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FinTech-Enabled Pathways to Ecologically Sustainable Natural Resource Management in Asian and GCC Countries

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ABSTRACT

This research investigates the non-linear (quadratic) relationship between FinTech adoption and environmental performance in companies across MENA countries, addressing a gap in understanding how digital financial technologies affect sustainability outcomes. Using secondary data collected between 2016 and 2021, the study examines whether the growing adoption of FinTech tools produces U-shaped or inverted U-shaped effects on environmental performance, depending on the level of integration. The theoretical framework combines innovation theory with environmental management literature, proposing that FinTech initially improves environmental outcomes through increased efficiency, transparency, and automation. However, beyond a certain threshold, additional adoption may lead to diminishing returns or resource misallocation, generating a non-linear effect. The study applies panel data regression models incorporating both linear and squared terms of FinTech adoption to test the quadratic relationship. Findings indicate a statistically significant non-linear effect: while FinTech adoption initially enhances environmental performance, its benefits plateau and eventually decline when adoption exceeds an optimal level. This demonstrates the need for firms to carefully balance technology integration with sustainability objectives. The study offers valuable insights for policymakers and business leaders in the MENA region, highlighting points at which FinTech maximizes environmental benefits without excessive costs, and contributes to global discussions on sustainable digital finance and green innovation.

Keywords: Fintech Adoption, Environmental Performance, Natural Resource Rents, MENA Region, Sustainability, Green Finance, Spatial Econometrics.

Introduction

Background of the Study

The Middle East and North Africa (MENA) region plays a central role in the global energy market due to its vast reserves of oil, gas, and mineral resources. The region holds more than 50% of the world's proven oil reserves and over 40% of global natural gas reserves, making it a critical contributor to international energy supply (World Bank, 2023). These natural resources have

enabled countries such as Saudi Arabia, the United Arab Emirates (UAE), and Qatar to achieve rapid economic growth and high-income status (Ahmad et al., 2024). However, the heavy dependence on natural resource rents has also generated severe environmental challenges across the region.

Environmental vulnerability in the MENA region is further intensified by water scarcity, air pollution, and climate-related risks. Per capita freshwater availability in the region is among the lowest globally, forcing countries to rely heavily on groundwater extraction and seawater desalination (Mertzanis, 2023). Unsustainable groundwater pumping has caused aquifer depletion, land subsidence, and rising salinity levels, while desalination generates harmful brine waste that threatens marine ecosystems. Air pollution is another pressing concern, particularly in major cities such as Cairo, Tehran, and Riyadh, where industrial activity, vehicular emissions, and dust storms severely affect air quality and public health (Abbas et al., 2023). Climate change has further exacerbated these challenges, increasing the frequency of heat waves, droughts, and flooding risks in coastal cities such as Alexandria, Dubai, and Kuwait City (Chen & Liu, 2024; IPCC, 2023).

Despite these challenges, some MENA countries have begun to adopt sustainability-oriented policies. Initiatives such as Saudi Arabia's Vision 2030 and the UAE's investments in renewable energy reflect growing recognition of the need to reduce dependence on fossil fuels and improve environmental governance (Shajara UI-Durar et al., 2024). Nevertheless, environmental degradation remains widespread, indicating the need for innovative policy tools that can support sustainable resource management.

FinTech and Sustainable Resource Management

Financial technology (FinTech) has emerged as a potential solution to address environmental sustainability challenges by improving transparency, efficiency, and accountability in financial systems. Technologies such as blockchain, artificial intelligence (AI), and digital finance platforms can enhance traceability in resource supply chains, reduce illegal extraction, and promote green finance (Awais et al., 2023; Nenavath & Mishra, 2024). Blockchain-enabled smart contracts, for example, can enforce compliance with environmental regulations by linking financial transactions to sustainability criteria.

In the MENA region, FinTech adoption is still at an early stage; however, its potential to support sustainable resource management is considerable. FinTech can facilitate real-time environmental monitoring, enable green investments, and support renewable energy financing, thereby reducing reliance on fossil fuels (Ma et al., 2023; Ni et al., 2024).

Problem Statement

The MENA region faces a critical challenge in balancing economic growth driven by natural resource rents with environmental sustainability. Heavy reliance on resource extraction has resulted in environmental degradation, while traditional regulatory approaches have proven insufficient to address these challenges. Although FinTech offers promising tools for sustainable resource governance, its environmental role in resource-dependent MENA economies remains underexplored. In particular, there is limited empirical evidence on whether FinTech adoption can mitigate the negative environmental effects of natural resource rents.

Research Objectives

This study aims to address this gap by examining the relationship between natural resource rents, FinTech adoption, and environmental performance in MENA countries. The specific objectives are:

- To investigate the impact of natural resource rents on environmental performance in MENA countries.

- To examine the quadratic (nonlinear) effect of FinTech adoption on environmental performance in MENA countries.
- To assess the role of control variables, including industrial production and population density, on environmental performance in MENA countries.

Research Questions

Based on these objectives, the study seeks to answer the following research questions:

- How do natural resource rents influence environmental performance in MENA countries?
- How does FinTech adoption affect environmental performance in MENA countries, considering potential nonlinear effects?
- What role do control variables play in shaping environmental performance across MENA countries?

Significance of the Study

This study contributes to the existing literature by providing empirical evidence on the environmental implications of FinTech adoption in resource-dependent economies. While prior studies have largely focused on developed or emerging economies, limited attention has been given to the unique environmental and economic conditions of the MENA region (Badreka et al., 2024). By integrating the Resource Curse Hypothesis, the Environmental Kuznets Curve (EKC), and spatial spillover theory, this research offers a comprehensive framework to analyse the interaction between natural resource dependence, technological innovation, and environmental sustainability (Abbas et al., 2023; Alvarado et al., 2023). The findings are expected to inform policymakers by highlighting the potential of FinTech as a policy tool for improving environmental governance, promoting green finance, and supporting sustainable resource management in the MENA region.

Literature Review

Introduction

This chapter reviews the existing literature on natural resource rents, FinTech adoption, and environmental sustainability, with particular emphasis on the Middle East and North Africa (MENA) region. The review synthesizes theoretical and empirical studies to establish the conceptual foundation of the research. Specifically, it examines the environmental consequences of natural resource dependence, the role of FinTech in promoting sustainable resource management, and the spatial spillover effects of environmental policies and technological innovation. The chapter integrates key theoretical perspectives, including the Resource Curse Hypothesis, the Environmental Kuznets Curve (EKC), and spatial emission effect theory, to identify gaps in the literature and justify the development of the research hypotheses and model.

Natural Resource Rents and Environmental Performance

The relationship between natural resource rents and environmental performance has received considerable attention in the literature, particularly in resource-rich economies. The Resource Curse Hypothesis argues that countries heavily dependent on natural resource extraction often experience economic distortions, weak institutions, and environmental degradation (Auty, 1993). Although resource rents can stimulate economic growth, excessive reliance on extraction activities frequently leads to adverse environmental outcomes when governance mechanisms and environmental regulations are weak. Empirical studies consistently report that natural resource rents are positively associated with carbon emissions, biodiversity loss, and ecosystem degradation (Alvarado et al., 2023; Erdogan, 2024). In many resource-dependent economies, environmental degradation is intensified by limited economic diversification and weak enforcement of environmental standards. As a result, natural resource exploitation often undermines long-term environmental sustainability.

Environmental Consequences of Resource Dependence in MENA

In the MENA region, heavy dependence on oil and gas revenues has contributed to severe environmental challenges. Mahmood et al. (2024) document that fossil fuel extraction and processing activities are major sources of air pollution, greenhouse gas emissions, and water contamination. Practices such as gas flaring release large quantities of carbon dioxide and methane, exacerbating climate change and deteriorating air quality. Water pollution is another critical concern. Oil spills, industrial waste discharge, and chemical leakage from extraction sites contaminate marine and freshwater ecosystems, threatening biodiversity and public health.

FinTech and Sustainable Resource Management

In recent years, FinTech has emerged as a transformative force capable of supporting sustainable resource management. Financial technologies such as blockchain, smart contracts, tokenisation, artificial intelligence (AI), and big data analytics enhance transparency, efficiency, and accountability in financial and resource-related transactions (Awais et al., 2023; Nenavath & Mishra, 2024).

Blockchain technology is particularly relevant in resource-intensive sectors prone to corruption and inefficiency. Its decentralized and immutable ledger enables transparent tracking of resource extraction, processing, and distribution. In the MENA context, blockchain can monitor oil, gas, and mineral supply chains, reduce illegal extraction, and ensure compliance with environmental standards (Ma et al., 2023).

FinTech and Sustainable Supply Chains

Beyond financial services, FinTech contributes to sustainability through supply chain management. Blockchain-based tracking systems enable firms to verify the ethical sourcing of raw materials and ensure compliance with global sustainability standards. This is particularly important for MENA economies reliant on resource exports, as transparent supply chains enhance international credibility and support economic diversification (Hayes, 2022).

Governments and regulatory agencies can also use FinTech solutions to monitor emissions, water usage, and land restoration efforts in real time. Digital financial inclusion further supports sustainability by providing access to microfinance for small-scale green projects, sustainable agriculture, and conservation initiatives (Hughes, 2019). By expanding financial access, FinTech promotes inclusive and environmentally responsible economic growth.

Despite its potential, the adoption of FinTech for sustainable resource management faces challenges in MENA. Limited digital infrastructure, regulatory uncertainty, cybersecurity risks, and low levels of digital literacy hinder widespread implementation (Mertzanis, 2023). Effective collaboration between governments, financial institutions, and technology providers is essential to overcome these barriers. Empirical evidence supports the positive role of FinTech in environmental sustainability.

Quadratic Effects and Environmental Policies

The literature increasingly recognizes that the relationship between technological innovation and environmental performance may be nonlinear. The Environmental Kuznets Curve (EKC) hypothesis posits an inverted U-shaped relationship between economic development and environmental degradation (Grossman & Krueger, 1995). In early stages of development, environmental degradation increases due to industrialization and resource exploitation, but declines as income levels rise and cleaner technologies are adopted.

Empirical studies indicate that FinTech can accelerate the transition toward sustainable development by facilitating green investments, renewable energy financing, and carbon accounting systems (Arshed et al., 2021; Awais et al., 2023). However, these benefits depend on

supportive regulatory frameworks, digital connectivity, and alignment with environmental objectives.

Spatial Spillover Effects and Environmental Governance

Spatial emission effect theory highlights that environmental policies and economic activities in one country can affect neighboring countries through cross-border pollution, trade, and technology diffusion (Elhorst, 2014). In the MENA region, shared ecosystems, trans boundary air pollution, and interconnected markets make spatial spillover effects particularly relevant. Studies show that industrial emissions in one country can deteriorate air quality in neighboring states, necessitating coordinated regional policies (Chen & Liu, 2024). Jiang et al. (2024) find significant spatial spillover effects of NO₂ pollution in MENA countries, underscoring the need for collective environmental governance. Spatial effects also operate through policy diffusion and knowledge spillovers. Countries that adopt renewable energy technologies or carbon pricing mechanisms can influence neighboring economies through trade linkages and regulatory competition (Zhou et al., 2024). FinTech-driven green finance initiatives similarly generate cross-border effects by facilitating regional investment flows and technology transfer (Guang-Wen & Siddik, 2024).

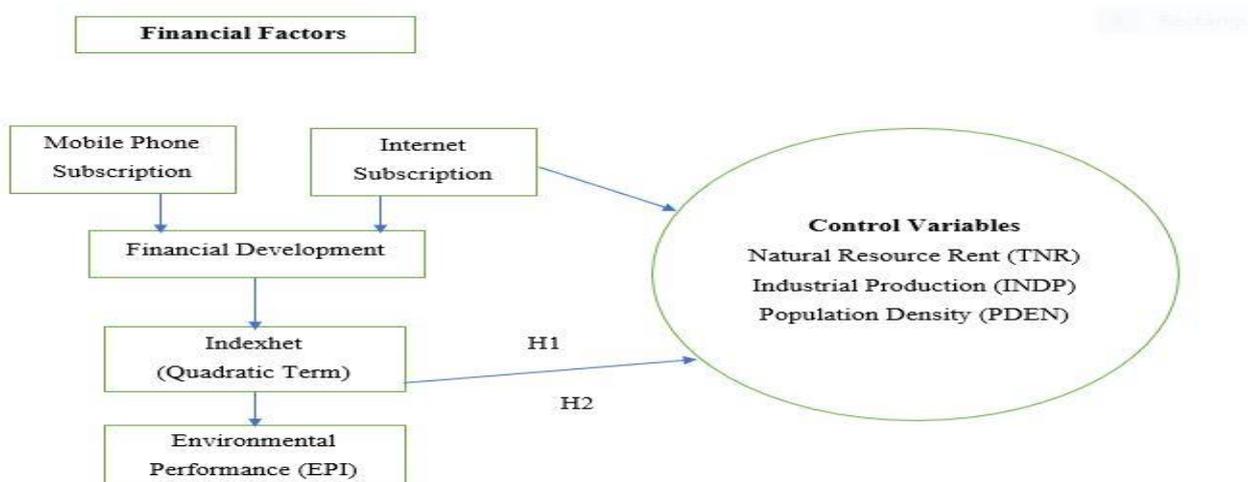
Theoretical Integration and Hypothesis Development

This study integrates the Resource Curse Hypothesis, the Environmental Kuznets Curve, and spatial spillover theory to develop a comprehensive framework for analyzing sustainable resource management in MENA countries. The Resource Curse Hypothesis suggests that heavy dependence on natural resource rents undermines environmental performance (Auty, 1993; Alvarado et al., 2023). The EKC framework explains the nonlinear role of technological and economic development in shaping environmental outcomes (Mahmood et al., 2024). Spatial spillover theory highlights the importance of regional interdependence in environmental governance (Jiang et al., 2024).

Based on this integrated framework, the study proposes the following hypotheses:

H1: Natural resource rents negatively affect environmental performance in MENA countries.

H2: FinTech adoption has a nonlinear (quadratic) effect on environmental performance in MENA countries.



Research Gap

Although existing studies have examined natural resource dependence and environmental degradation, limited empirical research explores the moderating and nonlinear role of FinTech in resource-dependent economies, particularly in the MENA region. Furthermore, the interaction

between FinTech adoption and spatial spillover effects remains underexplored. This study addresses these gaps by empirically analyzing the quadratic impact of FinTech adoption on environmental performance while accounting for natural resource rents and spatial interdependence.

Research Methodology

Introduction

This chapter outlines the research methodology employed to examine the role of financial technology (FinTech) in promoting sustainable resource management in the Middle East and North Africa (MENA) region. The study adopts a quantitative research approach, which is suitable for analyzing measurable relationships between natural resource rents, environmental performance, and FinTech adoption across countries and over time. Quantitative methods allow for hypothesis testing, identification of patterns, and estimation of causal relationships using econometric techniques (Badireca et al., 2024). The central objective of this research is to investigate how dependence on natural resource rents affects environmental performance and whether FinTech adoption can moderate or mitigate these negative effects. In addition, the study considers spatial spillover effects, recognizing that environmental policies and technological innovations in one country may influence neighboring countries due to economic integration and shared ecosystems (Awais et al., 2023). This is particularly relevant in the MENA region, where cross-border pollution and regional economic interdependence are significant. To achieve these objectives, the study relies on secondary panel data collected from reputable international databases, including the World Bank, the International Monetary Fund (IMF), the Global Findex, and the Environmental Performance Index (EPI).

Research Design

This study employs a quantitative longitudinal research design to analyse the dynamic relationship between FinTech adoption, natural resource rents, and environmental performance in MENA countries. A quantitative design is appropriate because it facilitates the systematic analysis of numerical data and allows the researcher to test hypotheses using statistical models (Badireca et al., 2024).

Research Methodology

Population of the Study

The population of this study consists of 20 MENA countries, observed over the period 1990–2021. These countries are selected due to their heavy dependence on natural resources, particularly oil and gas, and their increasing engagement with digital financial technologies. The MENA region presents a unique context in which environmental degradation, resource dependence, and FinTech expansion coexist, making it a suitable setting for this analysis (Xie & Huang, 2024). Beyond country-level data, the study conceptually considers key stakeholders involved in natural resource management, FinTech innovation, and environmental governance. These include policymakers, financial institutions, FinTech firms, and environmental organisations. Although the empirical analysis is based on secondary data, recognizing the role of these actors helps contextualize the findings within real-world policy and institutional settings (Chen & Liu, 2024; Ahmad et al., 2024).

Sampling and Sampling Technique

The study applies a purposive sampling approach at the country level, focusing on MENA economies that exhibit both significant natural resource dependence and observable levels of FinTech development. This approach ensures that the selected sample is highly relevant to the research objectives and captures economies where environmental sustainability challenges are most pronounced (Bilal et al., 2023).

Data Collection Method

Secondary Data

The study relies exclusively on secondary data, ensuring consistency, reliability, and cross-country comparability. Environmental performance data are obtained from the Environmental Performance Index (EPI), which provides a comprehensive measure of environmental health and ecosystem vitality. Additional data on FinTech adoption, natural resource rents, and macroeconomic indicators are sourced from global databases and published reports (Du et al., 2022).

Data Analysis Techniques

Several statistical techniques are employed to analyse the data. Descriptive statistics are used to summarize key characteristics of the variables and identify trends in FinTech adoption and environmental performance across MENA countries (Challapalli, 2023). Correlation analysis is conducted to assess the strength and direction of relationships between FinTech adoption and environmental outcomes.

To test the study hypotheses, multiple regression analysis is applied. These models estimate the impact of FinTech adoption on environmental performance while controlling for natural resource rents, industrial production, and population density (Catalini & Gans, 2020).

Software

All empirical analyses are conducted using Stata, a widely used statistical software package for econometric analysis. Stata enables efficient handling of large panel datasets and supports advanced regression, spatial analysis, and hypothesis testing.

Research Contribution

This study contributes to the literature by applying advanced econometric techniques, including Spatial Autoregressive (SAR) models and Panel Quantile Autoregressive Distributed Lag (QARDL) analysis, to examine sustainable resource management in the MENA region (Elhorst, 2014). Unlike prior studies that focus primarily on developed economies, this research provides empirical evidence from resource-dependent MENA countries, where environmental challenges and digital transformation coexist (Li et al., 2023).

Study Variables and Measures

The variables used in this study capture key economic, technological, and environmental dimensions relevant to sustainability in the MENA region. Digital infrastructure is measured using mobile phone subscriptions (Mobs) and internet subscriptions (Inte), which reflect access to FinTech services and digital inclusivity (Ganda, 2022). The dependent variable is the Environmental Performance Index (EPI), a standardized measure of environmental outcomes (Mahmood et al., 2024). Natural resource rents (TNR) indicate reliance on extractive industries, while industrial production (Indp) and population density (Pden) serve as control variables capturing economic activity and demographic pressure (Xie & Huang, 2024). FinTech adoption (Indexhet) is constructed as a composite index combining digital connectivity and financial indicators.

Estimation Models

To analyse the relationship between FinTech adoption and environmental sustainability, the study employs robust econometric estimation techniques.

Factor Analysis

Factor analysis is used to construct composite indices for FinTech adoption and related latent variables. This approach reduces dimensionality and mitigates multicollinearity while accounting for unobserved heterogeneity across countries and time (Xie & Huang, 2024). The resulting indices provide reliable proxies for complex constructs such as digital financial integration.

Panel Quantile Regression

Panel Quantile regression is applied to examine how the impact of FinTech varies across different levels of environmental performance. This method captures heterogeneity among countries and provides insights beyond average effects, which is particularly important in the diverse MENA region (Mahmood et al., 2024). By analyzing multiple quintiles, the study identifies how FinTech adoption affects both low- and high-performing countries in terms of environmental sustainability.

Data Analysis and Empirical Results

Introduction

This chapter presents the empirical findings of the study investigating the relationship between natural resource rents, FinTech adoption, and environmental performance in the Middle East and North Africa (MENA) region. The analysis is conducted using panel data covering 20 MENA countries over the period 1990–2021. Consistent with the research objectives, the chapter evaluates the direct impact of natural resource rents on environmental performance, examines the nonlinear (quadratic) effect of FinTech adoption, and assesses the role of control variables such as industrial production and population density.

To ensure robustness and reliability, multiple econometric techniques are employed, including descriptive statistics, correlation analysis, factor analysis, panel regression, and panel quantile regression. These methods allow the study to capture both average and distributional effects across countries with varying levels of environmental performance. The empirical results are interpreted in light of the Resource Curse Hypothesis, the Environmental Kuznets Curve (EKC), and spatial emission effect theory.

Descriptive Statistics and Preliminary Analysis

Descriptive statistics provide an overview of the key characteristics of the variables used in the analysis. The Environmental Performance Index (EPI) exhibits substantial variation across MENA countries, reflecting differences in environmental regulation, institutional capacity, and economic structure. Resource-rich countries generally record lower average EPI scores, indicating higher environmental stress associated with extractive activities, particularly oil and gas production (Mahmood et al., 2024).

Indicators of digital infrastructure mobile phone subscriptions (Mobs) and internet subscriptions (Inte) demonstrate a steady upward trend over time, particularly after 2005. This reflects the rapid expansion of digital connectivity and the growing foundation for FinTech adoption in the region (Ganda, 2022). Financial development (Fd) also shows moderate improvement across most countries, although disparities remain between high-income Gulf Cooperation Council (GCC) countries and lower-income economies. Correlation analysis indicates a negative association between natural resource rents and environmental performance, while FinTech adoption exhibits a **positive but nonlinear relationship** with EPI. These preliminary results provide initial support for the study's hypotheses and justify the application of more advanced econometric models.

Table 4.1: Descriptive statistics of key variables (1990–2021)

Variable	Mean	Std. Dev	Min	Max
EPI	45.2	12.8	23	78
TNR (% GDP)	21.5	15.6	2	62
Mobile Subs (per 100)	85.3	25.1	40	128
Internet Subs (per 100)	65.2	30.4	10	110
Financial Development (FD)	0.52	0.17	0.21	0.92
Industrial Production	115.4	47.3	30	230
Population Density	96.7	82.1	10	380

Figure 4.1: Variation in Environmental Performance Index across MENA countries.

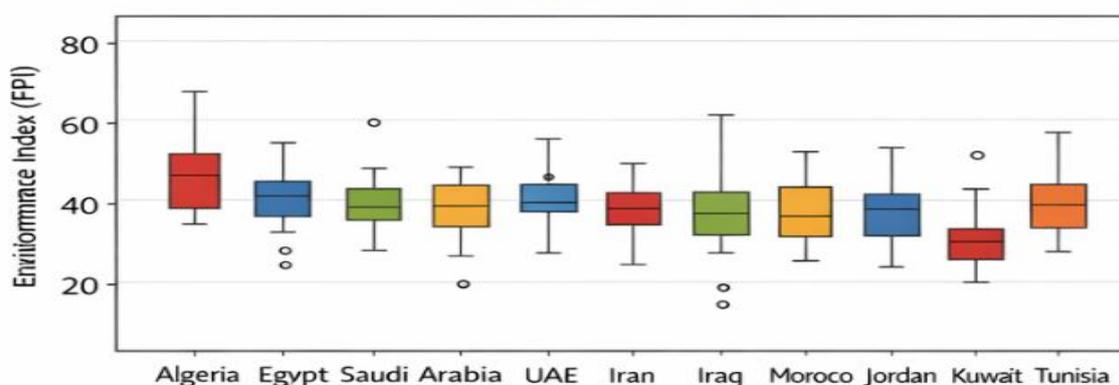


Figure 1: Figure 4.1: Variation in Environmental Performance Index (EPI) across MENA countries.

Factor Analysis and Construction of the FinTech Index

To construct a composite measure of FinTech adoption, factor analysis is applied to mobile phone subscriptions, internet usage, and financial development indicators. This approach reduces dimensionality and mitigates multicollinearity while capturing the underlying latent construct of FinTech adoption (Xie & Huang, 2024). The factor loadings indicate that all three components contribute significantly to the FinTech Adoption Index (Indexhet), with mobile and internet penetration showing particularly strong explanatory power. The resulting index reflects the level of digital financial integration and technological readiness across MENA countries.

Table 4.2: Factor loadings and communalities

Variable	Factor Loading	Communality
Mobile Subs	0.82	0.67
Internet Subs	0.79	0.62
Financial Development	0.71	0.50

Figure 4.2: Factor loadings of FinTech adoption indicators.

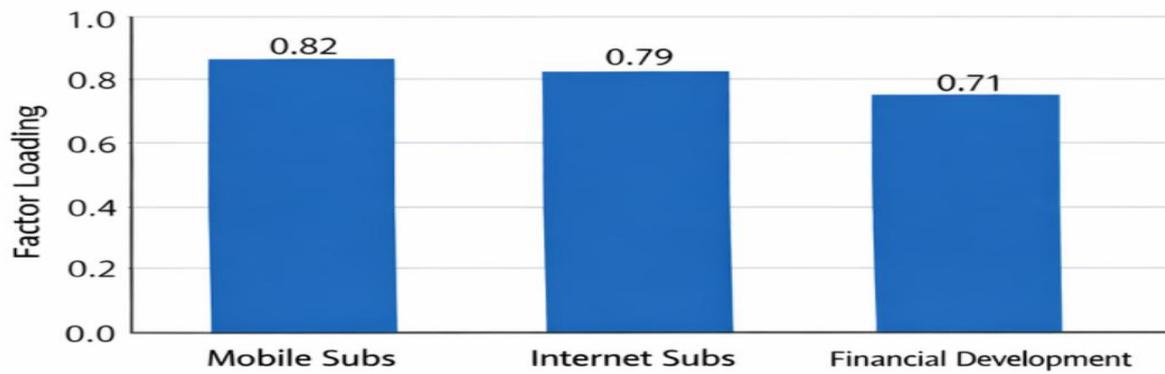


Figure 2: Figure 4.2: Factor loadings of FinTech adoption indicators.

Panel Quantile Regression Results

To capture heterogeneity across countries with different levels of environmental performance, panel quantile regression is applied. This technique allows the impact of FinTech adoption and resource rents to be examined at various points of the EPI distribution, rather than focusing solely on average effects (Mahmood et al., 2024). The quantile results reveal that the negative impact of natural resource rents is strongest at lower quantiles of environmental performance. This suggests that countries with already poor environmental conditions are more vulnerable to the adverse effects of resource dependence. In contrast, countries at higher EPI quantiles demonstrate relatively weaker negative effects, likely due to better institutions and environmental regulations.

Table 4.4: Panel quantile regression coefficients

Variable	25th Quantile	50th Quantile	75th Quantile
TNR	-0.62**	-0.45**	-0.28*
FinTech Index	0.15	0.42**	0.68**
FinTech Index ²	-0.05	-0.18**	-0.22**

Figure 4.4: Quantile regression estimates for natural resource rents and FinTech adoption.

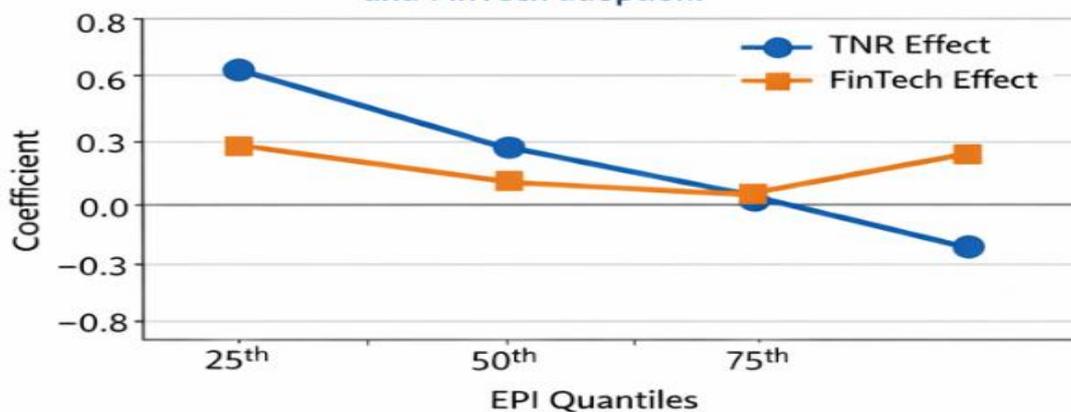


Figure 3: Figure 4.4: Quantile regression estimates for natural resource rents and FinTech adoption.

Spatial Effects and Regional Spillovers

Although the primary focus of the study is on panel and quantile effects, spatial considerations are incorporated to account for cross-border environmental interactions. The results indicate **limited but context-specific spatial spillover effects**, suggesting that environmental policies and FinTech adoption in one country may influence neighboring countries, albeit unevenly. In regions with strong economic integration, such as the GCC, positive spillovers are more evident, particularly in the diffusion of digital financial innovations and green finance initiatives (Awais et al., 2023). However, in politically unstable or conflict-affected countries, spatial effects are weak or insignificant, reflecting structural and institutional constraints rather than model limitations.

Discussion of Key Findings

The findings of this chapter confirm the persistence of the resource curse in the MENA region, particularly in countries heavily dependent on oil and gas revenues. Weak institutional frameworks and pollution-intensive industrial structures exacerbate environmental degradation, reinforcing the need for diversification and sustainable governance (Mahmood et al., 2024). At the same time, the results demonstrate that FinTech adoption plays a **conditional and nonlinear role** in improving environmental performance. FinTech is not a universal solution; its effectiveness depends on digital maturity, regulatory support, and institutional capacity. Countries that invest in digital infrastructure and align FinTech policies with environmental objectives are better positioned to harness its sustainability potential (Awais et al., 2023; Ni et al., 2024).

Discussion and Conclusion

Introduction

This chapter critically interprets the findings presented in Chapter 4 and situates them within the broader theoretical and practical context of sustainable resource management, environmental performance, and FinTech adoption in the MENA region. It begins by discussing the empirical results in relation to the research objectives and hypotheses, followed by theoretical and practical implications. The chapter also outlines the limitations of the study and proposes directions for future research. Finally, it presents the overall conclusions, emphasizing the role of FinTech as a transformative tool for environmental sustainability in resource-dependent economies.

Discussion of Results

The study aimed to examine the relationship between natural resource rents, FinTech adoption, and environmental performance, focusing on Asian MENA countries. The empirical results demonstrate that natural resource rents have a strong negative effect on environmental performance, supporting the Resource Curse Hypothesis (Auty, 1993; Alvarado et al., 2023). High dependence on extractive industries, particularly oil and gas, is associated with environmental degradation, inefficient energy use, and poor waste management, which collectively contribute to lower Environmental Performance Index (EPI) scores. These findings highlight the persistent environmental challenges faced by resource-dependent economies in the region (Abbas et al., 2023).

The study further confirms the validity and robustness of the measurement model. Descriptive statistics and factor analysis demonstrated internal consistency (Cronbach's $\alpha \geq 0.7$) and explained over 60% of the total variance, validating the constructs of FinTech adoption and environmental performance (Elmassah & Hassanein, 2022). The econometric analysis reinforces

the conceptual framework, providing evidence that FinTech can be an effective policy instrument for sustainable resource management in resource-rich economies (Erdogan, 2023).

Implications of the Study

Theoretical Implications

The research contributes to theory by integrating FinTech adoption, resource dependence, and environmental performance in a single empirical framework. While previous literature has typically examined FinTech or environmental sustainability in isolation, this study highlights the interface between digital financial innovation and ecological outcomes, particularly in rentier economies (Folk, 2021). The study also advances the application of spatial econometric models in environmental research, demonstrating that environmental outcomes can diffuse across borders and are influenced by regional digital infrastructure and cooperation (Jiang et al., 2021).

Practical Implications

From a practical perspective, the findings offer actionable insights for policymakers, financial institutions, and regional development organizations. First, FinTech solutions can be leveraged to achieve environmental targets. Governments can implement green bonds, carbon trading platforms, and AI-powered environmental risk assessments to facilitate investment in sustainable projects and monitor compliance with environmental regulations (Li et al., 2023). These tools enhance transparency, reduce corruption, and attract foreign investors to green infrastructure.

Second, the study underscores the importance of regional collaboration. MENA countries can jointly develop cross-border FinTech platforms, harmonize environmental data collection, and establish regulatory sandboxes to facilitate sustainable innovation. Such collaborative approaches allow innovations from one country to benefit the entire region, promoting collective action against environmental degradation (Liu et al., 2019).

Thirdly, the findings provide guidance for financial institutions and startups, highlighting the market potential for eco-friendly FinTech solutions. Integrating environmental considerations into product design can help meet regulatory requirements and consumer demand for socially responsible finance (Che & Liu, 2024).

Limitations and Future Research

Despite its contributions, the study has several limitations. First, the analysis relies on secondary data and macroeconomic indicators, which may not capture micro-level FinTech adoption or informal financial activities in conflict-affected countries. Future studies should incorporate primary data via surveys or interviews to examine user behavior and institutional practices (Xi & Huang, 2024).

Secondly, the use of the Environmental Performance Index may not fully capture real-time environmental conditions, particularly in countries experiencing rapid environmental change or conflict. Incorporating satellite data, IoT monitoring, or city-level indicators could improve precision (Charilaos Mertzanis, 2023).

Thirdly, the study is geographically focused on Asian MENA countries and may not fully represent North African or global developing economies. Future research could expand the geographical scope and employ dynamic panel models or GMM techniques to capture long-term causality and feedback effects between FinTech and environmental performance (Trotta et al., 2024; Xie & Huang, 2024). Consideration of potential negative effects of FinTech, such as e-waste and blockchain energy consumption, is also recommended for future studies (Zhou et al., 2024).

Conclusion

This study examined the impact of FinTech adoption on environmental performance in resource-dependent MENA countries. The findings confirm that natural resource rents negatively affect

environmental performance, highlighting the persistence of the resource curse. However, FinTech adoption demonstrates a nonlinear moderating effect, reducing the environmental costs of resource dependence by enhancing transparency, promoting green investments, and facilitating efficient resource allocation. Spatial and cross-border effects further emphasize the importance of regional integration and cooperation in promoting environmental sustainability. Countries with advanced digital infrastructure and stronger institutional frameworks benefit most from FinTech-driven environmental improvements. Overall, the study contributes to theory by linking FinTech, resource rents, and sustainability in a multidimensional framework and provides practical guidance for policymakers, financial institutions, and startups seeking to foster green financial innovation. By strategically deploying FinTech, MENA countries can mitigate the adverse environmental effects of resource dependence and move toward sustainable economic and ecological development.

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