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| **LYDİA IRADUKUNDA** |
| **GREEN GROWTH: HOW NATURAL RESOURCES AND RENEWABLE ENERGY DRIVE FINANCIAL PROGRESS** |
| MASTER THESIS |
| 2025 |



**NEAR EAST UNIVERSITY**

**INSTITUTE OF GRADUATE STUDIES**

**DEPARTMENT OF BANKING AND ACCOUNTING**

**GREEN GROWTH: HOW NATURAL RESOURCES**

**AND RENEWABLE ENERGY DRIVE**

**FINANCIAL DEVELOPMENT**

**M.Sc. THESIS**

**Lydia Iradukunda**

**Nicosia**

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**M.Sc. THESIS**

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**June 2025**

**APPROVAL**

We certify that we have read the thesis submitted by **Lydia Iradukunda** titled **“Green Growth: How Natural Resources And Renewable Energy Drive Financial Development”** and that in our combined opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Educational Sciences.

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# DECLARATION

I hereby declare that all information, documents, analysis and results in this thesis have been collected and presented according to the academic rules and ethical guidelines of Institute of Graduate Studies, Near East University. I also declare that as required by these rules and conduct, I have fully cited and referenced information and data that are not original to this study.

Lydia Iradukunda

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Lydia Iradukunda

# ABSTRACT

**Green Growth: How Natural Resources**

**And Renewable Energy Drive**

**Financial Development**

**Lydia Iradukunda**

**M.Sc., Department of Banking and Accounting**

**June, 2025, 83 pages**

This study investigates the impact of natural resource availability, renewable energy, green technology, and green finance on the financial development of North African economies specifically Egypt, Algeria, Morocco, and Tunisia over the period 1999 to 2021. Recognizing the growing importance of sustainable development, the paper explores how these environmental and technological factors shape the financial sectors in the region, which face unique challenges and opportunities amid global climate and energy transitions. Using advanced panel data econometric techniques, the analysis employs the Pooled Mean Group (PMG), Mean Group (MG), and Dynamic Fixed Effects (DFE) estimators to explicitly account for potential heterogeneity and dynamic adjustments across countries. A Hausman test is conducted to identify the most appropriate and reliable model, with results favoring the PMG estimator due to its superior efficiency and consistency, in capturing both short-run dynamics and long-run equilibrium relationships.

Empirical findings reveal that green finance has a positive and statistically significant relationship with financial development in the long run, underscoring the critical role of environmentally focused financial instruments and policies in fostering sustainable developments. However, its short-run effect, while positive, is not statistically significant, indicating a time lag in translating green finance into tangible financial sector improvements. Green technology demonstrates a robust and significant positive influence on financial development across both short- and long-run horizons, highlighting the immediate and sustained benefits of technological innovation in driving financial development. Renewable energy contributes positively to financial development, with significance emerging only in the long run, suggesting that investments in clean energy infrastructure require longer periods to impact financial systems substantially. Conversely, natural resource availability shows a significant positive effect only in the short run, reflecting perhaps the initial economic stimulus provided by resource exploitation but cautioning against over-reliance on natural resources for long-term financial development.

The paper offers pragmatic policy recommendations aimed at guiding governments and policymakers in the selected North African countries. These include prioritizing strategic investments in green finance mechanisms and technological innovation to catalyze sustainable financial development, alongside policies that support renewable energy expansion and prudent natural resource management to balance short-term gains with long-term resilience. Moreover, the paper highlights avenues for future research, to explore the interactions between these green drivers and other macroeconomic variables, also to address the limitations of the current paper and methodological approaches, to deepen the understanding of green growth dynamics and policy effectiveness in emerging economies.

***Keywords:*** Financial Development, Green Finance, Renewable Energy, Natural Resources, Green Technology

**ÖZET**

**Yeşil Büyüme: Doğal Kaynaklar**

**ve Yenilenebilir Enerji Finansal Kalkınmayı**

**Nasıl Tetikliyor**

**Lydia Iradukunda**

**Yüksek Lisans, Bankacılık ve Muhasebe** **Bölümü  
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Bu çalışma, doğal kaynak mevcudiyetinin, yenilenebilir enerjinin, yeşil teknolojinin ve yeşil finansmanın, Mısır, Cezayir, Fas ve Tunus gibi Kuzey Afrika ekonomilerinin finansal kalkınması üzerindeki etkisini 1999–2021 dönemi için incelemektedir. Sürdürülebilir kalkınmanın artan önemini dikkate alan bu makale, söz konusu çevresel ve teknolojik faktörlerin, küresel iklim ve enerji dönüşümleri sürecinde bölgedeki finansal sektörleri nasıl şekillendirdiğini ele almaktadır.

Gelişmiş panel veri ekonometrik teknikleri kullanılarak yapılan analizde, ülkeler arası olası heterojenlikleri ve dinamik uyumları açıkça dikkate almak için Pooled Mean Group (PMG), Mean Group (MG) ve Dynamic Fixed Effects (DFE) tahmincileri uygulanmıştır. En uygun ve güvenilir modeli belirlemek amacıyla Hausman testi gerçekleştirilmiş ve sonuçlar, hem kısa vadeli dinamikleri hem de uzun vadeli denge ilişkilerini etkili ve tutarlı bir şekilde yakalayan PMG tahmincisinin daha üstün olduğunu göstermiştir.

Ampirik bulgular, yeşil finansmanın uzun vadede finansal kalkınma ile pozitif ve istatistiksel olarak anlamlı bir ilişkiye sahip olduğunu ortaya koyarak, çevre odaklı finansal araçlar ve politikaların sürdürülebilir kalkınmayı desteklemedeki kritik rolünü vurgulamaktadır. Ancak, kısa vadeli etkisi pozitif olsa da istatistiksel olarak anlamlı değildir; bu da yeşil finansmanın finansal sistem üzerinde somut etkiler yaratmasında bir zaman gecikmesi olduğunu göstermektedir.

Yeşil teknoloji, hem kısa hem de uzun vadede finansal kalkınma üzerinde güçlü ve anlamlı bir pozitif etki göstermektedir. Bu durum, teknolojik yeniliklerin finansal kalkınmayı hızla ve sürdürülebilir şekilde teşvik ettiğini göstermektedir. Yenilenebilir enerji, uzun vadede anlamlı hale gelen pozitif etkisiyle finansal kalkınmaya katkı sağlamaktadır. Bu, temiz enerji altyapısına yapılan yatırımların finansal sistemler üzerinde etkili olabilmesi için daha uzun süreler gerektirdiğine işaret etmektedir. Öte yandan, doğal kaynak mevcudiyeti, yalnızca kısa vadede anlamlı bir pozitif etki göstermektedir; bu durum, kaynakların kullanımının başlangıçta ekonomik bir canlanma sağlayabileceğini ancak uzun vadeli finansal kalkınma için bu kaynaklara aşırı bağımlılığın riskli olduğunu göstermektedir.

Bu çalışma, seçilen Kuzey Afrika ülkelerindeki hükümetler ve politika yapıcılar için uygulamaya yönelik politika önerileri sunmaktadır. Bunlar arasında, yeşil finans mekanizmalarına ve teknolojik yeniliklere yönelik stratejik yatırımların önceliklendirilmesi, yenilenebilir enerji genişlemesini destekleyen politikalar ve doğal kaynakların ihtiyatlı yönetimi yer almaktadır. Bu öneriler, kısa vadeli kazançlarla uzun vadeli direnç arasındaki dengeyi sağlamayı amaçlamaktadır. Ayrıca, çalışma, bu yeşil faktörler ile diğer makroekonomik değişkenler arasındaki etkileşimleri inceleyecek ve mevcut çalışmanın sınırlılıklarını ele alacak gelecek araştırmalara da ışık tutmakta; gelişmekte olan ekonomilerde yeşil büyüme dinamiklerini ve politika etkinliğini daha derinlemesine anlamayı hedeflemektedir.

***Keywords****:*Finansal Kalkınma, Yeşil Finans, Yenilenebilir Enerji, Doğal Kaynaklar, Yeşil Teknoloj

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# LIST OF ABBREVIATIONS

**Bn:** Billion

**CO2 emissions** Carbon Emissions

**DFE:** Dynamic Effect Estimator

**ECT:** Error Correction Term

**EG** Economic Growth

**ESG:** Environmental, Social and Governance

**FA** Financial Accessibility

**FD** Financial Development

**FDI** Foreign Direct Investment

**FFSR:** Fossil Fuel Subsidy Reform

**GDP:** Gross Domestic Product

**GF:** Green Finance

**GT:** Green Technology

**MASEN:** Moroccan Agency for Sustainable Energy

**MG:** Mean Group

**NCCS:** National Climate Change Strategy 2050

**NISGP:** National Initiative for Smart Green Projects

**NR:** Natural Resources

**PMG:** Pooled Mean Group

**RE:** Renewable Energy

**SDGs:** Sustainable Development Goals

**SDS:** Sustainable Development Strategy

**USD:** United States dollar

**CDM** clean development mechanism

# CHAPTER I

# Introduction

# Background

Financial progress, natural resources, renewable energy, green technologies, and green finance are some aspects of modern research of sustainable development. Even though these variables are distinctly different from one another, each of them is an integral part of all the countries economy and environmental sustainably development. Economically, countries such as Egypt, Algeria, Morocco and Tunisia which are expansive in index of resources have to maintain equilibrium between optimal economic growth and resource employment. The comprehensive analysis we offer helps understand the region’s sustainable development challenges through the point of view of multidimensional interdependence of the shadow and mainstream economy.

Natural resources remain a driver of financial development globally. Despite the relative importance of such resources to the economy, the resource curse theory is currently garnering increased attention as it indicates substantial issues with the economic growth and development of financial systems in resource boomed economies (Muhammad Asif Khan et al., 2020). People become accustomed to focusing more on resource management and export which leads to corruption, poor governance, and volatile development. It is not uncommon for countries blessed with great amount of resources to be solely reliant on these resources in the economy which would then lead to neglect of investments in other productive areas (Mlachila & Ouedraogo, 2020). Hydrocarbons stand out as the primary export in countries across North Africa and also play a key role boosting the national income, which makes it challenging to realize consistent financial growth. Gylfason (1999) emphasize that the negative sides of being resource-rich, such as a Dutch disease, which emerges when an inflow of resource wealth leads to high exchange rates that makes non-resource industries less competitive, slow down financial growth. The Resource Curse, as it is known, coupled with these challenges, calls for strong institutional arrangements to ensure that income from resources is used in making long term development augmenting investments while ensuring that the financial sector remains robust.

On the other hand, renewable energy can help cope with these issues and at the same time addressing the issues of ecological damage resulting from the paradox of plenty. According to UNDP 2021 global Trends, renewable energy steers sustainable development. The Northern Africa region has several instances, such as Morocco which has been ahead in renewable energy with its Solar Complex (Noor Ouarzazate) the biggest solar energy complex in whole globe. However, renewable energy is capital intensive, components for it are not cheap and availability of suitable policy is critical. Renewable sources of energy investment considerably improve the finance sector (Nucu & Anton, 2019) and increase energy security. So, it could be noted that renewable energy emphasizes innovation and facilitates the entrepreneurship.

The idea of green technology integrally elevates the probability of sustained economic growth because it encourages innovations that are intended to cause minimal harm to the environment. These also include energy efficient machines, better waste disposal which hold the benefits of improving the environment while increasing efficiency in the economiy (Habiba et al., 2022). Within green technology markets, countries endowed with natural resources such as in North Africa are able to meet local demands such as mitigation of desert encroachment and increased water scarcity. As an illustration, solar energy powered desalination plants are useful in responding sustainably to the water scarcity inadequacy in Egypt as well as Tunisia. Nonetheless, green technology adoption and diffusion is difficult without adequate finances. The mobilization of funds for the research, developing and implementation of green innovations is a responsibility of the financial system (Jiakui et al., 2023).

The critical complement for such transformations is green funding as it provides the necessary funds to support activities that are deemed eco-friendly. Green finance is understood as the provision of funds for activities that help protect the environment, hence being an area where the immediacy of environmental and economic issues intersect (Lv et al., 2021). Therefore, the transition towards a sustainable economy is enhanced by investing in clean energy projects, sustainable infrastructure, energy efficiency, etc. Nevertheless, the green finance markets in North Africa are quite nascent, and their characteristics include a thin market structure and a lack of regulatory coherence and consistency (Shahbaz et al., 2021). Efforts by governments, financial companies, and both international and local investors must be done to create the optimal circumstances for investment while mitigating the threat of financial instability.

Simultaneously, the purpose of the research is to comprehend how natural resources, renewable energy, green technology, and green finance and financial development are related in Egypt, Algeria, Morocco, and Tunisia. These nations are more interesting to study because their resource base, the stage of financial development and energy policies are quite different. The insights gained through this research are beneficial, as they can be turned into policies, or assist in making further decisions. The insights will be used to expand the conversation on how to achieve financial development in resource rich economies.

# Statement of the Problem

The building of sustainable economies based on heavy resources poses a difficulty, particularly in regions that have low level of fiscal and institutional development. Egypt, Algeria, Morocco and Tunisia, deal with unsolved problems of poverty - the over-dependence on resources, economic survival, and over-exploitation of the environment. Even though these countries have a huge supply of natural resources, they still suffer from structural issues such as weak economic diversification, inhibited economic development, and pollution. Apart from systematic problems there are various strategic issues regarding the implementation of carbon-free economies that should be resolved.

The theory of the “resource curse” gives an explanation for this paradox; namely that resource abundant countries grow slower in terms of their economies and financial sector development because of factors like rent-seeking behavior, corruption, and weak institutions. At the same time, Morocco is experiencing a few stricter challenges with respect to renewable energy integration as well as green technology implementations regardless of being less resource rich. This point out the importance of recognizing how natural resources might inhibit or promote financial development as a function of the established frameworks by the government and institutions.

Using energy and green technology can help foster sustainable economic development and minimize environmental degradation, while solving most of these problems. However, these technologies are not widely utilized in Northern Africa partly due to a lack of affordable financing, ill-defined policies and insufficient encouragements for private sector participation. Large renewables projects are possible for instance Noor Ouarzazate Solar Complex has been successful, however parallel developments in other countries in North Africa are far behind. This generates discussions on what part financial development plays in alleviating such constraints and attracting the required capital flows.

As a resource mobilization mechanism for investing in green projects, green finance has great potential. However, its use in the region is impacted by shallow market penetration, inconsistencies in regulation and a lack of consistency in application. Green finance has to be explored in more depth for it to successful enable green technology and renewable energy initiatives, and how it can be embedded in the national financial systems. Indeed, the absence of reliable green financing mechanisms adds to the challenges of expanding initiatives of renewable energy and green technology.

Considering the wide variety of topics covered by this research, a substantial amount of literature remains to be generated in order to thoroughly assess the connection among renewable energy, green finance, natural resources, green technology, and financial development in North Africa. Majority of previously mentioned works are focused on individual variables, leaving aside their inter dependencies and interactions which are likely to impact the economic and environmental conditions. This segmented perspective makes it difficult for decision-makers and other participants to develop holistic measures to promote sustainable development.

By focusing on Egypt, Algeria, Morocco, and Tunisia, this research aims at filling out those voids, utilizing the aforementioned variables to explain financial development in the region, and how green technology, renewable energy and natural resources contribute to it. With that in mind, it seeks to aid decision-makers along with other stakeholders come up with policies intended to enhance sustainable development through utilizing financial development.

# Research Hypotheses

The research hypothesis includes:

**H1:** Natural resources have a significant impact on financial development in Egypt, Algeria, Morocco, and Tunisia, with institutional quality moderating this relationship.

**H2:** Renewable energy adoption positively influences financial development by promoting investment and reducing dependency on traditional energy sources.

**H3:** Green technology innovation contributes significantly to financial development by enhancing energy efficiency and reducing environmental costs.

**H4:** Green finance positively impacts financial development by mobilizing capital for sustainable economic activities.

**H5:** The collaboration of green technology, natural resources, green finance and renewable energy on financial development in the selected countries is significant.

# Research Questions

The Research Questions for your study:

* How do natural resources influence financial development in Egypt, Algeria, Morocco, and Tunisia?
* What role does renewable energy adoption play in advancing financial growth in these countries?
* What is the influence of green technology innovation on financial development and in the North African context?
* To what degree does green finance raise financial development in countries with plenty resource?
* What are the synergistic impacts of renewable energy, green technology, natural resources, and green finance on financial development in these countries?

# Study Objectives

The aim of this investigation is to ascertain how factors such as natural resources, renewable energy, green technology and green finance impact financial advancement in Northern Africa economies of Egypt, Morocco, Algeria and Tunisia.through different models, this study aims to analyze and determine the role played by natural resources in the sustainable development of a nation. The studied countries are resource abundant and this study attempts to unravel the complexity of how resource dependency, moderated by institutional quality, influences their financial systems. Moreover this research aims to develop frameworks for enhancing sustainable development through resource rents hence addressing the complex ‘resource curse’ problem. Moreover, analyzing the way renewable energy enhances financial growth and facilitates diversification of the economies of these nations is one of the goals. Environmentally friendly renewable technologies can reduce the reliance on traditional resources and the environmental crisis but are still not well developed in the region due to insufficient funding and financial instruments. The contribution of renewable energy projects to the advancement of the financial sector is analyzed and how it facilitates investment and enhancing regional energy security. Other areas of emphasis include the innovation of green technology. This research aims to assess how technological innovations, especially the ones that are aimed at improving energy efficiency while reducing the carbon footprint, impact economic growth. The spread of green technologies is crucial in dealing with local issues such as desertification and water scarcity, and this research intends to determine the financial and policy conditions that can enable the advancement of those technologies.

Furthermore, the aim of the study is to analyse the ability of green funding in enhancing investments to green growth activities. In the reconciliation of environmental and economic development needs, green finance acts as a crucial mediator, however its inclusion into the financial systems of North African countries has not been widespread. The research considers how renewable energy investment and adoption of green technologies and financial mechanisms can contribute towards economic growth. Additionally, the research is also aimed at understanding how natural resources, renewable energy, and green technology combined with green finance impacts the economic growth of the selected nations. This understanding would help inform policy interventions, as this research will give a picture of how financial systems in economies heavily reliant on resources are structured as a result of several factors.

# Study Justifications

Using Egypt, Algeria, Morocco, and Tunisia as a case study, this research aims to expand the existing hitherto in these North African countries. This case emerges from the larger question of addressing the issues of financial development, reliance on resources, clean energy utilization and, clean economy in a composite manner within the framework of resource dependent countries which is a precise focus of this paper. Such issues further shed light on the question of how these economies can evolve to become sustainable while at the same time build solid financial systems. The concern of over reliance on resources is deeper rooted within the context of resource curse, there is evidence that resource rich nations rich in resources like oil,gas and hydrocarbons are subject to weak institutions implying constrained economic growth and financial progress, this continues to be a shortcoming for a large number of countries global and over time, focused development in this sector can enable positive growth trajectory. In North African regions, this can be seen as structural disequilibrium, lack of economic diversification or relying too heavily on central factors Areas that are external in nature. This research’s rationale also stems from the growing emphasis on renewable energy. Given the growth of international movements in quest of sustainable alternatives to carbon energy sources, such as the Paris agreement, renewable energy has also gained international attention. For countries in North Africa, switching to renewable energy helps tackle environmental problems and provides a unique chance to decrease reliance on exhaustible resources and improve energy security. However, insufficient financing and absence of regulations frequently serve as a bottleneck in the realization of renewable energy projects. This research’s aim is justified in the need to analyze the role of financial growth in renewable energy utilization so as to promote economic growth and environmental protection. Green technology and green finance further justify the significance of this research. Regional problems including water shortages, desertification, and carbon emissions may be met through the deployment of green technology revolution. In the same vein, resource allocation towards sustainability-oriented projects is greatly supported by green finance, but the development of such initiatives in North Africa is still scant. How those variables affect financial development therefore becomes important in developing policies that foster sustainable economic growth. The novel perspectives offered by the issue can contribute to the technological outcome of the country. However, an examination of the current literature reveals considerable gaps. A substantial amount of studies exists on how these variables of finance, market development and economic sustainability, but few studies deal with the interrelationships among natural resources, renewable energy, green technology and green finance in North Africa as a whole. This research addresses that issue within the frame of contextual assessment involving all these indicators and provides concrete policy advice to the relevant authorities. Given its focus on the specific country context, this study seeks to contribute to the dialogue on and financial expansion and diversification in countries endowed with natural resources.

# Contributions of the Study

In particular, this research provides significant political and academic contributions to the literature on economic development of countries with plenty natural resources including Egypt, Algeria, Morocco, Tunisia, among others. These contributions cut across the theoretical, empirical and practical level providing a roadmap for how these structural elements can be effectively knitted to drive the desired changes and economic development. In theory, the paper enhances the existing body of knowledge by introducing a conceptual framework that incorporates natural resources, renewable energy, green technologies and green finance to examine their relationship with financial development. Although these variables have been studied separately in the literature, the relationships among them are quite poorly researched, especially for the North African case. This research addresses that problem and how these influences enhance financial systems in resource abundant countries. By contrast, the study explores the sociopolitical realities to offer context specific recommendations that facilitate financial development in North Africa. This is particularly so for the region under focus as it incorporates unique social, environmental and economic structures. Northern Africa nations of Egypt, Algeria, Morocco and Tunisia were specifically targeted as sources of key data and use their case to interrogate regional and country specific facts for informed policy options. This regional approach adds to the thematic discourse on emerging markets and responds to the institutional void for major global non- renewable resources such as oil, gas, copper, including insights for resource agnostic economies. Political actors, government policy, financial institutions, and other stakeholders are likely to be impacted by financial development policy action choices. It analyzes measures to mitigate the negative impact, such as rent seeking behaviors and economic instability, of being resource dependent while harnessing the nation's financial capacity. In accentuating how combining both these green finance and renewable is significant for achieving financial objectives, the research impresses how these factors are relevant to sustainability of the market in the long run. The research also shows how the innovation of green technologies can be used in overcoming the challenges associated with water and desert in the region simultaneously facilitating the civilization of the financial sector. This looks into impacts of the institutional structure and policy environment on the relationships in green funding and clean energies and any financial systems. This analysis is useful in providing directions on how policies that enhance institutional capacity and enabling environment for sustainable development could be formulated. Lastly, this research illustrates the North African experience and participates in the world discourse about the sustainable development paradigm. These responses provide a basis for rising and achieving the same goal of sustainable strategy in other economies that struggle with dependence on resources and how to navigate an environmentally friendly economy. Through the integration of solutions with an emphasis on sustainability and economic growth, the study adds to advancement the literature, fostering a comprehensive understanding of the problems at hand.

# Research Model

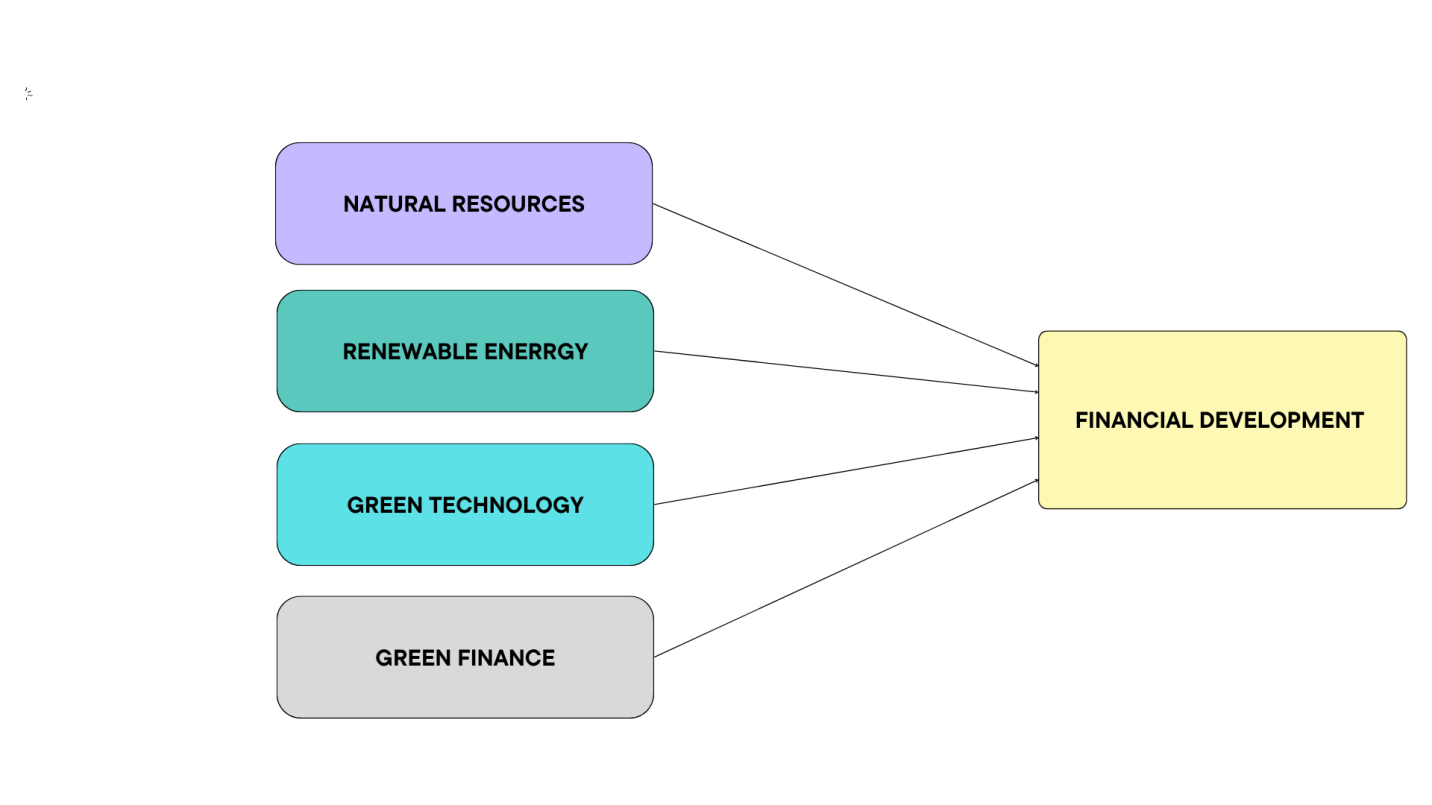


Figure 1: Hypothesized model

# Research Method

The paper uses a quantitative research methodology in examining how natural resources, renewable energy, green technology, and green financing affect financial development, in Northern Africa region from 1999 to 2021. Although the main factors are natural resources (as a % age of GDP), Renewable energy as a part in total final energy use and green finance as International finance received for clean energy while financial development is calculated as financial development index. Given the anticipated occurrence of different orders of integration within the collected data, the paper captures short and long term dynamics in the variables using the ARDL.

Three estimators are used to within the ARDL model, including the Pooled Mean Group (PMG), which assumes that coefficients are homogeneous in the long term but permits diversity during the short run and error variance, moreover the Mean Group (MG), allows complete variability across countries, finally the Dynamic Fixed Effects (DFE), which assumes homogeneity together with fixed effects in the full run. Furthermore the study employs Dumitrescu- Hurlin (DH) granger causality test to assess how these variables granger cause each other. Finally, the unit root tests, cross-sectional dependence, and cointegration diagnostic tests will be utilized to guarantee the model's resilience.

The use of PMG-ARDL ensures that the analysis captures the full spectrum of relationships between the study variables, moving beyond average effects to provide insights that are highly relevant for policy and decision-making. This approach is particularly significant for countries in North Africa, where economic structures, resource endowments, and financial systems vary widely. The findings from this study will offer data-driven recommendations tailored to the specific financial and economic contexts of Egypt, Algeria, Morocco, and Tunisia.

# Sample of study and Data Source

This investigation particularly focuses on the 4 nations of Tunisia, Morocco Algeria and Egypt in North Africa, regarding the assumed interrelationship between financial development, natural resources, renewable energy, green technology and green finance. These specific countries were chosen because of their complexity in economic structures, the extent to which they are resource dependent, and the approach taken towards green technologies and renewable energy. Furthermore, North Africa serves as a good point of departure in the analysis of the interplay of financial growth in emerging countries with plenty resources since these countries share same issues of economic diversification, environmental sustainability, and institutional reforms. The period of the sample is from (1999–2021) due to the availability of good and consistent data for these selected variables. In order to enhance the reliability of the study, the sample data set used for this research was acquired from credible international sources such as the World Bank. The longitudinal data set designed from these sources serves as an important support for the application of the PMG Autoregressive Distributed Lag technique.

# Limitations

The understanding of the correlation of these variable, financial development, natural resources, renewable energy, green technology, and green finance in Egypt, Algeria, Morocco, and Tunisia, is contributed by this study, however this study is still subject to certain constraints. These constraints will be useful when reading the results in a broader application context.

To begin, the research uses only secondary information from either international or national databases. Such sources of information are undoubtedly credible however the accuracy, consistent with the dataset completeness and consistency of the data over multiple countries and variables can vary. In other instances, re-interpolation of missing data, or extending sample periods led to a decrease in set sample size which may affect the outcomes’ strength.

Furthermore, the PMG, MG, and DFE are effective tools in capturing dynamic relationships and accounting for heterogeneity effects across the panel but they do not inherently address potential biases arising from unobserved factors. The disregard of some unobserved factors of individual countries such as informal economy or missing institutional variables is one of the reasons causing biased estimates. Although fixed effects and diagnostic checks help mitigate some of these issues, they cannot fully account for all sources of endogeneity or measurement error.

Thirdly, it is confined to four countries within North Africa. The review of literature offered unique insights into the subject under study, however, it may not be possible to transfer the findings into other parts of the world that have diverse institutional, economic, and environmental frameworks. In relation to energy and finance, the structures may differ, thus, the correlation found in this investigation may not exist in those countries.

This study sets out the basis for future research which may increase the geographical scope undertaken, and include different descriptive techniques or utilize newer data for analysis, in this way describing further green growth in other nations.

# Concepts of the Study

The study revolves around five central concepts: financial development, natural resources, renewable energy, green technology, and green finance which have a distinct yet interrelated function in shaping the economic and ecological trajectory of nations, particularly for emerging and resource wealthy nations like Algeria, Egypt Morocco, and Tunisia.

**Financial Development** is the main component of the research, it is referred to as the financial system’s growth and efficiency, including markets, institutions, and instruments that which mobilize and allocate resources in an efficient manner, it includes metrics like loans to the private sector, stock market growth, and provisioning of various services to individuals and businesses. It is broadly seen as an important enabler of economic development, stimulating investments, promoting advanced technologies, and increasing the robustness of economies. Still, the question of how natural resources, renewable resources, green tech, and green finance impact financial development is still open and is the question this paper attempts to answer.

**Natural Resources** are one of the key economic resources available in numerous regions worldwide, especially in North Africa regions that heavily rely on rents from hydrocarbons such as oil and gas. A standard viewpoint posits that natural resources may be treated as resource rents, that is, revenues from the production and marketing of natural resources. Ironically there could be a detrimental effect on the economy due to this bounty of natural resources. The extrema of this view are that rather than promoting financial deepening, resource dependence may impede it through the resource curse by inducing rent seeking, instability, and weak governance. The dual role of natural resources as both a driver and a potential impediment to financial development is examined in this study.

**Renewable Energy** - Sustainable development is a concept that most nations have adopted to ensure that the generations to come possess the resources they need. It’s no wonder then that renewable energy has become such an important aspect of this paradigm. It is defined as energy generated from resources which are constantly being replenished, including wind, solar, hydropower and biomass. Classic fossil fuels are substituted with renewable sources of energy, which decreases the emission of greenhouse gases and strengthens energy safety. Considering the context of the study, renewable energy is seen both as a stimulus for economic diversification and as a tool for achieving financial development. The investment opportunities created along with a decrease in over reliance on resources makes it evident that renewable energy would aid in changing the economies and helping them move towards sustainability.

**Green Technology** - is all the innovations and technologies which would help improve the condition of the earth while ensuring resources are utilized efficiently. This encompasses developments in energy efficiency, waste reduction, renewable energy sources and low carbon technologies. Achieving sustainable development requires economic growth while curbing the rise of degradation of the environmental which is where green technology comes in as a huge help. The emphasis of this investigation is on the significance of green technology in improving production, costs, and financial development. It also examines what hinders adopting and diffusing green technologies, particularly in resource-rich economies.

**Green Finance** refers to services in the finance sector that seek to encourage sustainable projects and initiatives. Through green bonds, renewable energy project loans, and green investments, infrastructure could be constructed with green technologies at the core. These services help to connect the dots in financial development and environmental protection as they provide funding for initiatives that support sustainable development. In this research, green finance is examined as an approach in which financial development can be encouraged through investment in innovation and sustainable economic activities. As these countries are moving from resource-based economies towards more green economies, the need for going green is crucial for them.

# Organization of the study

The structure of this research is: chapter 1 includes the introductory on the subject matter, definition of the research problem statement, presents research questions, formulates hypotheses, specifies the study objectives, outlines the justification for the investigation, highlights the study contributions, explores the research model and research method, articulates the study’s concepts, the sample of the study and the limitations. Chapter 2 delves into the theoretical and literature review, examining relevant theories and previous studies that inform the current research context. Additionally, chapter 3 presents the methodological framework employed to examine the relationship among natural resources, renewable energy, green technology, green finance, and financial development. Furthermore, chapter4 addresses the results and discussions, whilst chapter five pertains to conclusions and recommendations.

**CHAPTER II**

**Literature Review**

This chapter entails the empirical and theoretical insights of pertinent investigations by different scholars about the linkage of financial development, green finance, natural resources and green technology.

# Empirical Review

# Financial Development and Natural Resources

Having a lot of natural resources used to be seen as a good thing, but now the “resource curse” has started to be analysed in the economic growth literature. Dutch disease, rent-seeking, and the shortcomings of legal framewoks are topics discussed by Caselli and Cunningham (2009) and Sachs (1995) and how they relate to natural resource abundance. However, research indicates how plenty natural resources can be both beneficial and detrimental.

For instance, in countries such as Norway, a strong link between abundant resources and institutional success is seen, that results in development (Mehlum et al., 2006). On the other hand, in nations in which institutions, law regulation, and accountability are lacking, an abundance of natural resources has resulted in widespread corruption (Leite & Weidmann, 1999).

A study by Asif et al. (2020) analysed this 'paradox of plenty theory, revealing how natural resource rents positively and negatively influences financial development over the period of 1975 to 2017 in Pakistan, the ARDL was employed to evaluate overtime link of these factors. In the short-run, forest and oil revenues boosted financial growth however other natural rents decreased financial development for the long term as revealed by the study findings, hence emphasizing the "paradox of plenty". Moreover, another study by Oben (2022) examined the role of natural resources in financial development in the whole world during the years 1980-2019 period. Outcomes showed how natural resources have a statistically significant adverse effect on financial development only in the long term, confirming the hypothesis of a "financial resource curse". Moreover, Huang et al. (2024) explored this relationship utilizing time series data for the period 1990 to 2020 of eleven economies by applying the Panel Quantile Regression. A significant long lasting relationship is found where oil decreases financial growth but natural gas increases financial development.

Furthermore, Kurronen (2015) explores characteristics of the financial system in 128 economies that rely on resources utilizing data from 1995 to 2009. The results revealed a low threshold point where increased reliance on resources starts to negatively affect the domestic banking sector and there were also a tendency of smaller banks in resource dependent economies.

He and Deng (2023) examined how total natural resources rents affect global financial development using novel Quantile-on-Quantile regression model on global data 1990-2020. Natural resource rewards are found to have a predominantly adverse effect on financial advancement in the whole world, backing the natural resource curse, moreover a causal relationship with financial development is found for the long run

Natural resources are found to adversely impact financial development by various studies such as Badeeb et al. (2017) who investigated how paradox of plenty affects banking sector of 12 oil producing economies over the years 2001 to 2019. The results confirmed the presence of ‘the paradox of plenty’ theory. Similarly, Sun et al. (2020) focused on E-7 economies over the years 1990 to 2017. The results reveal a negative impact of natural resources on financial development in emerging seven nations, supporting theory too. Additionally, Muhammad Atif Khan et al. (2020) analyzed the way natural resource rent impact financial development using data from 1984-2018 in 87 nations. By incorporating the importance of quality institutions in this paradigm, findings showed that rewards from natural resources negatively impacts financial development in those economies. Moreover, Han et al. (2022) analyzed this relationship in the ten most rich nations in natural resource, for the years of 1990-2020 using Regression analysis and causality tests. Natural resources are found to reduce financial development in these most natural resource abundant economies.

Moreover, Zhang and Liang (2023) explored 4 South Asian nations, using a non-parametric bootstrap quantile regression approach to analyze how natural resources influenced financial development from 1990-2020, a negative role was confirmed by natural resources on development of financial markets hence confirming the curse.

Q. He et al. (2024) investigated natural resources, economic growth, and financial development relationship in China, in post-COVID era. The novel Fourier Autoregressive Distributed Lag (ARDL) is employed for methodology to examine how natural resources, economic growth, and financial development relate using data over the period of 1991-2020. The study also checked how ICT influences this connection. Natural resources were found to adversely affect the development of the financial sector in china overtime. The integration of Information Communication and Technology can to increase financial development later, but will have adverse effects during the short run when paired with natural resources.

Previous literature provides empirical evidence of how financial development and natural resources link is positive. Natural resources efficiency can be achieved when financial systems are developed. Yuxiang and Chen (2011) argued that enhanced financial institutions can mitigate the adverse effects of this paradox, even though the regions with different amounts of resources are affected differently. Moradbeigi and Law (2017) also analyzed this relationship and found that financial development can facilitate the distribution of wealth from natural resources to other investment projects which would also mitigate the negative impacts of natural resources while potentially changing the curse into a blessing. Moreover, (Yang et al., 2024) on this relationship in the context of  China analyzed data from the period 2000-2019. The investigation applied the ARDL analytical technique to analyse variable dynamics overtime between. A strong and lasting positive link between natural resource efficiency and financial development was found hence highlighting that higher knowledge on finance among individuals and businesses contributes positively to the effective natural resources use. The necessity of channeling funds towards sustainable projects and technologies to improve efficient utilization of natural resource is also highlighted. Moreover, Dosso (2023) examined financial growth in countries rich in resources and the influence of institutional quality. The study employed the Panel threshold technique, an extension of the Hansen Panel Threshold Model to analyze this relationship in a 100 nations for the years 1996 to 2017, hence finding a negative impact of natural resources. Nevertheless, this adverse effect can be reduced to a significant degree (by 78%, 86% or 96%) by improving institutional quality in the nations with abundant resources.

Shahbaz et al. (2024) studied the impact of rents from natural resources influenced international capital accumulation from 1970–2016 in various resource laden-nations. The study revealed an affirmative and significant role of financial development in the studied relationship using ARDL in the selected resource enriched economies during the short and long term. Additionally, K. He et al. (2024) on the nexus between natural resources and economic growth in including the effective role of the financial inclusion and sustainable innovation utilized MMQR (Markov-Switching Quantile Regression) model for primary analysis then employed the FMOLS and DOLS for robustness checks on a yearly data set from emerging economies during 2004-2019 in developing countries. The findings revealed that natural resource endowed emerging economies are subject to the curse, but a positive link exists between financial inclusion and economic growth.

Osman et al. (2025) confirmed how significant financial strategies are in improving renewable energy practices. They investigated panel data from the years of 2000-2020 for Africa. The econometric models such as PCSE and the panel-fixed quantile regression were utilized to analyze the relationship of natural resources, financial development and renewable energy. The outcomes show that while renewable energy is adversely influenced by natural resources and financial development, when analyzed separately, their interaction results into a substantial transition. Precisely, the adverse effects of natural resources on renewable energy consumption can be mitigated through robust financial development. Additionally, Zhong et al. (2024) investigated financial institutions and markets in China are affected by natural resources, for the period of 1983 to 2021, the Bayer-Hanck tool was applied to assess cointegration among the variables both dependent and independent and the the FMOLS model was utilized for primary estimations. The outcomes indicated the ‘paradox of plenty’ impact meaning natural resources negatively impact financial development within complex and institutional indices. However, a "blessing" impact was also noted on financial markets, indicating a complex link between these variables hence confirming the concept of a 'resource blessing' effect, indicating that natural resources availability can enhance the performance of the economy over time. Additionally, financial development can also lead to economic growth. This shows how for leveraging natural resources effectively and promoting overall economic advancement that a an advanced financial system is crucial.

various researchers claim that this curse is nonexistent, pointing out the positive link between having plenty of resources and economic advancement (Sievenpiper et al., 2009).A study by Gylfason and Zoega (2001) also confirms the link between resource dependency and financial advancement. Likewise, Atil et al. (2020) explored this linkage in Pakistan utilizing Long-run covariability and Cross-quantilogram model. The results revealed a positive correlation. Additionally, Yıldırım et al. (2020) investigated how oil rents and other natural resource influence financial development in sixteen emerging nations. The study applied the estimators of PMG and DFE to investigate the long run and immediate relationships. a longterm positive influence was confirmed on financial development from oil rents. However, during the short run natural resources wealth does not have an impact on financial development. Leng et al. (2024) suggested that nations continue to use and diffuse fintech and efficiently extract natural resource. Econometric models of MMQR, FMOLS, and DOLS were applied to check how the natural resources and financial technology cause sustainable development as per STIRPAT, data utilized was for the period of 2000 to 2020 from seven resource rich nations of Brazil, Morocco, China, Russia, Turkey, Saudi Arabia and Botswana. A positive and strong link was found between natural resources and financial technology in sustainable development

Likewise, Tian et al. (2024) analyzed data from USA in the years 1983-2021 using Various econometric models such as the FMOLS, DOLS and the CCR to provide accurate estimations of the long run connections of natural resources, financial and economic development. Findings revealed a positive and strong link in the long run.

# Financial Development and Renewable Energy

This discussion around how the spread of renewable energies is influenced by financial development really heating up. It highlights the need to rethink our financial systems to better support sustainable development. Typically, putting funding clean energy projects comes with huge expenses needed to implement and develop it (Eren et al., 2019).

Financial development facilitates lending in the renewable energy sector. The financial sector advancement is important for development of renewable energy initiatives. A study by Kim and Park (2018) explained a mechanism of sustainable growth may greatly facilitate financial access in clean energy productions. Various studies actually looked into how renewable energy production is driven by clean development mechanisms in selected different nations. They observed how clean development mechanisms enhance the deployment of renewable energy in countries that have nascent capital markets. They highlighted how hard it is to finance renewable energy projects through debt or capital, particularly for financial markets which are not developed. On the other hand, Best (2017) indicates that finances facilitates transition towards better renewable energies. The research examines about 137 countries from 1998-2013, transitioning to capital-intensive clean energy is easier for countries that have a lot of equity.

Mixed findings arise from this research on the connection of these two factors. Kim and Park (2016) investigated this relationship in 30 different economies using data from 2000 to 2013, the results revealed how effects are highly significant advanced financial markets exist. Similarly, Lin et al. (2016) examined what affects renewable electricity utilization by applying th VECM method for panel data (1980 to 2011) in China. Financial development is seen as a supporter of the utilization of sustainable electricity. Ji and Zhang (2019) emphasized these results about China and how financial development is crucial for the advancement of clean energy by contributing 42.4% in its growth fluctuations.

Le et al. (2020) examined some nations from 2005 to 2014, his conclusion confirms findings of Kim and Park (2016) on this connection financial development was found to be important in the advancement of clean energy in developed nations, but have small influence emerging and underdeveloped nations. Additionally, Raza et al. (2020) looked at top nations utilizing renewable energy and how this relationship affects them. The PSTR model with two regimes was applied to analyze data from 1997 to 2017, they discovered the existence of a positive link in the two variables.

The study by Wen et al. (2023) explored this relationship while grouping about 17 nations into 3 sections of high income developing countries, low income developing counties, and all developing nations. The study utilized panel data from 1990-2020. CUP-FM and CUP-BC econometric methods were applied to examine the relationship. A positive link between financial development and natural resources was found in the various countries employed. Moreover, a bidirectional causality link was found in developed countries and all developing countries.

Dimnwobi et al. (2022) this relationship in Nigeria using a wider index for FD and a part of total energy use as renewable energy. Results confirmed the significance financial development in clean energy use in Nigeria. Likewise, Mukhtarov et al. (2022) examined the link between financial development and renewable energy in Turkey using models of VECM and ARDL. The findings from their study indicate an affirmative substantial effect of on renewable energy use in Turkey. Additionally, Rezagholizadeh and Abdi (2022) examined developing and developed nations. The outcomes indicate how for both developed and developing countries, FD advances RE.

Prempeh (2023) reported a positive impact of financial development on renewable energy use in Ghana. Moreover, Chireshe (2021) examined the link in selected sub-Saharan Africa countries in 2000-2016 period and also confirmed a higher renewable energy production capacity as result of financial advancement. Results revealed how financial growth advances the clean energy use, although the influence is not the same for all contexts. Additionally, Sun et al. (2023) analyzed this relationship from worldwide using an econometric estimator and data from 103 nations, outcomes suggest that development of financial systems has an affirmative effect on the use of renewable energy globally.

Habiba and Xinbang (2023) studied this relationship in 7 developing economies in 1991-2018. Using the MMQR, the research found a positive link. Additionally, Zhang et al. (2023) examined the influencers of clean energy in OECD economies, applying GMM model the main model for 36 nations during 1990-2020. Findings from the study indicate that mitigation of issues caused by environmal destruction and enhancement of clean energy use is achieved through financial advancement.

Moreover, Anton and Nucu (2020) looked into this relationship for 28 countries in the EU for the years 1990 to 2015. Utilizing a panel fixed effects method the results confirmed the positive link and how an increase in financial development will increase renewable energy use.

Lahiani et al. (2021) investigated these variables in America from 1975 to 2019. Using nonlinear autoregressive distributed lags model the results confirmed how changes in financial development influence the use of renewable energy. Likewise, Pata et al. (2022) using annual data for  1980–2019 tested this relationship in America, the outcomes confirmed the importance of Financial development growth in sustainable energy.

Vatamanu and Zugravu (2023) have examined the nexus between the quality of insitutions, financial growth and sustainable energy. They employed annual data of 27 EU nations for the years 2000 to 2020. Findings showed how a raise in financial development leads to increase in sustainable energy consumption. Additionally, Assi et al. (2020) also analysed this linkage of FD and RE for 28 selected developed nations over the years of 1996-2017. The study applied ARDL panel method for estimation and also used a DH causality test. It was revealed, development of financial systems and economic freedom are linked to increased use of renewable energies in countries with economic freedom.

Additionally, Hafeez et al. (2022) examined four most polluted nations of Asia and how they are affected by the relationship between financial growth, co2 emission and sustainable energy . They employed panel data for 1995 to 2020 and analyzed it with pmg ardl. A positive impact was found to be by financial development on eco- innovations, moreover the results revealed how using renewable energy reduces carbon emissions in highly polluted Asian countries.

Zhe et al. (2021) utilized VAR analysis to examine annual data from 1990 to 2015, to examine if relationship between clean energy, economic and financial growth is positive. It was found that renewable energy demand advances financial development. Moreover, Skare et al. (2023) studied this link using Cross-country analysis of financial growth data (depth, access, efficiency, stability) for the period 1960-2017 in selected countries and found out that macroeconomic and energy development conditions are crucial in leveraging financing and enhancing financing conditions for renewable energy producers.

Zioło et al. (2024) investigated this nexus in European Union nations from 2013 to 2021 using TOPSIS method to analyze the way these two variables relate. This relationship was found to be different in EU nations, with more financial growth having less progress in sustainable strategies. This is different from previous researches by Ziolo et al. (2020) where in OECD nations, sustainable energy leads to green financial development of the economy as examined with the Data envelopment analysis test on sample data from 2000-2018.

Though numerous previous researchers found a positive linkage of this relationship (Ali et al., 2024; Dimnwobi et al., 2022), some found a negative connection (Wu et al., 2023). An investigation carried out by Saygin and Iskenderoglu (2022) applied Generalized method of moments model to study this link in 20 emerging nations and found out how financial development, as a proxy for banking and stock market, doesn’t affect the demand for clean energy in emerging economies. similarly, Assi et al. (2021) explored the ASEAN +3 nations and how this relationship is, using data from 1998 to 2018. The findings from the ARDL model showed how financial development does not play a major role in the utilization of clean energy for this group. Nguyen (2022) explored nations of Vietnam, Indonesia, Malaysia, Thailand, Philippines and how financial growth relates with clean energy there. The generalized least squares method used found out how financial development adversely affects renewable energy consumption.

Various studies also confirm that carbon emission is mitigated through this relationship, environmental deterioration and unemployment. For example, Kirikkaleli et al. (2022) explored how financial advancement and clean energy come together to mitigate co2 in Chile using non-linear ARDL technique on panel data for the years 1990-2018. Findings clearly indicate how the development of the financial system and utilization of renewable energy mitigates co2 polution.

Additionally, Abbass et al. (2025) investigated the role of developed financial systems, economic globalization, and clean energy on CO2 emissions. Using econometric models on data from 1990 to 2022 in 11 emerging economies to understand relationships and causality among the factors involved overtime. Findings indicate a 1.25% decrease in co2 when there is growth in the financial sector and a 2.90% decrease due to clean energy. This indicates that investment in such sectors is beneficial for ecological development.

Additionally, Tsaurai (2022) investigated the role of development of financial systems and clean energy on unemployment for Northern countries of Africa for 1992 -2019. The findings show how financial development with renewable energy significantly reduces unemployment from Fmols and pooled ols.

Wang et al. (2023) examined impacts of development of financial sector, energy, foreign investments on the environment using data from fourteen EU nations for the years 1995-2020. The Augmented Mean Group and CCEMG methods were used and there outcomes revealed how sustainable environmental development is enhanced by clean energy and new technology in the overtime however the rest of the variables studied show a significant role in driving environmental destruction overtime. Moreover, Tran et al. (2023) examined environmental deterioration overtime and how it is influenced by renewable energy consumption and financial growth. They analyzed data from 1995 to 2020 of ASEAN economies, different analytical methodologies are employed and the outcomes show how heightened consumption of clean energies contribute to environmental degradation reduction, while financial economic expansion and are associated with an escalation in ecological destruction.

# Financial Development and Green (Technology & Finance)

According to literature assessment, financial growth can support economic growth via risk reduction, efficient distribution of fund, and investment assembly (Nawaz et al., 2021). The financial system has the potential to impact energy use and enhance sustainable development of the economy (Paramati et al., 2022). Economic development, expansion of financial markets, and an high capital are all outcomes of more financial development (Abidin et al., 2021; Hwang et al., 2022). Argues that the utilization of automobiles, homes, and power appliances are all enhanced by financial advancement (C. Zhang et al., 2022). As demand increases, pollution rise consumption, these financial sector projects raise co2 effects.

Two factors connect financial markets to economic development and investment activity, claim Shahbaz et al. (2022). First, it involves capital raising for high-return businesses via financial channels. Moreover, it increases productivity. It illustrates how financial development boosts liquidity, diversifies assets, and directs funds toward the most lucrative sectors. The wealth impact, the business impact, and the direct effect are the three ways that financial development affects power consumption. The atmosphere of higher financial growth is linked to the direct impact. In order to buy durable goods and use a lot of energy, consumers can be able to borrow money more readily and affordably (Khan et al., 2022). When financial development enables it easier and more cheaper for businesses to get financial resources, the business effect takes place (Xie et al., 2022). The wealth impact happens when increased economic security boosts energy demand and spurs economic growth (Shahbaz et al., 2022).

Environmental protection may be greatly aided by financial prosperity. Governments can transfer funds to protect environmental programs through an improved financial system (Ayayi & Wijesiri, 2022). Therefore, a better financial system can help advance environmentally friendly industrial technology, which in turn can improve energy infrastructure and lower CO2 emissions (Khan et al., 2022). Second, in order to prevent ecological damage, nations around the world are adopting eco-friendly strategies to enhance their industrial structures (Lu et al., 2022). It needs a sustainable financial structure. Moreover, public corporations have to strictly abide by government laws for environmental protection, which helps to address the issue of environmental degradation (Abbas, 2020). In order to reduce environmental harm, financial development is essential (Bhammar et al., 2021). To lessen environmental harm, nations have to enhance their financial institutions (Olalere et al., 2021).

Moreover, Mehmood et al. (2023)  examines the connected roles of green technology innovation, financial development, and green finance in the context of the Sustainable Development Goals (SDGs) for the G20 countries by applying econometric model of SPSS on data of replies from 250 participants. The results suggest that green funding and green technology innovation are positively connected with financial development in the context of attaining sustainable development goals. similarly, Zhou and Du (2021) investigated how regulating the environment increase financial development for green technology in China using data from 2003 to 2018. The findings confirm that financial development can promote green technological innovation, but the effect is different, it depends on environmental regulation and sustainable finance. The development of green finance, in the context of sustainable development goals (SDGs), is an important driver of green technological progress.

Moreover, Liu et al. (2021) studied the impact of Financial Technology on Green Finance using data from 2015 to 2019 of 3 provinces and cities of Yangtze River Delta in china using The QAP analysis method. The key connection between green finance, sustainable technology, and financial advancement is how financial technology may contribute to advancement of the financial system to support sustainable development, which is a priority for China's sustainable growth. The study found that financial technology has a significant positive impact on the regional development of green finance. Additionally, Sachs et al. (2019) studied the importance of sustainable financeand suggested that Green finance, including new financial instruments and policies, is important to scale up investment in green technologies and achieve sustainable development goals.

Additionally, Yin (2023) explored the nexus between financial development and financial markets in EU nations for the years of 2000 to 2022 using Panel quantile regression method. Findings indicated that financial development plus the stock market have a positive and relevant impact on sustainable economic financing in the EU. Moreover, Jiakui et al. (2023) studied the influence of green finance, financial growth, and clean technology innovation on green total factor productivity in selected provinces of China for the period of 2011-2021 utilizing nonparametric data envelopment test and directional distance function (DEA-DDF) technique. Findings showed that both financial development and green technology innovation contribute to increasing sustainable total factor productivity in China. Green finance in particular is found to have a strong positive impact on sustainable productivity.

Bai and Lin (2023) analyzes the relationship between sustainable finance growth and clean innovation utilizing listed companies in China from 2008 to 2018 using the panel regression model. The findings show that green finance positively improves green technological innovation and reduces the possibility of enterprises declining to engage in sustainable innovation. Additionally, Hsu et al. (2021) evaluated green technology and financial advancement applying data of 28 Chinese provinces from 2000 to 2018 with Ordinary least square (OLS) estimation. The results claimed that financial development has driven green technological development and innovation. Furthermore, Cao et al. (2022) analyzed the impact of financial advancement and technological innovation on green growth in China from 2011 to 2018 utilizing the Spatial Durbin Model. The results revealed that the interaction between financial development and technological innovation has a negative effect on green growth.

Moreover, (Huang et al., 2022) examined the link between green finance and green innovation in 30 china provinces for period of 2009 to 2017, examined spatial autocorrelation and spillover effects of green finance on green innovation. The results revealed that green finance and green innovation are positively correlated.

Additionally, Mirza et al. (2023) analysed the link between fintech investment and Green finance using a fixed effects regression model **examined** European banks between 2011 and 2021. The results showed that investment in financial technology (fintech) has a positive relationship with green lending by banks.

Furthermore, Farooq et al. (2024) investigated how financial advancement influences green technology using data from 6 Gulf Cooperation Council countries for the period 2001 to 2020. They employed fixed effect model and FMOLS model to analyze the assumed connection, the results revealed that financial development has a direct significant positive impact on clean technological innovation in studied nations. Moreover, Çeştepe et al. (2024) confirmed how technological advancement positively affects financial development while natural resources reduce it in the long term. GLS model was used to analyze the influence of technological innovation on financial growth from 1990–2018 for 21 Organization for Economic Cooperation and Development (OECD) countries.

Likewise, Mensah et al. (2019) examined impact of technological innovation on green growth applying STIRPAT and IPAT models on data from 28 OECD economies over the period 2000 to 2014. The research found a significant positive impact of transport-related technology on green growth in the Oceania area of OECD economies and technology for manufacturing of products affected green growth in the OECD Asia region. Additionally, Kharb et al. (2024) analyzed the role of green finance, green technology, financial development, and FDI on environmental sustainability of developing nations. The fixed effect and random effect model plus a robustness check was applied to investigate the relationship using data from 5 selected developing nations for the period of 2000 to 2020. Results revealed that green funding positively impact green technology and have a negative relationship with carbon emissions, while green technology and financial development are positively correlated with carbon emission.

Moreover, Xu and Lin (2024) analyzed the connection between Green capital, green technology, and wind power development for China, utilizing panel data of 30 provinces from 2013 to 2021. Spatial quantile model was applied and the outcomes revealed that green finance has a positive influence on wind power advancement, moreover green technology innovation is an important tool via which green finance influences wind power development. Moreover, L. Zhang et al. (2022) explored the link between green finance, renewable energy and financial inclusion, more specifically the cause of the rise of green finance employing on data over the period of 1990 to 2020. Findings show that green finance and financial inclusion are beneficial to development globally.

Moreover, (Xiong & Dai, 2023) employed the pooled OLS and System-GMM technique to investigate the effect of green finance, technological innovation and renewable energy on sustainable development in China for the years of 1990 to 2020. The outcomes proved that Green finance, Technological innovation and renewable energy advance sustainable development in China. Additionally, Mansour (2023) explored the role of financial service systems in green technology development in China. The study analyzed previous literature in china from top international journals and official documents over the years 2016 to 2022 about the relationship, and the findings suggest policy recommendations of creating a market that supports green technology in China. The study also urges the financial systems financing to finance green technology companies.

Zeng et al. (2023) explored the relationship between green finance and green technology innovation in china. They employed data from 1581 enterprises in the manufacturing sector particularly Shanghai and Shenzhen markets that went public from 2012 to 2020. For the investigation of the influence of green finance policies on green technology innovation, the Difference-in-difference model was applied, findings showed a positive and significant effect of sustainable finance policies on green technology innovation in enterprises by lifting funding constraints. Additionally, Yu et al. (2023) explored the link between renewable energy, financial development, and environmental growth in Asia. The main analytical tool employed by the research was CS-ADL test to examine the influence of clean energy, financial development plus green technology on co2 from 1990 to 2019. The results revealed that financial growth tends to raise co2 emissions, but clean energy and green innovation reduce to CO2 emissions in the long-run. The short-run results align with these findings but show a lower magnitude of impact.

Abbasi et al. (2022) investigated how economic globalization, financial advancement, energy consumption, economic growth and technological innovation infuence consumption and territory-based emissions in Pakistan using data 1990 to 2019. The study employed analytical techniques of Dynamic ARDL and FDC to examine how of variables such as financial development, economic development, and technological innovation influence emissions in Pakistan. Findings from the study indicate how Financial and economic development encourage both consumption and territory-based emissions both immediately and in long term while Technological innovations decrease both consumption and territory emissions substantially in Pakistan in the long term.

Additionally, Lv et al. (2023) analyzed the impact of financial development, green technology, sustainable tourism and economic growth on environmental sustainability. While utilizing an analytical tool of Quantile Autoregressive Distributed Lag model to investigate both the short and long term relationships between the variables, the study employed data for the years 2000-2019 in china. The results show that green technology has a significant and negative effect on ecological footprint however the connection of financial development and ecological footprint is positively significant in the long run. The study suggested policymakers and government officials to channel green technology in order to reduce ecological footprint and increase environmental sustainability for china while also controlling financial development according to environmental guidelines.

Moreover, Ağan (2023) explored the role of financial development, technology, and the ecology on green growth in OECD economies using a panel dataset from 1990-2020. The research used dynamic tools and empirical analysis to analyze cross-sectional and time-series data, which is crucial for understanding the effects of financial advancement in different countries, the results revealed that financial development has a substantial effect on green growth development while economic growth, green technology positively influences the green growth index.

Furthermore, Li et al. (2024) explored how green technological innovations, financial development (measured through efficiency of financial markets and access to financial institutions), and Financial technology influence environmental sustainability in selected Asian economies over the years of 2012 to 2021. The research used CS-ARDL model to analyze the relationships between the variables and the outcomes indicated that efficiency of financial markets and Fintech contribute to high carbon emissions hence deteriorating the environment sustainability, but on the other hand access to financial institutions and Green technological innovations are shown to improve environmental sustainability. This indicates that advancements in technology aimed at reducing environmental impact can effectively contribute to lowering carbon emissions and enhancing ecological quality.

Bergougui (2024) examined the impact of green technology and financial growth on ecological footprint levels, the Fourier autoregressive distributed lag model and the Fourier causality test were employed to examine panel data from 1990 to 2021 in Algeria. The results showed that financial development leads to ecological degradation while clean technology decreases ecological footprint, hence indicating the substantial moderating role of green technology in the relationship between financial development and ecological footprint.

Similarlly, Zhang et al. (2025) investigates different impacts exerted by green finance via green technology innovation on carbon emission intensity. Data from 251 selected cities in China is utilized during the years 2011 through to 2020. The econometric models employed include, the kernel density estimation model, the spatial Durban models and the mediating effect model. Outcomes revealed that sustainable finance plays a substantial role in reducing co2 emissions but sustainable technology innovation acts as a pivotal mediator in the intricate relationship of green funding and co2 emissions. Moreover, Jiang et al. (2022) analyzed the influence of sustainable financial growth on enterprises’ green technology innovation using mediating effect and moderating effect techniques to examine data from 2012 to 2019 for Shenzhen and shanghai listed enterprises (China). Findings suggest that Green finance encourages green innovation by reducing financing constraints.

Shafqat et al. (2023) investigated the role of green finance, technology, and financial growth in mitigating environmental degradation using the Nonlinear Autoregressive Distributed Lag (NARDL) model to capture the nonlinear relationships and intricate dynamics that exist between the variables. The data analyzed was over the period of 1990-2022 from the top 10 CO2 emitting nations. The findings suggest that a multifaceted initiative including green finance, technology transfer, and financial development is crucial in effectively reducing environmental degradation in the top CO2 producing countries.

# Theoretical Review

The Resource Curse Theory (RCT), referred to as the ¨paradox of plenty¨, argues that countries endowed with abundant natural resources often experience slower economic growth and weaker financial sector development compared to resource-scarce economies. This paradox arises from various factors, including weak institutions, corruption, and rent-seeking behaviors that can hinder effective governance and economic performance. This theory has been broadly documented in the literature, with studies showing the detrimental effects of resource dependence on macroeconomic stability, institutional quality, and financial sector growth. Sachs (1995) argue that rather than fostering long-term economic prosperity, resource wealth often leads to structural distortions that hinder economic diversification and financial deepening.

Abundant resources may raise corruption and patronage networks. Akinyetun et al. (2023) explored the link between resource curse and autocratisation in the Sahel utilising qualitative research method. The Sahel region is made up of countries wealthy in natural resources such as oil, gold, uranium and fertile soils. The findings reveal that the abundance of natural resources in the Sahel, when mismanaged, leads to corruption and conflict. Autocrats exploit the natural resources to build patronage networks, which hinders financial development and democratic growth. The study highlights that weak institutions in the Sahel make it difficult for governments to effectively utilize resource wealth for the gain of the population.

Moreover, Azarhoushang and Rukavina (2014) investigated the negative impact of oil revenue on economic performance in china, Iran, turkey and Russia from 2000 to 2010. The paper compares macroeconomic factors and institutional quality of resource wealthy nations and countries not rich n resource to evaluate whether natural resources serve as a curse or a blessing. The results reveal that both Iran and Russia have experienced poor economic performance despite their rich natural resources because of ineffective governments and corruption which reduce financial development and lead to the negative consequences associated with the resource curse.

Moreover, resource curse can lead to deindustrialization, whereby heavy reliance on resource exports can erode manufacturing bases, limiting diversification and sustainable development. Murshed and Murshed (2018) argue that resource-rich countries may experience deindustrialization, where manufacturing sectors decline due to the focus on extraction and export of those resources hence hampering financial growth.

Furthermore, rent-seeking is prevalent in resource-rich economies, where the concentration of wealth in the extractive sector encourages political elites and private actors to engage in inefficient allocation of financial resources, thereby weakening financial institutions and reducing financial inclusion. Asiegbu et al. (2024) examined Nigeria's approach to managing and governing the revenue generated from its petroleum resources. The study revealed that Nigeria's governance and management strategies for oil revenue has contributed to the persistent rent-seeking behavior among political elites, where individuals or groups gain economic benefits through manipulation or exploitation of the political environment rather than through productive economic activities.

Additionally, Wadho and Hussain (2023) argues In ethnically diverse societies, rent-seeking can be raised, steering greater political power concentration and increased income inequality. The study developed a theoretical model to explain how the abundance of natural resources affects rent-seeking activities, which in turn influences income per capita and income inequality. The model divides the economy into two classes: the elite, who have access to political power and may use revenues from natural resources and the non-elite workers. The findings indicate a negative relationship between the size of the elite and ethnic polarization. In societies with high ethnic polarization, there is a greater concentration of political power, which exacerbates the issue of rent-seeking and leads to lower economic performance.

The Dutch disease refers to an economic situation characterized by a rise in foreign income, particularly from natural resources that leads to negative impacts the economic and financial development of a nation. A surge in resource exports steers currency appreciation, reducing the competitiveness of non-resource tradable sectors such as manufacturing and services. This thus restricts the expansion of financial markets via limiting demand for credit from non-resource industries. Brinčíková (2016) argues that Dutch disease leads to adverse effects on financial development particularly in smaller resource wealthy nations. The infusion of foreign revenue may lead to a situation of over reliance on resource exports which can be detrimental in the long run and may lead to the appreciation of the real exchange rate which in turn can harm the competitiveness of the export sector, making it more challenging for these countries to compete in international markets.

Additionally, Brahmbhatt et al. (2010) indicates that when a country benefits from a booming natural resource sector, it often sees a decline in other sectors, especially manufacturing and agriculture. This happens because resources and labor shift towards the booming sector, causing stagnation or contraction in the non-resource tradable fields. Likewise, Hassan (2024) explored particularly the availability of Dutch Disease in the Gulf Cooperation Council (GCC) countries which are known for their significant oil and gas exports. The results confirmed that Dutch Disease is indeed observable in the GCC and a significant negative relationship between the percentage of non-petroleum exports and the consumer price index which means that as gas and petroleum production increases, the non-petroleum export sector tends to decline, which is a hallmark of Dutch Disease.

The debate surrounding this curse theory versus the resource blessing hypothesis is still complex, with evidence endorsing both viewpoints. A few studies reveal that the impact of natural resources on economic growth varies significantly based on context, governance, and the type of resources involved. Norway exemplifies how effective institutions can transform resource wealth into economic prosperity, contrasting with countries like Iran and Russia, where poor a government steers a resource curse (Azarhoushang & Rukavina, 2014). Xie et al. (2021) basing on the resource curse theory investigates the relationship between natural resource reliance and economic expansion in 256 cities of China, covering the period 2003 to 2016. The study revealed that natural resources generally promote economic development which aligns with the 'resource blessing' theory, suggesting that resource-rich areas can benefit economically. Dinga et al. (2024) examined the impact of renewable and non-renewable resource rents on Cameroon's economic growth from1977 to 2018 using the autoregressive and dynamic autoregressive distributive lag models, the results reveal that non-renewable resources are a curse, while renewable resources are a blessing, highlighting the need for proper resource allocation.

The relationship between natural resource dependence and financial expansion has undergone substantial empirical scrutiny. Financial development plays a pivotal role in fostering economic growth by facilitating effective capital distribution, improving credit accessibility, and advancing risk control mechanisms. By applying the CS-ARDL framework, Hou et al. (2023) investigated the resource-curse hypothesis in the Organization of the Petroleum Exporting Countries for the period 1996 to 2021. The outcomes reveal that natural resource rents can promote financial development in high-income economies, and highlight the importance of strong institutional frameworks, government effectiveness, and clean energy adoption in fostering financial progress.

Similarly, Huang et al. (2023) explored the effect of financial development on Resource curse by applying Structural Equation Model for the period of 2010 to 2021 in China. The results revealed that that financial quality development can break the curse through various channels. Yıldırım et al. (2022) argues that in resource-rich countries positive shocks from resource rents may hinder financial development, while negative shocks can enhance it, suggesting a nuanced relationship

However, in resource-dependent economies, financial sector development is often constrained by overreliance on resource rents, which discourages private sector investment and financial sector reforms (Beck, 2011; Yıldırım et al., 2022). Governments in such economies tend to finance public expenditures through resource revenues rather than promoting financial intermediation, leading to underdeveloped banking and capital markets. Additionally, the volatility of resource prices exacerbates financial instability, as fluctuations in resource revenues contribute to economic uncertainty, discouraging long-term financial investments (Corden & Neary, 1982). Despite these challenges, there is growing evidence that resource wealth does not inevitably lead to financial underdevelopment. Countries that have successfully leveraged their resource endowments to strengthen financial institutions have done so by implementing policies that promote economic diversification and sustainable financial strategies (Narh, 2023).

In reaction to the negative consequences of the resource curse, recent discussions have stressed the importance of renewable energy, green technology, and green finance in reducing the adverse effects of resource dependence on financial development. Leonard et al. (2022) argues that renewable energy investments provide opportunities for economic diversification, reducing reliance on extractive industries and fostering financial sector stability. By shifting towards sustainable energy sources, economies can mitigate the cyclical volatility associated with fossil fuel dependence, thereby promoting financial resilience. Green technology further supports this transition by fostering innovation, improving energy efficiency, and forming new economic industries that drive credit expansion plus investment in financial markets (Sun et al., 2025; Zhao et al., 2024). Additionally, Ali et al. (2023) argues that green funding that includes sustainable investments, green bonds, and climate finance, plays a vital role in facilitating financial sector development. By mobilizing capital towards environmentally sustainable projects, green finance contributes to financial deepening and reduces economic volatility, creating a more stable financial environment. Empirical evidence from (Sun et al., 2025; Zhou et al., 2023) suggests that economies that integrate green financial policies experience stronger financial sector performance, enhanced institutional quality, and reduced exposure to the risks associated with resource price fluctuations.

The theoretical integration of the resource curse framework with sustainable financial development highlights the importance of transitioning from resource dependence to a sustainable economy. While the existing resource curse studies emphasize the negative effects of resource abundance on financial sector development, the emerging discourse suggests that resource-rich economies can mitigate these challenges through strategic investments in renewable energy, green technology, and sustainable finance. This perspective shifts the narrative from one of inevitable financial underdevelopment to one that recognizes the ability for resource wealth to be harnessed for overtime financial sector growth, provided that the right institutional and policy frameworks are established. Through examining the interplay between financial development, natural resources, renewable energy, green technology, and green finance, this study contributes to the growing body of literature exploring sustainable pathways for financial sector expansion in resource-rich economies.

# CHAPTER III

# Methodology

# Introduction

This chapter presents the methodological framework applied to scrutinize the effect of natural resources renewable energy, green finance, and green technology in the financial progress of North African countries; Egypt, Morocco Algeria and Tunisia over the period of 1999 to 2021. This research aims to empirically analyze the impact of green growth mechanisms on the advancement of the financial sector in a region wealthy in resources and undergoing transitions in energy initiatives. Considering the panel nature of the data and the possibility of cross-sectional dependence among nations, the analysis employs a comprehensive group of econometric tools designed to identify both long-term equilibrium correlations and short-term changes.

The initial part of the methodology chapter, data provides brief description of the variables used in the study, their measurements and sources. The estimation tools part adresses the preliminary tests utilized, inclufing the Cross sectional dependence (CSD) test, Cross-Sectionally Augmented Dickey-Fuller (CADF) test, and Cross-Sectionally Augmented IPS (CIPS) test, to evaluate cross-sectional interdependence and order of integration in the panel data. The Westerlund Cointegration test is employed to investigate the existence of long-run relationships among key variables.

Following the preliminary tools, this research employs 3 econometric estimators—Pooled Mean Group (PMG), Mean Group (MG), and Dynamic Fixed Effects (DFE), to analyze both long-run plus short-run interactions within the Autoregressive Distributed Lag (ARDL) framework. These methodologies present differing assumptions on slope homogeneity and error correction process, facilitating a thorough investigation of the effect of independent variables on financial development over time. Finally, the Dumitrescu-Hurlin Panel Granger causality Test is employed to investigate the directionality and causation among the variables.

Together, these methods establish a robust empirical basis for analyzing the relationship between the independent variables and financial development in North Africa.

# Data

This research employs yearly secondary data spanning from 1999 to 2021 to examine the impact of natural resources, renewable energy, green technology and green finance on financial development in North African nations (Egypt, Algeria, Morocco, and Tunisia). These nations are selected due to their strategic location and shared characteristics of natural resource wealth, growing renewable energy, clean technology adoption, green finance and the availability of data.

The explained variable, Financial Development (FD) refers to the process of improving and growing the financial system of a nation to facilitate economic growth. It enables access to financial services and efficiency of financial institutions. The independent variables, firstly natural resources are the assets and raw materials found in the environment including fossil fuels, minerals, and forests which forms a country's wealth and are used for economic development. Renewable energy refers to the natural resources that are continuously generated including wind, hydropower, biomass, and geothermal energy which may be used to produce electricity, heat, and fuel with low ecological footprint. Additionally, green technology is the development and utilization of products, equipment, and systems that reduce detrimental effects on the environment with the objective of fostering sustainability and preserving natural resources. Finally, green finance refers to financial activities including loans, debts and investments created to ensure environmental stability hence aligning with sustainable development.

The econometric model is as follow:

**(1)**

In the above model, financial development, natural resources, renewable energy, green technology and green financing, are represented by the factors , , , and respectively. Moreover, refer to intercept, coefficients for explanatory factors (NR, RE, GT and GF), sample nations taken to study, time period (1999-2021) and white noise, respectively. Additionally, Table 1 provides comprehensive details on the studied variables and Figure 2 shows a graphical representation of variables.

Table 1. Variables summary

|  |  |  |  |
| --- | --- | --- | --- |
| Variables | Abb. | Measurement | Source |
| Financial Development | FD | Financial development index | IMF (2025) |
| Natural Resources | NR | Total natural resources rents (% of GDP) | WDI (2025) |
| Renewable Energy | RE | Renewable energy consumption (% of total final energy consumption) | WDI (2025) |
| Green Technology | GT | Measures the environmental impact and sustainability of technologies, often incorporating various indicators related to resource efficiency, pollution reduction, and renewable energy adoption | IRENA |
| Green Finance | GF | International finance received for clean energy | OWD (2025) |

Source: Author Compilation

**Green growth trend**

Figure2 demonstrates the movement of natural resources, financial development, green finance, green technology and renewable energy for the four nations over the period of 1999 to 2021.examining this graph helps gain insight into the evolution of the selected variables across the Northern Africa region.

For natural resource, Egypt shows notable fluctuations with peaks around 2008 then declines after, Algeria shows higher levels of natural resources while Morocco and Tunisia show low levels of natural resources, suggesting reduced dependency on natural resources compared to the other countries.

Moreover, financial development shows a generally increasing trend for all nations, Egypt shows the highest levels of financial development but with some fluctuations. Algeria appears relatively flat, indicating a slow moving financial sector while Morocco shows a steady upward moving trend, indicating a strong financial system.

Green finance shows sharp irregular spikes in its trends. Algeria appears very low for the most period with a slight increase from 2011. Egypt shows the highest levels of green finance of about 2 billion around 2018 followed with a sharp decline, Tunisia shows more levels of green finance compared to Algeria. However, Morocco shows a more sustained trend level of green finance. Additionally, green technology shows volatility there is no clear upward or downward trend. Egypt shows spikes with the highest peak in 2014, suggesting specific projects or measurements for green technology adoption that are not consistent, Algeria and Tunisia show relatively low levels of green technology with noticeable volatility indicating cautious adoption of green technology. Morocco shows an upward trendy, indicating consistent investment in green technology.

Finally, renewable energy shows a more continuous upward trend, Egypt demonstrates a significant increase after 2014, Morocco and Tunisia indicate a consistent upward trend, while Algeria remains relatively low for the most part but shows an increase around 2007.



*Figure 2: variable trends*

## Descriptive statistics

The collected data is summarized and organized in a more meaningful way. This provides a simplified better view and understanding of the organized variables; Natural Resources, Renewable Energy, Green Technology, Financial Development and Green Finance.

The descriptive statistics of the variables are shown in Table 2. in a more understandable and meaningful way

It is ascertained that natural resources has an average growth rate of 9.734 with a deviation from the sample mean of 9.263. renewable energy has an average of 8.643 with a standard deviation of 5.926, green technology with a mean of 2.263 with a standard deviation 2.9, financial development possessing an average growth rate of 0.24 with variation of 0.087, green finance has a mean of 1.56E+08 and a standard deviation of 3.33E+08. This revealed that the deviation of each of the series from the sample mean is moderate. The discoveries also depict the median values of the parameters in which natural resources (NR) possesses a median value of 6.137, renewable energy (RE) 9.600, green technology (GT) 1.000, financial development (FD) 0.246, and green finance (GF) 176. The value of maximum value of natural resources (NR) is 34.191 and the minimum value is 0.195. Renewable energy, green technology, financial development and green finance possess maximum units of 22.400, 13.000, 0.434 and 2.06E+09 respectively and minimum values of 0.100, 0.000, 0.114 and 0.000 accordingly. The Jarque-bera statistics reveals that the data is not normally distributed. This is backed by the crystal fact that most of the factors probabilities are below 5%; specifically, natural resources, green technology and green finance while renewable energy and financial development has a probability value greater than 5%. In terms of skewness, natural resources, green technology, financial development and green finance are positively skewed while renewable energy (RE) is negatively skewed.

Kurtosis that indicates the extent to which the information included in point estimates related a certain distribution deviates from that of normally distributed data. This may also be utilized to assess for the existence of extreme numbers in dispersion. This gauges how many tails are in the concerned dispersion .The kurtosis values indicate how renewable energy and financial development are platykurtic while natural resources, green technology and green finance are leptokurtic.

Table 2: Descriptive Outcome

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | NR | RE | GT | FD | GF |
| Mean | 9.734388 | 8.463043 | 2.26268 | 0.240789 | 1.56E+08 |
| Median | 6.136794 | 9.600 | 1.000 | 0.246109 | 17615000 |
| Maximum | 34.19132 | 22.400 | 13.000 | 0.434173 | 2.06E+09 |
| Minimum | 0.194633 | 0.100 | 0.000 | 0.113803 | 0.000 |
| Std. Dev. | 9.262695 | 5.9258 | 2.931058 | 0.086907 | 3.33E+08 |
| Skewness | 1.098237 | -0.07753 | 1.495524 | 0.076633 | 3.588282 |
| Kurtosis | 3.059202 | 1.880163 | 4.580576 | 1.847571 | 17.42054 |
| Jarque-Bera | 18.50736 | 4.899311 | 43.87092 | 5.18107 | 994.5775 |
| Probability | 0.000096 | 0.086323 | 0.000 | 0.07498 | 0.000 |
| Sum | 895.5637 | 778.6 | 208.1666 | 22.15256 | 1.44E+10 |
| Sum Sq. Dev. | 7807.575 | 3195.474 | 781.7904 | 0.687302 | 1.01E+19 |
| Observations | 92 | 92 | 92 | 92 | 92 |

Source: Authors’ compilation

# Estimation Techniques

This study firstly utilizes preliminary tests to assess the characteristics of the data then selects a methodological approach based on the determined data characteristics.

Firstly, the preliminary tests employed in the first phase, include the Cross-sectional dependende estimator (CSD) which helps determine if we are to employ the 1st or 2nd generation unit root test, afterwards the study utilized the second generation unit root tests of CADF and CIPS, additionally, to evaluate variable cointegration, westrlund cointegration test was utilized.

Secondly, the study utilized the ARDL model depending on the outcomes from the preliminary tests. Finanly, the Dumitrescu-Hurlin Panel Granger Causality test is applied to test the casual relationships between the variables.

# Cross‑sectional dependence (CSD) estimator

The Cross-sectional dependence test is utilized in our study to determine the best statistical approach. This test is applied on panel data analysis to determine whether there is correlation across cross-sectional units due to shared unobserved characteristics, like common shocks spillover effects. Indeed this test is crucial for our nations due to their geographical closeness, they could be having common characteristics.

The outcome of this test enables us to choose the appropriate unit root test method (first or second generation). In presence of cross sectional dependence in the panel setting, the study will use second generation unit root test, the first generation unit root test may not be valid because it assumes independence of the panel units. This CSD test is important for this research because it helps get unbiased, reliable and efficient results, neglecting cross sectional dependence may lead to skewed and biased results of limited importance (Ali & Seraj, 2022).

Different cross-sectional dependence techniques are commonly used in literature such as the Breusch and Pagan (1980) Lagrange multiplier test , andtests (Pesaran, 2004), later adjusted by Pesaran et al. (2008). Our research uses the Pesaran (2004) tool.

Therefore, we used CSD in our research so that we might avoid some of these concerns. The equation of CSD is written as follows:

(2)

Where;

=

is the correlation coefficients of the residuals of ADF estimation.

Additionally, the T represents time while the N represents cross-sectional area.

The null hypothesis for this test states that there is no relationship between cross-sections; the alternative hypothesis asserts that there is a relationship between cross units.

# Panel unit root estimator

Moreover, we checked the unit root to evaluate the steady state of our framework indicators, before proceeding with the cointegration assessment. The results from the CD test reveal how the 1st generation stationarity test might face certain inefficiencies due to its assumption of cross-sectional independence. So, to focus on the inefficiency in estimating, we utilized the second-generation stationary test, specifically the “ Cross-Sectionally Augmented Dickey-Fuller (CADF) and Cross-Sectionally Augmented Im-Pesaran-Shin (CIPS) test.” These tests are expressed mathematically in Eqs. (3) and (4), respectively, below:

(3)

(4)

Where;

refers to intercept,

, refers to factor estimation,

is variance operator,

*T* and refer to times interval, and white noise.”

The CIPS and CADF tests are crucial in panel data analysis because they provide more reliable and robust outcomes when there is cross sectional dependence.

# Panel cointegration estimator

To evaluate variable co-integration the study uses the cointegration test proposed by Westerlund (2007). the westerlund cointegration tool assumes heterogeneity and cross sectional dependence and it is also appropriate for small N and large T panels, hence becoming perfect for our research.

Westerlund (2007) suggests that there was no co-integration for the panel co-integration tool, hence being the a null hypothesis. The Westerlund panel co-integration test assumes the presence of error correction for each panel member and the panel as a whole without any common-factor limitation.

# PMG ARDL approach

In this second phase the study bases on outcomes from the previous tests; the Cros-sectional dependende test (CSD), unit root tests of CADF &CIPS and westrlund cointegration, our study applied the PMG-ARDL model. Pesaran et al. (1999) introduced the Pooled Mean Group (PMG), Mean Group (MG), and Dynamic Fixed Effect (DFE) estimations under the Maximum Likelihood Method for Estimation. Expression (5) below presents the panel regression as a group in the error correction model within the PMG;

(5)

Here 1,2,3…N stand for the number of chosen countries, *t* = 1,2,3,4…,t shows the annual periods, (s) represents the time lag numbers. The explanatory variables lag is denoted by (p) while (n) the independent variable lag. The key variables are financial development (FD), green technology (), renewable energy (), green finance (), and natural resources is , lastly is the error term that has fixed effect. The equation (5) is rearranged basing on Pesaran et al. (1999) into the formula presented as follows:

(6)

where, and ,

We can also modify equation (6) by incorporating the error correction formula by grouping parameters at their levels.

(7)

The vector for longterm equilibrium relationship between [ and ] is shown as [ ]. The short-term parameter is linked to past values and new growth dynamics, such as variations in [] are represented by [ and ].

Finally, the error adjustment parameter is [], that assesses the speed of adjustment of [] to the long-run equilibrium after a diversion in []". The factor or parameter should be both significant and negative to build a long-term connection (< 0). Now that the [ ] is significantly negative, it endorses integration. As a result, the following estimates are computed:

(8)

Here S is equal to 0, …..,p-1.

The model below is derived based on approach of equation 7:

(9)

The PMG ARDL model is used for panel data analysis to estimate long run and short run relationships between variables simultaneously, it is particularly used where there is a mixed order of integration, cointegration and heterogeneity, hence providing robust outcomes.

The PMG estimation proposed by Pesaran et al. (1999) assumes long-run homogeneity of the slope coefficients and assumes short-run variability of coefficients. It is the most efficient if there is longterm homogeneity, which is usually the case for panel data.

The next estimator for the ARDL model is the Mean Group estimator introduced by Pesaran and Smith (1995), it is used for study on a country-by country basis in the short and long run .The MG method, assumes both long-run and short-run heterogeneity of parameters unlike the PMG that only assumes heterogeneity in the immediate term, the MG is less efficient than PMG if the long-run homogeneity assumption is correct.

Finally, the DFE estimator allows short and long-run homogeneity constraints, assuming that all parameters both short-run and long-run are the same (homogeneous) across all cross-sectional units. This assumption is too restrictive among all the three and could be biased where there is heterogeneity. The limitation of these estimators is that none of them assumes cross sectional dependence.

## The Hausman Test

Our study employs the hausman test by Hausman (1978) to compare the Pooled Mean Group (PMG) estimator with both the Mean Group (MG) and Dynamic Fixed Effects (DFE) estimators within the ARDL framework. This procedure tests the validity of the long-run homogeneity assumption and informs the selection of the most appropriate model. The Mean Group estimator while robust to diversity can be less efficient than the PMG when the long run coefficients are homogeneous across units.

The null hypothesis of this test assumes that the difference in coefficients is not systematic, meaning that the PMG estimator is more consistent and efficient while the alternative hypothesis assumes that the difference in coefficients is systematic, suggesting that the PMG is incostisent and less efficient if the long term parameters are not homogeneous therefore MG is more efficient. If the hausman test is not significant, PMG is more efficient and appropriate.

# Dumitrescu-Hurlin panel granger causality test

The P-ARDL can provide important presumptions about the coefficients, however, the results may not display causal relationships between variables. Therefore, our study adopted the Dumitrescu-Hurlin Panel Granger Causality Test by Dumitrescu and Hurlin (2012) to examine the causal relationships among natural resources, renewable energy, green technology and financial development in North African countries.

This test modifies the old Granger causality framework for panel data, maintaining sufficient power and robustness to include short time dimensions while allowing for heterogeneity in causal links among cross-sectional units.

The Dumitrescu-Hurlin test is based on the following dynamic panel regression model:

(10)

Where:

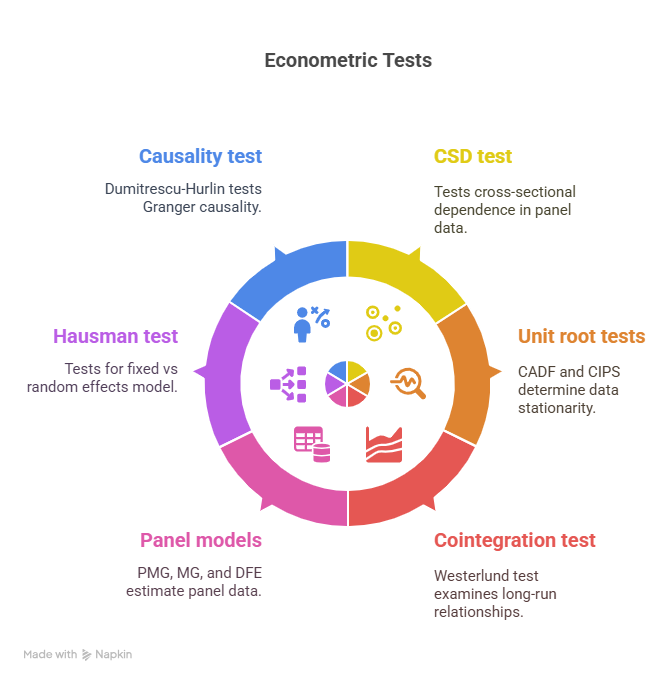
X, , refers to a constant term

X, , refers to the parameter of lag

), , and, represent coefficients that can channge across cross-sections

The null hypothesis of the test assumes no Granger causality for all cross-sectional units (not homogenous)

The alternative hypothesis allows for causality in the panel results for atleast some units



*Figure3: methodological flow*

Source: author’s own

# CHAPTER IV

# Findings and Discussion

## Introduction

This chapter presents the outcomes from the various econometric tools applied to examine the data. The findings from each analytical tool utilized in chapter (3) above is analyzed and explained in this chapter (4). Here, the impact of natural resources (NR), renewable energy (RE), green finance (GF), and green technology (GT) on financial development (FD) in the short run and long run is determined through the P-ardl analysis.

## CSD outcomes

The outcomes from CSD test demonstrate if the variables or residuals in the study are correlated across various countries in the panel datasets. This tool is important because it helps ascertain the suitable unit root test method for the next step of our methodology, ignoring cross sectional dependence would result in bias estimates.

The CSD test results are shown in Table 3, The outcomes of t-statistics of this test for FD (2.743), GF (0.425), GT (3.943), RE (7.876), and NR (7.132) are significant at 1%, suggesting the presence of cross-sectional dependence.

Table 3: CSD Outcome

|  |  |  |
| --- | --- | --- |
| **Variable** | **CD-test** | **p-value** |
| **FD** | 2.743 | 0.006 |
| **GF** | 0.425 | 0.036 |
| **GT** | 3.943 | 0 |
| **RE** | 7.876 | 0 |
| **NR** | 7.132 | 0 |

Source: Authors’ compilation

## Panel unit root test outcomes

Moreover this investigation checks the order of integration of the coefficients in the research. We employ the CADF and CIPS unit root tools by Pesaran (2007) to address homogeneity issue. Due to the inefficiency of first order unit root tool, the second order unit root tools such as the CADF and CIPS unit root tools are suitable in this study. To yield reliable outcomes, the study employs CIPS and CADF to accurately look into the study’s variables stationarity.

The results of these tools are presented in table 4. An asterisk (\*) in the CIPS column indicates the test statistic is significant at the 1% level, while the CADF column shows the test statistic and p-value, values below 0.01 are statistically significant. The results for CIPS reveal that at level, green finance, green technology and renewable energy are notably significant and stationed at levels, while financial development and natural resources are not significant and stationed at level however at the first different they both became significant at 1% level.

Moreover, the CADF outcomes reveal that both green finance and green technology are stationed at level with a probability value of 0.02 and 0.01 respectively. However, financial development, renewable energy and natural resouces are all statistically significant and stationed at the first difference with a p value of 0.00, 0.00 and 0.03 accordingly.

These results show how neither of these variables accepts the no stationary hypothesis, given that there is a mixed order of stationary of variables at I(0) and I(1) making them suitable for panel cointegration analysis in the next stage of the empirical framework.

Table 4: Stationary Outcome

|  |  |  |
| --- | --- | --- |
| **Variables** | **CIPS ESTIMATOR** | |
| **Level I(0)** | **First Difference I(1)** |
| **FD** | -2.17 | -4.053\* |
| **GF** | -3.936\* |  |
| **GT** | -2.839\* |  |
| **RE** | -2.896\* |  |
| **NR** | -1.576 | -3.318\* |
|  | **CADF ESTIMATOR** | |
| **FD** | -0.610 [0.27] | -3.617 [0.00] |
| **GF** | -2.046 [0.02]\* |  |
| **GT** | -2.186 [0.01]\* |  |
| **RE** | -0.652 [0.25] | -3.130 [0.00] |
| **NR** | -1.094 [0.13] | -1.868 [0.03] |

Source: Authors’ compilation.

## Panel cointegration outcomes

Furthermore, the study investigates how these variables are connected in the long run. The analysis employs the Westerlund (2008) technique to demonstrate the long run relationship among the parameters. These cointegration techniques are used due their reliable outcomes. The result of Westerlund panel cointegration test is displayed in table 5. Outcomes divulge the long run relationships among the variables. The group statistics (Gt and Ga) test the null hypothesis of no cointegration for at least one cross-sectional unit, while the panel statistics (Pt and Pa) test the null hypothesis for the panel as a whole.

The probability values for Ga and Pa are 0, indicating significance at 1% level hence rejecting the null hypothesis denoting that there is no co-integration between the variables. This affirms a long run relationship between FD, GF, GT, RE and NR. The shocks to each factor can cause overtime impacts on the others.

The probability values for Ga and Pa 0.997 and 0.954 accordingly, show that we accept the null hypothesis which could be due to the smaller sample size. These reports can be utilized as a guide for the co-integration of the whole panel or one of the panel countries.

Table 5: Cointegration Outcome

|  |  |  |  |
| --- | --- | --- | --- |
| Statistical | Value | Z-value | P-value |
| Gt | 3.061 | 9.801 | 0 |
| Ga | 0.06 | 2.795 | 0.997 |
| Pt | 1.422 | 3.674 | 0 |
| Pa | 0.047 | 1.685 | 0.954 |

Source: Authors’ own

## PMG ARDL Results

The study employed the pmg-ardl technique to investigate the relationship between the explained variable (financial development) and the explanatory variables (natural resources, green finance, green technology and renewable energy). The Pooled Mean Group (PMG), Mean Group (MG) and Dynamic Fixed Effect (DFE) estimators within the ARDL framework were employed for a comprehensive analysis.

This method was employed specifically for this research because it allows analyzing both the long term and short term relationships between variables at the same time. It also permits the estimation of variables with different stationarity, such as I (1) or I (0).

The MG estimator assumes heterogeneity for both short run and long run coefficients. The PMG estimator on the other hand assumes homogeneity only in the long-run coefficients while allowing heterogeneity for the short run coefficients and error variances. The DFE estimator assumes that all coefficients, both short-run and long-run, are the same (homogeneous) across countries.

The MG is effective in the absence of long-run homogeneity, which is not invariably applicable to panel data, particularly in our dataset where the nations exhibit similar characteristics and are geographically proximate. The DFE is the most restrictive because it assumes homogeneity for both long run and short run coefficients, because it is unlikely for the dynamics of the relationship between variables are identical across all units. However the PMG is the most efficient among all three because it allows balance by assuming both variability and homogeneity.

The MG, PMG, and DFE findings, shown in Table 6, reveal that all selected explanatory variables, Green Finance (GF), Green Technology (GT), Renewable Energy (RE), and Natural Resources (NR) have an influence on the Financial Development (FD) of the nations studied both in the long and short run, although the size and direction vary in estimators. However, natural resources link with financial development is not significant under the PMG estimator in the long term, and in the short run under the DFE. Moreover, Green finance is not significant in the short run under both MG and PMG models finally, short term renewable energy is not significant in the PMG model.

These results demonstrate coherence and reinforce the notion that sustainable development inputs play crucial roles in shaping the financial landscape of North African nations.

The results show that the financial systems of these countries adjust from short termdisequilibrium to long-run equilibrium at varying speeds as indicated by the Error Correction Term (ECT)

## The MG estimation findings

Table () shows the long run and short run empirical findings of the MG estimator, the Error correction term (ECT) result is statistically negative and significant (-0.2995, p = 0.005), indicating a substantial long run link. The ECT indicates the speed of adjustment back to the long-run equilibrium after a short-run shock.

The MG estimation results show that Natural Resources (NR) has a positive and substantial effect on Financial Development (FD) the long run and short run, the long run parameter is 0.00318 and is significant with a p value of 0.001, suggesting that a 1% increase in natural resources leads to 0.00318% increase in financial development in the long run. Similarly, in the short run, a 1% increase in ∆NR leads to 0.00246% increase in FD since the coefficient is 0.00246 and significant at 0.063. These results confirm that resource wealth leads to financial advancement, hence aligning with previous results (Atil et al., 2020; Gylfason & Zoega, 2001; Mehlum et al., 2006). Moreover, Green Finance (GF) also has positive and significant relationship with financial development, the long term MG results (1.17, p = 0.012) indicate that in the long run GF has a positive and significant effect on FD. However, in the short run ∆GF has a coefficient of 5.88e-10 and a p value of 0.305, suggesting a positive relationship that is not significant. This indicates that investment in green finance projects might not provide an immediate significant impact on financial development but will eventually lead to financial development in the African nations in the long term. These results agree with previous empirical findings by (Gull et al., 2023).

GT also shows a strong and statistically significant affirmative link with financial development in both terms. The MG estimation results reveal a long run positive coefficient of 0.00284 with a p value of 0.027, showing significance at 1 %, while highlighting the importance of green technology innovation in driving financial development. A 1.0% increase in GT results in approximately 0.0028% raise in FD during the long run. The short run MG estimations also confirm a positive and statistically significant link between ∆GT and FD (0.00062, p=0.046). Reinforcing the view that green technological advancement supports financial system expansion.

However, the MG findings show how Renewable Energy (RE) has a negative relationship with financial development in the long run but not in the short term, indicating that on average across these countries, renewable energy consumption raises financial development only in the initial stages but later decreasefinancial development in the long term.

The estimator results indicate a negative coefficient of -0.0204 and p value of 0.010 during the long run, suggesting significance at 10% therefore, an increase in RE leads to a reduction in FD by 0.0204% in the long run while the short run results of ∆RE (0.00092, p=0.006) suggest that an increase in Renewable energy use by 1 unit will lead to a raise in financial development by 0.00092 units.

The ECT is negative and significant (-0.2995, p = 0.005), a negative and statistically significant error correction term confirms the existence of a long term equilibrium relationship among the variables and indicates that the system returns to equilibrium following any disturbance. Result from the MG ECT confirms the existence of a long-run equilibrium relationship between natural resources, green finance, green technology, renewable energy and financial development. Indicating that deviation from long run financial development is corrected at about 30% speed of adjustment.

## The PMG findings

The outcomes of the PMG estimator in the long run and short run are displyed in the table (6). Green Finance (GF) has strong and significant relationship with Financial Development in the long run but not in the short run as approved by the PMG estimation results. For the long run GF has a coefficient of 4.8E-11 with a p value of 0.044, suggesting a positive and statistically significant long run link between GF and FD. However in the short run the PMG outcomes (1.6E-10, p=0.253) suggest that there is a positive but not significant relationship between ∆GF and FD in the short term. These results are in line with the MG findings that GF has a positive relationship with FD but it is only significant in the long run.

For Green Technology (GT), the results show a positive and statistically significant relationship between GT and FD in the short and long term. This shows that green technology adoption enhances financial development in the chosen Northern Africa nations. This supports the result of (Battiston et al., 2024). The PMG results are consistent with the MG results, except the magnitude of the long run coefficient (0.00449) is smaller than the one in the MG estimation results and for the short run the PMG results have are more statistically significant.

Renewable Energy also exhibits a positive relationship with Financial Development but only significant for the long term under the PMG. The short term parameter of ∆RE is 0.00342 with a p-value of 0.476, indicating a positive but statistically not significant relationship with FD, while the long term coefficient of RE is 0.00143 with a probability of 0.000, indicating a strong significant and positive relationship between RE and FD. This contrasts the results by the MG where RE has a positive relationship with FD IN the short run but not in the long run, showing the effect of the homogeneity assumption imposed by the Pooled Mean Group on the long-run coefficients.

The results from the PMG show that natural resources have a positive and significant relationship with financial development in the short run, the coefficient is 0.00183 and p value = 0.015, indicating how increase in ∆NR by 1% will increase it to 0.00183% rise in Financial Development. However, in the long run the relationship between NR and FD is positive but not significant (0.00034, p=0.573), indicating some heterogeneity in the long-run influence of resource wealth. Therefore, change in natural resource rents does not significantly impact financial growth in the longrun. The outcomes are different from the MG results that suggest a significant relationship in both the long and short run. Natural resource rents may provide shorterm liquidity to the financial sector, via this impact can diminish later. The result of the study is supported by the outcomes of (Asif et al., 2020; Oben, 2022; Sun et al., 2020).

The Error Correction Term is -0.37383 and has a probability of 0. This demonstrates how it is significant and approximately 37.38% of deviations from the long-run path are corrected each period. If the ECT was zero, it would imply that there is no long-run association, and if positive, it would suggest divergence

## The DFE estimation findings

The DFE estimation results for the relationship between the independent variables and the dependent variables. Firstly, Green Finance (GF) bears a long term coefficient of 6.90e-11 and a p value of 0.037 hence indicating there is a positive and significant relationship between Green Finance and Financial Development. Increase in GF can raise FD. ∆GF has parameter of 1.51e-11 and p = 0.034, indicating a positive and significant relationship as well in the short run. Green finance enhances financial development across both short and long run, this is different compared to the findings of MG and PMG where ∆GF has an affirmative but not significant impact on FD in the short run. The outcome of the study aligns with the results of (Ali et al., 2024; Paramati et al., 2022) indicating that increased access to and investment in green finance positively influences the financial ecosystem of Norther Africa nations both immediately and over time.

Similarly, Green Technology has a positive and significant effect on Financial Development. The DFE estimation results align with both the MG and PMG outcomes of a positive and significant relationship in the long term and short term. GT has a long run positive and significant coefficient (0.0001, p = 0.019), indicating that a 1 % increase in GT will lead to 0.0001% increase in FD across the selected countries. The short term coefficient of ∆GT is 0.0006 and the pvalue = 0.048, indicating that GT has a positive relationship with FD which is statistically significant at 5%. Hence green technology adoption and increase leads to immediate and sustained financial development The outcome is in alignment with the study of (Abidin et al., 2021; Hwang et al., 2022).

For Renewable energy, the DFE estimation results show a long term coefficient of 0.0138 and a p value of 0.003, suggesting a positive strong and significant link between Renewable Energy and Financial Development. These results are contrary to the MG results where RE has a negative impact on FD in the long run. Moreover, in the short run ∆RE has a positive coefficient of 0.0044 with a p value of 0.046, indicating positive and significant relationship, hence being contrary to results the Pooled Mean Group results where ∆Renewable Energy exerts a positive however not significant link with FD.

In the long run Natural Resource has a positive and significant coefficient of 0.0011 and p value = 0.048, suggesting that resource wealth boosts financial development, which aligns with the MG estimator however contradicts the Pooled Mean Group findings of a positive but not significant relationship. However in the short run ∆NR exhibits a positive but not significant coefficient of 0.0006, suggesting that natural resource rents may not provide immediate liquidity to the financial sector but over time.

The ECT is -0.203 with a probability value of 0.33, showing that there is a good relationship between the explanatory variables and dependent variable, moreover when there is there's a short-term deviation from the long-run relationship the correction back to that longterm equilibrium is at a speed of about 20.3% per period. These results align with the argument that investing in clean energy not only benefits the environment but also strengthens financial markets. The outcomes of the study is supported by the study of (Chireshe, 2021; Prempeh, 2023).

Table 6: MG, PMG and DFE Outcome

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Estimators | MG | | PMG | | DFE | |
| Variables | Long Term | | | | | |
|  | Coefficient | p-value | Coefficient | p-value | Coefficient | p-value |
| GF | 1.17E-09\*\* | 0.012 | 4.8E-11\*\* | 0.044 | 6.90e-11\*\* | 0.037 |
| GT | 0.00284\*\* | 0.027 | 0.00449\*\* | 0.01 | 0.0001\*\* | 0.019 |
| RE | -0.0204\*\* | 0.01 | 0.00143\*\*\* | 0 | 0.0138\*\*\* | 0.003 |
| NR | 0.00318\*\*\* | 0.001 | 0.00034 | 0.573 | 0.0011\*\* | 0.048 |
|  | Short Term | | | | | |
| ∆GF | 5.88e-10 | 0.305 | 1.6E-10 | 0.253 | 1.51e-11\*\* | 0.034 |
| ∆GT | 0.00062\*\* | 0.046 | 0.00114\*\*\* | 0 | 0.0006\*\* | 0.048 |
| ∆RE | 0.00092\*\*\* | 0.006 | 0.00342 | 0.476 | 0.0044\*\* | 0.046 |
| ∆NR | 0.00246\* | 0.063 | 0.00183\*\* | 0.015 | 0.0006 | 0.468 |
| ECT(−1) | -0.2995\*\*\* | 0.005 | -0.37383\*\*\* | 0 | -0.203\*\* | 0.033 |

Source: Authors’, NR = Natural Resources, RE = Renewable Energy, GF = Green Finance, and GT = Green Technology and FD = Financial Development. Note: \*\*\*, \*\*, and \* indicate significance at 1 %, 5% and 10% respectively.

## Hausman test results

Additionally, the hausman test outcomes are displayed in table (6). This test is applied to compare the PMG and DFE estimator to determine the most appropriate for estimating the long run relationship between FD and GF,GT,RE and NR. The statistic of the hausman test output is 7.05 and the p value is 0.0705 and since the pvalue is higher than 0.05 we fail to reject the null so the PMG model is the most appropriate to pool the longterm parameters since the assumption of long run homogeneity across panels is true and significant. However, there could be heterogeneity because the pvalue is close to 0.05 therefore the results of the DFE are also consistent and efficient

## Granger casuality test

Moreover, as shown in Table 7, this research utilized Dumitrescu-Hurlin Panel Granger causality analysis to determine the directions of the variables causal relationships in order to enhance the thoroughness of the empirical data. There are three directional relationship causalities possible; firstly the unidirectional causation or one way causality is where one variable (x) causes an impact on another (y) and the changes in X lead to change in Y, but Y cannot cause an impact on X, the relationship only flows in one way X→Y. Bidirectional causality can be interpreted as two way directional impact, where both variables cause an impact on each other and changes in each of the variable can predict future change in the other variable, hence X↔Y. The no causality or non-directional relationship implies that neither of the variables causes an impact on the other, therefore changes in either will not predict change in the other, X≠Y.

To put it simply, the study conducted found three unidirectional causalities and one bidirectional causalities. Particularly, unidirectional causation was shown between NR to FD, from FD to GF and from GT to FD. While a bidirectional causalities between RE to FD.

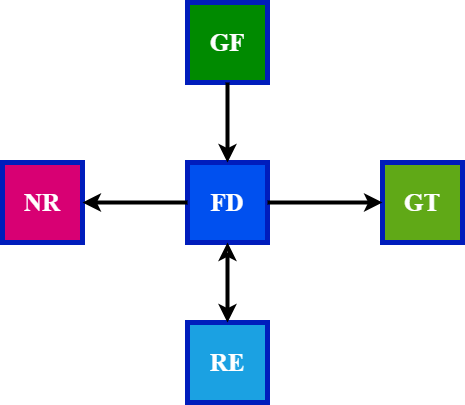


Figure 2: Causalities Direction

Table 7: Causality Outcomes

|  |  |  |  |
| --- | --- | --- | --- |
| Null hypothesis | F- statistic | Prob. | Causality direction |
| NR ≠ FD | 2.0169 | 0.0437 | → |
| FD ≠ NR | 1.3118 | 0.1896 |
| RE ≠ FD | 5.5346 | 0.0000 | ↔ |
| FD ≠ RE | 3.9775 | 0.0001 |
| GF ≠ FD | -0.4400 | 0.4500 | ← |
| FD ≠ GF | -0.5500 | 0.0060 |
| GT ≠ FD | -0.7536 | 0.0010 | → |
| FD ≠ GT | -0.7514 | 0.6460 |

Source: Authors’ compilation

**CHAPTER V**

**Discussion**

This study analyzed the influence of green finance, green technologies, renewable energy, and natural resources on the financial development of Northern Africa countries. The outcomes from the MG, PMG, and DFE estimators unequivocally support the hypothesis that sustainability-oriented inputs influence financial growth in the region, both in the short and long term, albeit with differing intensity and direction contingent upon the model specification employed.

The PMG results are preferred and primary in our study as they were considered consistent and efficient by the Hausman test results. However, the other estimation results are considered because they are also efficient. These three models altogether provide valuable insights while offering a comprehensive understanding of our data.

The residual value of the adjustment was confirmed by the presence of a statistically significant negative ECT (–0.3738) derived from the PMG estimator. All the other ECT statistics are negative and significant too under MG and DFE. This signifies the presence of a long-term equilibrium among the examined variables and implies that around 37.38 percent of the short-term disequilibrium is rectified each period. Consequently, it may be contended that North African nations possess diverse financial systems; yet, they generally demonstrate a moderate rate of adjustment towards long-term equilibrium when influenced by sustainability policies and practices.

Green Finance (GF) has the highest significant effect on financial growth in the long-term but only significant in the short run under DFE, indicating that increased investment in green-directed finance correlates with financial development in North Africa. The outcomes indicate that the immediate impact of green finance on the financial sector in these North African economies is not yet discernible but the implementation and management of green finance is still crucial for long-term financial development.

These results are significant for Egypt and Morocco as both nations have just formulated their green finance strategy and commenced the issuance of green bonds to address climate change and promote environmental sustainability (Jouahri & Al‑Maghrib, 2019; Mohammed, 2023). Green bonds are green financing tools used to fund projects that aim to preserve the environmental resources and climate change impacts, such as renewable energy, green technology innovation and natural resources sustainable management. These green bonds not only solve climate change problems and environmental issues, but as they channel funds towards sustainable development projects they can solve unemployment and lead to green financial development.

The green finance market is experiencing significant growth, as shown bythe Emerging Market Green Bonds Report 2023, published by Amundi and the International Finance Corporation (IFC). Egypt and Morocco are leading in North Africa with a cumulative volume of green bonds issued over the period of 2012-2023 worth $900 million and $400 million, respectively while Algeria and Tunisia are still in their early stages (Bonds, 2023).

Moreover, the 2024 Sustainable Banking and Finance Network (SBFN) report indicates that both Egypt and Morocco have upgraded from the developing phase to the advancing phase in implementation of sustainable practices. The SBFN works with financial sector authorities and banks from developing nations to enhance sustainable finance practices in line with global best practices, it produces regular reports on the overall green progression in countries basing on ESG integration, climate risk management, and financing sustainability (Habib et al., 2023).

Egypt is transitioning to a green economy through the promotion of green banking, green credit, and innovative finance mechanisms. The nation developed projects like the National Initiative for Smart Green Projects (NISGP) and the National Climate Change Strategy 2050 (NCCS) to implement advanced green financing infrastructure (Abou-Ali et al., 2023; Chen, 2018). These initiatives have influenced financial development by creating new investment opportunities and diversifying the financial market.

The government of Egypt formulated the Sustainable Development Strategy (SDS) with a priority of financial inclusion. Through this financial initiative, the Central Bank of Egypt (CBE) put vision 2030 in line with the Sustainable Development Goals (SGSs). Egypt’s vision 2030 focuses on sustainable development by expanding banking and financial services which enables easy access of various financial products to all segments of the society.

In 2020, the government of Egypt established its green finance system by taking a significant step towards sustainable finance in the North African region. The Ministry of Finance in Egypt issued green bond worth USD 750 mn with a five year term, the bond was marked as North Africa’s first sovereign green bond. The revenue from the bond was directed towards finance of green projects such as renewable energy, waste reduction and clean transportation. This put Egypt on the green finance map and attracted many more investors than expected (Aly, 2024; Samak, 2021). This put Egypt on the green finance map and attracted many more investors than expected.

The Bank of Africa in Morocco got a loan of about €70 m to promote sustainable lending practices and enhance financial access in Morocco. The Bank of Africa received this loan from the European Bank for Reconstruction and Development (EBRD) in partnership with the European Union (EU), the Green Climate Fund (GCF) and Canada as part of the High Impact Partnership on Climate Action (HICPA) aimed at addressing climate change and environmental degradation. This loan supports private sector companies in Morocco wishing to invest in climate change mitigation and green technologies (GOVERNORS, 2020; PAVANETTO & NICOLO, 2019).

Morocco issued its first green bond of $115 million in 2016 through the Moroccan Agency of Sustainable Energy S.A. (MASEN) to finance the Noor phase I solar power project, this showed Morocco’s commitment to green finance and paved the way for other green bonds from the Moroccan Bank for Trade and Industry (BMCE), Banque Centrale Populaire (BCP) and Casablanca Finance City which attracted more investments. Specifically, in 2018 the BMCE and BCP Moroccan banks issued green bonds of 500 million dirhams and 1.5 billion dirhams respectively, by the end of September 2021 the Casablanca Finance City (CFC) issued green bonds worth 335 million dirham (BENNIS, 2023).

Green Economy Financing Facility (GEFF) in Morocco is a credit line facility program which provides help via financial institutions to businesses and households wishing to invest in green technologies, clean energies, green buildings, water conservation and pollution reduction (Holmes, 2020).Investments in green initiatives have increased the GDP of Morocco, suggesting a synergistic relationship between financial development and ecological responsibility (Nabil et al., 2024). This shows the importance of integrating sustainable finance practices in the economy since focusing on both growth and environmental sustainability can bring long term benefits to the economy.

Even though Tunisia and Algeria may still be in their early implementation stages of green finance, they recognize the benefit of adoption and transition to green finance. The Central Bank of Tunisia plays a crucial role in advancing the shift towards green finance by supporting local banks in implementing green strategies that has helped Tunisia achieve higher financial development as it addresses the impacts of climate change on the financial sector. Moreover, the central bank of Tunisia partners with several international organizations and banks such as the European Bank for Reconstruction and Development (EBRD) to establish green finance strategies. This has mobilized green investments and contributed to Tunisia’s development plan. However, Tunisia still faces some legal constraints that hinder financial development through green banking. These green projects are still voluntary, they are created by firms and organizations that are willing there is no well-defined regulatory framework (Mansour, 2023a).

Algeria developed a 5 years (2014 to 2019) growth plan to reduce reliance on nonrenewable energies and diversify the economy by attracting foreign investment. It focused on key sectors such as energy, water resource use and education. This plan encouraged the development of green industries, promoted entrepreneurship and job creation. However, the nation still faces financial constraints and heavy reliance on hydrocarbons which limit its ability to fully finance green projects (Bara & Baar, 2024). Therefore the country needs to commit more to sustainable development by using clean energy and technology so it can receive international financial help and boost its financial sector.

Despite the significant green initiatives and policy reformations North African nations are still facing some challenges in scaling green finance, such as overreliance on external development banks, slow progress in utilizing the revenues, limited funding and weak institutional frameworks,. The long term vision and investments are poised to drive financial development, but the short-term effect may not be immediate as green frameworks are still developing and being implemented.

Green finance often funds long term and capital intensive projects that usually take time to develop and implement, economies also tend to prioritize immediate financial returns which can overshadow green finance strategies. Therefore green projects may not yield immediate financial development but they eventually lead to sustainable economic growth in the future. The effectiveness of green finance in reducing carbon emissions is also low in resource dependent countries (Xiao & Chen, 2024). Resource dependent economies often suffer from ‘the resource curse’ characterized with weak and corrupt institutions that fail to effectively allocate and monitor green finances,

The enduring advantages of green initiatives indicate that North African nations aim to enhance their financial markets and access to sustainable financing, while also striving to improve investor perception, diversify capital inflows, and facilitate lasting transformations in the economic structure concerning climate objectives. Green finance significantly contributes to long term sustainable development but remains insignificant in the short term (Gull et al., 2023).

Moreover, resource dependent economies tend to have carbon intensive industries as the backbone of the economy which makes them resistant to green transition. Algeria’s economy remains heavily reliant on hydrocarbons despite its increasing budgetary allocation to green projects (Chabouni et al., 2024). To reduce green investment associated risks and increase the rate of investment, financial institutions show more interest in fossil fuel projects than green projects because of the low returns and risks associated (Downie & Peterson, 2025).

Green finance plays a crucial role in promoting financial development by directing funds towards environmentally friendly projects. However green financial markets in North Africa are still in their infancy as some countries are not aware of the risks or returns from green investments, they hesitate to form new green financial instruments required or mobilize capital towards green projects. This lack of awareness might affect sustainable development in the short run because of failure to prioritize green projects among financial institutions (Amolo; Dzingirai & Mhlanga, 2025; Taghizadeh-Hesary et al., 2022).

Our results show that green technology is significant in both the short term and long term under all the models, showing innovation is crucial for promoting financial inclusion and sustainable banking. Using the appropriate technology enables easy access of funds and reduces costs. North African countries particularly, Egypt, Morocco, Tunisia and Algeria are increasingly recognizing the pivotal role of green technology innovation in driving financial progress. The influence of Green Technology (GT) activities on financial development was significant and beneficial, reinforcing the assertion that progress in sustainable sectors contributes to financial advancement. The significance of this pertains to North Africa, where the cleantech and green innovation sectors have advanced through government subsidies and private sector support. According to the Global Innovation Index (GII) 2024, Morocco, Tunisia, Egypt and Algeria rank 66th,81st, 86th, and 115th globally in technological innovation (Majumdar, 2024).

The Green Morocco plan employs green technology to address water problems in agriculture. This has improved agricultural productivity while reducing water consumption and farmers reported a better understanding of water which is essential for sustainable agricultural development (SIGHROUCHNI et al., 2024). Morocco is advancing green technologies in its industrial sector to reduce environmental impacts while promoting sustainable growth (Nejjari & Aamoum, 2022).

Over the long term, green technology fosters sustainable development by reducing environmental risks and enhancing energy security. Egypt and Tunisia are investing in climate smart cities to address climate change and urbanization challenges as they transition to greener economies. Egypt is developing new fourth-generation ‘smart’ cities using eco-friendly technologies as part of the Sustainable Development Strategy 2030 to implement green areas, advance living standards and generate employment opportunities. Moreover, Tunisia has taken steps towards creating smart cities through the Clima-Med project, in the fight against climate change. These Green City projects are transforming cities into models of climate resilience and sustainable development through renewable energy and sustainable practices (clima-Med, 2019; UN-Habitat, 2019).

The government of Tunisia has adopted green technology through the 2005 PROSOL program which promotes solar energy and makes it accessible to the rural areas. This has led to job creation through the project installation and maintenance (Omri et al., 2015; Zhou et al., 2024). The government has also established several waste management projects that use green technology to turn waste into clean energy while generating wealth and creating jobs.

The government of Algeria has implemented initiatives and programs aimed at promoting renewable energy. It provides training and educational programs courses related to renewable energy, waste management, and sustainable agriculture to develop a skilled workforce which promotes green technology innovation, hence driving economic transformation and sustainable development.

North Africa is deploying green digital platforms such as Solar-powered IoT devices, smart water management systems, and renewable energy platforms to combat climate challenges. These digital tools can help local artisans access global financial markets, Internet of Things technologies and optimize energy and water use in different sectors (Baghouri, 2024; Rumbayan et al., 2025).

Green technology advances SDGs and gives as a solution to the region’s pressing issues of climate change and unemployment. The Environmental Management program drives green technology adoption in North African firms through environmental regulation and financial exposure to environmental Impediments. while contributing significantly to SDG 12 of Responsible Consumption and Production and SDG 13 of Climate Action (Ayouni & Zouiri, 2024).

Northern Africa nations via micro grid technologies have become a hub for renewable energy. This green technology mitigates reliance on fossil fuels and addresses climate and energy issues in the region. They enhance cheaper integration of clean energy resources and energy storage systems via smart control frameworks (Naseri et al., 2024).

The adoption of green technology demonstrates a positive and significant impact on financial development in the short term through green technologies such as energy efficient systems and clean production methods which stimulate demand for tailored financial tools by firms like green credit while enhancing financial development and inclusion. Subsequently as green innovation is embedded in government strategies FDIs are attracted hence advancing financial development (Taghizadeh-Hesary & Yoshino, 2020). Green technological innovation contributes significantly to competitiveness between local firms and businesses which increases local production and helps to provide more sophisticated financial markets, hence financial development.

The effects of Renewable Energy (RE) were quite intricate, demonstrating positive and significant effects in all the estimators calculations except PMG that indicates Renewable Energy has no significant effect in the short run. The rise of renewable energy, especially solar and wind resources prevalent in North Africa, both internationally and regionally, contributes to the expansion of the financial sector by attracting investment, reducing reliance on energy imports, and fostering innovative financing mechanisms associated with clean energy infrastructure.

In the short term, renewable energy may have limited impact on financial development in these North African countries because of high investment costs. Renewable energy projects require billions and millions of dollars of capital for implementation and maintenance which often burdens public budgets and require external financing. The government usually takes time to establish these projects while gathering funds. Lack of skilled labor and advanced technology can delay the benefits of renewable energy projects.

The Maghreb countries (Morocco, Algeria, and Tunisia) are rapidly expanding their renewable energy sectors, particularly solar power. They have ambitious targets of increasing the share of renewable energy in electricity production. Although, Morocco has been leading the way in Africa and the Middle East in solar power, Egypt is on the verge of becoming the largest solar power producer. Moreover, Tunisia is progressing and has awarded contracts for solar projects of 500 megawatts. Algeria on the other hand is determined with goals but is being slow in implementing them (Analytica, 2018).

Egypt and Morocco have notably excelled in the advancement of renewable energy, and the financial advantages shown in this study underscore the significance of investment developments in these nations. A reinforcing loop exists between renewable energy (RE) and financial development, whereby each sustains the other: increased investment in renewable energy fosters financial development, which subsequently promotes additional investment in energy.

Egypt has a goal to generate 42% electricity from renewable energy resources by 2035. One of the ways it has supported it is through developing the Benban Solar park, one of the largest renewable energy projects in the world to generate 3.8 terawatt hours of electricity per year. The project received financing from various international organizations and financial institutions, it received about USD 55 million from the African Development Bank, Egypt received a USD 3 billion credit from World Bank to support its reforms in the electricity sector. The investments flowing through this project have not only helped Egypt curb down its carbon footprint but also created jobs for many while also leading to financial progress for Egypt (AfDB, 2023; Chavez, 2017).

Morocco has tranistioned towards renewable energy since 1960, prioritizing hydroelectricity and dam construction. The nation aims to reduce dependence on imports of oil and gas, and lead the way in the transition to green energy in Africa and Middle East. Morocco has successfully been able to derive 45% of its electricity from renewable energy exceeding its initial goal of 42% of electricity produced by 2020. Now it is determined to produce 52% of its energy through clean renewable sources by 2030 (Kasraoui, 2024; Vedie, 2020).

The Noor 1 Ouarzazate Solar complex was also developed as a component of the National Energy Strategy to generate 52% of electricity from renewables by 2030. It has improved access to electricity for over one million people. It is known to be among the largest power plants in the world. This project has been funded through green bonds and various loan instruments by the World Bank, African Development Bank, European Investment Bank which boosted Morocco’s banking and financial system (Laaroussi et al., 2023).

The Moroccan government has implemented a range of policies and incentive such as the Renewable Energy Developmental Law which addresses several challenges in renewable energy by filling legal gaps and encouraging investments, the feed-in tariff policy was also implemented to encourage investments in renewable energy by offering a fixed purchase price above market price to renewable energy producers, due to price certainty and incentives, Morocco has secured long term investments in large scale renewable projects which has led to long term financial development (Claire Posno & Matthew Chasmar, 2023; GlobalData, 2022).

The renewable energy projects such as the Noor 1 Ouarzazate in solar complex Morocco and the Benban solar park in Egypt have led to financial growth by attracting investments and other green financial instruments. The Benban project mobilized about $2 billion in private investment, the success of Noor Solar Complex also paved way for Morocco’s first green bond, indicating the development of sustainable finance in the region. However, these projects require significant land and water use, which can cause delay in financial development.

The delayed but eventual significant impact of renewable energy on financial development demonstrated by the PMG model reflects a transitional process of these nations from heavy reliance on fossil fuels to clean energy. These nations have long dependeded on hydrocarbons for income but they have recognized the harmful impacts of these hydrocarbons to the environment and how the hydrocarbon rents can cause fiscal instability. Therefore each of them is actively pursuing ambitious goals to transit to renewable energy sources, clean technology and diversification. For instance; Egypt, Algeria, Morocco and Tunisia have goals to produce more electricity from renewable energy sources by 2035 and 2030.

Moreover, morocco has a goal to reduce dependence on fossil fuels through the Fossil Fuel Subsidy Reform that contributes to a just transition. Fossil fuel subsidies reduce the prices of consumption and production, this may help the population and economy get fossil fuels cheaper but there can also be negative impacts. According to Merrill et al. (2017) fossil fuel subsidies to consumers and producers discourage sustainable development and hold countries back from building sustainable energy projects as they exacerbate CO2 emissions and hinder the achievement of SDGs. However, fossil fuel subsidy reform involves allocation of savings towards sustainable energy and development hence allowing transition towards a cleaner economy. Morocco’s commitment to FSSR is of two objectives, first to address its budgetary constraints by reducing its big subsidy bill by 2030 which was about 6.5% of its GDP in 2012. Secondly is to support the country’s transition to cleaner energy and sustainable development (Gass & Echeverria, 2017). The FFSR was successful in developing both the economy and the environment, which enabled Morocco to raise savings from the reduced fuel subsidies that created investments for renewable energy sectors. These reforms have not only contributed to Morocco’s transition towards a decarbonized economy, but have also contributed to employment opportunities. There was a significant growth of 26.5% in employment, and by 2020 13,000 jobs were created in the renewable energy sector(Gutierrez, 2025).

Other than the FFSR, Morocco has come up with plans to support the transition towards a cleaner economy by reducing the reliance on fossil fuel energy. The plans include the sustainable development strategy, the national strategy and the low carbon development strategy. The national energy strategy has invested about $13 bn in renewable energy used to generate power and another $49 bn was invested in renewable energy to reduce greenhouse emissions (Gass & Echeverria, 2017). This has contributed to the boost of both sustainable and financial development.

Natural Resources (NR), while traditionally strength for North African economies such as Algeria and Egypt, funds development in these sectors; nonetheless, the long-term benefit was negligible under the PMG and DFE model. This indicates that although natural resource rents temporarily infuse capital into the financial system, particularly in extractive industry nations, sustainable long-term growth is contingent upon effective management and governance of resources, diversification and investment in advanced industries. It means that the results support the validity of the “resource curse” and “Dutch disease” theories in the economy of these nations.

Natural resources revenue often boosts financial development in the short term via liquidity surges, but fail to significantly improve sustainable development in the long run. This could be due to the Dutch disease, where resource wealth leads to appreciation of the exchange rate and weakens others sectors of in the economy such as manufacturing and services. This in turn limits the expansion of financial markets by constraining credit demand from non-resource industries.

Algeria’s over reliance on hydrocarbon revenues has hindered the growth of other sectors and limited diversification of the banking system. The government of Algeria controls the hydrocarbon (oil and gas) sector which has limited competition from other financial services (Chekouri et al., 2017). Most natural resource endowed countries are suffering the resource curse and are unable to develop sectors outside the production and export of natural resources.

Algeria’s over reliance on oil for domestic consumption and export also negatively impacts the quality of the environment due to the increased CO2 emissions. Therefore, the government of Algeria directs funds towards mitigating the negative impacts caused by oil resource consumption. These funds could have been used for other financial development projects and initiatives (Nwani et al., 2021).

The economy of Algeria depends on the export of hydrocarbons as the main source of revenue for the country. Revenue from oil and gas exports makeup above half of the country’s yearly revenue which makes it vulnerable to global market shocks of hydrocarbons. Fluctuations in global market prices of oil and gas can destabilize the national budget and influence fiscal policies. When the oil prices are high, the country is able generate more revenue hence financial development but when global prices are declining, the fiscal policies are adjusted and public spending is reduced. This makes the government prioritize short term fiscal stability short term financial development. The reliance on natural resources may hinder long term diversification efforts (Rahal & Amieur, 2024).

Morocco and Tunisia have limited fossil fuel reserves in with some areas still not explored. To meet its high energy demand, the government heavily depends on imported hydrocarbons. This may hinder financial development as the absence of hydrocarbon rents and the import duties and tariffs can reduce fiscal space for public finance and investments into other development sectors (Bahgat, 2013). Moreover, the reliance on oil and gas imports expose Morocco to global price shocks which can affect the national budget and trade balance hence hindering financial development (Morabet et al., 1998).

Egypt has also got the largest oil and natural gas reserves, the exploitation and exportation of these resources has provided substantial revenue for the government and contributed to GDP growth since the 1970s, but now Egypt's economy suffers the effects of global oil and gas prices fluctuations. When these prices drop, its government receipts and the BOP are directly impacted hence leading to economic instability and crises. Ibrahiem and Sameh (2022) confirm the presence of a natural resource curse in Egypt due to failure to use natural resources efficiently and direct sufficient investments to other productive sectors that support financial development.

Developing countries rich in natural resources like Algeria, Tunisia, Egypt and Morocco tend be highly corrupt which may delay long term financial development. This is because corrupt governments tend to focus more on short term gains than long term development, moreover corrupt governments can facilitate tax evasion and poor taxation systems(Chebab et al., 2022).

The North African region holds the largest oil and gas reserves in Africa. This region has historically encountered both the benefits and downsides associated with these resources. Hydrocarbons have been a major source of revenue for these countries particularly, Algeria and Egypt as they make up a significant part of their GDP. However, the oil and gas rents have contributed to financial instability, unemployment and fostered high dependence on a limited range of exports. High dependence on hydrocarbon wealth has hindered diversification efforts of these countries and led to dependence on oil and gas exports (WorldBank, 2025).

Algeria and Egypt’s over reliance on hydrocarbon rents leads to short term financial development but may expose these nations to global price fluctuations hence leading to fiscal instability which may deter foreign direct investments in other sectors. Foreign direct investments are crucial for financial development, however financial insecurity might scare potential investors away due to the market risk. For instance, Algeria faced a fiscal deficit surge in from 1.4% to 15.7% of GDP over the period of 2014 to 2016 as a result of oil price decrease from USD 115 per barrel to less than USD 50. This caused inflation and weakened the currency and also contributed to the resignation of the president that time (Chabouni et al., 2024).

Natural resource extraction can lead to environmental degradation, over exploitation of natural resources cause severe environmental damage such as deforestation, pollution and habitat loss which can have long-term economic costs and also impact other sectors like agriculture and tourism (Barbier, 2010). This in turn compels the government to allocate substantial financial resources towards restoration of the eco system. This diversion of funds could have been channeled to other productive sectors to promote financial development. However, nations with strong financial systems can change the curse of natural resources into a blessing. The inherent resources are explored and used to achieve financial development through the ability of the institutions to invest in green technologies, renewable energies and human capital (Hou et al., 2023; Rahim et al., 2021).

Egypt had aimed to become a major gas exporter, after discovering the zohr gas field in 2015 by an Italian energy group called Eni. However, the rapid development of the gas fostered over extraction in a rush to generate export revenue as too much water was injected into the reservoir, this together with weak investment plans led to the decline of the domestic gas production in from 2021, the government has accumulated about USD6 bn of debt for gas and fuel supplies .

Due to the increasing over extraction and exploitation of natural resource, a growing need to adopt sustainable environmental practices through green technology and use renewable energy sources arises so as to mitigate the consequences of environmental degradation and natural resources depletion (Jiakui et al., 2023).

Westerlund Granger causality findings enhance comprehension of these interactions. The evident unidirectional causality from FD to GT and NR, GF to FD indicates that these variables serve as precursors or influencers rather than results. The unidirectional Causality of Financial Development to Natural Resources indicates that change in FD will lead to change in NR. This implies that a nation’s financial system directly influences the natural resources sector through various ways such as investment in resource extraction and management, investment in technologies and practices that improve resource efficiency to increase natural resource rents. However, weak financial systems can also impact the natural resource sector negatively through over exploitation of resources for short term gains, hindering investments and vulnerability to global price shocks. This relationship positions financial development as a driver of the natural resource sector rather than an outcome or consequence of it.

Financial development is important for controlling natural resources effectively through enhancing investments while fostering economic development in resource rich countries. Financial development refers to the growth and improvement of the financial institutions and market. This growth and improvement of financial institutions plays a crucial role in resource management by the economy. Well-developed financial institutions and markets can help increase savings for resources and allocate resources effectively that is essential for economic growth. More equity can also be used to invest in other productive sectors hence diversifying the economy. Financial development can also help turn a resource curse into a blessing. A resource referred to as the paradox of the plenty can be mitigated through financial development. The developed financial institutions can ensure that resource wealth is used effectively and also manage the fluctuations associated with resource rents, thus promoting economic growth. Financial development can impact natural resources through various ways such as providing better access to credit and financial services to private investors in the resource sector (Group, 2008).

Additionally, financial development has a unidirectional linkage to green technology (FD→ GT), signifying that a robust and evolving financial system is driver of green technology development. This may be through funding of green tech companies, offering insurance and other risk control methods to new clean technologies via financial institutions.

Financial development helps in promoting green technology is multifaceted as it can have both positive and negative effects. Developed financial institutions can facilitate investment into green technology through different green tools like bonds, credit, market incentives and others while enhancing green technology innovation and efficiency. However, the structure and depth of financial development can hinder green technology progress. Without the support of capital green technology innovation cannot be successful, therefore financial development provides the necessary funds through green bonds and credit which are specifically designed to support environment friendly or green projects. Moreover, one of the main barriers to green technology innovation is financing constraints. Financial development helps alleviate these constraints by offering more accessible funding options. Financing constraints may act as a mediator between green finance and green technology innovation therefore improved an financial system can lead to increased innovation in green technologies (F. He et al., 2024; Tang, 2024).

Shifts in Green Finance influence changes in financial development, making it as a key enabler of the financial sector development rather than a result of it. Meaning, investment in green strategies appears to have a direct impact on the growth of a nation’s financial system, suggesting that policies promoting green finance can have a profound impact on the financial development. Green finance attracts new types of investors hence broadening the investor base and increasing market liquidity. The introduction of green bonds, carbon markets, and green funds expands the range of financial products and services available. This indicates the necessity for additional proactive investment and policy reformation in these domains.

For instance, Egypt's Vision 2030 emphasizes green finance in form of green bonds as essential tools for sustainable development, linking environmental conservation with economic advancement. However, challenges such as regulatory frameworks and market dynamics affect the successful implementation of these financial instruments. Green bonds help mobilize resources for projects that contribute to both environmental and economic stability. The successful implementation of these green bonds can enhance market dynamics by attracting different investors for green projects. This can increase liquidity in financial markets and promote development of new financial products tailored to green initiatives (Elhelaly & Algarhy, 2024).

The bidirectional causation between renewable energy (RE) and financial development (FD) illustrates a mutually reinforcing link, wherein clean energy investment and the expansion of the financial system enhance and fortify one another in a self-sustaining manner. On one side the introduction and expansion of renewable energies significantly stimulates financial development. Renewable energy projects are capital intensive, therefore there installation and operation usually attracts investments from international organizations and banks which put liquidity and increase the investor base, further enhancing financial development. On the other hand well developed financial systems pave way for efficient capital allocation and channeling funds to clean energy projects. Different studies have confirmed the bidirectional causality in financial development and renewable energy consumption in various contexts, suggesting that improvements in one can lead to advancements in the other (Radulescu et al., 2024; Wen et al., 2023).

# CHAPTER VI

# Conclusion and Recommendations

# Introduction

The study investigates the linkage between natural resources (NR), green finance (GF), green technology (GT), renewable energy (RE) and financial development (FD) in four resource rich North African nations over the period of 1999 to 2021. The data analysis employs econometric techniques to examine the relationship between the variables of interest. This investigation applies the CADF and CIPS second-generation unit root tests (Pesaran, 2007) to check for the stationarity of the parameters. To investigate the existence of long-run relationships among the key variables the Westerlund Cointegration test is applied. The research utilizes the PMG, MG and DFE estimators under the P-ARDL model to examine the long term and short term relationships between the variables. The hausman test is applied to determine the robust estimator. Finally, the Dumitrescu-Hurlin panel granger causality test is used to examine the casual relationships between variables.

# Summary of the conclusion

The study examined the impacts of green finance, green technology, renewable energy, and natural resources in North African nations utilizing the MG, PMG, and DFE estimators. The results from all estimating methods employed in this research indicate that all four variables exert a beneficial influence on the level of financial development, both in the short and long term, but to varying degrees that are statistically significant. A steady long-run equilibrium relationship, supported by a substantial error correction term, demonstrates the sustainable development factors in the region and the adaptive evolution of the financial system.

The evolution of green finance reflects the significance of green investment instruments in fostering the growth of financial markets, as it has become a fundamental catalyst for financial advancement. Similarly, the impacts of green technology and renewable energy were determined to be markedly beneficial, highlighting the strategic importance of such innovations in extensive economic diversification and sustainable capital flow contributions. Despite the uneven impact of natural resources, the short-term results confirm that resource richness is crucial for liquidity provision and the robustness of the financial sector, especially in resource-dependent nations such as Algeria and Libya.

The causality analysis validated the robustness of these connections, indicating that green finance, green technology, and natural resources exerted a unidirectional causal influence on financial development, whereas the association with renewable energy was bidirectional. These findings underscore an alternative perspective in North Africa, wherein sustainability is treated as an independent variable rather than a dependent outcome of financial development.

# Policy Recommendations

Based on the outcomes of the investigation, the following policy recommendations are proposed to enhance financial development through sustainable pathways in North African nations:

* Policy Recommendations for Egypt
* **Strengthen green finance infrastructure**  
  Egypt has already made a lot of progress with programs like the National Climate Change Strategy (NCCS) and the National Initiative for Smart Green Projects (NISGP). The government should build on this by putting money into expanding these initiatives so that they may reach local governments, rural areas, and businesses. This means making it easier for people to get green bonds, giving commercial banks better tools to evaluate green projects, and making green loan services available online to reach areas that don't have them.
* **Deepen financial inclusion through green finance**  
  Vision 2030's goal of financial inclusion should be in line with ecological goals. The Central Bank of Egypt (CBE) should offer special green financial products, like micro green loans and green savings accounts, for women, young people, and businesses in rural areas. Egypt can improve social fairness and make the financial sector deeper by making sure that the green transformation includes everyone.
* **Monitor and evaluate green bond impacts**  
  Egypt was the first country in North Africa to issue a sovereign green bond. However, to gain investors' trust, there needs to be clear reporting and impact assessment. Setting up a system for third-party verification and making public reports on the environmental and developmental results of funded projects will attract more investors and make the market more trustworthy.
  + **Accelerate Smart City Development and Green Infrastructure**  
    Egypt's ambitious fourth-generation smart city initiatives should be expanded by incorporating cutting-edge green technologies including solar grids, smart waste systems, and energy-efficient building methods. These cities can show how to change cities to be more eco-friendly, which can create jobs and help people get and stay financially stable in the long run.
  + **Support Eco-Innovation Clusters and Tech Startups**  
    The government should work with universities and businesses to set up eco-innovation hubs and incubators. These hubs would help new businesses that deal with green technology like clean mobility, energy storage, and climate-smart farming by giving them money, advice, and access to the market.
  + **Scale Up Large-Scale Renewable Energy Infrastructure**Egypt should speed up its large-scale use of renewable energy even more by using more than just solar energy, such wind and biomass. The Benban Solar Park is one example of this. Priority should be given to making sure that long-term financing options, such green bonds and public-private partnerships, are available. These options will lower the burden on the budget while also bringing in private investment.
  + **Improve Domestic Supply Chains and Workforce Capacity**  
    Egypt should create local manufacturing and training programs for solar panels, inverters, and wind turbines to cut down on how much they depend on imported technology and know-how. Working with the private sector to set up Renewable Energy Training Institutes can help create a qualified workforce and speed up the completion of projects.
  + **Stabilize Fiscal Policy Through Natural Resource Revenue Smoothing**  
    Use counter-cyclical fiscal frameworks that preserve extra money when oil and gas prices are high and spend it when they go down. This helps keep the budget stable and lets the government keep investing in infrastructure and the growth of the financial industry.
  + **Institutionalize Transparent Resource Governance**  
    To make things more accountable, cut down on corruption, and boost investor trust, Egypt should embrace global standards like the Extractive Industries Transparency Initiative (EITI). When resource revenue and spending are reported clearly, it fosters trust and makes it easier for the public to make responsible investments.
* Policy Recommendations for Morocco
* **Enhance public-private partnerships for green infrastructure**Morocco should use blended finance models that include multilateral banks, sovereign wealth funds, and private investors to pay for big infrastructure projects like solar electricity and public transportation. The government might also make bonds for infrastructure projects that are focused on renewable energy and give people incentives to use land.
* **Institutionalize green bond practices**Different Moroccan institutions have issued green bonds, but there is no one set of rules or laws that everyone follows. The government should set rules for issuing green bonds, make sure that projects that qualify fit into certain categories, and provide issuers and investors tax breaks to get the market going.
* **Incentivize Industrial Eco-Innovation**Give tax breaks and green certification schemes to businesses that use clean production methods to lessen their impact on the environment. Encourage businesses, the government, and universities to work together on research to come up with green production systems, recycling technologies, and supply networks that don't pollute the air.
* **Institutionalize Public Procurement of Green Technology**Government agencies should put buying green and energy-efficient solutions (such solar lights and green IT infrastructure) at the top of their list of things to do. This boosts the demand for eco-friendly tech solutions in Morocco and makes the country's cleantech industry stronger.
* **Expand Green Financing Tools and Incentives**The government should make tax-exempt green bonds, sustainability-linked loans, and blended financing models permanent after the success of Morocco's first green bond. Small-scale renewable energy providers, such households and cooperatives, should be able to get feed-in tariffs and guaranteed purchase agreements.
* **Boost Local Content in Renewable Projects**Encourage renewable energy projects to buy things from local businesses to boost the production of equipment in the US and create jobs. This also makes investments more sustainable by making sure that the benefits stay in the local economy.
* **Build Strategic Resilience to Energy Import Dependency**Morocco should diversify its energy sources by building more renewable energy production and storage systems at home. This is because the country doesn't have a lot of fossil fuels and depends a lot on imports. This secures the fiscal room for development and makes it less likely that outside events will hurt the economy.
* **Integrate Natural Resource Efficiency in Public Investment**Use natural resource budgeting that takes into account the long-term consequences to the environment. Green finance tools like green bonds and SDG-linked funds should help pay for public infrastructure projects that use technology that are good for the environment and save energy and resources.
* Policy Recommendations for Tunisia
* **Strengthen the role of the Central Bank in green supervision**The Central Bank of Tunisia should keep a close eye on climate-related risks in the financial system. It should add green finance indicators to its reports on financial stability and tell banks to stress-test their portfolios against climate risks.
* **Collaborate with international partners to establish a national green investment fund**Tunisia requires a special fund for green investments that donors like the EU, EBRD, and World Bank can help with. This fund should provide out low-interest loans, equity investments, and guarantees to get more green initiatives started in the country and make it easier for people to get climate money.
* **Introduce tax incentives and subsidies for green adoption**The government should give tax breaks to businesses who put money into clean technology, renewable energy, and energy efficiency. Also, giving money back or subsidies for green equipment like solar panels or efficient irrigation systems might get businesses involved.
* **Scale Up Smart City and Green Urban Planning Projects**Keep growing programs like Clima-Med and use green technologies in housing, garbage, and transportation in cities. In modern smart cities, use public-private partnerships to develop electric transportation systems, energy-efficient buildings, and utilities that run on renewable energy.
* **Develop a Green Innovation Framework**Make a national plan to bring together research, funding, and the sale of green technologies. Policies for green inventors should include protecting intellectual property, speeding up licensing, and encouraging investment.
* **Address Legal Gaps in Waste-to-Energy Projects**Make it easier for the government to approve waste-to-energy technology and provide businesses tax breaks to invest in them. Give cities the power to work with local businesses that can recycle trash into energy or compost, which will create jobs in the circular economy.
* **Simplify Regulatory Framework for RE Investment**Tunisia should make it easier for investors in renewable energy to get licenses, permits, and land. Set up a one-stop shop for developers of renewable energy projects to get more private sector participation and cut down on delays.
* **Create Targeted RE Subsidy Programs for Households and SMEs**For rural families and small enterprises that want to buy solar home systems or solar-powered irrigation, create sensible subsidies or result-based financing. This method can improve access to energy and productivity while connecting energy access to economic growth.
* **Reduce Fiscal Pressure from Resource Imports**Invest in renewable energy, biofuels, and regional energy integration to lessen the detrimental effects of hydrocarbon imports on the economy. These investments can help balance trade and make us less reliant on other countries for energy.
* **Invest in Financial Instruments for Resource Sustainability**Create financial solutions (such green microcredit and sustainability-linked loans) that help small farmers and companies use technology that use less resources. Central bank measures that encourage green financing should help Tunisia's banks and other financial institutions.
* Policy Recommendations for Algeria
  + **Accelerate Economic Diversification Beyond Hydrocarbons**Algeria should put more money into areas that don't rely on oil and gas, such renewable energy, agriculture, manufacturing, and digital services. Tax breaks for private investment in non-hydrocarbon sectors, financing for small and medium-sized businesses (SMEs), and support for value-chain growth in industries that aren't being used enough are all ways to do this.
  + **Strengthen Resource Revenue Management Frameworks**Set up and enforce a Sovereign Wealth Fund (SWF) with clear regulations for how to save and spend money made from oil and gas. To make sure that the economy grows over the long term, especially while oil prices are high, some of the money should be put into productive capital, such infrastructure, education, and green technologies
* **Foster Skills Development for RE Workforce**Through public-private collaborations, make technical and vocational education connected to renewable energy more widely available. To build a pool of qualified workers who can help with project growth, focus on solar PV, grid integration, and microgrid design.
* **Partner with Global Development Banks for Project Finance**Algeria should work with the World Bank, the Islamic Development Bank, and the European Investment Bank to co-finance large-scale RE projects using concessional loans or guarantees in order to address financing shortages.
* **Invest in Green Technical Education and Workforce Development**Use Algeria's renewable energy training programs to set up a formal framework for certifying green talents. This will make it easier for people to find jobs in solar, wind, sustainable agriculture, and eco-construction, especially women and young people.
* **Encourage Local Manufacturing of Green Technologies**Algeria could help make solar panels, biogas systems, and smart water gadgets at home to cut down on its reliance on imports. Give companies who make or put together clean tech locally money and tax breaks.
* **Implement Microgrid Projects in Rural and Desert Areas**Help set up solar and wind systems in off-grid villages to use as sustainable energy microgrids. These microgrids can help people get cheap electricity and promote financial inclusion by making it easier for businesses to grow and use digital payments.
* **Reduce reliance on fossil fuels by reallocating investment**The government should move subsidies and loans from fossil fuel projects to green projects. Banks and energy companies that invest more in solar, wind, and other renewable energy sources should get incentives.
* **Partner with international development banks**Algeria should work with organizations like the AfDB, IFC, and EIB to get around money problems and technical limitations. These partnerships can help Algeria with its green transition by giving it technical help, low-interest loans, and policy advice.

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# APPENDICES 1

## Ethics Committee Report



# APPENDICES 2

## Similarity Report