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The Nonlinear Impact of Financial Development and Institutions Quality on Green GDP: A Case Study of OIC Countries

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Abstract

Our study investigates the linear and nonlinear impacts of financial development and institutional quality on green GDP using some macroeconomic factors, with an emphasis on OIC countries. We evaluate the effects of financial development, institutional quality, investment, trade openness, and population on green GDP from 2016 to 2019 using the System GMM (SYS-GMM) estimator. According to the study's empirical findings, institutional quality positively correlates with green GDP. In addition, we found that financial development, investment, and trade openness significantly negatively affect green GDP. According to our research, a 1% increase in institutional quality leads to a 0.047% increase in green GDP. Accordingly, a 1% rise in investment and trade openness decreases green GDP by 0.018% and 0.097%, respectively. Despite the linear nexus, the projected data visualisation reveals a U-shaped relationship between institutional quality and green GDP. The results validate the link as a higher degree of institutional quality contributes positively to green GDP in OIC countries. Even though financial development contributed negatively to green GDP, OIC governments should emphasise preserving and expanding the quality of their institutions to increase and promote green GDP in effort to minimize environmental degradation.

Keywords: Green GDP, Financial Development, Institutional Quality, OIC.

Introduction

Governments have made numerous efforts in many countries to achieve their development goals with the single aim of improving the welfare of the people. However, these efforts often lead to adverse outcomes such as pollution and other environmental deterioration. Although rapid economic growth is often viewed as positive, the unavoidable environmental harm it causes is a significant challenge, especially for developing countries. Economic growth is crucial to economic development Perera & Lee (2013), but it also affects the environmental quality (Arouri et al., 2012; Kasman & Duman, 2015). Growth target increases carbon dioxide (CO2) emissions, affecting environmental sustainability (Arouri et al., 2012; Muhammad, 2019).

OIC member countries are especially prone to the environmental alterations caused by increased human activity. Due to their limited resources and inability to adapt to environmental changes, low-income and underdeveloped member states are particularly vulnerable. In recent decades, the socioeconomic growth of OIC countries has been rapid and stable. However, concurrently, environmental deterioration has increased due to this development. Even when compared to rising economies, OIC countries are among the world's leading contributors to CO2 emissions. OIC's greenhouse gas emissions (GHG) per capita increased over the years.

Most global warming is driven by human activities releasing greenhouse gases. The upward trend of greenhouse gas emissions persists despite economic, technical, and political efforts. Between 1990 and 2017, global greenhouse gas emissions increased by 43%, to 50 Gt-CO2 equivalent. Over the same period, GHG emissions in OIC countries rose by 77% to a total of 9 Gt-CO2 equivalent, accounting for 18.1% of world GHG emissions (OIC Environment Report 2021). Some member Countries in OIC region were the top emitters per capita in 2020, with Qatar having the highest GHG emissions per person (Brussels international center, 2022).

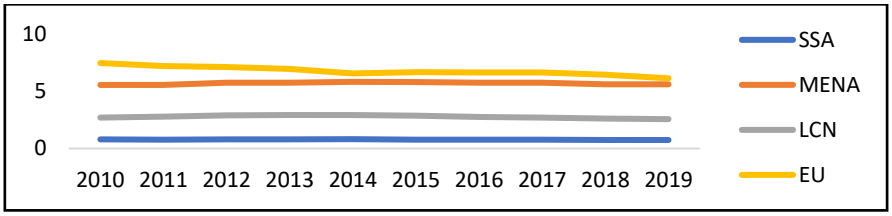

Figure 1: CO2 emissions metric tons per capita 2010-2019
Source: World Bank (2022).

A sophisticated financial system can foster industrialization by generating and distributing resources for productive investment (Bagehot, 1873). The importance of a country's financial system for economic development stems from the fact that it allots funds to productive investment (Schumpeter, 1911). Banks and financial markets facilitate communication between savings and investors. Financial development promotes economic growth by increasing savings, capital creation, resource allocation, and innovation (Levine, 2005). Despite data indicating that it encourages growth, the function of financial development in green economic growth remains understudied (Bist, 2018 and Pan & Yang, 2019). This study uses economic theory to argue that improved financial infrastructure leads to greater green economic growth by giving businesses easier access to more modern, less polluting forms of machinery (Adams & Klobodu, 2018).

Considering to the significance of financial development to environmental quality, several studies have investigated the connection between the environment and financial development. In the literature, the effects of financial development on environmental quality are not universally recognized. Several authors have distinct theoretical positions regarding how financial growth impacts environmental quality. Financial development may have both positive and negative effects on environmental quality (Tamazian et al., 2009; Jalil & Feridun, 2011). Developed financial markets lower financing costs and redirect financial resources to fund new projects and acquire new equipment, which increases energy consumption and impacts CO2 emissions. In addition, financial growth promotes energy-efficient technologies, hence reducing carbon dioxide emissions.

According to previous research, financial development increased energy consumption, carbon emissions, and environmental deterioration (Jalil and Feridun, 2011; Mardani et al.,

2019; Sadorsky, 2010). The expansion of the financial sector may motivate individuals to generate more wealth, exploit land, and devastate the green economy (Pan et al., 2021). Financial development helps to the green economy by reducing energy consumption and carbon emissions, as stated by (Al-Mulali et al., 2015; Ozturk and Acaravci, 2013; Tamazian et al., 2009). While some contended that economic growth had no impact on CO2 emissions (Ozturk and Acaravci, 2013; Ziaei, 2015; Dogan and Turkekul, 2016).

Green GDP is the final result of a country or region's economic activity after taking into account the impact of natural resources (mainly land, forests, minerals, water, and oceans) and environmental factors (including ecological environment, natural environment, human environment, and others). The costs of resource depletion and environmental harm incurred by economic activity lower GDP. (Vaghefi et al., 2015) Popular among the several formulas for determining green GDP is the following:

Green GDP = Total GDP - (environmental resource cost + environmental resource protection service fee).

Since the current traditional economic systems failed to take into account the environmental crisis in the world. The concept of green GDP has emerged. Green GDP is a substitute measure of economic growth that accounts for environmental concerns alongside traditional measures of GDP. Green GDP considers the damage caused by climate change and biodiversity loss. The greatest benefit of green GDP is that it assigns a monetary value to the cost of environmental damage and modifies GDP to represent environmental expenses more accurately. The connection between the economy and the environment is highly substantial, particularly in emerging countries such as the countries of the OIC region, who are now experiencing substantial economic growth.

Due to the ambiguous nature of the relationship between financial development, institutional quality, and CO2 emissions, this study focuses on the effect of financial development and institutional quality on green GDP in OIC nations. This study aims to determine if financial development and institutional quality positively or negatively affect green GDP. In contrast to past research, we focus on severely polluted nations and use green GDP as our dependent variable, although relatively few studies have used green GDP as an indication of environmental growth. In the case of OIC nations, the link between financial development, institutional quality, and green GDP has not been explored. Consequently, this study examines the influence of financial development and institutional quality on green GDP in OIC nations throughout the period of seven recent years, 2015 to 2022.

In the environment context, economists, scientists, and policymakers have recently been more concerned with institutional quality and how it influences green economic growth. the institutional quality strongly supports green growth movement and sustainable development trends across developing countries as governments can impose laws protecting the environment. Numerous studies have confirmed that nations with a strong institutional framework are more likely to contribute to reducing CO2 emissions, greenhouse gases, climate change, and continuing to improve quality of the environment (Ahmed et al., 2020; Dées, 2020; Ibrahim & Law, 2016; Khan & Rana, 2021; Ntow-Gyamfi et al., 2020; Sah, 2021).

Institutional quality can play a role in promoting sustainable development (Hunjra et al., 2020), as increasing institutional quality is a crucial instrument to manage and reduce pollutant emissions in the context of economic development progress (Lau et al., 2014). Furthermore, institutional quality assures legislation that reduces CO2 emissions due to

economic activity, leading to sustained economic growth or green economic growth. (Azam et al., 2021).

Within the field of institutional economics, there is widespread consensus that the quality of institutions is one of the most influential determinants of economic growth. In recent years, economists and decision-makers have placed a greater emphasis on institutional quality in relation to the surrounding environment. Moreover, the government has both direct and indirect influence over environmental quality. Additionally, a robust judicial system mitigates the effects of market failures (Salman et al., 2019).

This study contributes to the current literature on green economic growth by performing an empirical analysis into the influence of financial development and institutional quality on green GDP, an acceptable measure of green growth from OIC nations' perspective.

Research Problem

There are several issues related to OIC countries and green GDP topic. First, OIC countries are the most polluted countries as stated by the world air report. The report shows that the top 10 polluted countries are mostly OIC countries such as Afghanistan, Bangladesh, Bahrain and Kuwait. These countries have abundant natural resources, such as oil and gas. Second, Green GDP is a combination of GDP and environmental considerations, and the evidence indicates that financial development may have a nonlinear influence on economic growth via institutional quality (Law et al., 2013). In addition, finance-growth link is still inconclusive and further research that combines finance, institutional quality on the two in one factor of growth-environment (green GDP) would significantly contribute to the nexus.

Research Objectives

The primary purpose of this study is to evaluate the linear and nonlinear effects of financial development and institutional quality on green GDP in OIC countries. This study focused specifically on the direct influence of institutional quality and financial development on green GDP. Second, the quadratic impact of institutional quality on green GDP as well as the interaction impact of institutional quality and financial development on green GDP in OIC countries.

This research provides to the scholarly literature in three ways. First, this article combines financial development and institutional quality (political institutional quality) to examine their influence on green growth. The second contribution of this study is the introduction of the quadratic term of political institution on green GDP. This study seeks to investigate the extent to which OIC nations attain a green GDP in terms of institutional quality.

Literature Review

Financial development is one of developing nations' most important economic drivers (Sadorsky, 2010). As a result, the majority of research in this topic links the green economy to environmental quality, carbon emissions, or environmental degradation. However, there is insufficient study on financial development and green GDP. Several studies indicate that financial development contributes to environmental deterioration and is, therefore, detrimental to the green economy. However, other studies (e.g., Jalil and Feridun, 2011; Sadorsky, 2010; Al-Mulali et al., 2015; Hasan et al., 2021; Sehrawat et al., 2015; and Tamazian et al., 2009), assert that a greater level of financial development improves the green economy by lowering carbon emission. These contradictory results indicate that the link between the two measures depends on the scope and concerns of the research.

Financial Development and Green Growth

Numerous studies have examined the relationship between financial development, economic development, and environmental performance. Yang (2018) divides middle-income economies into three categories: "stuck middle-income economies, graduated middle-income economies, and high middle-income economies"; financial development is essential for promoting economic growth.

Masoud and Hardaker (2012) investigate the relationship between economic growth and social progress by evaluating twelve years of data from forty-two emerging economies. They uncover a link between the questioned variables. Donelli and Chiriatti (2017) examine the BRICS (Brazil, Russia, India, China, and South Africa) states, whereas Bayar (2014) emphasises the positive benefits of financial development on economic growth in emerging nations.

There exist a number of specialists that accept the positive influence of financial development on the green economy. Theoretically, there are different perspectives about the relationship between economic growth and environmental emissions. According to Zagorchev et al (2011), financial development stimulates technical innovation, which boosts output growth and decreases environmental emissions. Additionally, financial development is believed to increase the availability of low-cost funding for businesses and individuals to participate in clean energy activities (Halicioglu, 2009).

Al-Mulali et al (2015) analyzed the effect of financial development on carbon dioxide emissions in 129 nations. The nations were classified into four categories based on the World Bank's income classifications issued between 1980 and 2011. The model was estimated using dynamic OLS and Granger causality tests, revealing that financial development decreased carbon dioxide emissions and environmental deterioration across all income levels and nations. This lowering happened both temporarily and permanently.

In agreement with Al-Mulali et al (2015); Song and Li (2020) discovered that China's financial development boosted green production. Specifically, Song and Li (2020) demonstrated that the effect of financial development on green growth ought to be bidirectional, as they discovered that the green economy – as measured by green credit, green securities, green insurance, and green investment – also promoted financial development in China. This conclusion was reached based on Chinese data gathered between 2008 and 2016. Claessens and Feijen (2007) report on an extra aspect of excellent financial development and environmental quality, claiming that enhancements to the financial sector will strengthen corporate governance frameworks and thereby reduce CO2 emissions. Recent research Baulch et al (2018) reveals that pricing restrictions are limiting the adoption of solar household systems in Ho Chi Minh City (Vietnam) residents.

Contrary to these positive benefits of financial development on environmental quality, other writers contend that an increase in financial development might result in a rise in CO2 emissions (Jensen, 1996). According to proponents of this idea, financial expansion fosters industrialization and industrial pollution. In addition, Zhang (2011) discovered that rapid financial development will allow the issuance of loans for large consumer products like as air conditioners, refrigerators, automobiles, and residences, hence increasing energy consumption and aggravating pollution emissions. In addition, the author contends that a rise in financial development might result in an increase in foreign direct investment, which in turn raises environmental emissions.

Multiple studies suggest that financial development is associated with an increase in pollution, which is damaging to the green economy. Sadorsky (2010) evaluated the

relationship between financial development and energy use in 22 rising nations between 1990 and 2006. Foreign direct investment, the ratio of bank deposits to GDP, the ratio of stock market capitalization to GDP, stock market turnover to GDP, and stock market total value exchanged used as proxies for financial development in this study. The study's hypothesis was that energy use is governed by prior consumption, income, price, and economic growth. The model was calculated using the Arellano and Bond approach according to the GMM methodology. Estimated models indicated that financial development, as assessed by stock market characteristics, positively influences the demand for energy consumption in developing countries (Zhang et al., 2022). This study suggests a correlation between financial development and low levels of green growth.

The negative association between financial development and green economy, as proven by Sadorsky (2010), is consistent with findings from prior research. Hasan et al (2021) investigated the causal relationship between economic growth and carbon emission. Between 1980 and 2018, research was conducted in Bahrain. Under the premise of a constant GDP per capita and population growth, economic development was predicted to be influenced by domestic credit and carbon emission. Evaluation of the model utilizing the vector error collection approach revealed cointegration among carbon emission, financial development, GDP per capita, and population.

In addition to panel studies, a country-by-country examination indicates the detrimental effects of financial development. Jalil and Feridun (2011) evaluated the effect of China's financial development on environmental pollution, taking economic growth and energy consumption into account. The research included the years 1953 through 2009. Utilizing factors such as the ratio of private sector loans to nominal GDP, the capital market index, and the ratio of commercial bank assets to the sum of commercial bank assets and central bank assets, financial development was estimated. The estimation approach revealed that financial development in China has no significant effect on environmental deterioration, indicating that it had no effect on green growth.

Zhang (2011) discovered a correlation between China's financial development and carbon emissions between 1980 and 2009. Loans, capitalization, and stock market turnover were utilized by Zhang (2011) to measure financial development. China's financial development increases carbon emissions, particularly when proxied through lending rather than stock. Unfortunately, utilizing a large number of financial proxies and calculating them separately may provide inconsistent and incorrect findings. Shahbaz et al (2016) and Tamazian and Rao (2010) discover that financial development influences CO2 emissions favorably. According to their study, financial advancement tends to promote industry, which favorably impacts CO2 emissions.

Economic Growth and Environmental Quality

Evolving nations have deviated from the path to a low-carbon economy so as to maintain stable growth and development (Ali et al., 2019). Energy, growth, and environmental quality all have a significant link. According to Temiz Dinc and Akdoan (2019), these aspects must be effectively managed for human welfare, sustainable development, and effective policy direction.

Li et al (2015) explored the relationships between economic development, financial growth, and environmental quality. The sample of 102 nations was computed using the generalized method of moments between 1980 and 2010. (GMM). The scientists discovered a significant and robust U-shaped link between economic growth and CO2 emissions. The

study's findings identified a crucial threshold at which higher economic growth is detrimental to environmental quality. Once this threshold is passed, the degradation of environmental quality produces a considerable decline in economic growth. The findings revealed a robust positive correlation between economic growth and environmental quality. According to study, increasing energy use might stimulate economic growth. Charfeddine and Kahia et al (2019) analyzed the influence of RE use on CO2 emissions in the MENA region from 1980 to 2015 using the panel VAR method. The data suggested that RE had little effect on CO2 emissions.

Green Economic Growth and Institutional Quality

Using panel data, Khan and Rana (2021) investigated the relationship between institutional quality and CO2 emissions for 41 Asian nations between 1996 and 2015. The findings demonstrated that more effective political and economic institutions reduce environmental damage. Rodríguez-Martínez et al (2019) explore the link between institutional characteristics (quality of institutions and corruption control) and environmental performance using cross-sectional data from 149 countries and conclude that institutional quality has a direct influence on environmental performance.

Ahmed et al (2022) investigated the link between institutional quality, financial development, and green growth in South Asian countries. Using World Bank statistics from 2000 to 2018, this study experimentally examined the data with the FMOLS and DOLS models. The findings of the inquiry were remarkable. Institutional quality has been found to have a positive influence on green economic growth, and governments in South Asian nations are actively working to promote economic growth and sustainability.

Numerous empirical studies on the role of institutional quality in the growth-emissions nexus have previously been conducted. Abid (2017) included institutional quality into a growth-emissions model for 58 Middle East and African (MEA) states and 41 European Union (EU) nations using data from 1990 to 2011. In the economies he selected to examine, he argued that enhancing institutional quality was necessary for supporting economic growth and decreasing carbon emissions simultaneously. Bhattacharya et al (2017) examined the influence of institutional quality on economic development and CO2 emission reduction in 85 industrialized and emerging nations from 1991 to 2012 using system-GMM and completely modified OLS techniques. The findings indicate that institutions in the examined nations have a substantial effect on both the acceleration of economic growth and the reduction of carbon emissions.

Samarasinghe (2018) examines the link between governance and economic growth using corruption control as a proxy for governance. A one percent increase in corruption control resulted in a 6.9 percent increase in economic development, according to his research. Salman et al (2019) aimed to explore how institutional quality influences the association between economic growth and emissions. From 1990 to 2016, they included two additional variables: energy use and trade openness in three East Asian countries. The study explored the concept that institutional quality has a positive impact on CO2 emissions.

Materials and Methods

Model Specification

The goal of this paper is to examine the effect of financial development and institution on green GDP in OIC countries. Thus, the empirical model augmented from Hayat (2019) and the model for analysis is as follows

$$lnGGDP_{it} = \alpha + \beta_1 lnGGDP_{i,t-1} + \beta_2 lnFD_{it} + \beta_3 lnIQ_{it} + \beta_4 X'_{it} + v_i + \eta_t + u_{it} \quad (1)$$

Where *i* and *t* are the country and time index, respectively, *GGDP* is green GDP. *IQ* It is extensively used in the literature to imply institutional quality, which is proxied by level of democracy *(Demo*) (Slesman et al., 2015; Williams, 2017; Acemoglu et al., 2005). FD is financial development, and this study follows Law and Habibullah (2009), who utilized domestic credit to the private sector (% of GDP), and X' is the vector of control factors anticipated to effect green GDP, v_i is country specific effect, η_t is the time specific effect, and u_{it} is the error term. In order to evaluate the nonlinear relationship between institutional quality and green GDP, the squared term of institutional quality (IQ_{it}^2) is included in the model specification in order to capture the nonlinear effect of institutions on green GDP and determine whether the relationship is U-shaped or inverted U-shaped. Law et al. (2013) utilized a squared expression to describe the impact of institutional quality on financial development, while previous study hypothesized that institutions indirectly influence finance (Girma & Shortland, 2007).

Moreover, Zakaria and Bibi (2019) investigated the interaction impact of financial development and institutional quality on pollution and the natural environment. Consequently, the model specification includes the word democracy squared as follows:

$$lnGGDP_{it} = \alpha + \beta_1 lnGGDP_{i,t-1} + \beta_2 lnIQ_{it} + \beta_3 lnIQ_{it}^2 + \beta_4 lnFD_{it} + \beta_5 X'_{it} + v_i + \eta_t + u_{it} \quad (2)$$

$$lnGGDP_{it} = \alpha + \beta_1 lnGGDP_{i,t-1} + \beta_2 lnIQ_{it} + \beta_3 lnFD_{it} + \beta_4 (lnFD_{it} * lnIQ_{it}) + \beta_5 X'_{it} + v_i + \eta_t + u_{it} \quad (3)$$

The general method of moments (GMM) is addressed, as proposed by Holtz-Eakin et al (1988) and refined by Arellano and Bond (1991), Arellano and Bover (1995), and Blundell and Bond (1998). From 2007 to 2016, the System GMM (SYS-GMM) estimator is used to a panel of 74 developing and emerging economies for the estimation. To establish the validity of the enhanced findings, two diagnostic tests based on Arrelano and Bond (1991) are utilized to analyze the first and second order serial correlation in the errors. According to the rule of thumb, serial correlation of the first order may be ignored, while serial correlation of the second order cannot. The second test is the Sargan/Hansan test, which addresses the issue of overidentification, which is induced by a variety of instruments and would lead to an estimate that is skewed. In addition, the U test is used to assess whether or not an interval has a U-shaped (or inverse U-shaped) relationship.

The system GMM estimator (Blundell and Bond, 1998) is utilized because it offers consistent parameter estimates and is more objective than the pooled ordinary least squares (OLS), within-groups (fixed effect), and difference GMM estimators. The system GMM can account for endogeneity because it provides more precise estimates than alternatives like the difference GMM and fixed effect models. An additional benefit of system GMM over pooled OLS and dynamic fixed effect estimations is bias, which implies that the correlation between the lagged dependent variable and the specific fixed effect may be distorted if the coefficient on the lagged dependent variable approaches zero. In models with shorter temporal dimensions, the bias has a greater impact. Bond et al. (2001) report that the coefficient on the lagged dependent variable generated from pooled OLS is upwardly biased, but the within-groups estimate is downwardly biased. Before offering actual data, this study will validate the above-mentioned reasons for employing the network GMM estimator.

One-step and two-step estimators are the two variants of GMM estimators. Using optimal weighting matrices, the two-step estimator is potentially more successful than the one-step estimator. Note that its use to a sample with a small cross-sectional size may lead to biased standard errors, biased estimated parameters, and a weakened over-identification test (Windmeijer, 2005). Roodman (2009a) illustrates that the proliferation or excess of instruments is the primary cause of these problems. The author offers a unique strategy that reduces the dimension of the instrumental variable's matrix. According to Roodman (2009b), the dimension of the matrices of instrumental variables is reduced. Due to the possibility that the regressors are endogenous, they must be instrumented with two lags of themselves and one lag of the first-difference in the level equation.

Data Source

Institutional quality is proxied by democracy, which is re-scaled with a maximum score of 0 for total autocracy and a maximum score of 100 for total democracy, according to the World Governance Indicator (WGI). The World Bank also releases data on trade openness. As a proxy for investment statistics, the ratio of gross domestic capital creation to gross domestic GDP is utilized. The WDI database defines FD as financial development.

Results and Discussion

Table 1 below displays the descriptive statistics for each variable utilized in the study. Our findings indicate that for the dependent variable, the green GDP, the mean value is 1.34e+11, and the minimum and maximum values are 8.97e+08% and 1.09e+12, respectively, indicating that there are substantial disparities in green GDP among the various OIC countries.

The variable of financial development has the highest value of 123.1037 and lowest value of 4.769306 with standard deviation is up to 26.59 and average value of 32.83329. likewise, the institutional quality has minimum and maximum values of .948 and 94.762, with standard deviation of 21.467. High standard deviations indicate data dispersion relative to their means. Compared to other variables such as investment, institutional quality, and financial development, the standard deviation of trade openness is 47.371% higher. This implies that there are substantial differences in trade openness amongst OIC countries. The investment variable has the highest value of 60.058 and a minimum value of -3.946 with a standard deviation of 9.647. The majority of OIC nations have investments that are close to the average. Nonetheless, there are a few outliers with extremely high and extremely investment scores, respectively.

Table 1
Descriptive Statistics

Variable	Obs	Mean	Std.Dev.	Min	Max
years	329	2016	2.003	2013	2019
ggdp	329	1.34e+11	2.15e+11	8.97e+08	1.09e+12
fd	307	32.83329	26.59955	4.769306	123.1037
iq	329	29.409	21.467	.948	94.762
inv	327	26.45	9.647	-3.946	60.058
to	328	76.839	47.371	1.219	347.997
pop	329	3.51e+07	5.63e+07	404000	2.71e+08

Following the descriptive statistics is a correlation matrix (see Table 2) that depicts the degree of connection between the key variables. By examining the correlation coefficients, we found that collinearity was not a significant problem. Most of the correlation coefficients are lower than 0.3, so collinearity was not an issue that needed to be addressed in this study. This research's panel data series were suitable for accurate and robust estimations. Hence, no spurious regression was found.

Table 2
Matrix of Correlations

Variables	(1)	(2)	(3)	(4)	(5)	(6)
(1) ggdp	1.000					
(2) fd	0.283	1.000				
(3) iq	-0.162	0.366	1.000			
(4) inv	0.039	0.167	0.206	1.000		
(5) to	-0.167	0.299	0.317	0.046	1.000	
(6) pop	0.692	-0.032	-0.370	-0.021	-0.373	1.000

The figure 2 below illustrates the expected relationship between institutional quality and green GDP. The regression line reveals a U-shaped nonlinear relationship between the two variables. This suggests that there is a turning point, where before the turning point, institutions have a negative effect on green GDP, however after the turning point, institutions are projected to have a positive effect on green GDP. The turning point as can be seen in the figure is between 3 and 4 of institutional quality (x-axis). The figure is used to depict the expected nonlinearity relationship between institutional quality and green GDP which can be confirmed using further regression analysis with the exact value of the turning point.

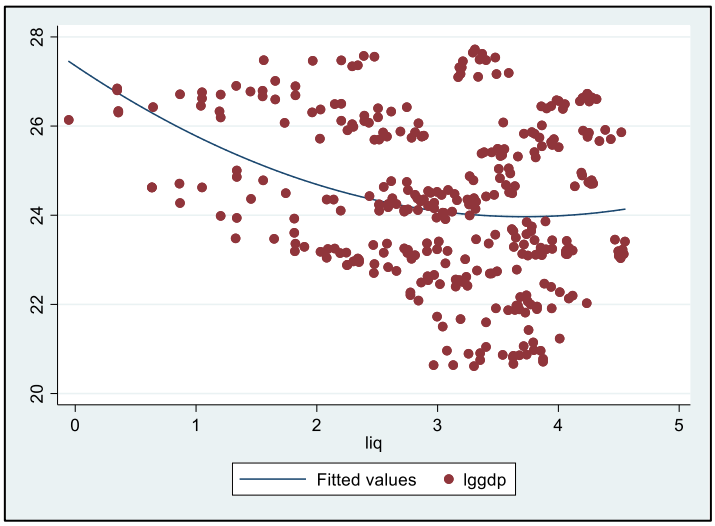

Figure 2: Institutional Quality and Green GDP Relationship

Table 3 below displays the acquired results on the effect of financial development and institutional quality on green GDP in OIC countries. We can see that the coefficient of financial development is statistically significant and denoted by a negative sign, showing a negative relationship between financial development and green GDP. Although it is expected that financial development will positively impact green GDP, our result indicates otherwise. When there is increase of financial development by 1%, green GDP decreases 2.23%. The institution quality coefficient is negative, demonstrating a negative relationship between institution

quality and green GDP. Surprisingly, the coefficient of institutional quality was significantly negative. So, we test the nonlinear effect of institutional quality to determine what the result will be if an institution's quality improves. The graph reveals that the relationship between institutional quality and green GDP is nonlinear and U-shaped. The investment coefficient is negative and statistically significant, revealing a negative relationship between investment and green GDP in OIC countries. A 1% increase in investment reduces green GDP by 1.8%. In all models, trade openness is represented with a negative sign, indicating an inverse relationship between trade openness and green GDP. When trade openness increases by 1%, green GDP decreases by 9.7%. These findings concur that trade openness tends to be concurrently distorting and harmful to green growth. In this case, the population coefficient is significant and positive, indicating a positive correlation between green GDP and population.

Table 3
Regression Results

	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)
	lggdp	lggdp	lggdp	lggdp	lggdp
l.lggdp	0.696***	0.693***	0.697***	0.729***	0.686***
	(0.036)	(0.042)	(0.040)	(0.044)	(0.041)
lfd	-0.223***	-0.245***	-0.206***	-0.232***	-0.445***
	(0.026)	(0.029)	(0.021)	(0.029)	(0.080)
liq	0.025	0.028	-0.205***	-0.179***	-0.186***
	(0.026)	(0.027)	(0.048)	(0.052)	(0.064)
liq2			**0.043*** **	**0.040*** **	
			(0.010)	**(0.011)**	
linteraction					**0.069*** **
					(0.025)
linv		-0.018			-0.016
		(0.015)			(0.014)
lpop			0.044	0.004	0.029
			(0.053)	(0.052)	(0.048)
lto	-0.097***	-0.095***	-0.117***	-0.126***	-0.113***
	(0.020)	(0.019)	(0.024)	(0.023)	(0.024)
cons	8.441***	8.535***	7.994***	7.951***	8.961***
	(0.865)	(1.006)	(0.908)	(0.837)	(1.107)
AR(2) (p-value)	0. 763	0.776	0. 797	0. 814	0.762
J-test (p-value)	0.122	0.084	0.141	0.109	0.083
U-test	-	-	**3.30*** **	**3.24*** **	-
No. of Instruments	28	30	30	31	31
No. of Countries	47	47	47	47	47
No. of Observations	263	262	263	263	262
Time dummies	Yes	Yes	Yes	Yes	Yes

We conducted a robustness check to provide more reliable and precise estimations. Table 4 below shows the financial development, institutional quality – green GDP link. The results show that financial development is still statistically significant and negative. Furthermore, the coefficient of institutional quality iq2 turned positive, indicating a positive link between institutional quality and green GDP. A strong institutional quality increases green GDP. Except for the institutional quality variable, the signals for the control variables stay constant, showing that the obtained results are consistent prior to and after the robust check. Thus, we

can conclude that the findings of our study are reliable and consistent. Our estimations indicate that institutional quality has a positive relationship with green GDP whereas financial development, investment and trade openness have a negative and significant impact on green GDP. Additionally, population has a substantial and positive relation with green GDP in OIC countries.

Table 4
Robustness check

	Model (1) lggdp	Model (2) lggdp	Model (3) lggdp
L.lggdp	0.737***	0.281***	0.350***
	(0.043)	(0.055)	(0.059)
lfd	-0.252***	-0.489***	-0.214***
	(0.023)	(0.101)	(0.031)
liq	-0.219***	-0.281***	-0.265***
	(0.061)	(0.103)	(0.072)
linteraction		**0.074****	
		(0.035)	
linv		-0.011	
		(0.021)	
lpop	0.036	0.415**	0.432***
	(0.058)	(0.163)	(0.154)
lto	-0.128***	-0.226***	-0.213***
	(0.032)	(0.033)	(0.030)
liq2	**0.047*****		**0.049*****
	(0.011)		**(0.014)**
cons	7.306***	13.401***	10.723***
	(1.023)	(2.626)	(2.390)
AR(2) (p-value)	0.903	0.919	0.971
J-test (p-value)	0.212	0.165	0.247
U-test	**3.56*****	**-**	**2.56*****
No. of Instruments	30	25	25
No. of Countries	47	47	47
No. of Observations	253	213	215
Time dummies	Yes	Yes	Yes

Conclusion

The primary objective of this study is to investigate the impact of financial development and institutional quality on green GDP in OIC countries. The data set included the years 2016 through 2019. This study employed the System GMM (SYS-GMM) estimator for estimate purposes. Two diagnostic tests based on Arrelano and Bond (1991) are conducted to investigate first and second order serial correlation in the errors in validating the reliability of the augmented results.

According to the findings, there is a statistically significant negative relationship between financial development and green GDP. This study concurs with and provides empirical support for the expanding body of literature indicating that developed financial markets entice more investment, speeds the industrialization process, and raises energy demand, which eventually results in increased CO2 emissions.

Nonetheless, although nonlinear, institutional quality has a statistically significant positive relationship with green GDP. Moreover, trade openness and investment have a negative association with green GDP. The conclusion that can be derived from the figures shown above is that green GDP growth will be higher in proportion to the number of countries that maintain their institutional quality. Additionally, our findings reveal a negative correlation between trade openness and green GDP. These findings lend empirical evidence to the expanding body of research that relates greater openness with environmental deterioration, income inequality, and an upsurge in environmentally destructive economic activities. This result has significant policy considerations that the government could implement to accelerate the growth of its green GDP. To minimize environmental contamination, the OIC governments should emphasize preserving and improving the quality of their institutions in to boost and develop green GDP in their respective nations. In addition, policymakers should establish effective government regulations to improve institution quality measurements. The governments should also promote green investment, which consists of investment projects and processes that enable adopting renewable energy sources, ecologically friendly technology, etc., reducing environmental pollution.

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