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Green Finance, Governance, and Sustainable Competitiveness: Policy Pathways for Carbon Mitigation

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Abstract

Green finance is increasingly seen as an important tool for reducing carbon emissions and supporting sustainable development. However, a critical gap persists in understanding the collective effects of green finance and governance on carbon mitigation, which is important for effective policy design. Therefore, this study investigates the interaction effect of green finance and governance quality on carbon emissions across OECD economies from 2000 to 2022. Using the method of moments quantile regression, the results show that countries investing more in green finance reduce carbon emissions across quantiles. Furthermore, the interaction between green finance and institutional quality is inversely related to carbon emissions at higher quantiles. The empirical results further indicate that GDP and imports contribute to increasing carbon emissions, whereas exports negatively affect emissions. These findings highlight strategic pathways for policymakers and regulators. To enhance sustainable competitiveness, it is crucial to combine the expansion of green finance with comprehensive institutional reforms, thus facilitating more effective progress toward global climate objectives.

Keywords: Green Finance; Institutional Quality; Carbon Emissions; Sustainable Competitiveness; Trade

JEL Classification: G28, Q56, C21

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1. INTRODUCTION

Over the past decade, the global economy has been shifting from a carbon-intensive economy to a sustainability-based model. OECD economies show high economic growth; however, environmental deterioration in the form of carbon emissions remains a major challenge for these

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economies (Yi et al., 2025). Despite economic development, environmental outcomes remain closely tied to governance quality and green finance (Hunjra et al., 2024); thus, sustaining economic growth while controlling carbon emissions remains a central challenge for these economies. In this context, green finance provides an opportunity to channel investment toward low-carbon projects, but its effectiveness depends on other factors as well, such as the quality of regulations, policy stability, and strong governance. These factors play a key role in shaping financial support for real environmental improvements (Danish et al., 2025; Saba et al., 2025). Specifically, green finance may reduce consumption-based emissions by supporting technology upgrades, energy-system transitions, and industrial restructuring, whereas effective governance enhances these efforts through improved project selection, enforcement, regularity stability, and corruption control. The present study analyzes the direct and interactive effects of green finance and institutional quality on carbon emissions, motivated by the interdependence of governance structures and financial mechanisms.

Since the Paris Agreement in 2015 and the subsequent climate commitments of 2020–2021, emphasis has been placed on the different factors affecting emissions. Several variables have been studied to examine the determinants of environmental performance (e.g., (Chang et al., 2026; Chhabra et al., 2023; Hassan et al., 2024; Zheng et al., 2025). Moreover, studies have been carried out to identify different aspects of the economy that significantly affect carbon emissions (Du et al., 2025; Han & Li, 2025). The focus on financial and governance factors has attracted attention because they significantly impact environmental deterioration (Danish et al., 2025; Hunjra et al., 2024). Despite this, the literature has overlooked the governance–green finance nexus, and limited studies have examined the influence of green finance and institutional quality interactions. However, recent studies of OECD economies have examined green finance and governance separately (e.g., Safi et al., 2024; Danish et al., 2025) , and limited studies have examined the relationship between green finance and institutional quality on carbon emissions through the MMQR approach. Countries with greater green finance investments may direct resources toward low-carbon technologies, thereby reducing emissions and enhancing their contribution to carbon mitigation (Chen et al., 2025).

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The present study explores the role of institutional quality, green finance and their interaction in carbon emissions in selected OECD economies. This study contributes to the literature in different ways. First, the existing literature have overlooked the role of green finance–institutional quality interactions on the carbon emissions of OECD economies using the quantile regression approach. Second, this study separately measures the direct and interactive effects of green finance and institutional quality on carbon emissions across different quantiles. Third, this research examines the role of macroeconomic factors on carbon emissions in OECD economies. We measured carbon emissions using consumption-based CO_2 data and analyzed the relationships across different quantiles of the distribution. Empirical evidence concerning carbon emission determinants may help policymakers and environmental regulators reduce environmental degradation in OECD economies.

2. LITERATURE REVIEW

Research has shown a linkage among green finance (GF) and carbon emissions. Du, Zhang, and Hou (2025) carried out a research study to examines the impact of GF reform on the efficiency of carbon emissions in Chinese cities and reported that the policy significantly improved efficiency by encouraging innovation, expanding financial supply, and streamlining industrial structures. Similarly, Han and Li (2025) examined the carbon emissions of corporations in China and confirmed that GF reform strongly reduces carbon emissions through enhancing the green innovation capacity of enterprises. Their study also revealed that the reduction effect of emissions is greater among nonstate enterprises and firms in areas where financial development is more advanced. Hunjra et al. (2024) assessed the role of green finance on the environmental outcomes of 21 countries between 2000 and 2021, and their results indicate that there are both direct and indirect relationships between GF and CO_2 emissions in the long run and short run. Yi et al. (2025) examined OECD economies and found that GF lowers the greenhouse gas emissions and the impact is greater in high-emission nations than in low-emission nations. This association has also been investigated by several other studies, and their findings indicate that GF improves carbon emissions and broader corporate environmental performance in a variety of ways, such as

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industrial upgrading, technology advancement, and better energy structures (Chen et al., 2025; Tan et al., 2025; Zhao et al., 2024).

Several research studies have shown that there exist an association between institutional quality (IQ) and carbon emissions. Danish et al. (2025) explored the contribution of IQ in carbon emissions in 35 OECD countries over the period 1990-2020 and found that IQ has a direct influence in reducing carbon emissions, while also moderating the association between energy transition and emissions. Hussain and Dogan (2021) analyzed the BRICS economies and demonstrated that countries with stronger environmental technologies and institutional structure have a lower ecological footprint. A research study carried out by Khan et al. (2022) on 107 developing and 39 Belt Road Initiative (BRI) countries found that individual governance indicators such as regulatory quality and rule of law were weak in reducing carbon emissions on their own, whereas their interaction with financial development and FDI significantly contributed to emission reduction. Chhabra et al. (2023) also examined the BRICS countries and found that IQ has a positive influence on environmental sustainability, reflected in low corruption, high political stability, and a high level of regulatory enforcement. The study by Saba et al. (2025) investigates the governance indicators of 183 nations and their findings reveal that the impact of governance indicators on emissions vary significantly across regions, with governance and institutional indicators aggravating carbon emissions to varying degrees depending on the regional context. Besides, Nam and Ryu (2024) studied European transition economies and discovered that institutional quality, such as corruption control is relevant to reduce emissions, and Salman et al. (2019) revealed that effective domestic institutions are significant to enhance economic growth and also lessons carbon emissions.

Few studies have explored the association between green finance and institutional quality in terms of carbon emissions. Hunjra et al. (2024) discovered direct and indirect associations between governance, green finance, and environmental performance that highlight governance in the development of environmental policies and the effectiveness of green finance initiatives. Barra and Falcone (2025) examined institutional quality and financial development in 133 global economies and showed that financial development reduces environmental inefficiency (measured with CO2 as an undesirable output), with institutional quality strengthening this effect. Orazalin

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and Mahmood (2021) assessed the features of boards and country governance and found that a strong institutional structure enhances the performance of corporate environmental practices. Related evidence on institutional interactions, although not specific to green finance, is also informative. Bambi et al. (2024) investigated institutions and governance in Sub-Saharan Africa and reported threshold effects in which the interaction between institutions and governance follows an inverted U shape. Wang and Guan (2025) investigated the role of institutional quality in the reduction of agricultural carbon emissions through the digital economy in 252 Chinese cities. Their findings showed that institutional quality directly reduces emission intensity and that the carbon reduction effect of the digital economy is nonlinearly expanded with the improvement of institutional quality.

Although several studies on green finance and institutional quality have been carried out, few studies have explored the interactive influence on CO_2 emissions in OECD economies using the quantile approach. Thus, this study bridges this gap by assessing the direct and interactive effects of green finance and institutional quality on carbon emissions in the various quantiles of the emission distribution. On the basis of the literature discussed above, we develop the following testable expectations. First, green finance is expected to have a negative effect on carbon emissions, and this effect should be stronger at higher quantiles where greater scope for emission reduction exists (Hypothesis 1). Second, institutional quality is predicted to reduce carbon emissions across quantiles by improving regulatory enforcement and policy effectiveness (Hypothesis 2). Third, the interaction between green finance and institutional quality is expected to produce additional emission reductions, particularly at higher quantiles, as strong governance enhances the effectiveness of green finance investments (Hypothesis 3).

3. METHODOLOGY

This study evaluates the effect of green finance, institutional quality, and their interaction effect on the carbon emissions for OECD economies from 2000 to 2022. The dependent variable in this study is carbon emission measured using the consumption-based carbon emissions (CO_2) by Peters et al. (2012). We use consumption-based emissions because they account for carbon embedded in imports and exports, something production-based measures overlook, especially for economies

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that have shifted manufacturing abroad (Peters et al., 2012). We measure green finance (GF) using Research, Development, Demonstration and Deployment (RD&D) expenditure, a reliable proxy for public clean energy investment (Hunjra et al., 2024; Safi et al., 2024). Although this excludes broader instruments like green bonds and ESG flows, it captures the government-led spending that characterizes green finance in OECD economies. Institutional quality (IQ) is constructed as a composite index using the six World Governance Indicators (WGI) from the World Bank, which includes regulatory quality, government effectiveness, political stability and the absence of violence, voice and accountability, control of corruption and rule of law. Since each dimension captures a different facet of institutional quality (Khan et al., 2022; Saba et al., 2025). Green finance and institutional quality are multiplied to determine the interaction term $(GF \times IQ)$, which captures the combined impact of these two factors on carbon emissions.

As control variables, we use World Bank data on imports (IM), exports (EX), GDP and natural resources rents (NR). GDP captures the economic development level and is expected to influence emissions. Imports and exports capture the trade openness of economies, with imports potentially increasing emissions through the consumption of carbon-intensive goods and exports potentially reflecting cleaner domestic production. Natural resources rents measure the economy's dependence on natural resource extraction, which may affect environmental outcomes. Since GDP, trade, and natural resources are the most frequently used determinants of carbon emissions in cross-country studies, these control variables were chosen on the basis of the well-established environmental economics literature (Chhabra et al., 2023; Danish et al., 2025; Khan et al., 2022). The base model is given as follow:

$$Model\ 1: CO_{2i,t} = f(GF_{i,t} + GDP_{i,t} + IQ_{i,t} + IM_{i,t} + EX_{i,t} + NR_{i,t}) \quad (1)$$

$$Model\ 2: CO_{2i,t} = f(GF_{i,t} + GDP_{i,t} + IQ_{i,t} + IM_{i,t} + EX_{i,t} + NR_{i,t} + GF \times IQ_{i,t}) \quad (2)$$

3.1 ANALYTICAL STRATEGY

The panel data presents a number of econometric issues that must be resolved before estimation. One such issue in OECD economies is cross-sectional dependency (CD), since a shock in one

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nation is unlikely to remain contained there, as they are closely linked through trade, capital flows, and policy coordination. Since ignoring such spillovers would compromise our standard errors and possibly our coefficient estimates as well, we use the Pesaran (2015) and Fan et al. (2015) CD tests to check for this.

Another issue is whether the influence of green finance on environmental pollution is the same across countries in our sample. Given that OECD economies differ in their industrial composition, energy mix, and policy frameworks, we test for slope heterogeneity using Pesaran and Yamagata (2008). The results reject slope homogeneity, supporting our use of quantile methods. We check the order of integration with the Im et al. (2003) test and apply the Westerlund (2005) cointegration analysis to check for a long-run equilibrium relationship among the variables

We use the method of moments quantile regression (MMQR) as our main estimation strategy. OLS or fixed effects would provide a single average coefficient for the influence of institutional quality, and green finance on emissions, but this could be misleading if the effect is not the same across the emission distribution. For instance, economies that already have relatively low emissions may not benefit from green finance in the same way as economies where emissions are still high.

The MMQR approach of Machado and Santos Silva (2019) is preferred over traditional panel quantile regression or fixed-effects quantile models because it accommodates individual heterogeneity through location and scale effects while allowing the entire conditional distribution to be estimated, not just the conditional mean. We complement the MMQR results with Bootstrap Quantile (BQ) Regression following Koenker and Bassett (1978), which gives us robust standard errors and an independent check on our main findings.

4. RESULTS AND DISCUSSION

Table 1 reports results of cross-sectional dependence (CD) and slope heterogeneity for the panel data. It shows significant CD statistics for all the variables, indicating the presence of CD. The CD statistic for the CO_2 variable is 28.14, that for GF is 4.29, GDP is 64.58, IQ is 7.87, IM is 36.35, EX is 31.03, and that for NR is 24.47. Similarly, the CDw+ test of Fan et al. (2015) further

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confirms the cross-sectional dependence across variables. Slope homogeneity is strongly rejected by the delta statistics for Models 1 and 2, which are 11.309 and 9.398, respectively.

Tab. 1 – CD and Slope Heterogeneity Tests. Source: own research

a) CD analysis	**CD**	**CDw+**
CO_2	28.14***	770.57***
GF	4.29***	435.66***
GDP	64.58***	1037.82***
IQ	7.87***	508.01***
IM	36.35***	691.35***
EX	31.03***	694.85***
NR	24.47***	493.64***
b) Slope heterogeneity	**Delta Stat**	**Adjusted Delta**
Model-1	11.309***	14.537***
Model-2	9.398***	12.606***

*Note: ***p < 0.01*

Table 2 reports the unit root test results. CO_2, GDP, IM, and EX contain unit roots at levels but become stationary after first differencing. GF, IQ, and NR are found to be stationary at levels.

Tab. 2 – Unit Root Analysis. Source: own research

Variables	**Level Z-stat**	**p-value**	**1st Diff Z-stat**	**p-value**	**Order**
CO_2	-0.366	0.357	-11.309***	0.000	I(1)
GF	-5.883***	0.000			I(0)
GDP	3.235	0.999	-8.983***	0.000	I(1)
IQ	-2.369***	0.009			I(0)
IM	-0.294	0.384	-10.074***	0.000	I(1)
EX	-0.447	0.327	-9.297***	0.000	I(1)
NR	-1.552*	0.060			I(0)

*Note: ***p < 0.01, *p<0.10*

Table 3 gives the cointegration analysis results and shows a robust long-run relationship among green finance, institutional quality, and carbon emissions. The Westerlund VR statistics of 2.579 (Model 1) and 4.823 (Model 2) are significant. The higher statistic in Model 2 reveals that the interaction between green finance and institutional quality contributes to a stronger equilibrium relationship with emissions.

Tab. 3 – Westerlund Cointegration Analysis. Source: own research

Test	**Model 1**	**Model 2**
Variance Ratio (VR)	2.579***	4.823***

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*Note: ***p < 0.01*

The MMQR estimations that are given in Table 4 and shows the results for OECD economies at the 25th, 50th, 75th, and 90th quantiles. Table 4 reports that green finance has a significantly negative impact on carbon emissions across quantiles. The finding implies that economies that invest in green finance have a lower contribution to carbon emissions. The coefficient increases in magnitude from -0.082 at Q25 to -0.238 at Q90, green finance investments are particularly effective in economies with higher baseline emission levels, where there is greater scope for emission reductions through technological upgrading and industrial transformation. The increasing magnitude of the coefficient across quantiles also implies that policies aimed at promoting green finance should be particularly targeted at high-emission economies to maximize their carbon mitigation potential. Our results are in line with Chen et al. (2025) and Du et al. (2025), who found that green finance reform enhances carbon emission efficiency through multiple channels, including industrial structure optimization, technological innovation, and improved energy efficiency.

Tab. 4 – MMQR Results - Model 1. Source: own research

Quantile	GF	GDP	IQ	IM	EX	NR
Q25	-0.082** (0.040)	0.901*** (0.020)	-0.006*** (0.001)	1.445*** (0.182)	-1.472*** (0.154)	0.006 (0.012)
Q50	-0.137*** (0.035)	0.914*** (0.017)	-0.007*** (0.001)	1.308*** (0.159)	-1.254*** (0.135)	0.009 (0.011)
Q75	-0.191*** (0.039)	0.927*** (0.019)	-0.007*** (0.001)	1.175*** (0.176)	-1.042*** (0.150)	0.013 (0.012)
Q90	-0.238*** (0.047)	0.938*** (0.023)	-0.007*** (0.001)	1.058*** (0.216)	-0.858*** (0.181)	0.015 (0.014)

*Note: Parenthesis shows standard errors. ** p < 0.05 *** p < 0.01.*

Our results in Table 5 show that institutional quality has an inverse effect on emissions, with coefficients ranging from -0.006 to -0.007. The OECD economies with strong governance structures (i.e., regulatory quality) play important roles in reducing emissions. The consistency of the institutional quality coefficient among quantiles indicates that good governance is equally significant in terms of carbon mitigation, irrespective of the level of baseline economic emissions. Our results are in line with Danish et al. (2025) and Hussain and Dogan (2021), who reported that

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institutional quality directly improves environmental outcomes; Danish et al. (2025) further found that it moderates the relationship between the energy transition and emissions. The findings show that GDP has a positive impact on carbon emissions, implying that the higher the economic output is, the greater the contribution to emissions. These findings are consistent with the positive growth–emissions relationship reported for BRICS economies by Chhabra et al. (2023) and for OECD economies by Yi et al. (2025). Imports have a positive effect, and exports have an adverse effect on emissions. The positive import effect is expected under consumption-based accounting, as imports embed the carbon footprint of goods produced abroad. The negative export effect may reflect the fact that when domestic production is exported rather than consumed domestically, it reduces the consumption-based emissions attributed to the exporting economy, as these emissions are instead counted in the importing country's consumption footprint. Natural resources rents are not significant across all quantiles.

Tab. 5 – MMQR Results - Model 2 (with Interaction). Source: own research

Quantile	GF	GDP	IQ	IM	EX	NR	GF×IQ
Q25	-0.083** (0.034)	0.901*** (0.020)	-0.006*** (0.001)	1.450*** (0.192)	-1.475*** (0.165)	0.007 (0.013)	0.001 (0.003)
Q50	-0.149*** (0.029)	0.912*** (0.017)	-0.006*** (0.001)	1.328*** (0.163)	-1.262*** (0.140)	0.009 (0.011)	-0.002 (0.003)
Q75	-0.214*** (0.032)	0.923*** (0.019)	-0.006*** (0.001)	1.209*** (0.176)	-1.054*** (0.152)	0.012 (0.012)	-0.005* (0.003)
Q90	-0.266*** (0.038)	0.932*** (0.023)	-0.007*** (0.001)	1.113*** (0.213)	-0.884*** (0.182)	0.014 (0.014)	-0.008** (0.003)

*Note: Parenthesis shows standard errors. *p < 0.10, ** p < 0.05 *** p < 0.01.*

Table 5 demonstrates the results for Model 2 with the interaction term. The influence of green finance and institutional quality remain significant and negative, further confirming the robustness of the baseline results. The interaction term (GF×IQ) has an increasingly negative effect at higher quantiles, becoming significant at Q75 (-0.005, p<0.10) and highly significant at Q90 (-0.008, p<0.05). These findings show that the synergistic effect between green finance and institutional quality is especially significant in the case of high emissions. The negligible correlation at the lower quantiles (Q25 and Q50) indicates that in the case of low-emissions, the direct impact of green finance and institutional quality is enough to meet the carbon mitigation targets. However, in the case of high-emission economies in the upper quantiles of the distribution, the combination of green finance investments and high institutional quality produces additional benefits of emission

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reduction compared with their respective effects. The reasoning behind this interaction can be understood is that in high-emission economies, green finance investments require strong institutional support to translate into actual emission reductions. Strong governance ensures better project selection and monitoring of green investments, effective enforcement of environmental regulations, regulatory stability that encourages long-term clean energy commitments, and control of corruption that prevents the misallocation of green finance resources. The findings are similar to those of Barra and Falcone (2025), who found that financial tools are more effective at reducing environmental damage when the institutional environment is strong.

To further validate the results, we employed the Bootstrap Quantile (BQ) Regression. The BQ results in Table 6 show that green finance remains a significant negative predictor of carbon emissions at all quantiles, ranging from -0.064 at Q25 to -0.174 at Q90. These estimates are smaller in magnitude compared to the MMQR results (-0.082 to -0.238), but given that the two methods use different estimation procedures, some variation in coefficient size is to be expected. More importantly, the negative direction and statistical significance of the green finance effect are maintained across both approaches, and the finding that green finance has a stronger emission-reducing effect in high-emission economies is confirmed.

Institutional quality also maintains its significant inverse association with emissions across quantiles, with coefficients of -0.005 at Q25 to -0.007 at Q75 and Q90, confirming the reliability of our baseline results. The GDP coefficients remain positive and highly significant across all quantiles, which is consistent with the MMQR estimates and further confirms that economic growth continues to be associated with higher carbon emissions in OECD economies. Imports have positive effect on carbon emissions in the BQ results, with coefficients ranging from 1.332 at Q25 to 0.740 at Q90, and exports continue to show a significant negative effect across all quantiles. The pattern of decreasing import and export coefficients at higher quantiles is also observed in the MMQR results, suggesting that the trade-emissions relationship weakens somewhat for high-emission economies. Natural resources remain positive but insignificant across all quantiles in the BQ estimation, which is in line with the MMQR findings and further supports that resource dependence nonsignificant role in explaining carbon emissions in the OECD context.

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Overall, the consistency between the BQ and MMQR results across all variables and quantiles strengthen the results and that the findings are not driven by the choice of estimation method.

Tab. 6 –BQ Regression – Robustness analysis Model 1. Source: own research

Quantile	GF	GDP	IQ	IM	EX	NR
Q25	-0.064*** (0.021)	0.924*** (0.025)	-0.005*** (0.001)	1.332*** (0.155)	-1.421*** (0.124)	0.002 (0.013)
Q50	-0.156*** (0.038)	0.916*** (0.024)	-0.006*** (0.001)	1.548*** (0.216)	-1.447*** (0.174)	0.012 (0.016)
Q75	-0.224*** (0.026)	0.939*** (0.021)	-0.007*** (0.002)	1.036*** (0.178)	-0.884*** (0.167)	0.004 (0.015)
Q90	-0.174** (0.069)	0.891*** (0.040)	-0.007*** (0.002)	0.740*** (0.288)	-0.646*** (0.186)	0.024 (0.024)

*Note: Parenthesis shows standard errors. ** $p < 0.05$ *** $p < 0.01$.*

Table 7 reports BQ Regression estimates for Model 2, which includes the green finance-institutional quality interaction. The results support the main MMQR findings, with green finance showing a negative and significant effect across quantiles, ranging from -0.053 at Q25 to -0.201 at Q90. The interaction term (GF×IQ) remains significant at the 90th quantile (-0.017, $p<0.01$), which confirms that the combined effect of green finance and institutional quality holds when using a different estimation method. This confirms that the green finance-institutional quality interaction is most relevant for high-emission economies, and this result is not sensitive to the choice of estimation method.

The BQ interaction coefficient at Q90 (-0.017) is larger than the MMQR results (-0.008), which shows that the bootstrap method picks up a somewhat stronger interaction effect at the upper tail. This difference may be due to the sensitivity of upper quantile estimates to the estimation approach, but the main conclusion does not change: the interaction between green finance and institutional quality becomes more important at higher emission levels. Institutional quality shows a significant negative effect across all quantiles in the BQ estimates, with the coefficient reaching -0.009 at Q90, which is slightly larger than the MMQR estimate at the same quantile. GDP, imports, and exports keep their direction and significance from the MMQR results, and natural resources continue to be positive but insignificant across all quantiles. The fact that these control variable results stay the same across both methods gives us additional confidence that the findings are stable. Overall, the BQ results for Model 2 further confirm that green finance and institutional quality work together

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to reduce carbon emissions, especially for high-emission OECD economies, and this finding is not driven by the choice of estimation method.

Tab. 7 – BQ Regression – Robustness Model 2. Source: own research

Quantile	GF	GDP	IQ	IM	EX	NR	GF×IQ
Q25	-0.053** (0.026)	0.932*** (0.036)	-0.005*** (0.001)	1.300*** (0.212)	-1.386*** (0.148)	0.007 (0.015)	0.001 (0.003)
Q50	-0.154*** (0.036)	0.918*** (0.017)	-0.006*** (0.001)	1.549*** (0.249)	-1.463*** (0.202)	0.009 (0.015)	0.001 (0.003)
Q75	-0.238*** (0.033)	0.932*** (0.026)	-0.006*** (0.002)	0.921*** (0.307)	-0.772*** (0.279)	0.010 (0.018)	-0.007 (0.005)
Q90	-0.201*** (0.042)	0.880*** (0.024)	-0.009*** (0.002)	0.809*** (0.208)	-0.734*** (0.158)	0.021 (0.016)	-0.017*** (0.003)

*Note: Parenthesis shows standard errors. ** $p < 0.05$ *** $p < 0.01$.*

5. CONCLUSIONS AND POLICY RECOMMENDATIONS

Carbon emissions have a significant effect on sustainable development and climatic stability, which is a matter of growing concern among economies, regulators and policy makers about the ecological and economic costs of carbon emissions. Carbon emissions significantly impact the nation's economy and environment, which in turn causes climate change. Over time, this has further effects on population health, agricultural productivity, and economic advancement. Therefore, this study looks at how institutional quality and green finance can aid in lowering emissions in OECD economies. The study evaluates the period from 2000–2022 by evaluating the direct and interactive effects of institutional quality and green finance on each of the carbon emissions in different quantiles.

Our findings report that green finance can substantially decrease carbon emissions at all quantile levels. However, the impact is greatest at the upper end of the level, where the green finance coefficient increases in magnitude from -0.082 in the 25th quantile to -0.238 in the 90th quantile. These findings indicate that compared with economies with low green investment, economies with high green investment contribute less to carbon emissions. The results also confirm that there is a negative association between institutional quality and carbon emissions. Furthermore, the empirical findings show that, among the higher quantiles, the interaction between green finance and institutional quality has a significant negative effect on carbon emissions, and this effect is significant at both the 75th and 90th quantiles. We observed that GDP and imports have a positive

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impact, whereas exports have a negative effect on carbon emissions. Natural resources rents are found to have a negligible impact on carbon emissions given OECD economies.

The findings offer important policy implications. Specifically, we identify the significant role of green finance and other key factors that enhance carbon emission mitigation. Moreover, this study provides an overview of OECD economies and the determinants of environmental performance in OECD economies. The results do not imply that economies should reduce economic growth to achieve carbon mitigation, as studies have shown that sustainable growth pathways are achievable through green investments and technological innovation. However, countries, regulators and policymakers should introduce certain mechanisms, such as green finance incentives and stronger governance frameworks, to channel investments toward low-carbon technologies and restrain carbon-intensive activities to decrease the influence of economic growth on carbon emissions in OECD economies. Moreover, policymakers and environmental regulators should strengthen the institutional frameworks for environmental governance to reduce the impact of governance weaknesses on environmental performance. The results also support the view that economies with stronger institutional quality contribute less to carbon emissions. The quantile-level results suggest that policy responses should differ depending on where an economy sits in the emission distribution. For high-emission OECD economies, combining green finance expansion with governance reforms is likely to be more effective, given that the interaction term is significant only at the 75th and 90th quantiles. For low-emission economies, the direct effect of green finance already appears sufficient. These findings can help policymakers design targeted strategies for carbon mitigation in OECD economies.

While these findings offer important insights, certain limitations should be acknowledged. First, our green finance proxy captures public clean energy innovation spending, which is narrower than the full scope of green finance, which includes green bonds, green credit, and ESG investment flows. Future research could test the robustness of our findings using alternative green finance proxies such as green bond issuance or renewable energy investment data. Second, institutional quality is measured by the six WGI indicators, and the results may differ if individual governance dimensions are used separately. Third, while we use consumption-based CO_2 emissions, comparing the results with production-based emissions could reveal whether our conclusions

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depend on the emissions accounting framework. Moreover, future studies can consider the role of innovation, renewable energy, and carbon taxation and examine their influence on environmental performance. Moreover, future studies can investigate the role of regional differences and whether regional characteristics help enhance environmental performance. Future studies can also examine the influence of financial development and institutional depth in sustainable development.

Declarations

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