EKC theory can be traced to the pioneering work of Simon Kuznets in the 1950s. Kuznets initially developed the concept to elucidate the inverse U-shaped relationship between income inequality and economic growth (Kuznets, 1955). Over time, researchers adapted and expanded this framework to explore its relevance in the context of environmental dynamics. The EKC theory has been subjected to rigorous empirical scrutiny through numerous studies employing real-world data. Researchers have investigated the theory across various pollutants and geographical regions, yielding divergent outcomes (Stern et al., 1996).

The EKC theory holds significant implications for understanding the dynamics of environmental policy effectiveness (EPE) and industrialization. While the theory itself primarily focuses on the relationship between economic growth and environmental quality, it indirectly underscores the importance of targeted environmental policy effectiveness and its consequences for industrialization.

The Environmental Kuznets Curve (EKC) theory is pertinent to this study as it elucidates the non-linear relationship between Environmental Policy Effectiveness (EPE) and industrialization. During the early stages of economic development, efforts to enhance environmental quality (reflected in increases in EPE) tend to hinder industrialization. This is because nascent industries often lack the resources to comply with stringent environmental policies without compromising their growth. However, as economic development progresses, firms acquire the necessary financial resources to invest in environmentally friendly technologies and machinery. Consequently, increases in EPE begin to support industrialization. This forms a U-shaped EKC relationship between EPE and industrialization, where initial increases in EPE are detrimental to industrial growth, but beyond a certain threshold, they become beneficial (Stern et al., 1996).

Certain countries, such as the United States, have traversed the EKC curve concerning specific pollutants (Shahbaz & Sinha, 2019). Notable policies like the

Clean Air Act and Clean Water Act have played pivotal roles in enhancing environmental quality. In contemporary discussions, the pressing need to address global environmental challenges, such as climate change, presents formidable obstacles to the conventional EKC framework (Stern, 2004). These challenges may necessitate more proactive and assertive policies, potentially deviating from traditional EKC dynamics. The critics of the EKC assert that this relationship is not universally applicable, and economic growth does not guarantee an automatic environmental upswing (Kahia et al., 2020; Koc & Bulus, 2020).

The Porter Hypothesis theory

The Porter Hypothesis, originally formulated by Michael Porter in 1991, introduces a transformative perspective on the interaction between environmental policies and industrial practices. This economic theory posits that stringent environmental regulations can serve as catalysts for efficiency improvements and innovation, ultimately amplifying a firm's competitive prowess (Porter, 1991). While the hypothesis primarily centres on competitiveness, it is indirectly insightful in providing an understanding of the role of effective environmental policies in mitigating the environmental ramifications of industrialization.

In situations where industries are undergoing the transition towards sustainability while contending with strict environmental regulations, the hypothesis expounds the ways in which firms adapt and innovate. Their goal is not only to comply with regulations but also to enhance their competitiveness (Hermundsdottir & Aspelund, 2021). The implications for industrialization are profound, as the theory explains that firms can prosper economically while simultaneously contributing to sustainable industrial practices under the guidance of effective environmental policies (Porter & van der Linde, 1995).

An important mechanism that firms employ to innovate is to allocate resources to research and development, aiming to devise cleaner technologies and more sustainable production processes (Lopes et al., 2022). These proactive responses to effective environmental policies generate incentives for innovation, paving the path for industrialization characterized by a diminished environmental footprint (Mulaessa & Lin, 2021; Ryszko, 2016). As firms adapt to meet stringent environmental standards, the evaluation of policy effectiveness extends beyond immediate compliance to encompass the enduring transformation of industrial processes (Efobi et al., 2018; Testa et al., 2011). The Porter hypothesis may depend on government policies and regulations, level of standards enforcement, and the prevailing conditions of the market.

Pollution Haven Hypothesis (PHH)

The pollution haven hypothesis, first proposed by J. Peter Neary in 1995, suggests that multinational firms tend to operate in countries with less rigorous environmental regulations because they want to save cost of production. Hence, nations with stricter environmental standards may hamper their industrial progress that emanate from foreign direct investment (Copeland & Taylor, 1994).

The theory emerged in an era characterized by significant globalization, where multinational corporations expanded their reach across borders. This period witnessed a heightened mobility of capital and industries, which laid the groundwork for the PHH's formulation (Hoffman, 2018). Numerous studies have explored the PHH, yielding varying empirical evidence. Some research has supported the hypothesis, indicating that stringent environmental regulations can negatively impact a country's foreign direct investment (FDI), particularly in pollution-intensive industries when measured by employment levels (Levinson &

Taylor, 2008). However, complexities arise when examining the influence of neighbouring nations' environmental regulations on trade flows, as these effects may not always align with PHH predictions (Antweiler et al., 2001).

The central premise of the Pollution Haven Hypothesis (PHH) establishes a vital link to the broader theme of the Effect of Environmental Policy Effectiveness on Industrialization. Dechezleprêtre and Sato (2017) contends that stringent environmental regulations in industrialized nations can compel companies to seek locations with less robust regulations. When environmental policies are highly effective and strict, firms may grapple with compliance costs, prompting them to explore alternative locations. This hypothesis is in line with the adverse side of the Environmental Kuznets Curve (EKC) within this context. It suggests that higher levels of EPE lead to a reduction in industrialization.

Empirical Literature

The Industrial Revolution

Etymologically, the phrase "Industrial Revolution" was first used by French envoy Louis-Guillaume Otto in July 1799 to declare that France had joined the race to industrialize (Teich & Porter, 1996). The first wave started in Great Britain in the late 18th century. This wave relied heavily on the invention of new machinery and the adoption of mechanized production techniques. James Watt's development of the steam engine in the 1760s improved transportation and energy production, laying the groundwork for the widespread use of steam-powered equipment (Mokyr, 2009). This discovery was followed by numerous other inventions, such as the spinning jenny, power loom, and steam-powered trains, which revolutionized sectors like transportation and textile industry (Crafts, 2004).

Transportation, agriculture, and the petroleum industry all saw significant transformations during the Second Industrial Revolution. The introduction of the internal combustion engine to the transportation and manufacturing sectors greatly improved efficiency and productivity levels (Hounshell, 1984; Smil, 2004). It also saw heavy industries and infrastructure expansion, with steel production revolutionizing steelmaking through the Bessemer and open-hearth processes. The third industrial revolution, which began in the latter half of the 20th century, changed global industrialization by utilizing computer technology, automation, and digitalization (Brynjolfsson & McAfee, 2014). During this evolution, there was a combination of digital and computer technology, which improved accuracy, effectiveness, and productivity in the manufacturing sector. Telecommunications underwent a transformation throughout the industrial age, allowing for quicker, more dependable networks, seamless information sharing, worldwide supply chains, and transnational commercial operations (Brynjolfsson & McAfee, 2014).

The Fourth Industrial Revolution, also known as Industry 4.0, represents a significant leap in global industrial progress, underpinned by digital technology and automation (Schwab, 2017). It is characterized by the convergence of cutting-edge technologies, including artificial intelligence, robotics, big data, and the Internet of Things, resulting in transformative changes for both industries and societies. The Internet of Things (IoT) fosters smart and interconnected systems like smart factories and cities, connecting real-world devices to the internet for data sharing and process automation (Manyika et al., 2017). It integrates robotics, bringing about increased productivity and efficiency across diverse sectors such as healthcare, finance, and manufacturing promoting the evolution of supply chains, e-commerce, and the emergence of novel business models (Schwab, 2016).

Industrialization in Asia, Latin America, and Sub-Saharan Africa

Asia

Globalization and foreign direct investment (FDI) have played a crucial role in driving industrialization in Asia. According to Rodrik (2018), these factors are pivotal catalysts in this process. The study shows that Asia's strong integration into global value chains has been a transformative force, leading to significant industrial growth in the region. Significant investments in education and skill development, particularly in countries like China and India, have fostered a highly competitive workforce (Lall, 2020). However, this rapid industrialization in Asia faces challenges related to income inequality and labor rights as well as creating substantial environmental concerns (Kaplinsky, 2018)

Industrialization in Asia has significantly influenced the environment, primarily in terms of environmental degradation, particularly through increased carbon dioxide emissions (Ahmed et al., 2022; Zafar et al., 2020). The relationship varies across different regions of Asia, but overall, industrialization has been observed to have a positive impact on carbon dioxide emissions in the long term (Kim, 2006). Moreover, the rapid economic development in East Asia has brought about various environmental stresses and threats, including transboundary air pollution, water shortages, and deforestation. Studies on the impact of industrial growth, urbanization, and demographic changes on environmental quality in South Asian countries have shown a negative impact on environmental indicators such as CO_2 emissions and ecological footprints (Khan et al., 2021).

Latin America and the Caribbean

In Latin America & The Caribbean, the drivers of industrialization encompass political stability and governance, which have effectively attracted foreign investment. Findings from Tuman (2009) revealed that political stability and governance are critical determinants for encouraging foreign investment and, consequently, fostering industrialization in Latin America. Additionally, export-oriented growth, particularly pronounced in resource-rich nations, has significantly contributed to the region's industrial advancement (Schurman, 2001). Nevertheless, Latin America faces a set of formidable challenges in its industrialization journey. These include the prevalence of labor market informality and the presence of weak institutions that hinder the full realization of its industrial potential (Santarcángelo & Padín, 2019). The region’s dependence on the external sector makes its industrial sector highly vulnerable to external shocks (Huerta González, 2018).

Sub-Saharan Africa

In the mid-20th century, Sub-Saharan Africa embarked on industrialization efforts as a response to the wave of independence and decolonization. Many nations aimed to industrialize their economies to achieve economic independence and reduce their reliance on exporting basic commodities. The region depends on the agricultural sector as a driver of industrial growth. Naudé et al. (2018) asserts that by creating value chains, generating employment, and fostering economic diversification, agribusiness emerges as a crucial instrument for advancing industrialization in Sub-Saharan Africa. Sub-Saharan Africa adopted import-substitution industrialization (ISI) strategies during the 1960s and 1970s, with the goal of nurturing domestic industries and decreasing dependence on imports

(Oyelaran-Oyeyinka & McCormick, 2007). Governments implemented protectionist policies, established state-owned enterprises, and provided incentives to promote industrial sector growth (Austin, 2008).

However, the region faced numerous challenges, including inadequate infrastructure, a lack of skilled human resources, and unstable governance systems (Lall, 2004). Other challenges include structural constraints like infrastructure deficits and restricted technology access, as identified by McMillan and Rodrik's 2011 research. The findings of McMillan and Rodrik (2011) showed that overcoming infrastructure deficits, enhancing technology access, and developing human capital are critical policy imperatives for promoting industrialization in the region.

Environment Policy Effectiveness and Industrialization

Industrialization involves the transformation of economies from primarily agrarian-based systems to those dominated by industrial activity. This process is characterized by increased production capacity, technological advancements, and significant shifts in economic structures (Franck & Galor, 2021)

The harmful impact of industrialization on the environmental is well-documented in literature. Industrialization typically leads to increased environmental degradation through higher energy consumption, elevated greenhouse gas emissions, deforestation, and habitat destruction (Gyamfi et al., 2021; Sani et al., 2020). Studies have shown a healthy link between industrial expansion and decline in air and water quality in rapidly industrializing countries like India and China (Zhang et al., 2011; Vennemo et al., 2009; Hu et al., 2013). Moreover, studies highlight positive interactions between industrialization and environmental quality. For instance, Cui and Wang (2022) observed that industrial growth can contribute to economic advancement, which may eventually benefit environmental outcomes. Chen et al. (2020) argue that industrial agglomeration can reduce pollution and enhance ecological efficiency once it surpasses a certain threshold. Additionally, the negative environmental effects of industrialization can be mitigated through the adoption of greener practices, such as sustainable urban planning, energy efficiency measures, and the increased use of renewable energy. Grossman and Krueger (1995) suggest that many advanced industrialized countries follow the Environmental Kuznets Curve, where environmental degradation initially worsens with early industrial growth but eventually decreases as economic development progresses and investments are made in technologies that lower emissions.

The challenges posed by climate change can largely be linked to industrialization. According to IPCC (2014), the main cause of the increasing amount of greenhouse gases in the atmosphere is the burning of fossil fuels like coal, oil, and natural gas for energy and transportation. Global warming is caused by these gases, which trap heat and include nitrous oxide, carbon dioxide, and methane. But development has also spurred climate change mitigation efforts. The carbon footprint of enterprises is being reduced by technological innovations including energy-efficient practices and renewable energy sources like solar, wind, and hydropower (Hadian & Madani, 2015). Furthermore, global accords such as the Paris Agreement have united countries to pledge to curtail greenhouse gas emissions, signifying a crucial phase in tackling the climate emergency (Rose et al., 2017).

Several studies have confirmed the linear effect of environmental policy effectiveness on industrialization. Literature on Porter hypothesis establishes rapid industrial growth as a result of environmental regulations. Kemp et al. (2000) highlights that environmental regulation stimulates innovation, leading to positive industrial growth. Wu et al. (2018) found that the restructuring of industries prompted by strict environmental regulations led to a more environment sustainable industry composition. Parallel to results from Dasgupta et al. (2001), Albrizio et al. (2017), De-gan (2014), and Dotsenko et al. (2018) indicate that robust implementation of environmental policies is positively associated with greater environmental performance, economic development, and industrialization, although it may have varying impacts on labor innovations and productivity.

The literature indicates that the impact of environmental policy effectiveness (EPE) on industrialization is not always positive. Yang et al. (2021) argue that stringent environmental regulations can raise costs for industries, diminishing their competitiveness in the global market. This perspective suggests that such policies may inhibit economic growth and obstruct industrial development. Dechezleprêtre and Sato (2017) contend that the negative effects are particularly pronounced in pollution- and energy-intensive sectors. Additionally, research indicates that environmental regulation places small entrant at a disadvantage in terms of unit costs. Dean et al. (2000) found a correlation between increased environmental regulation intensity and a decline in the formation of small manufacturing firms. Furthermore, Saygili (2016) notes that environmental laws have led to a greater reliance on capital over labor in industries with high pollution abatement costs, resulting in a reduction in the number of plants and disproportionately affecting smaller facilities.

Another way in which environmental policy effectiveness (EPE) negatively impacts industrialization is through a decrease in foreign direct investment (FDI) in the industrial sector, often referred to as the Pollution Haven Hypothesis. Naughton (2014) suggests that environmental regulations initially increase FDI at lower levels of regulation but lead to a decline at higher levels. However, this view is challenged by Kim and Rhee (2019) who found that countries compete by adopting strict regulations and enhancing their environmental performance to attract more FDI.

Other studies have also identified a non-linear relationship between environmental quality and industrialization within the framework of the Environmental Kuznets Curve (EKC). Jin et al. (2019) indicates that there is an inverted U-shaped curve relating environmental policy stringency to green total factor productivity (GTFP), where moderate policy strictness positively affects GTFP, while excessively strict policies hinder productivity. Similarly, Ouyang et al. (2020) found that the relationship between environmental regulation and China's industrial sector is U-shaped, initially limiting the nation's capacity for research and innovation, but ultimately allowing for technological advancements that enhance pollution regulation.

Other determinants of Industrialization

Gross Domestic Product and Industrialization

The interplay between industrialization and economic growth is a cornerstone of modern economic theory, characterized by a bidirectional relationship. Notably, the link between Gross Domestic Product (GDP) and industrialization is reciprocally influential, with each factor driving the other.

Recent research by Ni (2020) underscores this connection, revealing a robust positive correlation between industrial structure and economic expansion.

Interestingly, the study found that China's industrial structure exhibits a relatively weaker association with economic growth compared to other countries and regions. Additionally, a study by Hossain et al. (2013) in Bangladesh revealed that an increase in the total number of industries directly contributes to GDP growth whereas unemployment rate reduces.

On the contrary, higher GDPs tend stimulate industrial growth through fostering an environment conducive to investment, technological advancements, and infrastructure development. Moreover, GDP serves as a crucial indicator for assessing a nation's investment attractiveness. Escobari and Vacaflores (2015) found that foreign direct investment (FDI) increases in 19 Latin American countries with higher GDPs. Similarly, Babenko et al. (2020) discovered that the United States and China, both of which have large GDPs, lead in foreign investment. Ramady (2014) further supported this finding, noting that despite significant political risks, foreign direct investment was attracted to Egypt and Tunisia, two African nations with substantial GDPs. As a result, countries with higher GDP levels are more likely to attract FDI, which in turn boosts their industrial sectors.

Financial Development and Industrialization

Financial development influences industrialization positively by mitigating challenges such as adverse selection and moral hazard. Manganelli and Popov (2013) note that financial development enhances allocation of resources to firms with growth potential, particularly in industries with greater opportunities for expansion. However, the impact of financial development on industrialization is predominantly linear, largely due to the complexities of the financial sector and issues related to human capital misallocation (Manganelli & Popov, 2013).

Law and Singh (2014) identified a threshold effect in the relationship between finance and growth, suggesting that financial development is promotes only up to a certain point; beyond this threshold, further development may negatively affect growth. This underscores the importance of achieving optimal levels of financial development for promoting economic growth. Similarly, Samargandi et al. (2015) observed an inverted U-shaped relationship between financial development and economic growth among 52 middle-income countries from 1980 to 2008. Their findings indicate that excessive financial development can hinder growth, further confirming this non-monotonic effect through a threshold model.

Trade Openness and Industrialization

Research on trade openness and industrialization has yielded conflicting outcomes. A study by Ebong et al. (2014) examined the impact of globalization on Nigeria's industrial development between 1960 and 2010. The findings revealed a positive correlation between trade openness and industrial growth, suggesting that increased trade facilitates the importation of vital industrial inputs and export of regional raw materials.

Similarly, Amsden (2001) posits that trade openness can drive industrial expansion by subjecting domestic firms to competitive pressures, fostering technology transfer, and promoting knowledge spillovers. Wong (2009) found that trade openness significantly enhanced manufacturing productivity in Ecuador's export-oriented sectors following trade reforms. Although productivity declined after 2000, the study attributed the overall increase in aggregate productivity to improvements within individual plants and output from high-performing establishments.

Furthermore, trade openness can result in an over-dependence on exporting raw materials, potentially hindering the development of value-added manufacturing industries. (Rodrik, 2006). This can limit the potential for industrialization and economic diversification. Moreover, local industries' inability take advantage of global integration can hinder the industrialization process.

A key factor contributing to this limitation is the unequal distribution of gains from trade openness. When benefits are not shared fairly, local industries may struggle to invest in technology, research, and development, essential for competitiveness (Tarzi, 2016). Moreover, insufficient absorptive capacity can prevent developing countries from effectively utilizing knowledge and technology transferred through trade, further hindering industrialization (Mamoon, 2017).

These challenges underscore the need for developing countries to carefully consider the potential risks and benefits of trade openness and implement policies that promote equitable growth, industrial development, and technological advancement.

Foreign Direct Investment and Industrialization

Foreign Direct Investment (FDI) is critical in promoting industrialization, particularly in developing countries, as noted in various studies. Ewane (2020) examined the impact of FDI on industrialization in 23 African countries from 1990 to 2017, finding a significant positive effect within the Franc zone, while noting a negative impact in non-Franc zone countries. Similarly, Almfrajia and Almsafir (2014) identified a positive relationship between FDI and economic growth, although they also observed instances where this association was either negative or negligible.

Studies by Liu (2002) and Su (2016) centered on FDI's influence on technology spill-over in China, particularly within domestic sectors. Their investigations unveiled a substantial spillover effect of FDI on manufacturing industries, contributing to heightened productivity levels and growth rates. Furthermore, Su (2016) found that human capital facilitates technology transfers from FDI, and that contributes to economic growth. Ndiaya and Lv K. (2018) conducted a comprehensive study to analyze the effect of industrialization on Senegal's economic growth, utilizing secondary data from the World Bank and the National Agency of Statistic and Demography in Senegal. Their study revealed a significant correlation between industrial development and economic growth, highlighting industrialization as a substantial stimulant for economic growth.

Human Development and Industrialization

Investments in human potential, encompassing technical skills, education, healthcare, and skill development, have yielded substantial dividends for industrialized nations (Sequeira, 2003). Research indicates that countries with robust human capacity, as measured by the Human Capacity Index, exhibit greater resilience in the face of economic fluctuations, foster innovation, and drive social advancement (Nepriadkina, 2019).

Furthermore, studies have demonstrated a positive correlation between intellectual capital and firm performance. For instance, an analysis of Indian companies listed on the Centre for Monitoring Indian Economy Overall Share Price Index revealed a significant impact of intellectual capital on business outcomes (Smriti & Das, 2018). Their study found that these firms performed well and efficiently, with human capital playing a crucial role in enhancing productivity.

Zhu and Li (2017) provided empirical evidence that both economic complexity and human capital positively influence long- and short-term growth, highlighting the significant role of secondary education. Similarly, Teixeira and Queiro (2016) found that dynamics of human capital and productive specialization are critical for economic growth, emphasizing that the interaction between human capital and structural change in knowledge-intensive industries has a substantial impact on economic advancement.

Real Effective Exchange Rate and Industrialization

A nation's trade competitiveness plays vital role in shaping industrial development, is significantly influenced by its Real Effective Exchange Rate (REER). This rate reflects the value of a country's currency, adjusted for inflation and compared to those of other nations. Research suggests that a lower REER can enhance industrialization in developing countries by improving their export competitiveness. For instance, Alfaro et al. (2022) found that real depreciations are associated with an increased likelihood of engaging in research and development, as well as faster productivity and cash-flow growth, particularly in emerging Asian markets. In contrast, firms in other emerging economies experience negative effects, and those in industrialized nations show no significant average impact. Similarly, Cimoli et al. (2013) indicated that a reduced REER enhances the affordability of a country's exports on the global stage, leading to higher demand for locally produced goods. This surge in demand not only drives industrial growth and job creation but also encourages technological advancements across various sectors, facilitating broader industrial development

Chamindani (2018) conducted a study using data from Sri Lanka to validate the hypothesis that sustained appreciation of the real effective exchange rate (REER) adversely affects exports, assuming other factors influencing manufacturing exports remain constant. The findings indicated that the REER is a significant determinant of Sri Lanka's industrial export performance, with appreciation hindering industrialization efforts. Similar conclusions have been reached in studies focusing on China (Yan et al., 2016) and countries in post-communist Eastern Europe (Cizmovic et al., 2020). Furthermore, research by Keller and Vinogradova (2017), Lee and Naknoi (2015), and Mugozhi et al. (2020) suggests that a substantial decline in currency value can lead to increased input prices for imported machinery and raw materials essential for industrial production. This rise in costs could adversely impact the manufacturing sector's cost structure and stifle industry growth.

Moderating Role of Regulatory Quality

The link between Environmental Policy Effectiveness and Industrialization can be significantly influenced by regulatory quality. Literature established that high regulatory quality which ensures higher levels of environmental policy effective increases the export intensity of local firms. According to Akama (2023), the high quality of strict environmental regulations on emission control in Kenya have a positive impact on industrial export performance, particularly in the Export Processing Zone (EPZ) firms. Micro firms experience the highest increase in export intensity (18.21%), followed by small firms (11.09%) and large firms (9.50%).

Effective enforcement mechanisms and transparent governance structures are crucial for ensuring that environmental policies do not impede industrial growth. Marquis et al. (2011) found that China's national development policy has changed, the bureaucracy has reorganized, and public and government scrutiny is intensifying, leading to a realignment of regulation and enforcement. As a result, businesses are embracing environmental innovation and combining regional and international requirements. Additionally, they are competing on reputation and are becoming more transparent.

Some studies have argued that lack of regulatory quality often undermines the intended outcomes of environmental policies. Weak institutions and corruption negatively influence the implementation and impact of environmental regulations on industrial development (Damania, 2002). Ortmann (2017) further found that strong economic interest groups actively work to undermine and erode the current institutions to oppose reform. The resources available to the environmental state are not enough, which has left it with little institutional capabilities. They also exploit the judicial system's shortcomings, which make it challenging to penalize offenders and evaded numerous reformers' attempts by using connections and corruption. Internal disagreements within the government exacerbates the situation by providing support to institutional opponents and dividing institutional reformers.

Conceptual Framework

The conceptual framework is a Directed Acyclic Graph that shows the relationship between Environmental Policy Effectiveness and industrialization with Regulatory quality acting as a moderating variable. The diagram also shows that other variables that affect industrialization include FDI, GDP, REER, Financial Development, Human Development, and Trade Openness. These variables are controlled for to obtain a good estimate of the relationship between EPE and industrialisation.

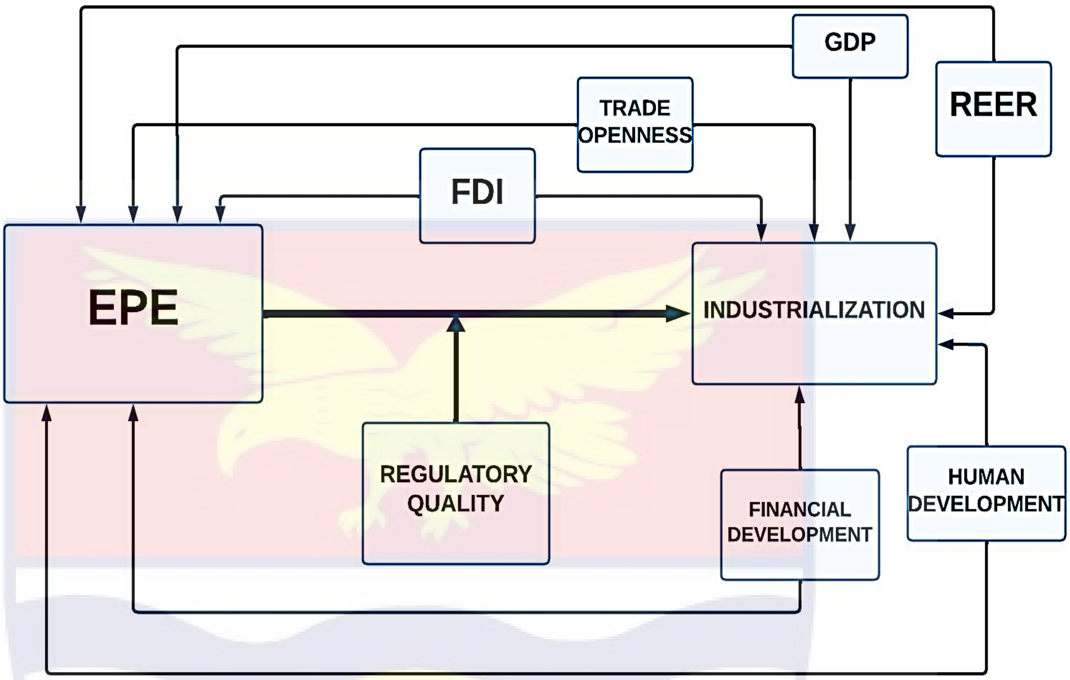

Figure 3: Relationship Between EPE and industrialisation

CHAPTER THREE

RESEARCH METHODS

Introduction

The procedure and relevant tools used in carrying out this study are explained in this section. The chapter details the theoretical and empirical specification of the model that captures the linear and non-linear relationship between environmental policy effectiveness and industrialisation. The section also specifies the model for the moderating role of regulatory quality in the relationship between EPE and industrialisation. It also provides a full description of the research design chosen for the study. It also covers the definition, measurement, and justification of the model's variables, the data source, estimation methodologies, and the econometric approaches used to achieve the study's key objectives.

Research Design

The study utilized a framework grounded in positivist philosophy. A central principle of positivism is the belief that knowledge is externally objective, necessitating that researchers maintain an impartial and detached stance regarding the phenomena they investigate. This objectivity is crucial for preventing personal biases from influencing research outcomes. Moreover, positivists assert that reality is stable and can be observed and described accurately, without affecting the phenomena under examination (Balarabe Kura, 2012).

This idea guided the adoption of a quantitative approach in the study. This approach is characterized by its objectivity and broad generalizability and applicability (Guba & Lincoln, 1994). The quantitative method is considered deductive in nature, as it employs regression analysis to systematically and replicable explore research problems. This enables the assessment of the strength and direction of relationships between variables, offering empirical evidence to support the study's conclusions. (Creswell & Creswell, 2017; Benjamin et al., 2018).

According to Babbie (2012), social science research is primarily motivated by three objectives: descriptive, exploratory and explanatory. This study employed an explanatory design, which traditionally emphasizes a quantitative approach aimed at elucidating rather than merely describing the phenomena under investigation (Maxwell & Mittapalli, 2010). The study's internal validity is established through its provision of a clear, singular explanation for the relationships among industrialization, institutional quality, and environmental policy effectiveness. Furthermore, the study's external validity is demonstrated by the generalizability of its findings, allowing for an objective application of these insights within the research context.

Empirical model specification

Based on the EKC literature reviewed and the conceptual framework, we establish a non-linear functional relationship between EPE and industrialization. If increases in EPE reduces industrialisation before or after the turning point, it will confirm the Pollution Haven Hypothesis and when the relationship is positive, it will confirm the Porter Hypothesis. This functional form will also help us to test whether there exists empirical evidence in these regions to support the EKC relationship between EPE and industrialisation. Other determinants of industrialisation from the conceptual framework are also included as control variables to get a good estimate of the relationship. The moderating effect of regulatory quality is also included in in the functional form. The functional model is given by:

$$IND_{it} = f\begin{pmatrix} IND_{i,t-1}, EPE_{it}, EPE_{it}^2, GDP_{it}, FD_{it}, \\ FD_{it}^2, TO_{it,} FDI_{it}, HDI_{it}, REER_{it}, RQ_{it} \end{pmatrix} \quad (1)$$

Where IND_{it} represents industrialization, $IND_{i,t-1}$ denotes the lagged value of industrialization, EPE_{it} and EPE_{it}^2 corresponds to the environmental policy effectiveness and its square term respectively. Additionally, GDP_{it} signifies the Gross Domestic Product at US dollars which takes into account the effects from structural requirements – technological, physical and communication and energy infrastructure (Escobari and Vacaflores, 2015), FD_{it} and FD_{it}^2 are Financial Development Index and its square respectively. The inclusion of the square of FDI is justified by Law and Singh (2014) which established a non-linear effect of financial development on industrialisation. TO_{it} represents Trade Openness, HDI_{it} *and* $REER_{it}$ are Human Development Index and Real Effective Exchange Rate and RQ_{it} stand for Regulatory Quality. i shows the country and t shows the year.

Equation (1) can be formulated in econometric terms to illustrate the non-linear relationship between environmental policy effectiveness and industrialization and the role of regulatory quality. The resulting econometric forms of (1), are presented in equations (2) and (3)

$$lnIND_{it} = \alpha_0 + \propto lnIND_{i,t-1} + \alpha_1 EPE_{it} + \alpha_2 EPE_{it}^2 + \alpha_3 lnGDP_{it} + \alpha_4 FD_{it} + \alpha_5 FD_{it}^2 + \alpha_6 TO_{it} + \alpha_7 FDI_{it} + \alpha_8 HDI_{it} + \alpha_9 REER_{it} + \mu_i + \varepsilon_{it} \quad (2)$$

$$lnIND_{it} = \gamma_0 + \rho lnIND_{i,t-1} + \gamma_1 EPE_{it} + \gamma_2 EPE_{it}^2 + \gamma_3 RQ_{it} + \gamma_4 EPE_{it} * RQ_{it} + \gamma_5 lnGDP_{it} + \gamma_6 FD_{it} + \gamma_7 FD_{it}^2 + \gamma_8 TO_{it} + \gamma_9 FDI_{it} + \gamma_{10} HDI_{it}$$

$$+\gamma_{11} REER_{it} + \mu_i + \epsilon_{it} \quad (3)$$

Where ln represents the natural logarithm. Using natural logarithms transforms data characterized by exponential growth into linear relationships, facilitating the use of linear regression techniques. This transformation also helps stabilize variation among data points, reduces heteroscedasticity, and improves the overall reliability of statistical analyses. Furthermore, expressing results as percentage changes enhances comprehension of the correlations between variables, thereby aiding in the clarification of findings (Wooldridge, 2019; Gujarati & Porter, 2009). Also, ε_{it}, and ϵ_{it} are the error terms, μ_i captures the country level fixed effect and the rest are the parameters of the variables.

Variable Description, Justification and Expected Sign.

Industrialization

In this study, industrialization serves as the dependent variable, defined by the value added to the industry, which encompasses construction measured in US dollars. According to the World Bank's standard definition, Industry Value Added falls within the International Standard Industrial Classification (ISIC) divisions 05–43, including manufacturing (ISIC divisions 10-33). This definition encompasses value added from various sectors, including mining, manufacturing (often highlighted as a distinct subgroup), construction, power generation, water supply, and gas distribution. Value added is calculated as the net output of the sector, obtained by summing all outputs and subtracting intermediary inputs. Notably, this measure excludes considerations of depreciation of manufactured assets and the depletion or degradation of natural resources. The source of value added is guided by the International Standard Industrial Classification (ISIC), edition 4.

Environmental Policy Effectiveness (EPE)

The Environmental Policy Effectiveness (EPE), measured in percentages, was operationalized in the study using the environmental performance index (EPI) from Yale University (Hsu & Zomer, 2016; Wolf et al., 2022). It is justified to use this index as a factor in determining how effective environmental policies are because of its comprehensive analysis of numerous environmental indicators, international recognition, accessibility of longitudinal data, ability to make cross-country comparisons, and policy relevance. The EPI provides a wide-range of assessment of country's environmental policy, ensuring accuracy and objectivity in research. EPI is a composite index that compiles and summarizes data on 40 crucial sustainability topics (Appendix 1A) into a single figure that represents country-level policy effectiveness (performance). Transforming data into success measures and combining different indicators to create an overall composite score are steps in this process. The EPE determines a country's "proximity to target" score by calculating its distance from a target that has been established as a high-effectiveness benchmark. The hierarchy from which these efficiency targets are derived is as follows:

- Specified effectiveness standards in international treaties, institutions, or agreements.
- Effectiveness goals established in accordance with professional advice.
- Effectiveness goals based on country percentile rankings. Depending on how the indicator data are distributed, high effectiveness targets are typically established at either the 95^{th} or 99^{th} percentile, whereas worst effectiveness targets are typically set at the 1^{st} or 5^{th} percentile.

The results are then combined to create a success meter; the higher the indicator score, the nearer the nation is to achieve its goal. Using an algorithm, the unprocessed environmental data is transformed into indicators that rank nations according to their environmental policy effectiveness on a scale of 0 to 100. The formula for this indicator score is given by:

$$Indicator\ Score = \frac{X-W}{B-W} \times 100\% \qquad (4)$$

where X is the actual value of a country, B is the target for best performance, and W is the worst performance. The indicator score is capped at 100 for a country if its actual value exceeds B. Similarly, if actual value falls below W, the indicator score is assigned a value of zero.

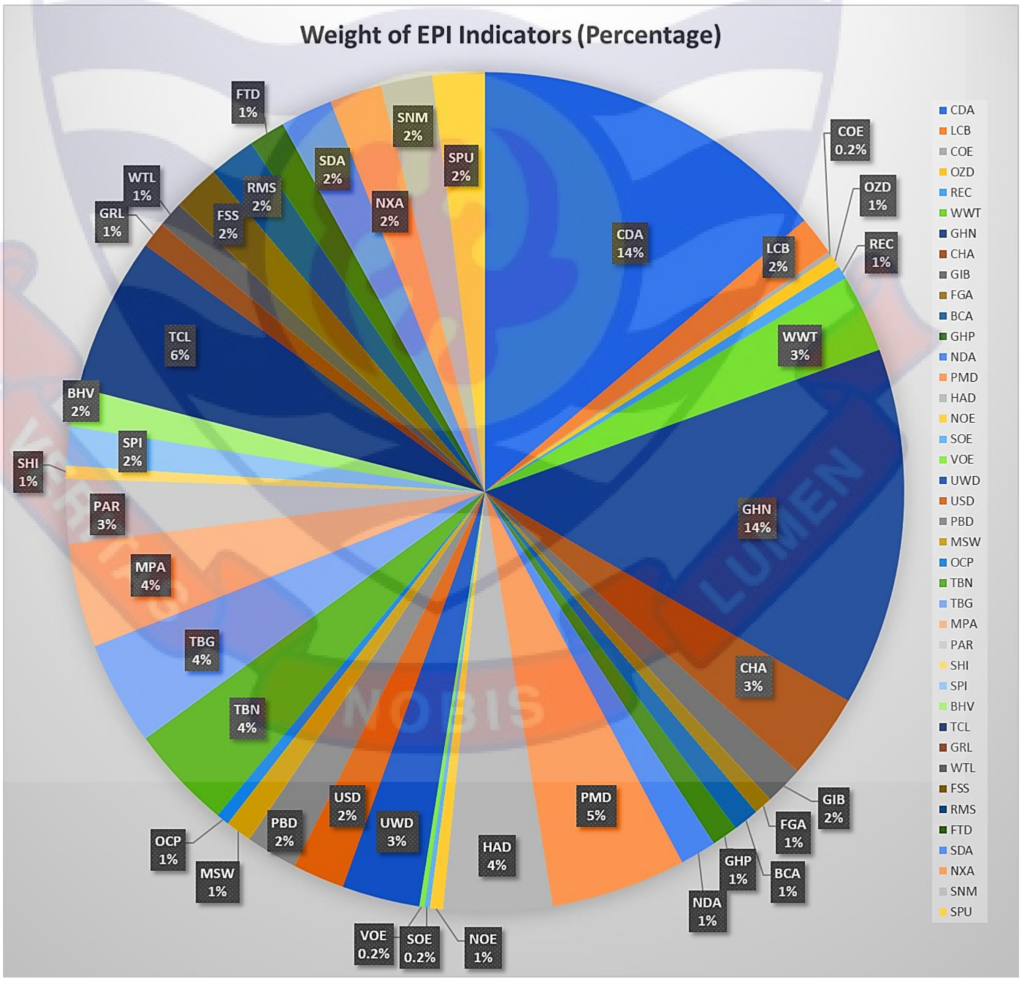

Figure 4: Weight of EPE Indicators

The study adopted the methodology of Munda, 2012; Munda and Nardo, 2009 to calculate Environmental Policy Effectiveness. It obtains a simple arithmetic mean of all the 40 indicators for each country for each year. This approach ignored missing values. For instance, if three variables are given and one of the indicators is absent in some observations, EPE will still contain the mean of the two indicators that are present in those observations. The average of all three indicators will be present in other observations. EPE is set to missing in cases where none of the indicators are present. The Environmental Policy Effectiveness is expected to have a non-linear relationship with industrialization. Thus, the study expects EPE to have negative effect on industrialization agenda in the incipient stage but would improve the industrialization after the threshold. This is justified by the U-shaped Environmental Kuznets Curve relationship.

Gross Domestic Product

Gross Domestic Product (GDP) at market prices is determined by summing the gross value added by all resident producers, including relevant product taxes and subtracting any subsidies not included in the goods' prices. This calculation does not account for the deterioration or depletion of natural resources, nor does it consider the depreciation of manufactured assets. The GDP data is expressed in US dollars, with figures converted using official exchange rates for the specified year. The inclusion of this variable is justified by studies conducted by Jorgenson and Griliches (1967), Barro (1991). The Gross Domestic Product is anticipated to have a positive relationship with industrialization as higher Gross provides a favourable environment for industries to expand their contribution to the overall economy.

Financial Development

Financial Development Index (FDI) by the International Monetary Fund (IMF) is used to gauge financial development. It provides an overview of the depth (size and liquidity), accessibility (The financial services that individuals and companies can obtain), and efficiency of financial institutions and financial markets (capacity of institutions to deliver financial services at a reasonable cost and with steady income streams, as well as the degree of capital market activity). Nine indexes make up the index. The study assumes a non-linear relationship between financial development and industrialization. This is justified by Kothakapa et al. (2021).

Trade Openness

Trade openness denotes the extent to which a country is involves in international commerce and economic exchanges with other nations. It measures the degree to which a nation allows unrestricted trade in goods, services, and capital across its borders. This is ascertained by dividing the sum of import and export by the country's GDP. The hypothesizes that trade openness has a positive impact on the dependent variable (Elfaki et al., 2021).

Foreign Direct Investment

Foreign direct investment (FDI) is defined by the World Bank as the net inflows of capital used to acquire a long-term management stake (10 percent or more of voting shares) in a company operating in a country other than that of the investor. According to the balance of payments, FDI includes equity capital, reinvested earnings, other long-term capital, and short-term capital. This data is expressed as a ratio of GDP, reflecting net inflows (new investments minus outflows) of foreign capital into the reporting economy. The study posits that FDI will positively influence industrialization (OECD, 2002).

Human Development Index

The Human Development Index (HDI), published annually by the United Nations Development Programme, assesses key dimensions of human development. It encompasses three main aspects: a long and healthy life, indicated by life expectancy; access to education, represented by the arithmetic average of expected years of schooling and the mean years of schooling for the adult population; and a decent standard of living, measured by Gross National Income per capita adjusted for the country's price level. The HDI is calculated by taking the geometric average of these three dimensions. This study expects a positive relationship between HDI and industrialization (Iskandar, 2017).

Real Effective Exchange Rate

The Real Effective Exchange Rate (REER) is an index adjusted to account for variations in relative national price indicators for the home country, chosen countries, and the euro area, using 2010 as the base year. This study hypothesizes a negative correlation between industrialization and the Real Effective Exchange Rate (Cizmović et al., 2021).

Regulatory quality

Regulatory quality reflects public perceptions of the government's ability to formulate and implement effective laws and regulations that foster private sector growth. To address changes in the composition of countries included in the Worldwide Governance Indicators (WGI) over time, percentile ranks have been adjusted accordingly. This study anticipates a positive influence of regulatory quality on industrialization (Ribeiro & Kruglianskas, 2015).

Data Type and Source

The study utilized secondary data, encompassing a panel dataset of 104 developing countries across Sub-Saharan Africa, Latin America and the Caribbean, and Asia. The study chose the countries based on their classification by the World Bank as low- or middle-income. The analysis covers the years 2002 to 2020, totalling 19 years. Table 1 presents the different sources of the dataset employed in this research.

Table 1: Data Sources

Variable	Measurement	Source
Industrialization	Industry Value Added	WDI
Environmental Policy Effectiveness	Index of 40 indicators	Yale university
Gross Domestic Product	Gross Domestic Product (current values)	WDI
Financial Development	Financial Development Index	IMF
Trade Openness	(Export + Import)/GDP	https://ourworldindata.org
Foreign Direct Investment	Foreign Direct Investment	IMF
Human Development	Human Development Index	https://ourworldindata.org
Real Effective Exchange Rate	Real Effective Exchange Rate	IMF
Regulatory Quality	Regulatory Quality (estimates)	WGI

Source: Agbesi (2024)

Estimation techniques

Baseline Model

The research adopts the regression model established by Méndez and Sepúlveda (2006) to carry out the empirical analysis. The foundational model of the study is defined as:

$$IND_{it} = \alpha_o + \alpha_1 EPE_{it} + \alpha_2 EPE_{it}^2 + \alpha_3' X_{it} + \mu_i + \eta_t + \varepsilon_{it} \quad (5)$$

where IND is industrialization, EPE is an environmental policy effectiveness. The subscripts i and t represent country i and year t, respectively; X_{it} is a vector of all control variables; μ_i is the unobserved country-specific effects; η_t is the time-specific effects and ε_{it} represents the error term. Méndez and Seplveda (2006) claim that fixed effects estimators may also make it possible to control for endogeneity brought on by time-invariant effects. However, it fails to consider the endogeneity resulting from possible connections between industrialization and the EPE indicators. Because dynamic adjustment is disregarded in the traditional static panel data approach, endogeneity among the explanatory factors may result. A dynamic panel data model addresses and enhances many of the limitations associated with cross-sectional and static panel data methods. The dynamic model follows from the basic model (equation 5) as:

$$IND_{it} = \propto IND_{i,t-1} + \alpha_o + \alpha_1 EPE_{it} + \alpha_2 EPE_{it}^2 + \alpha_3' X_{it} + \mu_i + \eta_t + \varepsilon_{it} \quad (6)$$

When applying Ordinary Least Squares (OLS) to estimate the model, the inclusion of a lagged dependent variable often leads to correlation with the error term, resulting in biased estimates. To address this issue, the study used the dynamic panel Generalized Method of Moments (GMM) model developed by Arellano and Bond (1991), Arellano and Bover (1995), and Blundell and Bond (1998). This method provides consistent and efficient estimators for dynamic panel data models. Particularly, the first-differenced version of Equation (6) eliminates country-specific effects, thereby generating the first-difference GMM model as follows:

$$\Delta IND_{it} = \propto IND_{i,t-1} + \alpha_o + \alpha_1 \Delta EPE_{it} + \alpha_2 \Delta EPE_{it}^2 + \alpha_3' \Delta X_{it} + (\eta_t - \eta_{t-1}) + \Delta\varepsilon_{it} \quad (7)$$

Where Δ stands for the first difference. The first difference GMM estimator has the drawback of removing the pure cross-country dimension of the data and lowering the signal-to-noise ratio, hence amplifying measurement error biases (Levine et al., 2000)

Arellano–Bover/Blundell–Bond linear dynamic panel-data estimation

The estimation employs a linear dynamic panel-data model that associates lagged values of the dependent variable with unobserved panel-level effects. The model supports a significant ratio of the variance of the panel-level effect relative to the variance of the idiosyncratic error, representing an extension of the Arellano-Bond estimator. This approach is particularly suitable for datasets characterized by many panels and a limited number of time periods, as seen in this study with 104 countries over 19 years. It requires that the panel-level effects are uncorrelated with the initial difference of the first observation of the dependent variable and assumes the absence of autocorrelation in the idiosyncratic errors.

Arellano and Bond (1991) introduced a consistent generalized method of moments (GMM) estimator tailored for this model. In contexts with numerous panels and fewer time periods, the Arellano–Bond estimator is formulated by first-differencing to eliminate panel-level effects, then employing instruments to establish moment conditions. Blundell and Bond (1998) highlighted that lagged-level instruments in the Arellano–Bond estimator may weaken if the autoregressive process becomes overly persistent or if the ratio of the variance of panel-level effects (μ_i) to the variance of the idiosyncratic error (ε_{it}) becomes excessively large.

To address this, Blundell and Bond (1998) proposed a system estimator that incorporates moment conditions using lagged differences as instruments for the level equation, alongside moment conditions of lagged levels for the difference equation, building on Arellano and Bover's (1995) framework. The validity of these additional moment conditions relies on the initial condition E [μ_i IND_{i2}] = 0 for all i (Blundell & Bond, 1998; Blundell, Bond & Windmeijer, 2000). Consequently, the study employed system dynamic two-step panel-data estimators, assuming that error terms are both independent and homoscedastic across countries and over time. The residuals from this first step are subsequently used to obtain a consistent estimate of the variance-covariance matrix, thereby relaxing the assumptions of independence and homoscedasticity.

Calculation of Threshold

The thresholds are the turning points of Environmental Policy Effectiveness. Holding other factors constant, the study expressed the non-linear relationship between Industrialization and EPE by:

$$IND_{it} = \alpha_1 EPE_{it} + \alpha_2 EPE_{it}^2 \qquad (8)$$

Where IND_{it} is the industrialization and EPE_{it} is the Environmental Policy Effectiveness. Differentiating IND_{it} with respect to EPE_{it} and equating to zero yields:

$$\frac{dIND_{it}}{dEPE_{it}} = \alpha_1 + 2\alpha_2 EPE_{it} = 0$$

$$\textbf{Threshold} = \frac{-\alpha_1}{2\alpha_2} \qquad \textbf{(9)}$$

Pre-estimation tests

The study employed the Fisher-type panel unit root test to assess stationarity within the data. According to Choi (2001), the null hypothesis is that each panel exhibits a unit root. The approach entails performing a unit root test on each individual panel series and then aggregating the p-values to provide an overall evaluation of whether the panel series have a unit root. This approach leverages four distinct methods proposed by Choi (2001) to improve robustness of the results.

Post Estimation diagnosis tests.

To enhance the reliability and robustness of the findings, the study utilized the Arellano–Bond test to check for serial correlation in the first-differenced residuals. This test evaluates the presence of serial correlation in the residuals, which is crucial for validating the model's assumptions. Additionally, the Sargan test of overidentifying restrictions was conducted to assess the validity of the instruments utilized in the estimation process. This two-pronged approach helps confirm the adequacy of the model and the soundness of the instruments applied.

Conclusion

The methodological framework fit for the study was established and exhibited in this chapter. The model was developed from the Arellano–Bover/Blundell–Bond linear dynamic panel-data estimation technique. The panel data of 104 countries drawn from Asia, Latin America and The Caribbean and Sub-Saharan Africa spanning 19 years (2002-2020) was employed. The chapter contained information on industrialization, environmental policy effectiveness, financial development index, human development index, Gross Domestic Product, Trade Openness, Real Effective Exchange Rate, foreign direct investment, and regulatory quality. The threshold calculation as well as the pre and post estimation tests conducted were fully discussed in the chapter.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

Introduction

This section presents the various results obtained in the study and their discussions. The results include the descriptive statistics, correlation matrix, the linear dynamic panel-data estimation, and the post estimation results. The section discusses these results in the context of all the selected countries and considering the sub-regional dynamics according to the specific objectives of the study. The section ends with a conclusion of the chapter.

Descriptive Statistics of Variables

Table 2 shows the descriptive statistics of variables included in the model. From the table, the average industrialization (which is a share of industry including construction) for the 104 countries over the 19-year period is US$72.5billion with highest and lowest contributions of the industrial sector to GDP of US$5.56trillion and US$ -1.31billion respectively. Over the study period, the environmental policy effectiveness (EPE) of the countries averaged 39.84 percent with peak EPE of 64.5 percent and least policy effectiveness being 23.4 percent. The individual observations are about 6.6 percent spread from the mean EPE. Regulatory Quality had mean value of -0.38 showing how poor countries perform with this governance indicator. Meanwhile, individual observations of Gross Domestic Product of the countries over time deviated 1.02 trillion from the mean GDP of US$ 218 billion. This shows high variations in the GDP of the countries adopted. It further recorded a minimum of US$72.2 million and a maximum of US$14.7 trillion.

Table 2: Descriptive Statistics of Variables

Variable	Obs	Mean	Std. Dev.	Minimum	Maximum
Industrialization	1976	7.25e+10	3.83e+11	-1.31e+09	5.56e+12
Environmental Policy Effectiveness	1976	39.84172	6.648974	23.3596	64.57095
Regulatory Quality	1976	-0.3828858	0.7027328	-2.366042	2.255347
Gross Domestic Product	1976	2.18e+11	1.02e+12	7.22e+07	1.47e+13
Financial Development (FD)	1976	0.2144465	0.1605034	0.0262936	0.9245158
Trade Openness	1976	82.41953	48.45849	0.193331	437.3267
Foreign Direct Investment	1976	4.393749	7.065964	-37.17265	103.3374
Human Development Index	1976	0.6085977	0.1373943	0.274	0.943
Real Effective Exchange Rate	1843	111.5959	145.7483	50.97153	6185.893

Source: Agbesi (2024)

Furthermore, the average score of Financial Development Index (FD) is 0.21, and trade openness mean of 82.4 percent over the study period. The average proportion of Foreign Direct Investment is 4.39 percent while the average Human Development Index is 0.61. The average of the Real Effective Exchange Rate is 111.6 percent. Meanwhile, Financial Development has a minimum value of 0.026 and 0.92 as a maximum value. The minimum and maximum values for Trade Openness are 0.93 and 437.33 respectively while the minimum and the maximum value of Foreign Direct Investment are -$37.17million and $103.33million. Human Development Index (HDI) has a minimum index of 0.27 and a maximum index of 0.94 while real effective exchange rate has a minimum and maximum rate of are 50.97percent and 6189.89 percent. The results also show that the Human

Development Index has the lowest variability with a standard deviation of 0.14 while industrialization has the highest variability with a standard deviation of US$383 billion.

Pre-Estimation Test Results

Correlation Analysis

Pearson Correlation analysis was performed for all variables with results included in the appendix. Aside from Foreign Direct Investment and Trade Openness that have negative relationships with the explained variable, all the other explanatory variables have significant positive correlation with industrialization at 5 percent alpha level. At 5 percent alpha level, the results show a high and significant correlation between Regulatory Quality and Financial Development (69.2 percent) and Human Development Index (65.8 percent). Financial Development also has a significant correlation with HDI (70.3 percent).

These significant relationships in the independent variables may be sources of multicollinearity. However, correlation coefficients of 0.81 calls for suspicion of multicollinearity (Kennedy, 1998). Moreover, panel data has an advantage of more degrees of freedom, less multicollinearity, and more variation in the data as compared to cross-sectional and time series data (Baltagi, 2007). Furthermore, the application of the Arellano–Bover and Blundell–Bond linear dynamic panel-data estimation method addresses the possible bi-causal relationship between GDP and industrialization. The rest of the explanatory variables have weak to moderate correlation with one another.

Regression Results

Linear and Non-linear Effect of EPE on Industrialization in all countries

Table 3 shows the results for the linear and non-linear effects of environmental policy effectiveness (EPE) on industrialization. Arellano–Bover/Blundell–Bond linear dynamic panel-data estimation was used to assess the relationship between industrialization and Environmental Policy Effectiveness (EPE) as well as the control variables. To check whether the instruments used were valid, the study employed the Sargan test for overidentifying restriction of instruments (Sargan, 1958). The p-value (0.2557) indicates a non-rejection of the null hypothesis and hence the acceptance that the instruments used in the estimation are valid. Also, the significant AR (1) with p-value of 0.0034 and insignificant AR (2) with p-value of 0.0792 show that the past year value of industrialization has significant effect on the present value and therefore needs to be incorporated into the model.

Linear Effect of EPE on Industrialization in all countries

Table 3 illustrates a linear negative relationship between environmental policy effectiveness and industrialization. Thus, a percentage increase in EPE leads to about 1.05 percent reduction in industrialization and vice versa in selected regions, ceteris paribus. The result confirms the Environmental Kuznets Curve (U-shape) relationship between EPE and industrialization in the selected regions (Grossman & Krueger, 1991). As the countries implement environmental policies to protect the environment, it has negative impact on the industrialization agenda but tends out to have positive impact after the threshold. Other studies including Ahmed, Ali, Kousar, and Ahmed (2022); Aslam et al. (2021); Munir and Ameer (2020); Byaro, Mafwolo, and Mayaya (2022) align with this finding.

Table 3: The Effect of EPE on Industrialization (All countries)

	Δ *in* **Industrialization**
Environmental Policy Effectiveness (EPE)	**-0.0105***** **(0.00313)**
EPE²	**0.000145***** **(0.0000321)**
L1. Industrialization	0.401*** (0.00818)
Gross Domestic Product	0.758*** (0.0101)
Financial Development (FD)	0.697*** (0.111)
FD²	-1.777*** (0.160)
Trade Openness	0.00179*** (0.0000586)
Foreign Direct Investment	0.000891*** (0.0000979)
Human Development Index	0.200** (0.0809)
Real Effective Exchange Rate	-0.00327*** (0.000198)
Constant	18.17*** (0.920)
Chi²	199370.8
Sargan	**85.79 (0.2557)**
arm1	**-2.928 (0.0034)**
arm2	**-1.755 (0.0792)**
Threshold	**36.206897**
N	1599

Standard errors in parentheses $^{*} p < 0.1$, $^{**} p < 0.05$, $^{***} p < 0.01$

Source: Agbesi (2024)

Firstly, environmental policies usually lay costs on industry to adopt cleaner technologies and minimize pollutants. Firms find it very challenging to handle the financial burden of adhering to these laws in the early phases of industrialization, when resources are scarce and adopting new technology is expensive, forcing productivity down and forcing firms to exit the market. This slows down their industrial progress. This is evident in the selected regions as they are classified among the low- and middle-income categories. This finding aligns with results of Boyd and McClelland (1999) which found that implementation of environmental policies cut production by 9 percent, a quarter of which is attributed to pollution abatement capital constraints. Yang et al. (2021) found that when the SO_2 removal rate increases by 0.1, the Total Firm Productivity decreases by 3.61 percent (Olley–Pakes method), and 4.04 percent (Levinsohn–Petrin method). The paper further found about 70 percent of low-cost firms in China exit the market due to cost burden of implementation of environmental regulations.

Environmental policies largely impact the growth of small firms. Thus, small firms are particularly forced to exit the market due to compliance cost of environmental regulations because large firms have a greater competitive advantage due to economies of scale, making it more difficult for small firms to channel compliance costs to customers. According to the findings of Yin et al. (2007), there is about 1.8 higher odds of a small-scale firms exiting the market because of environmental regulations than larger firms. These exits clearly dampen the growth in the industrial sector and thus the sector's contribution to GDP. This position is also supported by Dean et al. (2000).

Furthermore, there is technological capacity constraint. Advanced environmental technology development and implementation can be capital-intensive and slow to adopt. This is because major technological advances tend to be adopted gradually and takes time to reflect in aggregate productivity statistics. In the case of mechanized cotton spinning during the Industrial Revolution in France, the adoption of the new technology led to an initial low average productivity because workers needed to learn the use of the technology (Juhász et al., 2020). Similarly, the transition to environmentally friendly technologies in manufacturing can result in an asymmetric situation where modern firms in one country disregard traditional units in another country (Pires & Pontes, 2020). Countries in the early phases of industrialization lack the technological competence to embrace and integrate cleaner technology effectively, creating operational difficulties and slowing the expansion of the industrial sector due to low market sales of products (Bhandari et al., 2019).

Lastly, Pollution Haven Hypothesis confirms this finding (Copeland, 2008; Gill, Viswanathan, & Karim, 2018; Taylor, 2005). Most of industries found in these regions are predominantly owned by foreigners which aim to maximise profit; therefore, they relocate to areas that tend to have lower production costs. Hence, the implementation of these stringent environmental policies, which leads to increased EPE, will be disincentivising as they tend to increase the same costs the foreign firms seek to avoid. These could result in fold-ups, which decrease investment in the industrial sector thereby hindering industrial growth. Guzel and Okumuş (2020) obtained similar findings in a study conducted on ASEAN-5 countries (Malaysia, Indonesia, Singapore, Thailand, and Philippines) over the period 1981 – 2014 with increased foreign direct investments leading to environmental degradation. Also, stringent environmental policies reduce foreign direct investment and employment by 52.6 percent and 50.4 percent respectively in China (Cai et al., 2016). Ge et al. (2020) further confirms that less foreign direct investment (FDI) is flowing into extremely polluting businesses in province with higher pollution reduction target because of China's 11^{th} and 12^{th} Five-Year Plans for SO_2 emission reduction.

Non-linear Effect of EPE on Industrialization in all countries

Beyond a threshold of 36.21, countries tend to benefit about 0.15 percent increase in contribution of industrial sector to GDP with a 10 percent improvement in EPE, ceteris paribus. This is significant at 95 percent confidence interval. Industries can innovate and adapt to meet environmental rules more successfully as economies develop and technological capabilities advance. Through innovation, new, more effective technologies may be created that increase overall production and competitiveness while also reducing pollution. This finding aligns with that of Dai and Sun (2021) which specify that innovation is associated with 4.3 percent increase in firm productivity and in Chinese manufacturing industry, average annual growth was 6.958 percent between 2005–2007. Other papers (Ambec & Barla, 2002; Ambec, Cohen, Elgie, & Lanoie, 2013) confirm the positive effect of innovation on industrial growth. Thus, innovating environmentally friendly technology can benefit industries in developing confirming the Porter Hypothesis (Rexhäuser & Rammer, 2014; Rubashkina, Galeotti, & Verdolini, 2015)

Additionally, recent trends in the global economy and customer preferences are moving toward sustainable goods and services. Kronthal-Sacco et al. (2020) observed a rising trend in demand for environmentally friendly products with sustainability-marketed products accounting for 50 percent of the growth in the consumer-packaged goods market from 2013 to 2018. Firms that make investments in more eco-friendly manufacturing techniques and goods tend to capitalize on this expanding consumer demand and capture a larger market share which promotes industrial development.

A variety of payments in the form of subsidies are also in place to encourage eco-friendly production as a result of current worries about climate change. Teichmann et al. (2020) reports that the European Union provides subsidies of US$65 billion a year, three times the amount provided by the US. The US federal government also offers subsidies such as Investment Tax Credit (ITC) and Emission Reduction Credits (ERCs) for renewable energy equipment. These subsidies, tax credits and grants reduce cost of production and increase profitability and expansion for industries (Yu et al., 2016). Lastly, the spill over effects in terms of knowledge and technological dissemination across sectors and country boundaries as industries adopt greener technologies promote industrial expansion and industry value added (Zhao, Jiang, & Wang, 2019; Verdolini & Bosetti, 2017).

Effects of Other Variables on Industrialization in all countries

Gross Domestic Product (GDP) plays a crucial role in enhancing industrialization, contributing to about 76 percent improvement. Higher GDP levels create a favorable environment for investment, technological advancements, and infrastructure development, which further promote industrialization (Escobari & Vacaflores, 2015; Babenko et al., 2020). Strong economic performance attracts foreign direct investment, which supports industrial growth even in politically unstable regions (Ramady, 2014). Thus, maintaining a robust economic foundation is indispensable for fostering industrial development and overall economic progress.

The significant lag value of industrialization shows that the previous year's industry value added is an essential determinant of the current value as it determines about 40 percent of the current value. The study indicated a significant "inverted U-shape relationship between financial development and industrialization (about 69.7 percent increase in industrialization before the threshold and 177.7 percent after the threshold). The presence of financial institutions ensuring better allocation of resources affects the industrialization process positively. Existence of efficient banking system ensuring careful financing to firms, notably small and medium sized firms, reinforce domestic entrepreneurship capabilities (Levine, 1997). However, beyond a certain level of industrialization, overreliance on financial sector for growth may jeopardize the industrialization agenda as the sector may become susceptible to financial crises, and external shocks especially because these economies depend heavily on external sources for finance. Many additional empirical studies have confirmed this finding as well (Manganelli and Popov 2013; Law and Singh 2014; Samargandi et al. 2015). However, this result deviates from that of Kothakapa, Bhupatiraju, and Sirohi (2021), who discovered a U-shaped link.

Trade Openness also influences industrialization positively, increasing it by about 0.179 percent. It is regarded as a crucial component of economic growth because it gives nations access to international markets, encourages specialization, and capitalizes on comparative advantage (Kong, Peng, Ni, Jiang, & Wang, 2020; Pernia & Quising, 2003). Studies show that trade openness boosts industrial development by facilitating the import of essential inputs and the export of raw materials (Ebong et al., 2014), and by promoting efficiency and innovation through competitive pressures and technology transfer (Amsden, 2001). Wong (2009) found that trade reforms significantly improved manufacturing productivity in Ecuador.

Foreign Direct Investment and Human Development Index have a positive relationship with industrialization (Liu, 2002; Su & Liu, 2016). As Foreign Direct Investment increases by US$100, industrialization will increase by 8.91 percent and vice versa. Higher foreign direct investment ensures the infusion of capital, transfer of technology (Liu, 2002 and Su, 2016) and managerial know-how which boost productivity and competitiveness within domestic industries (Ewane, 2020). Also, a 10 unit increase in Human development will lead to a 2 percent increase in industrialization in the regions. Sequeira (2003) argues that investments in education and vocational training are critical to building the technical skills needed to increase productivity in industrial sectors. Intellectual capital, emphasized by Smriti and Das (2018), plays a vital role in enhancing firm performance and productivity in developing country contexts, thereby contributing to industrial competitiveness.

With regards to Real Effective Exchange Rate, there is a negative relationship existing between REER and Industrialization. An appreciation of the currency may promote imports and make a country's exports more expensive for foreign buyers. This can negatively impact export-oriented industries, which are often a key driver of industrialization. (Guillou, 2008).

Linear and Non-linear Effect of EPE on Industrialization by region

The study further analysed the effect of EPE on industrialization according to the regional blocks using the fixed effect model. The results confirm the earlier finding of a significant non-linear relationship between EPE and industrialization in all the regions. However, there are differences in the effect before the threshold and effects after the thresholds. The threshold in each region also differs. These findings are illustrated in Table 4. Asia recorded the highest threshold of 43.47 percent, followed by Sub-Saharan Africa (41.99 percent) and then Latin America & The Caribbean (40.32 percent).

Linear Effect of EPE on Industrialization by region

The results show that, in Asia, EPE has about 4 percent negative impact on industrialization in the initial stages of implementing environmental regulations. This may be due to constraints to production level caused by increased overall cost of production (increment due to high adjustment and abatement of pollution cost). There is a similar result in LAC as a percentage increase in EPE cause about 3 percent increase in industrialization. The situation is however different in Sub-Saharan Africa as implementation of effective environmental policies improves industrialization in the initial stages by 5.87 percent. These figures are significant at 95percent confidence level.

In Sub-Saharan Africa, a 1 percent increase in the Environmental Performance Index (EPE) is linked to a 5.87 percent rise in industrialization, up to a threshold of 41.99. This result differs from other regions and can be attributed to several factors. Firstly, Sub-Saharan Africa is known for its late industrialization efforts, which began in the 20th century. During this period, conversations about climate change were prominent. These climate-focused discussions promote the innovation and adoption of environmentally friendly technologies with high production levels which could account for the positive effect on industrialization. Secondly, the region is known for its least carbon emissions (Fields, 2005 and Kula et al., 2013) with emerging environmental regulations (Jiboku, 2018). Consequently, industrialized nations seeking to outsource or relocate to countries with developing environmental policies find Sub-Saharan Africa attractive, as confirmed by the Pollution Haven Hypothesis. World Bank data confirm huge foreign direct investments in Sub-Saharan Africa averaging about US$30.14 billion from 2002 to 2019, with over 50 percent in the industrial sector and a peak of US$45.55 billion in 2012. This substantial investment has enabled capital-intensive production and rapid industrial sector expansion, increasing industry value added. Supportive environmental policies further encourage the development of innovative sustainable products and services, promoting the growth of eco-friendly industries and aiding industrialization initiatives.

Table 4: Effect of Environmental Policy Effectiveness on Industrialization by Region

	Asia	Latin America & The Caribbean	Sub-Saharan Africa
EPE	**-0.0373*****	**-0.0281*****	**0.0587****
	(0.00963)	**(0.0107)**	**(0.0274351)**
EPE^2	**0.000429*****	**0.000271****	**-0.000699****
	(0.000110)	(0.000125)	**(0.0003297)**
L1. Industrialization	0.550***	0.630***	0.420***
	(0.0346)	(0.0326)	(0.0276037)
GDP	0.416***	0.546***	0.759***
	(0.0463)	(0.0670)	(0 0416486)
Financial Development (FD)	0.237	-0.342	-1.269**
	(0.305)	(0.351)	(0.5599675)
FD^2	-0.526	0.257	0.947
	(0.329)	(0.463)	(0.7085727)
Trade Openness	0.00122***	0.0000474	0.000737**
	(0.000338)	(0.000375)	(0.0003241)
Foreign Direct Investment	0.00196	0.00374***	0.000813
	(0.00115)	(0.00122)	(0.0008023)
HDI	0.178	-1.213***	-1.766***
	(0.449)	(0.449)	(0.3114666)
REER	-0.000221	0.0000561	-0.000918
	(0.000650)	(0.000332)	(0.0004793)
Constant	0.859	1.521	-3.854***
	(0.536)	(3.278)	(0.499489)
R^2	0.969	0.862	0.907
Threshold	**43.47**	**51.85**	**41.99**
N	397	471	719
Hausman chi2	200.41	103.94	494.61
Prob > chi2	0.0000	0.0000	0.000

Standard errors in parentheses $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

Source: Agbesi (2024)

Non-Linear Effect of EPE on Industrialization by region

For Asia and LAC, EPE tends to promote industrialization by 0.04 and 0.03 percent after a threshold of 43.47 and 51.85 respectively. This finding aligns with the earlier findings in Table 4 and confirmed by the conclusions of Grossman and Krueger (1991); Ahmed, Ali, Kousar, and Ahmed (2022); Aslam et al. (2021); Byaro, Mafwolo, and Mayaya (2022); and Munir and Ameer (2020).

This non-linear effect of EPE is different in SSA. Thus, there is about 0.07 percent negative effect on industrialization after threshold (41.99). After reaching the threshold, further increases in Environmental Policy Enforcement (EPE) may yield diminishing returns. Industries may struggle to balance competitiveness with adherence to strict environmental regulations. Overly stringent regulations can impede industrial development, leading some firms to relocate to countries with less stringent environmental standards, as suggested by the Pollution Haven Hypothesis (Copeland, 2008; Gill, Viswanathan, & Karim, 2018; Taylor, 2005).

Effects of Other Variables on Industrialization by region

GDP has a positive influence on industrialization in the all the selected regions (Asia, LAC, and Sub-Saharan Africa). A percentage increase in GDP increases industrialization by 41.6 percent, 87.8 percent, and 75.9 percent respectively. Financial Development reduces industrialization by 126.9 percent in Sub-Saharan Africa. This is counter intuitive as FD is expected to promote industrialization. Trade Openness on the other has a positive relationship with industrialization in all the three regions selected. Also, HDI reduces industrialization by 307.6 percent and 176.6 in LAC and Sub-Saharan African respectively. REER only influences industrialization in Latin America and The Caribbean negatively by 0.19 percent.

Moderating Effect of Regulatory Quality

Moderating Effect of Regulatory Quality for all Countries

The third objective of the study focused on analysing the role of regulatory quality in the relationship between EPE and industrialization. Table 5 displays the results for all the countries. The tests for valid instruments (Sargan test for overidentification) shows the instruments were valid. The autocorrelation values also show the first lag of industrialization is an essential determinant of the current value.

Table 5: Moderating Effect of Regulatory Quality (All Countries)

	Without RQ	**With RQ**
EPE	**-0.0105***** **(0.00313)**	**-0.00729**** **(0.00352)**
EPE^2	**0.000145***** **(0.0000321)**	**0.0000857**** **(0.0000366)**
L1. Industrialization	0.401*** (0.00818)	0.418*** (0.00769)
Gross Domestic Product	0.758*** (0.0101)	0.743*** (0.00976)
FD	0.697*** (0.111)	0.642*** (0.124)
FD^2	-1.777*** (0.160)	-1.795*** (0.194)
Trade Openness	0.00179*** (0.0000586)	0.00182*** (0.0000631)
Foreign Direct Investment	0.000891*** (0.0000979)	0.000926*** (0.000120)
HDI	0.200** (0.0809)	0.0355 (0.0750)
REER	-0.00327*** (0.000198)	-0.00327*** (0.000186)
Regulatory Quality (RQ)		**0.0555***** **(0.00967)**
EPE*RQ		**-0.00583***** **(0.000891)**
Constant	18.17*** (0.920)	16.28*** (0.877)
Chi^2	199370.8	394741.6 (0.0000)
Sargan (p-value)	**85.79 (0.2557)**	**87.28 (0.2211)**
arm1(p-value)	**-2.928 (0.0034)**	**-3.105 (0.0019)**
arm2 (p-value)	**-1.755 (0.0792)**	**-1.925 (0.0542)**

N	1599	1598

Standard errors in parentheses $^{*} p < 0.1$, $^{**} p < 0.05$, $^{***} p < 0.01$
Source: Agbesi (2024)

The positive coefficient of 0.0555 (p<0.05) of regulatory quality supports its moderating role in the effect of EPE on industrialization. The introduction of the regulatory quality variable in the model reduced the negative linear effect of EPE on industrialization from -0.0105 to -0.00729. With a value of -0.00583 (p<0.05), the interaction term between EPE and regulatory quality specifically indicates that a better regulatory environment can somewhat mitigate the detrimental effects of EPE on industrialisation. This shows that countries with strong regulatory frameworks are better able to balance the aims of industrialization and environmental preservation, at least in part offsetting the constraining effect of high EPE.

Country-specific regulatory framework quality has a major impact on how effective these initiatives are. Regulatory quality improves environmental quality through the application of strategies such as decentralization, planning and gradual implementation, performance-based measures, planning and flexible enforcement, prevention, innovation, multi-instrumental approaches, measurement and communication, reflexivity, and sufficient resources. As a result, industries are encouraged to innovate in cleaner technology and processes, which supports sustainable industrial growth. This finding is supported by Chen et al. (2020); Nair et al., (2020); and Yuan and Zhang (2021). Additionally, firms are more likely to adopt sustainable practices in the face of stringent environmental restrictions when a robust legal framework with defined criteria and penalties is in place (Ngowi, 2001; Gainet, 2010).

Moderating Effect of Regulatory Quality by region

The moderating role of regulatory quality for all countries in table 6 is confirmed in Asia. The negative effect of EPE is reduced from -0.0373 to -0.0293 after the Regulatory Quality is added to the model. Regulatory quality also has about 0.6 percent significant effect on industrialization. Even in the face of strict environmental regulations, most Asian nations tend to display more balanced and sustainable industrial growth due to their well-organized regulatory frameworks (Sabir et al., 2020).

Table 6: Moderating Effect of Regulatory Quality by region

	Asia	Latin America & The Caribbean	Sub-Saharan Africa
EPE	**-0.0293*****	**-0.0322*****	**0.0542**
	(0.0107)	**(0.0108)**	**(0. 0276079)**
EPE^2	0.000398***	0.000330***	-0.000721**
	(0.000112)	(0.000127)	(0.0003288)
L1. industrialization	0.534***	0.609***	0.416***
	(0.0351)	(0.0338)	(0. 0275641)
GDP	0.415***	0.631***	0.761***
	(0.0462)	(0.0746)	(0.0414786)
FD	0.120	-0.162	-1.340*
	(0.307)	(0.357)	(0.5592983)
FD^2	-0.384	0.0559	1.079
	(0.333)	(0.469)	(0.7127437)
Trade Openness	0.00117***	-0.000142	0.000847***
	(0.000342)	(0.000383)	(0.0003259)
Foreign Direct Investment	0.00227**	0.00385***	0.000648
	(0.00115)	(0.00122)	(0.0008027)
HDI	0.419	-1.214***	-1.778***
	(0.463)	(0.447)	(0. 310288)
REER	-0.000236	0.0000146	-0.00112**
	(0.000656)	(0.000330)	(0.000483)
Regulatory Quality	**0.00639****	**-0.126**	**0.0912****
	(0.00274)	**(0.0904)**	**(0. 0373088)**
EPE*RQ	**-0.000133****	**0.00179**	**-0.0113**
	(0.0000673)	**(0.00215)**	**(0. 0086133)**
_cons	0.783	5.999	-3.721***
	(0.543)	(3.708)	(0.5010707)
R^2	0.969	0.864	0.908
N	396	471	719
Hausman chi2	216.11	1955.25	453.54

Prob > chi2	0.0000	0.0000	0.000

Standard errors in parentheses $^{*} p < 0.1$, $^{**} p < 0.05$, $^{***} p < 0.01$
Source: Agbesi (2024)

The situation is different in LAC and SSA as regulatory quality does not significantly moderate the effect of EPE on industrialization. One of the reasons for this result is the presence of heavy informal sector in these regions. According to Medina et al. (2017), Sub-Saharan Africa still has one of the largest informal economies in the world, even though this percentage has been steadily falling. A large amount of heterogeneity is also discovered, with informality ranging from a low of 20 to 25 percent in Mauritius, South Africa, and Namibia to a high of 50 to 65 percent in Benin, Tanzania, and Nigeria. The economies of LAC are characterized by similarly high levels of informal work, greater informality heterogeneity, and substantial mobility (Biles, 2008). This means a sizable portion of economic activity takes place in the informal and frequently less regulated sector minimizing the overall moderating impact regulatory quality. This finding aligns with similar results of Elgin and Oztunali (2013) and Swain et al. (2020).

Additionally, the focus of regulatory reform in these nations has not changed from making sporadic adjustments to regulatory frameworks to adopting a methodical approach to regulatory governance and the strategies for fostering and developing it (Sun et al., 2020; Zhang, 2010). Furthermore, historical regulatory policies in Sub-Saharan Africa and Latin America and the Caribbean (LAC) have frequently prioritized economic and developmental concerns over environmental concerns. This emphasis has been influenced by elements including urgent needs for economic development, reliance on resource extraction, a lack of regulatory capability, and short-term political and economic constraints. The reason might account for the insignificant moderating effect of regulatory quality in these regions (King, 2010; Sun et al., 2020).

Conclusion

This chapter discussed the results from the regression and addressed the objectives of the study including the descriptive statistics, correlation matrix, the linear dynamic panel-data estimation, fixed effect model analyses as well as post estimation results. The section discussed these results in the context of all the selected countries and considering the sub-regional dynamics.

The results of the study demonstrate a negative linear relationship between environmental policy effectiveness (EPE) and industrialization in the initial stages, indicating that increased EPE leads to a reduction in industrialization. However, a non-linear effect beyond a threshold (36.21) suggests that after this point, a 10 percent improvement in EPE benefits industrialization by 0.15 percent. This aligns with the Environmental Kuznets Curve.

Thus, the implementation of strict environmental policies tends to negatively affect industries, especially in regions classified as low or middle income, impacting productivity, and causing firms to exit the market. The study aligns with other research that small firms face greater challenges due to compliance costs, leading to their exit from the market, thereby hampering industrial sector growth and contribution to GDP. Also, technological constraints and slow adoption of cleaner technologies hinder industrial expansion in countries in early phases of industrialization. The study also supported the Porter Hypothesis as well the Pollution Haven Hypothesis.

Various sub-regions show varied responses to EPE with Sub-Saharan Africa experiencing an incipient positive relationship between EPE and industrialization, possibly due to heavy foreign investment and less stringent environmental regulations compared to other regions. Asia and Latin America & Caribbean, on the other hand, initially experience negative effects of EPE, suggesting constraints to production due to increased overall cost. However, after reaching specific thresholds, EPE promotes industrialization in these regions. The study found evidence to support the inverted EKC in Asia and LAC but not in SSA.

Regulatory quality plays a moderating role between EPE and industrialization, reducing the negative effect of EPE in countries with stronger regulatory frameworks. Asia shows a better balance between strict environmental regulations and industrial growth due to their well-organized regulatory frameworks. However, in Latin America & Caribbean and Sub-Saharan Africa, regulatory quality does not significantly moderate the impact of EPE due to heavy informal sectors and historical regulatory policies prioritizing economic concerns over environmental ones.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Introduction

The study's summary, conclusions, and recommendations are presented in this chapter. A synopsis of each of the earlier chapters is provided as well as conclusions reached from the results. The chapter also presents pertinent recommendations to influence policy decisions. The chapter concludes with suggestions for further research.

Summary

While some studies demonstrate the positive influence of environmental policy effectiveness (EPE) on industrialization, others argue that implementing these policies could hinder initial industrialization in developing countries. This variance hints at a potential non-linear relationship between EPE and industrialization, which is unexplored in current literature, indicating the need for further examination. The current study examined the effect of environmental policy effectiveness on industrialization in low- and middle-income countries and explored the moderating role of regulatory quality in the relationship. The research employed panel data from 104 countries spanning a period of 19 years (2002 - 2019).

The first objective of the study was to investigate the linear effect environmental policy effectiveness on industrialization. The study utilized system GMM for analysis across all countries and fixed-effect models for regional analysis, exploring relationships within individual countries and across various regional blocks. The study found a significant negative linear relationship between EPE and industrialization for all countries over the study period up to a threshold of 36.21. Similar results were confirmed in Asia and LAC. However, Sub-Saharan Africa deviates as there is an initial positive of EPE on industrialization due to developing environmental regulations.

The second objective was to test the hypothesis that there is no non-linear relationship between EPE and industrialization. Same estimation techniques from objective one was used to reject the null hypothesis. The study found significant positive influence of EPE on industrialization after the threshold. Thus, countries begin to benefit from improving environmental standard and putting in place stringent environmental policies. This confirms the Porter Hypothesis which states that environmental regulations can serve as catalysts for efficiency improvements and innovation, ultimately amplifying a firm's competitive prowess. The result is the opposite in sub-Saharan Africa as there is negative effect after the threshold giving to diminishing returns and withdrawal of investment due to stringent environmental policies.

The study finally looked at how regulatory quality can play a moderating role in relationships. Overall, increasing the regulatory quality of countries improves the effect of EPE on industrialization. Thus, regulatory quality plays a significant moderating role between EPE and industrialization across all countries, reducing the negative effect of EPE in countries with stronger regulatory frameworks. Asia shows a better balance between strict environmental regulations and industrial growth due to their well-organized regulatory frameworks. However, in Latin America & Caribbean and Sub-Saharan Africa, regulatory quality does not significantly moderate the impact of EPE due to heavy informal sectors and historical regulatory policies prioritizing economic concerns over environmental ones.

Conclusions

The study concluded that there is a U-shaped EKC relationship between Environmental Policy Effectiveness and Industrialization. Making environmental policy more effective initially deteriorates industry value added to a threshold and then improves it afterwards. However, the U-shape relationship is not universal for all sub-regions as it does not hold for sub-Saharan Africa.

Regulatory quality is essential to reduce the negative effect of Environmental Policy Effectiveness on Industrialization in the initial stages. Countries with stronger regulatory frameworks experience a reduced negative impact of EPE on industrialization. Nonetheless, for a country to benefit from its regulatory quality, it must be well-structured and directed towards environmental quality.

Recommendations

Since Porter hypothesis is confirmed in Asia and LAC after the threshold, governments in these sub-regions further strengthen the technological innovation of their manufacturing industries. With the use of financial subsidies and tax breaks, governments should push the manufacturing sector to prioritize energy efficiency, reducing emissions, and technological innovation. Simultaneously, the government ought to increase the inspection of environmental law enforcement and notify businesses to engage in strategic innovation to secure policy resources for environmental protection subsidies, sewage charges, and other environmental policies.

Governments, especially in Latin America & the Caribbean and sub-Saharan Africa, should enforce institutional reforms that prioritize environmental quality within regulatory frameworks. They should establish mechanisms that encourage the convergence of economic development and environmental protection, ensuring that regulatory systems are not only strong but also directed towards environmental sustainability.

Authorities of countries in these sub-regions should foster international collaboration and knowledge-sharing platforms to facilitate the exchange of best practices in balancing industrial growth with environmental conservation. There should also be support for countries in LAC and SSA to build capacities for effective environmental policy formulation and implementation. This could include technological assistance, capacity-building programs, and financial aid to enhance capabilities in managing environmental challenges while fostering industrial growth.

Suggestions for Further Studies

Further studies should disaggregate the various EPE indicators and look at the individual effects on industrialization for the sub-regions. The data for the studies should also be updated to see recent dynamics of the relationship between Environmental Policy Effectiveness and Industrialization.

There should be an investigation into factors that could help countries in Asia and LAC to improve their EPE score and significantly push them faster to the threshold. Also, subsequent studies should explore policy measures to help countries in SSA to reduce the withdrawal of investment in the industrial sector with increases in EPE after the threshold.

Further studies could explore other estimation techniques that are more effective for small groups, enabling sub-regional analysis beyond the fixed effects model.

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APPENDICES

A: Expected sign of Variables

Variable	Expected Sign
Environmental Policy Effectiveness	+/-
Gross Domestic Product	+
Financial Development	+/-
Trade Openness	+
Foreign Direct Investment	+
Human Development Index	+
Real Effective Exchange Rate	-
Regulatory Quality	+

B: Pairwise Correlation analysis of Variables

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1) Industrialization	1.000								
(2) EPE	0.050*	1.000							
(3) Regulatory Quality	0.122*	-0.026	1.000						
(4) Gross Domestic Product	0.983*	0.054*	0.158*	1.000					
(5) Financial Development	0.405*	-0.011	0.692*	0.463*	1.000				
(6) Trade Openness	-0.129*	-0.012	0.257*	-0.149*	0.223*	1.000			
(7) Foreign Direct Investment	-0.062*	0.008	0.106*	-0.071*	0.042	0.331*	1.000		
(8) HDI	0.187*	-0.017	0.658*	0.220*	0.703*	0.256*	0.058*	1.000	
(9) REER	0.087*	0.013	-0.071*	0.083*	0.010	-0.015	-0.010	0.043	1.000

Source: Agbesi (2024)

C: Fisher-type unit-root test

Variable	Statistic	p-value
Industrialization	-7.4186	0.000
EPE	-11.0393	0.000
Regulatory Quality	-1.6257	0.0520
Gross Domestic Product	-10.3475	0.000
Financial Development	-22.4443	0.000
Trade Openness	-1.3757	0.0845
Foreign Direct Investment	-8.6571	0.000
HDI	-4.0310	0.000
REER	-21.1380	0.000

Source: Agbesi (2024)

D: Calculation of Threshold

The threshold values included in table 4, and 5 are the turning points of EPE. Given a non-linear relationship between Industrialization and EPE by

$$IND_{it} = \alpha_1 EPE_{it} + \alpha_2 EPE_{it}^2 \ldots \ldots \ldots \ldots \ldots \ldots 1$$

Where IND_{it} is the industrialization and EPE_{it} is the Environmental Policy Effectiveness. Differentiating IND_{it} with respect to EPE_{it} yields and equating to zero yields:

$$\frac{dIND}{dEPE} = \alpha_1 + 2\alpha_2 EPE_{it} = 0$$

$$\textbf{Threshold} = \frac{-\boldsymbol{\alpha}_1}{2\boldsymbol{\alpha}_2} \ldots \ldots \ldots \ldots \mathbf{2}$$

Thus, the Threshold is simply the negative of the coefficient of EPE divided by 2 times the coefficient of the square them.

From Table 4

$$\textbf{Threshold} = \frac{-(-0.0105)}{2(0.000145)} = \mathbf{36.2069}$$

From Table 5

$$\textbf{Threshold (Asia)} = \frac{-(-0.0373)}{2(0.000429)} = \mathbf{43.4732}$$

$$\textbf{Threshold (LAC)} = \frac{-(-0.0281)}{2(0.000271)} = \mathbf{51.8450}$$

$$\textbf{Threshold (SSA)} = \frac{-(0.0587)}{2(-0.000699)} = \mathbf{41.9886}$$

E: Linear Effect of EPE on Industrialization All Countries

	Δ *in Industrialization*
Environmental Policy Effectiveness (EPE)	**-0.00611^{***}**
	(0.000652)
L1. Industrialization	0.411^{***}
	(0.0113)
Gross Domestic Product	0.722^{***}
	(0.0125)
Financial Development (FD)	2.386^{***}
	(0.178)
FD^2	-3.979^{***}
	(0.286)
Trade Openness	0.00206^{***}
	(0.0000480)
Foreign Direct Investment	0.000805^{***}
	(0.0000907)
Human Development Index	-0.611^{***}
	(0.0665)
Real Effective Exchange Rate	-0.00549^{***}
	(0.000221)
Constant	-3.158^{***}
	(0.109)
Chi^2	98489.7
Sargan (p-value)	88.12 (0.2032)
arm1 (p-value)	-3.036 (0.0024)
arm2 (p-value)	-1.640 (0.1011)
N	1599
Standard errors in parentheses	$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

Source: Agbesi (2024)

F: Effect of Regulatory Quality on Industrialization-All countries

	Δ *in Industrialization*
L1. Industrialization	0.417***
	(0.00794)
Gross Domestic Product	0.744***
	(0.0100)
Environmental Policy Effectiveness (EPE)	-0.00935***
	(0.00302)
EPE^2	0.000135***
	(0.0000315)
Regulatory Quality	**0.0532*** **
	(0.00952)
Financial Development	0.669***
	(0.119)
FD^2	-1.821***
	(0.190)
Trade Openness	0.00181***
	(0.0000642)
Foreign Direct Investment	0.000918***
	(0.000112)
HDI	0.0297
	(0.0771)
Real Effective Exchange Rate	-0.00324***
	(0.000179)
Constant	16.31***
	(0.878)
Chi^2	366349.3
Sargan (p-value)	86.96 (0.2282)
arm1 (p-value)	-3.062 (0.0022)
arm2 (p-value)	-1.882 (0.0598)
N	1598
Standard errors in parentheses	* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: Agbesi (2024)