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Financial Inclusion, Foreign Direct Investment and Carbon Footprint Nexus in OIC Countries: The Role of Institutional Quality

[a] Nazia Nasir, [b] Noreen Safdar

[a] PhD scholar, The Women University Multan, Punjab, Pakistan
Email: nazianasir38@gamil.com
[b] Assistant Professor, The Women University Multan, Punjab, Pakistan
Email: noreen.safdar@wum.edu.pk

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ABSTRACT

Purpose: The study aims to examine the relationship between financial inclusion, foreign direct investment, and their impact on carbon footprint, as well as to investigate the connection between these factors and the quality of institutions in shaping carbon footprint.
Design/Methodology/Approach: Panel data analysis for 30 member nations of the Organization of Islamic Cooperation (OIC) has been conducted. We employed principal component analysis to construct the composite financial inclusion index and utilized quantile regression (MMQR) for estimations.
Findings: The study's findings indicate that variables such as the financial inclusion and the role of institutional quality positively affect carbon emissions while foreign direct investment are inversely related to carbon footprint.
Implications/Originality/Value: Financial inclusion leads to increased emissions; thus, the implementation of carbon taxes or cap-and-trade systems may effectively regulate pollution. Implement a carbon tax on industries that increase emissions due to enhanced credit accessibility, and educate new members, including individuals and enterprises, on making financially sound decisions. If improved governance leads to increased emissions, it is necessary to enhance regulatory thresholds. A portion of fiscal surplus or efficiency gains resulting from institutional changes should be allocated to climate mitigation efforts, enabling this budgeting approach to finance renewable energy, enhance energy efficiency, or develop sustainable infrastructure.

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***Corresponding Author's email address: noreen.safdar@wum.edu.pk**

1. Introduction

In 2015, the United Nations set the Sustainable Development Goals (SDGs) as part of the overall strategy to end poverty, combat climate change and protect the well-being of life by 2030 (Wennersten & Qie, 2018). These goals provide a platform for a holistic approach to some of the most critical issues that included, but were not constrained to, economic growth, environmental health and social equity. Several important sectors have led to this change in this context, including foreign direct investment (FDI) and environmental footprint management (Odugbesan et al., 2022). Moreover, the financial sector is essential in distributing scarce resources among competing uses and for the global financial activities accomplished in this process (Jahanger, Usman, et al., 2022; Porter, 1986). Many economies shifted towards improving FI as a development strategy after the 2007–2008 global recession instigated by the financial crisis. In comparison, debates on the role of IQ on FI, FDI, and in these countries have focused on attaining certain development goals as per global policy discourse. However, emerging concerns directed policy discourse towards how these goals can be realized, where the institutional quality (IQ) a critical determinant of the extent to which economies use the services of the formal financial sector in promoting FDI (Eldomiaty et al., 2020; Zeqiraj et al., 2022).

The primary objective of FI is to incorporate the "unbanked" individual into the formal financial sector. During the FI process, individuals and households can enhance their living standards and contribute to the nation's economic expansion (Aghion & Bolton, 1997; Banerjee & Newman, 1993; Yan, Xiao, & Sun, 2024). Benjamin, Beegle, Recanatini, and Santini (2014) reported a disparity in securing bank loans, indicating that 51% of firms in advanced economies secured bank loans, whereas only 34% of firms in developing countries performed accordingly. Consequently, certain individuals with entrepreneurial potential cannot initiate their businesses to achieve potential income growth due to a lack of requisite capital. Conversely, businesses typically experience sluggish growth without essential financial support, which results in prolonged low wages for employees. Thus, financial exclusion adversely affects poverty alleviation in low-income economies. At the same time, the mechanisms of capital misallocation in occupational choice that result from financial exclusion have not been comprehensively examined (Simba, Tajeddin, Dana, & Ribeiro Soriano, 2024).

The United Nations Development Program (UNDP 2010) defines financial inclusion (FI) as reasonable and sufficient availability of credit for different stakeholders. Therefore, accessibility, availability, and utilization of the financial system become the core dimensions of FI (Ben Naceur, Barajas, & Massara, 2015). In contrast, Consultative Group to Assist the Poor (CGAP) aims at a world where people experiencing poverty can access and use basic financial services without requiring a dedicated poor financial market. According to (Chakrabarty, 2012), FI refers to delivering financial services for the excluded proportions of society through the formal sector on a sustainable and cost-effective basis.

Since the 1990s, competition among economies to attract foreign direct investment has intensified, characterised by tax reductions and subsidies (Chudnovsky & López, 2000). Many developing countries implemented policies aimed at enhancing foreign direct investment (FDI) inflows and regulating foreign investment activities, which included financial sector adjustment programs, recovery strategies, and structural adjustment initiatives (World Bank, 2013). Dunning's eclectic paradigm theory (1988) asserts that an external stakeholder's choice to engage in a host country is influenced by factors such as firm size, management systems, labour and transportation costs, government policies, and political stability. Investors exhibit significant concern regarding risks and potential returns associated with entering foreign markets (Ashiru & Oni, 2022; Tatoglu & Glaister, 1998).

The IQ, which includes characteristics like government effectiveness, rule of law, and regulatory quality, is significant (Daude & Stein, 2007). High-quality institutions can reduce the negative environmental effects linked to the promotion of climate-sensitive behaviours and the development of green and inclusive finance (Latif et al., 2023). The indicator of IQ is connected to the interaction between foreign direct investment (FDI), foreign direct investment (FI), and environmental footprints in nations that are members of the Organisation of Islamic Cooperation (OIC). The participation of all societal members in accessing financial facilities through inclusion in the financial system has direct and indirect effects on the environment. The distribution of benefits from financial inclusion is uneven, with certain adverse effects emerging based on the operational institutional framework (Cuevas & Fischer, 2006). FI is associated with increased environmental footprints (Chaudhry et al., 2022; Singh et al., 2023).

This research has focused on the OIC countries largely concentrated in the Middle Eastern, Asian and North African regions. With industrial growth, there is usually an expansion of the environmental footprints with a consequent increase in greenhouse gas emissions, deforestation, and depletion of natural resources. Most OIC countries are emerging economies with large populations and expanding industrial sectors. These countries thus have a dual challenge of achieving economic growth while, at the same time, addressing the adverse environmental consequences. As it has been postulated that environmental performance is defined by the quality of institutions in a country. IQ can do this more effectively by following the environmental norms, promoting the sustainability and offering a substantial green finance (Ameer et al., 2022; Okoh, 2024). For instance, countries that have developed legal frameworks and policies on carbon emission and other investment on renewable energy are likely to succeed than those that lack institutional policies (Ameer et al., 2022). On the other hand, weak institutions may lead to the failure of environmental rules and only advance the profit-seeking perspective of the business (Hunjra et al., 2020; Jianguo et al., 2022). The quality of institutions appears to vary more widely across OIC countries and does impact the way countries deal with issues of the environment. For instance, Saudi Arabia, which has relatively more favourable institutions, has been able to level up with the rest of the countries utilizing clean technologies and sustainable development (Amran et al., 2020). However, in countries with weak institutions, this is still an issue that must be addressed, that is, environmental degradation.

Over the years, exploring the relationship between FI, FDI, and the environment within the scope of international development has become necessary. However, several OIC countries cannot realise this vision due to challenges such as high poverty levels, lack of financial services to the people and over-reliance on external funding for growth. FDI is also a major growth engine because it provides funds and technology. However, such investments' environmental consequences, especially in land areas with poorly structured governance, cannot be disregarded. In addition to this, in the OIC countries where governance challenges are common, this area has yet to receive adequate attention, particularly the role of IQ in determining the outcome of FI and FDI on the environment. On the other hand, although FDI is important for promoting industrial growth, it also creates havens for industries where pollution control facilities are non-existent in third-world countries with low levels of government regulations. The relationship between environment and FDI is always complicated, FDI inflows often bring ecologically hazardous technologies to developing economies with poor educational attainment. Once education levels above certain thresholds, FDI inflows may reduce CO_2 emissions, suggesting the environmental Kuznets curve (EKC) in certain nations. Khan et al., (2023). This concern has also drawn attention to the issue of providing countries with the environmental consequences of FDI in OIC countries. This research investigated the problems mentioned above and addressed the role of IQ in the relationship between FI, FDI, and the environment in OIC countries. Examine the influence of foreign direct investment and financial inclusion on the carbon footprint and investigate the impact of institutional quality, financial inclusion, and foreign direct investment on carbon footprint.

2. Literature Review

An increase in foreign direct investment (FDI) to middle-income and low-income nations has sparked environmental concerns, and the relationship between financial inclusion (FI), foreign direct investment (FDI), role of institution and environmental footprints has become a subject of debate in the fields of academia. Therefore, sustainable foreign direct investment (FDI) and inclusive financial systems have been gaining prominence among economists and policymakers around the world in recent years to promote economic growth while reducing environmental degradation.

Alsagr (2023) and L. Zhang et al. (2022) have examined the role of financial systems in facilitating the funding of green projects, while other studies have highlighted the detrimental effects of excessive financial development on the environment. The two objectives provide a foundation for a more in-depth analysis of the potential of FI to support the achievement of both environmental and economic goals (Mahmood et al., 2024). Consequently, FI may serve as a solution that promotes sustainability, whereas the absence of regulation contributes to environmental degradation. Mehmood (2022) demonstrated in a recent study that financial deepening and population growth are significant determinants of CO_2 emissions in G-11 economies. The study also indicated that the advancement of financial services without adherence to environmental quality standards will result in increased pollution. The significance of sustainability factors in financial development policies and strategies is emphasized. Zhang et al. (2022) examined FI's effect on CO_2 emission efficiency in 30 Chinese provinces from 2011 to 2019 using panel data. The same study indicated that FI reduces carbon emission efficiency using panel Tobit regression analysis and super-efficiency SBM-DEA data. Due to structural changes in industries, especially tertiary sector expansion, emissions increased. The study also found that FI affects CO_2 emissions differently among geographies. Policy recommendations included monitoring FI investments, encouraging renewable energy, and ensuring ecologically responsible industrial development. Boussaidi and Hakimi (2024) used seemingly unrelated regression (SUR) to estimate MENA data. This study found that FI can boost economic growth but degrade the environment into poor institutional environments. By improving sustainable project funding, IQ reduced environmental damage. This article also argues that robust institutional governance is needed to align FI goals with environmental sustainability.

Chunyu et al. (2021) conducted an analysis of the nonlinear relationship between the emerging economies of Central Asia and Europe, focusing on carbon emissions, financial development, and energy consumption. The relationship between CO_2 emissions, energy consumption, and financial development was analyzed through bound test and panel-ARDL methodologies, highlighting the presence of non-linearity. Data was gathered from eighteen economies across Europe and Central Asia during the period from 2010 to 2019. The results indicated an initial positive relationship between financial development and CO_2 emissions; however, as financial development advanced, both pollution and CO_2 emissions decreased, leading to a U-shaped economic trend. Furthermore, Chaudhary et al. (2022) examined the environmental effects of FI in OIC nations categorized into three income levels. The findings indicated a positive relationship between FI, CO_2, and deforestation, while revealing a negative relationship between N_2O and ecological footprint. An inverted U-shaped Environmental Kuznets Curve (EKC) was identified for OIC countries across varying income levels.

Doytch (2020) analyzed the impact of foreign direct investment (FDI) on the ecological footprints of countries, utilizing six sector-specific FDI flows, and four types of ecological footprints (EF) as defined by the Global Footprint Network: consumption EF, production EF, imports EF, and exports EF. High-income countries exhibit greater susceptibility to ecological impacts related to foreign direct investment tied to consumption. Conversely, low-income and middle-income countries exhibit greater vulnerability to ecological impacts associated with production-related foreign direct investment (FDI). Middle-income countries disproportionately bear the burden of exports financed by foreign direct investment. This study demonstrates that foreign direct investment has a limited impact on the production-related environmental footprints of developing economies and the consumption-related environmental footprints of affluent nations. This does not imply that nations ought to deter foreign direct investment (FDI); instead, it necessitates policy modifications that affect consumer behavior in developed countries, ensuring that extra revenue generated by FDI is utilized in an environmentally sustainable way.

Faridi et al. (2022) analyze panel data spanning from 1980 to 2017 to examine the effects of foreign capital inflows on environmental deterioration in developing nations. The analysis utilized panel ARDL and Granger causality to assess the relationship. Over an extended period, foreign inflows exhibited a positive correlation with environmental degradation; however, this relationship was not statistically significant in the short term. Various elements, including demographics and technological advancements, exhibited differing impacts, while prosperity played a notable role in contributing to degradation. Nonetheless, the Granger causality tests indicated an absence of a direct connection between foreign inflows and environmental degradation.

Chen et al. (2023) examined how corruption negatively impacts environmental quality by undermining the mechanisms for policy development and implementation. Corruption leads to the establishment and enforcement of inadequate environmental policies, resulting in poor adherence to environmental standards. Additionally, Welsch (2004) demonstrates the direct impact of corruption on pollution at certain income levels, as well as its indirect influence on pollution via its effect on economic growth. In a similar vein, Leitão (2010) and Cole et al. (2007) provide evidence for the statistically significant relationship between corruption and environmental deterioration by identifying primary and secondary channels that connect these two variables. Zhang et al. (2016) demonstrated that corruption exerts varied influences; it negatively affects low carbon-emitting countries while positively impacting high carbon-emitting countries, suggesting that corruption's effects are not uniform.

Democratic institutions are the most effective at preventing environmental degradation. Neumayer (2002) posits that democracies exhibit greater efficacy in environmental assessment owing to their foundational principles of transparency, accountability, and public engagement in the decision-making process. Furthermore, Panayotou (1997) incorporated institutional quality into the EKC model and discovered that superior institutions enhance environmental quality at elevated income levels. Nonetheless, the emerging economies are more predisposed to attain substantial economic expansion at the expense of environmental integrity and ecological equilibrium. These trends necessitate institutional reform to enhance economic growth while safeguarding the natural environment (Akbulut, 2024; Neumayer et al., 2002; L. Zhang et al., 2022).

Institutional quality and the functions of finance and sustainability have significantly impacted environmental quality and growth in recent years. Within the policy and institutional framework of finance and environmental protection, Abor and Ofori-Sasu (2024) and (Gyimah, et al., 2023) establish a correlation between globalization, FDI, and DFI. The study conducted by Zulkhibri and Ghazal (2017) provides a governance perspective on the context of FI in developing and Muslim countries. It investigates the impact of institutional enablers/restraints and structural-demographic factors on economic operations.

When it comes to designating foreign direct investment as the key driver, institutional variables also play an integral part, for instance, Zulkifli et al. (2024) found that FDI had a positive relationship with improvements in IQ (i.e. increased government efficiency, political stability, and regulatory quality) and a negative relationship with corruption. In some contexts, corporate transparency is an important institutional factor; in others, corruption regulation is critical (S. Chen et al., 2023; Cole et al., 2007; Zulkifli et al., 2024). Faruq (2023) investigated that political stability creates a protection net for foreign investment. Infrastructure and human resources are the focus of the literature, which reduces costs and increases output to improve a country's FDI attractiveness (Islam & Beloucif, 2024; Patel et al., 2024). Political discrimination may, however, lead to differences in the factors affecting FDI even when integration is present. In Brazil, investment and infrastructure were identified as key determinants Patel et al. (2024) found that the dynamics of these factors changed.

This review concludes that environmental challenges can only be addressed through a multidimensional approach involving robust institutional reforms, anti-corruption measures, and inclusive financial and environmental policies to achieve the balance between economic growth and sustainability.

This section discussed the interaction between institutional quality, financial inclusion, and FDI and served as a basis for studying their implications for environmental footprints and sustainable development in OIC countries. The importance of institutional quality in addressing environmental footprints through compliance, regulation enforcement and financial inclusion was emphasized. Strong institutions are shown to improve resource allocation. The environment provides its protection only if effective institutional frameworks are in place to ensure that FDI conforms with environmental objectives. This review concludes that environmental challenges can only be addressed through a multidimensional approach involving robust institutional reforms, anti-corruption measures, and inclusive financial and environmental policies to achieve the balance between economic growth and sustainability.

Limited research exists on the relationship between financial inclusion and environmental footprint, with few studies connecting financial inclusion to CO_2 emissions. We adopt a holistic approach to assess various aspects of environmental footprint, including carbon footprint, water footprint, and land footprint.

Evidence from literature has explored the EKC hypothesis; for example, Stern (2017) performed a theoretical analysis that substantiates the presence of EKC relationships in developed nations. Zhang (2021) examined the EKC hypothesis in emerging economies, concluding that while the hypothesis is valid for specific emission-related indicators, the quality of institutions and governance plays a crucial role in shaping environmental footprints. Nevertheless, empirical evidence shows that various control variables interact to shape the patterns of environmental degradation within a specific country; for example, industrialisation has led to air and water pollution in China. Recent economic growth, along with policy measures like investments in green technology and emission control, has started to diminish specific types of pollution, aligning with the Environmental Kuznets Curve hypothesis (Shahbaz et al., 2020).

Natural Capital Theory asserts that ecosystems and natural resources are fundamental forms of capital, like physical or human capital, as they deliver goods and services crucial for human survival, thereby necessitating their protection and management. The theoretical foundations of Natural Capital Theory are articulated in the works of Georgescu-Roegen (1971) and Daly (1977), which underscore the limitations of ecosystems and stress the necessity of accounting for the earth's carrying capacity (Costanza, 1992). Dasgupta (2021) advanced the concept by incorporating natural capital into economic accounts and policies to mitigate global biodiversity loss.

The Pollution Haven Hypothesis (PHH) is a fundamental theory in environmental economics that elucidates the impact of international trade, environmental regulations, and industrial mobility on pollution levels. Wagner and Timmins (2009) assert that in the 1990s, PHH expanded trade theory and environmental policy evaluation, positing that multinational corporations relocate their operations to nations with less rigorous environmental regulations to reduce compliance costs, thereby leading to the emergence of "pollution havens" (Copeland, 2008). The PHH examines the adverse environmental effects of globalisation, specifically regarding foreign direct investment, trade liberalisation, and industrialisation in developing countries (Gyamfi et al., 2022; Ke et al., 2022).

3. Data & Methodology

The study utilizes panel data sourced from the World Development Indicators (WDI) and Worldwide Governance Indicators, covering the period from 2004 to 2023 for 30 countries within the Organization of Islamic Cooperation (OIC). These countries include Afghanistan, Algeria, Albania, Azerbaijan, Bangladesh, Brunei Darussalam, Chad, Comoros, Guinea, Iran, Indonesia, Iraq, Kazakhstan, Kuwait, Kyrgyz Republic, Lebanon, Malaysia, Mali, Maldives, Mozambique, Nigeria, Pakistan, Qatar, Saudi Arabia, Tajikistan, Turkiye, Uganda, United Arab Emirates, and Yemen.

Principal component analysis is employed to create a composite financial inclusion index and an institutional quality index. In our model, We have employed MM-QR as our principal tool to examine the impacts of financial inclusion, foreign direct investment, and the role of institutional quality on the environment. The panel quantile regression method was initially proposed by Koenker and Bassett in 1978. Quantile regressions are the most resilient to outliers in estimate. Furthermore, it is more effective when there is minimal or no connection between the conditional means of the two variables (Binder & Coad, 2011).

This study estimates two models to examine the effects of financial inclusion, foreign direct investment, and institutional quality on carbon footprint.

Model-1: Financial inclusion and foreign direct investment model based on the carbon footprint

The standard representation of an econometric equation is as follows:

$$Q_{CO2_{it}}(\tau|\lambda_i,\delta_t,X_{it}) = \lambda_i + \delta_t + \beta_{1,\tau}FII_{it} + \beta_{2,\tau}FDI_{it} + \beta_{3,\tau}IQI_{it} + \beta_{4,\tau}GDP_{it} + \beta_{5,\tau}GDP^2_{it} + \varepsilon_\tau$$

Model-2: Role of institutional quality in conjunction with financial inclusion and foreign direct investment model based on Carbon Footprint

$$Q_{CO2_{it}}(\tau|\lambda_i,\delta_t,X_{it}) = \lambda_i + \delta_t + \beta_{1,\tau}FII_{it} + \beta_{2,\tau}FDI_{it} + \beta_{3,\tau}IQI_{it} + \beta_{4,\tau}GDP_{it} + \beta_{5,\tau}GDP^2_{it} + \beta_{6,\tau}FII*IQI_{it} + \beta_{7,\tau}FDI*IQI_{it} + \varepsilon_\tau$$

FII is financial inclusion index construct by four potential proxies: the quantity of bank credit, the quantity of bank deposits, the number of commercial bank branches per 100,000 people, and the number of ATMs per 100,000 people. The availability of the banking sector is demonstrated by the two early proxies, whereas the utilization of the banking system is demonstrated by the two latter indicators. FDI is foreign direct investment net inflows (% of GDP). IQI is an institutional quality index created by six measures of governance (estimates). GDP is Gross domestic product per capita growth (Annual %).

4. Results & Discussion

4.1 Descriptive statistics of key variables

In this section, analyze the descriptive statistics of the variables that are utilized in estimations during the period from 2004 to 2023. The statistics of the most important variables are summarized in Table1. In terms of means, the variable with the highest average value is GDP^2 38. 44921.The variable with the lowest means is GDP 1.838373 and analyzing skewness, GDP^2 exhibits the highest skewness value 10.13409 indicating a significant departure from symmetry. FDI with relatively high skewness is FDI 3.53775. Conversely, GDP and FII display a skewness close to zero 0.56674 and 0.7776 respectively suggesting a nearly symmetric distribution.

Table 1:

Summary Statistics

variables	Mean	Maximum	Minimum	Std.Dev.	Skewness	Kurtosis	J-Bera	Prob.
CO_2	10.59257	105.9629	.7057444	16.64665	2.91342	12.28377	3004	<0.001
FDI	3.41695	54.36505	-8.400837	5.461849	3.537755	23.79794	1.2e+04	<0.001
GDP	1.838373	49.03164	-34.20387	5.9269	.5667433	17.63588	5387	<0.001
GDP^2	38.44921	2404.102	.0001869	147.7704	10.13409	132.6426	4.3e+05	<0.001
IQI	7.05e-10	3.153938	-1.572539	1.000001	1.003473	3.389854	104.5	<0.001
FII	4.66e-09	2.663722	-1.342719	1.000003	.7776424	2.8964	52.64	<0.001

The remaining variables have moderate positive skewness values. Examining kurtosis, GDP^2 has highest kurtosis value 132.6426, indicating heavy tails and more extreme values compared to a normal distribution, FDI 23.7979 and GDP 17.6358 also have relatively high kurtosis values. On the other hand, FII and IQI exhibit lower kurtosis values 2.8964 and 3.389854 respectively suggesting lighter tails compared to the variables with higher values. Regarding JB statistics, GDP has the highest value of 5387 followed by $CO2$ 3004. These high JB values, combined with the associated very low probabilities, indicate significant deviations from normality in the distribution of these variables. The remaining variables have relatively low JB statistics.

4.2 Cross-Sectional Dependence and Slope Homogeneity Tests

Detecting cross-sectional dependence is essential, as its presence, if unaddressed, can distort the true parameter. To identify the robust coefficients, it is necessary to conduct the cross-sectional dependence test. We employed the Pesaran CD test for our models. The outcomes of the Pesaran CD test are presented in Table 2.

Table 2

Pesaran's Cross-Sectional Dependence (CD) Test

Variable	CD-test	Abs (Corr)
CO_2	12.93 ***	0.613
FDI	3.49 ***	0.297
GDP	19.81***	0.322
GDP^2	2.68 **	0.203
IQI	-2.55***	0.392
FII	12.83***	0.523

4.3 Slope Heterogeneity Test

To assess slope heterogeneity, utilize the Delta test as proposed by Pesaran and Yamagata (2008) alongside the HAC Robust Delta test (Delta Adjusted) developed by Blomquist and Westerlund (2013). These techniques operate under the assumption of slope homogeneity. The appropriate estimation technique identified is the Method of Moments Quantile Regression (MM-QR), which addresses the challenges of slope heterogeneity and cross-section dependence (Koengkan et al., 2021).

Table 3

Slope Heterogeneity Tests Results

CO2/ GDP, GDP^2, FDI, FII IQI

	Delta Test	HAC Robust Adjusted Delta Test
Adjusted	3.212***	-1.907***
Unadjusted	2.590***	-1.537

4.4 Unit Root Tests

The findings from the Im-Pesaran-Shin (CSDIPS) unit root test, we have implemented the second generation of unit root tests. In Table 4, the outcomes of the cross-section-dependence-based Im-Pesaran-Shin (CSDIPS) unit toot test mention in the models. The assumption of slope uniformity in parameters is relaxed by the Im-Pesaran-Shin (2003) test as shown in Table 4, validates the presence of a genuine long-term relationship.

Table 4

Im-Pesaran-Shin (CSDIPS) Unit Root Test

	without Trend		with Trend	
Variable	At I (0)	At I (1)	At I (0)	At I (1)
CO_2	-1.531	-3.394***	-1.956	-3.534***
FDI	-2.73***	-	-3.07***	-
GDP	-3.13***	-	-3.23***	-
GDP^2	-4.41***	-	-4.68***	-
IQI	-1.883	-4.166***	-2.465	-4.183***
FII	-1.712	-3.664***	-2.480	-3.628***

4.5 Panel Cointegration Analysis

The cointegration test, which employs four test statistics with the null hypothesis of no cointegration, is employed by Westerlund (2007), Kao, and Pedroni to investigate the existence of long-term relationships among the variables of the models. Most of the results indicate that the variables are cointegrated. Table 5 shows cointegration results

Table 5

Cointegration Tests

Westerlund Test	Gt	Ga		Pt	Pa
	5.208	-4.808***		-4.333***	0.822
Kao Test	**Modified Dickey-Fuller**	**Dickey-Fuller**	**Augmented Dickey-Fuller**	**Unadjusted Modified Dickey**	**Unadjusted Dickey-Fuller**
	-6.5029***	-7.8313***	-6.7478 ***	-4.0988***	-7.3169***
Pedroni Test	**Modified Phillips-Perron**		**Phillips-Perron**	**Augmented Dickey-Fuller**	
	5.8691 ***		1.6004***	1.6338***	

4.6 MM-QR Results of Model 1

This section presents and discusses in detail the results of the MMQR study, focusing on the impact of FII, GDP, GDP2, FDI, and IQI on the carbon footprint.

Table 6

MM-QR Results of carbon footprint

Variables	(1) Location	(2) Scale	(3) Q10	(4) Q25	(5) Q50	(6) Q75	(7) Q90
FII	4.3629***	3.4893***	0.9484	1.3477***	2.2761***	4.4824***	10.854***
	(1.1675)	(1.3971)	(0.7336)	(0.6776)	(0.6468)	(1.3191)	(2.9310)
FDI	-0.12012***	-0.0790***	-.024604	-0.0568***	-0.0963***	-0.1892***	-0.2835***
	(.037587)	(.029725)	(.027440)	.0261831	.0319149	.0597772	.0918716
IQI	7.8564***	1.9517***	5.4971***	6.2916***	7.2674***	9.5616***	11.8925***
	(.490254)	(.3877118)	(.344537)	.3313147	.4203451	.8099191	1.15668
GDP	-0.0985	.0196596	-0.1223***	-0.1143***	-0.1045**	-.0813874	-0.0579
	(0.068)	(.054422)	(.05039)	(.048087)	.0581158	.1082384	(0.1690)
GDP^2	4.2149***	3.7722***	0.7437***	1.0671***	1.7103***	3.6848***	11.211***
	(0.5725)	(0.6485)	(0.1491)	(0.1524)	(0.1957)	(0.6758)	(1.533)
Constant	6.3841***	4.2307***	1.2699***	2.9922***	5.1074***	10.0803***	15.1331***
	(0.3558)	(.281446)	(.256447)	.2387841	.3529912	.7215018	(0.7916)

Table 6 shows how FII, GDP, GDP^2, FDI, and IQI affect carbon footprint. Financial inclusion indexes measure a population's access to financial services and the performance of governments, employers, and financial systems in promoting FI (The Global Findex Database, World Bank, 2021). The FII is positively and significantly correlated with carbon emissions in all quantiles except Q10. The N-shaped Environmental Kuznets Curve (EKC) shows that financial inclusion and carbon emissions are nonlinear, shifting from an inverted U-shape to a U-shape, especially in developing economies. According to Le et al. (2020) and Hussain et al. (2023), income, energy consumption, industrialization, urbanization, foreign direct investment, and financial inclusion contribute to environmental pollution due to increased CO2 emissions.

The link between CO2 and FDI is complicated. This link can be favorable, increasing emissions, or negative, decreasing them. The host country's environmental rules, the FDI industry, and technology transfer affect the outcome (cole and Elliott, 2006) and (Wang et al. 2022). An extremely significant negative association with CO2 emissions exists across all quantities except Q10. All relevant quantiles show a progressive increase in magnitude. Several empirical considerations support this relationship, including the fact that US outbound investments in developing countries use more clean energy and energy efficiency than local alternatives. FDI inflows often bring ecologically hazardous technologies to developing economies with poor educational attainment. Once education levels above certain thresholds, FDI inflows may reduce CO_2 emissions, suggesting the environmental Kuznets curve (EKC) in certain nations. Khan et al., (2023).

All quantiles of Institution quality (IQI) show a positive and extremely significant correlation with CO_2 emissions. The positive link between CO_2 emissions and institutional quality is because institutional quality improvements may increase CO_2 emissions. Superior institutions can sometimes enhance carbon dioxide output, especially in developing nations with rapid economic expansion. Growth usually increases energy use and emissions, even with better controls. See Chhabra et al. (2023), Tabassum et al. (2023), and Wawrzyniak & Doryń (2020).

The gross domestic product exhibits a negative and statistically significant relationship with carbon emissions at the Q10, Q25, and Q50 quantiles. This relationship can be illustrated through several arguments, including the observation that increasing income levels result in a heightened demand for environmental preservation, underscoring the importance of implementing environmental policies aimed at reducing emissions during periods of economic growth. Onofrei and colleagues (2022). The findings suggest a strong and statistically significant link between GDP^2 and carbon emissions and can be supported by the Brundtland curve theory, known as the Brundtland report, which provides an alternative view on the connection between GDP and environmental degradation, in contrast to the Environmental Kuznets Curve (EKC). The authors of the report argue that impoverished nations initially cause considerable environmental degradation, which decreases as their economies grow, until a critical point is reached, after which environmental degradation increases.

Table 7

MM-QR Results of Model 2

Variables	(1) Location	(2) Scale	(3) Q10	(4) Q25	(5) Q50	(6) Q75	(7) Q90
FII	4.3629***	3.4893***	0.9484	1.3477***	2.2761***	4.4824***	10.854***
	(1.1675)	(1.3971)	(0.7336)	(0.6776)	(0.6468)	(1.3191)	(2.9310)
FDI	-0.12012***	-0.0790***	-.024604	-0.0568***	-0.0963***	-0.1892***	-0.2835***
	(.037587)	(.029725)	(.027440)	.0261831	.0319149	.0597772	(0.0918)
IQI	8.0719***	2.2409***	5.1881***	6.299***	7.492436***	10.043***	12.345***
	(0.6717)	(0.5415)	(0.5653)	(0.4976)	.594877	(1.009)	(1.5069)
GDP	-.098563	.0196596	-0.1223***	-0.1143***	-0.1045**	-.0813874	-.05790
	(.068815)	(.054422)	(.05039)	(.048087)	.0581158	.1082384	.1690005
GDP2	4.2149***	3.7722***	0.7437***	1.0671***	1.7103***	3.6848***	11.211***
	(0.5725)	(0.6485)	(0.1491)	(0.1524)	(0.1957)	(0.6758)	(1.533)
FDI*IQI	-0.3383***	-0.235***	-0.0346	-0.1517	-0.277***	-0.5458***	-0.788***
	(0.1448)	(0.1167)	(0.1250)	(0.1106)	(0.1278)	(0.2226)	(0.331)
FII*IQI	1.8608***	0.8935	0.7109	1.1542***	1.6297***	2.6468***	3.5648***
	(0.6831)	(0.550)	(0.587)	(0.5207)	(0.6012)	(1.0473)	(1.5591)
Constant	6.3841***	4.2307***	1.2699***	2.9922***	5.1074***	10.0803***	15.1331***
	(.3558843)	(.281446)	(.256447)	.2387841	.3529912	.7215018	.7916548

The MMQR results for our second model estimate the role of institution with financial inclusion and foreign direct investment in determining the carbon footprints. All the variables in table 7 show the same relationship as mentioned in table 6 expect FDI*IQI and FII*IQI. FDI*IQI is negatively and significantly correlated with carbon emissions in all quantiles. The theocratical reason for this negative relation illustrates through Porter Hypothesis which defines as despite large FDI inflows, green innovation is encouraged by strong institutions and environmental restrictions, which result in Lower emissions. Within the contexts of sustainable development, environmental regulations, and economic growth, the relationship between financial inclusion and institutional quality in relation to carbon emissions has been examined and their findings indicate a positive and statistically significant relationship with carbon footprints. Several empirical considerations support this relationship, such as Credit is used for polluting businesses, which results in increased carbon emissions in countries with weak institutions. This is because financial inclusion leads to higher carbon emissions (Zaidi et al.2018).

5. Policy Implications and Conclusions of the Study

Using MMQR for analysis, this study looked at the impact that factors such as financial inclusion, foreign direct investment, and institutional functions have on the carbon footprint of countries that are members of the Organisation of Islamic Cooperation (OIC) from 2004 to 2023.The study's results indicate that financial inclusion positively affects carbon footprints, while foreign direct investment negatively influences them while institutional quality has a positive impact on carbon footprints .The analysis of the combined effects of financial inclusion, foreign direct investment, and institutional quality on carbon emissions indicates that the interaction between FDI and IQI shows a negative correlation with carbon emissions, whereas the interaction of FII and IQI reveals a positive and highly significant relationship with carbon emissions. The findings of this study suggest several policy implications for OIC countries concerning environmental issues.

- Financial inclusion results in increased emissions, the implementation of carbon taxes or cap-and-trade systems may serve to regulate pollution effectively. Implement a carbon tax on industries that elevate emissions because of improved credit accessibility and instruct new members, both individuals and enterprises, on how to make financially viable decisions. Provide tax incentives to enterprises that invest in energy-efficient technologies or sustainable infrastructure.
- Foreign direct investment (FDI) increases as carbon emissions decrease, indicating investments in sustainable, environmentally friendly sectors. Targeted policies that encourage low-carbon growth can capitalize on this trend. Encourage foreign investors and local research institutions to collaborate on clean technologies and new ideas and create a green technology hub to help local businesses adopt advanced, low-carbon FDI solutions.
- A regulatory framework must be established to regularly assess and adjust environmental requirements based on institutional performance and real-time data. For example, regulatory thresholds should be tightened if improved governance leads to increased emissions. Furthermore, a specified percentage of any fiscal surplus or efficiency gains from institutional improvements should be allocated to climate mitigation initiatives, enabling this climate budgeting strategy to fund renewable energy, energy efficiency enhancements, or sustainable infrastructure.

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Nazia Nasir is a student at Department of Economics, The women University, Multan, Pakistan. she got the degree of Master of Philosophy from The Women University Multan, Pakistan and have five years' experience in banking sector. Her research focuses on Environmental Economics and Development Economics. ORCID: 0009-0008-3186-4799

Noreen Safdar is an Associate Professor at Department of Economics, The women University, Multan. Pakistan. She got his master's and PhD degrees in Economics from Bahauddin Zakariya University, Multan, Pakistan. Her research focuses on Energy Economics, Environmental Economics and Development Economics. ORCID: 0009-0002-0956-1309