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UNVEILING THE INSTITUTIONAL FOUNDATIONS OF GREEN GROWTH: THE ROLE OF CORRUPTION CONTROL IN A GLOBAL DYNAMIC PANEL FRAMEWORK

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Abstract
This study investigates how corruption mechanisms impact green growth strategies that manage environmental costs through the study of global panel data from 141 countries from 1996 to 2024. The study employs static and dynamic panel estimation techniques, including autoregressive distributed lag and System Generalized Method of Moments models to investigate corruption mechanisms, which show both short-term and long-term effects while handling endogeneity, unobserved heterogeneity, and persistence. The static results show that corruption mechanisms bring within-country advantages that help countries develop their green economic growth strategies, which create better environmental results through institutional quality improvements. The primary obstacle to environmental progress stems from structural economic limitations, which produce significant adverse effects on poverty reduction efforts. The relationship remains sensitive to model specifications, implying that complementary institutional and policy frameworks are necessary to achieve sustainable green growth. Different models produce mixed or weak statistical findings about trade openness and foreign direct investment because their results vary between different models. The researchers employ lagged institutional models together with autoregressive distributed lag panel specifications to analyze dynamic institutional changes that bring delayed effects. The models show that the green growth process maintains partial persistence while establishing different institutional effects for short-term and long-term periods. The short-run effects of corruption appear weak in statistical analysis because endogeneity emerges from reverse causality and omitted structural factors. The System Generalized Method of Moments estimator extends the analysis through its ability to correct dynamic panel bias and simultaneity problems by using internal instrumentation. The dynamic results demonstrate that corruption control plays a vital role in fostering green economic growth because endogeneity has been effectively resolved. The findings show that green economic growth depends on institutional quality and structural

economic conditions, which require governance reforms and complete policy frameworks to achieve environmental sustainability.

Keywords: Green Economic Growth, Governance Quality, Corruption Mechanism, Panel Data Analysis, Sustainable Development

1. Introduction

The world now considers environmental protection to be its top priority, but this environmental protection effort conflicts with economic growth in developing and emerging economies, which need rapid industrialization (Zafarullah & Mehnaz, 2025; Mehdi et al., 2025; Carlo, 2025). The development paths that policymakers should establish must achieve economic growth while sustaining environmental protection because of the current situation, which shows their two elements are out of balance (Ahmad, 2019; Mezentseva et al., 2024; Batool et al., 2025; Martin, 2025). The green economic growth models have become the preferred choice because they protect environmental concerns better than traditional growth models. Developed countries increasingly recognize that green economic growth is more desirable and suitable compared to traditional growth patterns because economic activities should produce good environmental results (Pearce & Turner, 1989).

Green economic growth serves as an essential transformation that protects the planet from climate change, biodiversity loss, and environmental degradation, while also functioning as an alternative method for environmental protection (Adamowicz, 2022; Khalid et al., 2025; Umair et al., 2025; Qasir & Agha, 2025). The green economic growth strategy combines essential economic performance elements, which include poverty reduction, social inclusion, and employment generation, with environmental sustainability requirements. The method intends to establish continuous environmental equilibrium by accomplishing three objectives, which protect ecosystems, enhance resource usage, and decrease carbon energy dependence. Green economic growth enables sustainable development through its framework, which connects economic, social, and environmental goals into a single system (UNEP, 2011). Economic systems depend on environmental systems since they maintain a fundamental relationship, and any disruption between these two systems will create permanent developmental obstacles. The development of green economic growth and sustainable development demonstrates how both fields share common elements, which create a complete vision of progress that exceeds traditional economic performance evaluation (Awan, 2013; Adamowicz, 2022; Gerlich et al., 2025; Naeem et al., 2025; Ahmad & Hu, 2025).

The successful execution of green economic growth strategies depends on the institutional framework that governs economic activities (Abyan, 2025; Chowdhury & Hassan, 2025). Institutions control economic behavior through their foundational functions, while they also determine how government policies will succeed and which resources will be distributed. Institutions establish human-created restrictions that determine how people will interact in political, social, and economic domains. People establish social rules that develop through time, and they function as the basic framework that governs organizational and individual behavior. Institutional strength depends on organizational members who make choices that determine the strength of institutional frameworks. This view demonstrates how institutions operate in a dynamic manner to define their economic development path. The institutional framework developed by North (1990) explains that institutions exist to decrease uncertainty, which results from limited information, and to organize economic relationships between parties. North (1990) makes a distinction between formal institutions, which include laws and property rights, and regulatory systems and informal institutions, which consist of cultural norms and traditions and social conventions. The formal rules that exist as a limited group of behavior constraints operate alongside informal norms, which people accept as social standards. The institutional structures create a framework that decreases uncertainty while providing economic agents with operational incentives, establishing property rights, stopping dishonest practices, and controlling transaction expenses, which in turn affects total economic output (North, 2000). Strong institutional frameworks operate as essential elements that governments need to use for their environmental regulatory systems to function while they protect their green investments and sustain their sustainability standards.

Economic sociology has established that economic activities exist as embedded components within institutional and social frameworks. According to Polanyi (1957), the economy functions as an embedded system because its operations depend on established institutional frameworks that encompass both economic and non-economic structures. Granovetter (1985) supported this view by showing that social networks determine how people and organizations behave in their economic activities. Institutions operate as governance tools that help economic agents to work together while decreasing coordination problems and market defects. People follow institutional frameworks, while their decisions are affected by both environmental factors and the availability of natural resources. Institutions maintain their dynamic character through ongoing interactions between people and their surroundings, which create continuous evolution (Hodgson, 1998).

The institutional framework produces corruption mechanisms that determine economic results and environmental outcomes. The corruption problem in institutions leads to weakened performance, which occurs through three main mechanisms (Thompson, 2018). Environmental management suffers from corruption because it causes improper resource distribution and illegal natural resource use, and prevents proper environmental rule enforcement (Tacconi & Williams, 2020; Ali et al., 2025; Lee & Zhuang, 2025). The green growth strategies face operational challenges while sustainable development efforts find their progress blocked by this practice. Environmental degradation continues because weak governance systems permit it to happen when regulations are either not applied or intentionally ignored (White, 2020; Jaelani & Nazara, 2022; Aziz et al., 2025). The successful fight against corruption leads to better institutional systems because it improves the transparency, accountability, and operational efficiency of public administration systems. Strong governance frameworks enhance environmental law enforcement while securing better resource distribution and driving investments into environmentally friendly industries (Oloko, 2022; Ning & Shen, 2024; Longston et al., 2025). Corruption control acts as an important factor that helps countries achieve their green economic growth goals. The approach enables governments to create and execute policies that protect environmental sustainability while they strive to achieve economic stability. The study of corruption mechanisms within institutional systems becomes necessary to assess how green growth strategies function in practice.

Despite the growing body of literature (Sumaira, 2020; Altaf & Shahzad, 2021; Lu & Xing, 2022; Ahmed et al., 2022; Solarin & Leong, 2022; Wang et al., 2023; James & Emons, 2023; Tawiah et al., 2024; Ali et al., 2025; Khan et al., 2025; Nazir et al., 2026) on green economic growth, together with institutional quality, studies that investigate governance indicators yet they cannot shown how corruption mechanisms affect environmental results. Existing research works (Shi et al., 2024; Dong et al., 2025; Xu, 2025; Ali et al., 2025) study specific regions or countries because researchers have not developed global studies that would show all research areas. Green economic growth measurement needs to integrate environmental cost dimensions because this integration enables a complete assessment of how economic activities affect the environment. Despite extensive literature on institutional quality, existing studies rarely isolate corruption mechanisms as an independent determinant of green economic growth, particularly within a dynamic global framework that accounts for persistence and endogeneity. To fill the gap, our study investigates the relationship between the mechanism of

corruption and institutional dynamics and green economic growth between 1996 and 2024 using panel data from 141 countries.

2. Literature Review

The idea of green economic growth has gained recognition as a strategic method to fulfill current generation requirements while safeguarding future generation needs (Ekins, 2002; Lorek & Spangenberg, 2014; Ernst et al., 2016; Adewoyin, 2021; Krueger et al., 2022; Gu et al., 2025; Aqeel et al., 2025). This concept exists as a response to the rising environmental problems that currently affect the global economy through three main crises, namely climate change, biodiversity loss, and environmental pollution (Singh & Singh, 2016; Alamandi, 2025; Sattar et al., 2025; Ali et al., 2025). The environmental crises emerge because traditional economic growth models, which prioritize industrial expansion and resource extraction, plus their immediate economic benefits, create negative environmental impacts. International and national organizations now recognize environmental protection as essential for economic planning, but most entities still fail to implement this obligation, which results in severe environmental damage and resource depletion. The majority of countries have developed their new policy direction toward green economic growth strategies, which prioritize sustainability and environmental protection after they discontinued their use of traditional growth frameworks (Wang et al., 2019; Khalil et al., 2025). The economic system transition demonstrates that all economic systems depend on ecological systems, while sustainable development requires proper management of natural capital. Structural transformation serves as the central element that enables economies to move away from methods that consume excessive resources and generate high pollution toward practices that achieve cleaner production through reduced resource consumption. The transformation process requires extensive investment in renewable energy growth and technology development, sustainable infrastructure building, and institutional framework creation, which will achieve enduring system transformations (Bhattacharya et al., 2015; Marc et al., 2022; Oluokun et al., 2024; Anus et al., 2025).

The existing studies show how energy systems enable green economic growth by their function in moving the world away from fossil fuels toward renewable energy resources. People believe renewable energy serves as the main driver of sustainable development because it lowers greenhouse gas emissions, which protects natural ecosystems and enhances energy security. Hassan et al. (2025) study how renewable energy links to digital economic growth and green economic development through advanced panel econometric methods, which they use to extend current research. The study employs three estimation methods for cross-sectional dependence and

variability analysis by applying panel corrected standard errors and Driscoll-Kraay standard errors together with augmented mean group and common correlated effects mean group methods. Energy access functions as a fundamental requirement, which enables economic and social progress, while natural resources work as fundamental assets that support energy delivery solutions. Renewable energy systems benefit from digital technology, which creates operational improvements that enable resource distribution and sustainable economic development. The implementation of all sustainable development approaches relies on technological progress and digital transformation as essential components for achieving sustainable development.

Institutional quality functions as the primary element that drives green economic development, together with energy systems. The rules that have been established through their enforcement by institutions function as economic activity control mechanisms that establish resource distribution methods. The research conducted by Degbedj et al. (2024) uses fully modified ordinary least squares to study how institutional quality affects green economic growth in West African Economic and Monetary Union nations. The results of the study demonstrate that different countries experience unique impacts from institutional quality because it helps some nations achieve green economic growth while it hinders progress in other nations. The different outcomes happen because countries have different governance systems and policy enforcement methods, and their citizens have different social and economic conditions. The research shows that strong institutions enable better regulatory enforcement, which reduces operational inefficiencies to protect environmental sustainability, while weak institutions create environmental harm through non-compliance and improper resource management.

The study by Zhou et al. (2021) shows how institutions operate because they examined the three parts of the institutional environment, which consist of legal structure, government operations, and cultural factors. The researchers used the generalized method of moments estimation to demonstrate that institutional environment creates a relationship between two extremes: institutional environment and green economic growth. The research shows that institutional quality improvements lead to green economic growth during initial improvements, but after reaching a particular threshold, further institutional growth results in diminishing returns and total negative results. The study establishes that cultural institutions have a stronger impact on green economic growth than both legal institutions and governmental organizations. The study establishes that informal rules and

social values, together with established behavioral patterns, serve as fundamental factors that determine environmental results. The study establishes that public attitude changes must happen together with policy changes to achieve sustainability objectives. The research conducted by Ngo (2025) extends this study by examining the factors that drive green economic growth in Asian economies through the framework of institutional theory. The research shows that institutional quality functions as a moderator that determines how economic factors affect environmental impacts. The research findings demonstrate that institutional quality functions as a beneficial driver that helps international investment and financial development, industrial expansion, and natural resource management through both dynamic and ordinary least squares models. The research shows that institutional structures serve as essential elements that enable green economic growth through their support of sustainable development. The research shows major gaps because researchers have not studied how institutional systems operate together with other green growth factors in developing countries that experience fast development. The relationship between institutions and environmental sustainability requires empirical research because specific contextual factors determine how these two elements interact with each other. The research conducted by Yan et al. in 2024 demonstrates that foreign direct investment functions as a vital force that helps developing nations create green economies through technology transfer and essential financial resources. The research shows that foreign direct investment serves as a key engine for sustainable energy development when countries have strong institutional frameworks. The research shows that countries with effective institutions can attract foreign capital, which investors will use to fund environmentally beneficial projects. The lack of proper enforcement of protective measures causes environmental damage because regulatory systems do not function effectively to protect natural resources. The environmental sustainability of investment activities depends on governance, which determines how foreign direct investment affects environmental sustainability.

The literature has extensively studied how institutional quality influences renewable energy consumption patterns. Rahman et al. (2022) analyze this relationship using autoregressive distributed lag models and panel co-integration techniques for a sample of developing countries. Their findings show that institutional effectiveness, economic growth, and export expansion lead to increased renewable energy consumption. The study establishes a unidirectional causal relationship that shows how renewable energy consumption affects corruption control. The study results demonstrate that effective corruption control mechanisms serve as essential factors for

achieving environmental sustainability, while institutional reforms function as vital drivers of green economic development.

The transition to renewable energy sources from fossil fuels forms the basis of green economic development through energy transition. The research conducted by Abbas et al. (2024) provides an in-depth assessment of worldwide energy developments because it shows both fossil fuel reserve restrictions and the need for alternative energy resources. The authors demonstrate that renewable and alternative energy sources function as essential elements for environmental problem resolution because they need extensive financial backing and technological advancements. The shift to sustainable energy systems functions as an environmental requirement and an economic challenge because it needs joint policy development with financial backing and institutional resources. The study shows that hydrogen-based energy systems and other emerging technologies will help society reach its sustainability objectives while showing that innovation will serve as the main factor for achieving long-term sustainability.

Natural resource management practices are directly linked to environmental sustainability through their impact on water scarcity and environmental degradation. The researchers Khan et al. (2025) explore the water stress causes in Pakistan, which include ecological footprint, carbon emissions, industrialization, and energy consumption. The study uses time series analysis with autoregressive distributed lag models to show that industrialization and environmental degradation cause increased water stress, while rainfall and forest area function as natural factors that reduce water stress. The research demonstrates how economic activities interact with environmental resources through complex pathways, thus showing the requirement for combined policy methods to solve sustainability problems. Economic growth leads to environmental damage, which results in resource loss that stops development, according to the study.

Overall, existing literature establishes the importance of institutional quality and energy transition; however, limited attention has been given to corruption control as a distinct institutional mechanism within a dynamic econometric framework. The research based on green economic growth has developed, while critical research gaps continue to exist. The first studies investigate a specific region or country, which prevents researchers from applying their results to other locations and leads to unreliable worldwide findings. The second problem exists because there are no complete green economic growth measurement systems that assess environmental costs through various environmental degradation elements that include water shortages, forest loss, and pollution emissions. The majority of research

studies depend on individual environmental indicators, which fail to show the complete picture of environmental sustainability. The research about institutional quality has received extensive study, but environmental impacts from corruption distribution mechanisms have not received sufficient research attention. Researchers study corruption through its connection to governance systems, but they need to analyze corruption as a separate element that affects green economic growth. Researchers need to develop improved empirical methods because current studies use outdated research techniques, which limit their findings. Our research about how corruption mechanisms function as a specific institutional element needs to be studied more through advanced research methods, which assess their impact over time. This study needs to fill these particular gaps because they help create complete knowledge about green economic growth while developing efficient policy methods that create sustainable development.

3. Theoretical Framework

The green growth framework establishes new production-environment relationships because it treats ecological costs as internal components of development instead of treating them as external effects, which traditional growth models use to evaluate development progress. Environmental issues like climate change, biodiversity loss, and pollution proved that traditional growth models needed development through resource-intensive growth to achieve their goals (Johnson & Villumsen, 2020; Marc & Ali, 2023). Wang et al. (2019) explain that the transition to green economic growth brings about a fundamental change that forces all economic activities to work toward achieving environmental sustainability goals. The environmental policy outcome of green economic growth through its fundamental transformation establishes a new system that achieves economic efficiency and social inclusion together with ecological balance. The organization needs to direct its resources toward cleaner technologies, renewable energy systems, and sustainable production processes while it deals with the socio-economic problems of poverty and inequality. Economies need to change from their current linear extractive practices to circular efficiency-based systems, which depend on technological advancement and institutional coordination to create this transformation. Green economic growth functions as a dynamic equilibrium when economic growth occurs within environmental boundaries, which organizations and policies handle through their management systems (Ali & Audi, 2016; Marc & Ali, 2018; Ali et al., 2021; Johnson & Villumsen, 2020).

The management system depends on institutional quality, which uses corruption mechanisms to determine its transformation efficiency and

direction. Institutions control environmental policy effectiveness, which depends on their capacity to develop environmental policies and execute their implementation process and environmental cost enforcement (Heyes, 2000; Marc & Ali, 2016; Ali et al., 2021; Steinebach, 2022). Corruption damages the process because it weakens enforcement power and creates resource distribution problems while it establishes undesired environmental practices. The system uses corruption control methods to create better transparency and accountability while establishing policy trustworthiness, which leads to improved economic-environmental goal alignment. Institutional frameworks directly affect green growth, and they also affect green growth through energy transition, investment flow, and resource management. The two studies show that renewable energy adoption with digital integration leads to better environmental performance, which assists sustainable development, and institutional differences between countries lead to different levels of green growth (Degbedj et al., 2024). Institutional development shows non-linear effects on environmental outcomes when the multidimensional nature of institutions, which includes legal, governmental, and cultural elements, leads to environmental effects (Zhou et al., 2021; Ali et al., 2022). The effectiveness of foreign direct investment toward environmental outcomes depends on the quality of institutions, which decides whether capital inflows will lead to positive environmental results or environmental damage (Yan et al., 2024). The connection between governance and renewable energy use shows how corruption control acts as a crucial element for countries to achieve their energy transition goals (Rahman et al., 2022). Energy system transformation (Abbas et al, 2024) and environmental resource constraints (Khan et al, 2025) show how economic systems, institutional systems, and environmental systems are interconnected. Theoretical and empirical frameworks show that corruption functions as a minor factor in governance systems, whereas it operates as an essential environmental impact mechanism. Green economic growth models require researchers to integrate corruption dynamics from theoretical modeling because endogeneity, persistence, and structural heterogeneity are critical in global dynamic environments (Tawiah et al., 2024; Qorraj et al., 2025).

The endogenous growth framework serves as an appropriate analytical foundation to establish the theoretical connection between institutional dynamic processes and environmental sustainability (Pittel, 2002; Yuan & Zhang, 2024). Endogenous growth theory shows that economic development requires internal factors, which include technological progress, institutional development, and human capital development, for its long-term growth. The institutional mechanisms of the system establish resource distribution rules,

policy implementation procedures, and incentive structure development through their corruption control systems. The framework integrates endogenous growth theory with institutional economics to explain how governance quality influences environmentally adjusted output through productivity channels. Following the insights of Chong and Gradstein (2007) and Gradstein (2007), the production structure can be represented through a modified Cobb–Douglas production function that incorporates institutional efficiency as a productivity-enhancing factor:

$$Y_{it}=A_{it}K^{\alpha}_{it}L^{\beta}_{it} \quad (1)$$

where Y_{it} represents output, K_{it} denotes capital, L_{it} represents labor, and A_{it} captures total factor productivity, which is assumed to be influenced by institutional quality, including the mechanism of corruption. Governance enhancements and corruption control improvements lead to productivity gains through their impact on transaction cost reductions, regulatory enforcement improvements, and resource distribution optimization. The framework expands its environmental elements through economic output calculations, which measure green economic growth by subtracting environmental damage costs from traditional output. Accordingly, the green economic growth function can be expressed as:

$$GEG_{it}=GDPC_{it}-(WS_{it}+NFD_{it}+PE_{it}) \quad (2)$$

where GEG_{it} denotes green economic growth, $GDPC_{it}$ represents gross domestic product per capita, WS_{it} is water scarcity, NFD_{it} is net forest depletion, and PE_{it} denotes particulate emissions. This formulation internalizes environmental externalities into economic output, providing a more accurate representation of sustainable development (Lin & Zhou, 2022). Building on this theoretical structure, the empirical model specifies green economic growth as a function of institutional quality and a set of control variables reflecting broader economic conditions:

$$GEG_{it}=\beta_0+\beta_1COR_{it}+\beta_2X_{it}+\varepsilon_{it} \quad (3)$$

where COR_{it} represents the control of corruption, X_{it} is a vector of control variables including foreign direct investment, population growth, trade openness, and poverty rate, and ε_{it} is the error term. To enhance interpretability and address potential non-linearity, the model can be expressed in log-linear form:

$$ln(GEG_{it})=\beta_0+\beta_1ln(COR_{it})+\beta_2ln(FDI_{it})+\beta_3ln(POP_{it})+\beta_4ln(TRADE_{it})+\beta_5ln(POV_{it})+\varepsilon_{it} \quad (4)$$

Furthermore, recognizing that green economic growth is inherently dynamic and exhibits persistence over time, a dynamic specification is introduced to capture adjustment processes:

$$GEG_{it}=\gamma GEG_{it-1}+\beta_1COR_{it}+\beta_2X_{it}+\mu_i+\lambda_t+\varepsilon_{it} \quad (5)$$

where GEG_{it-1} represents the lagged dependent variable, μ_i captures country-specific fixed effects, and λ_t represents time effects reflecting global shocks and environmental agreements. The inclusion of lagged dependent variables captures persistence and adjustment dynamics inherent in environmental-economic systems. This dynamic formulation is consistent with endogenous growth theory, as it allows for path dependency and gradual adjustment in environmental and economic outcomes.

In addition, to explicitly account for potential endogeneity between institutional quality and green economic growth, the model can be extended within a System Generalized Method of Moments framework:

$$GEG_{it}=\gamma GEG_{it-1}+\beta_1 COR_{it}+\beta_2 X_{it}+\varepsilon_{it},\ with\ instruments\ Z_{it} \quad (6)$$

where lagged levels and differences of the explanatory variables serve as internal instruments to address simultaneity bias. This approach ensures consistent estimation in the presence of reverse causality and omitted variable bias, which are common in cross-country panel data analyses.

The study uses a balanced panel dataset that includes data from 141 countries between 1996 and 2024 for its empirical analysis. The World Bank provides the data used in this study. Researchers gain multiple advantages from panel data methodology because it enables them to deal with country-specific hidden differences while they achieve better results through larger datasets and advanced modeling methods, which combine country data with time-based institutional changes. The System Generalized Method of Moments estimator is employed to address endogeneity, simultaneity, and dynamic panel bias. Empirical analysis is conducted using Stata 13 MP, which supports advanced panel econometric estimation.

4. Results and Discussions

The section presents research findings together with their analysis through two static and dynamic testing methods. The study used fixed effect, random effect, and panel ARDL and GMM methods for its empirical assessment. The fixed effects model estimation results shown in Table 1 present how green economic growth changes across different countries through time. The corruption mechanism shows a positive relationship with green economic growth, which achieves statistical significance because better governance leads to enhanced environmental outcomes for countries. The study shows that better corruption control systems lead to improved regulatory enforcement, which decreases operational waste and enables more efficient environmental resource management to achieve sustainable development goals. Governing systems operate as vital components that enable economic activities to achieve their environmental conservation goals according to the research evidence (de Oliveira et al., 2013; Ogunkan, 2022).

The study found that trade openness increases green economic growth, but the statistical evidence shows only a weak connection between the two variables. The trade agreements between countries enable them to access advanced technology and eco-friendly production techniques, which require environmental laws to achieve their maximum benefits. The research findings demonstrate that trade activities do not lead to environmental benefits because their implementation requires additional institutional policies, which transform trade activities into sustainable results through natural resource protection (Fischer, 2010; Bringezu et al., 2016; Chen et al., 2024). The existence of poverty creates social barriers that prevent people from achieving environmental sustainability, and this relationship between poverty and green economic growth proves significant through statistical analysis. The economic situation of poor people prevents countries from spending money on green technologies and environmental conservation activities because they must first satisfy their present economic requirements. The ongoing natural resource extraction activities, which poor people depend on for their survival, create environmental damage that decreases the pace of green economic growth (Reilly, 2012; Qamruzzaman & Karim, 2024; Abbas et a., 2024).

Table 1 analysis establishes that foreign direct investment does not exhibit a statistically significant effect, suggesting that its environmental impact depends on regulatory quality. The study results demonstrate that foreign capital investments will only lead to environmental sustainability improvements when investors choose to finance projects in environmentally protective sectors (Falcone, 2020; Jiang et al., 2025). The lack of effective regulatory systems allows foreign investments to finance projects that harm the environment, demonstrating that governance quality directly affects investment results. The study proved that population growth leads to environmental deterioration because growing populations reduce environmental protection capacity in green economies. The increasing population creates greater natural resource needs and environmental service demands, which leads to overexploitation that produces environmental damage (Scherr, 1997; Lead et al., 2005; Khalil et al., 2024). The study shows that population dynamics prevent communities from successfully adopting green conversion methods because they lack proper environmental planning and resource management systems.

Table 1: ***Fixed Effects Model***

Dependent Variable: Green Economic Growth

Variables	Coefficient	Std. Error	t-Statistic	p-value
Mechanism of Corruption Percentile	0.104	0.123	0.85	0.005
Trade	0.069	0.053	1.30	0.195
Poverty Rate	-0.427***	0.157	-2.72	0.007
FDI	0.017	0.026	0.63	0.526
Population Growth	-3.410*	1.894	-1.80	0.072
Constant	54.191***	13.939	3.89	0.000

Author's Calculation: *** and * indicate 1 % and 5 % of significant level.
Countries; 141and R^2 (Within): 0.0166.

The random effects model estimation results presented in Table 2 demonstrate how research outcomes from different countries show the environmental variations originating from their green economic growth differences. The corruption mechanism shows positive results with high significance, which demonstrates that institutional quality functions as an essential factor that determines environmental sustainability. Countries with strong governance systems and effective corruption prevention methods achieve higher green economic growth because their institutional systems enable them to implement environmental protection measures and sustainable resource management policies (Li & Tong, 2024). The results show that trade openness produces a positive yet slightly significant result, which indicates that global market integration might lead to environmental benefits under specific circumstances. Trade enables the distribution of cleaner technologies and environmentally friendly production methods, according to the results, yet these advantages can only occur if domestic institutions maintain their strength (Marchi et al., 2013). The relationship between trade openness and environmental impacts shows that environmental damage occurs when effective governance does not exist, which establishes a conditional connection between the two factors.

The random effects model analysis shows that the poverty rate displays a negative relationship with green economic growth through its statistically significant results. The evidence demonstrates that poverty functions as a fundamental structural barrier that prevents countries from financing sustainable technology development and environmental protection programs (Ayoo, 2022). The two models produced the same results, which demonstrate that poverty must be reduced to achieve environmental sustainability in the long term. The results show that foreign direct investment retains its

statistical insignificance, which confirms that this investment does not produce environmental benefits. The regulatory framework and institutional framework of host nations determine how foreign investment affects their green economic growth. Foreign investment fails to deliver sustainable results because investors will not comply with environmental requirements (Wang et al., 2025). The random effects model shows that population growth positively correlates with green economic growth, according to its statistically significant results, which differ from the fixed effects results. The difference shows how country-specific factors produce different outcomes from factors that affect multiple countries. Countries with higher population growth experience expanded markets, together with increased labor resources and heightened economic output, which enables them to finance green investments when their institutional and technological frameworks are properly established (Dutz & Sharma, 2012).

Table 2: ***Random Effect Model***

Variables	Coefficient	Std. Error	z-Statistic	p-value
Mechanism of Corruption Percentile	0.156***	0.033	4.66	0.000
Trade	0.029*	0.016	1.84	0.065
Poverty Rate	-0.156**	0.071	-2.19	0.029
FDI	0.000	0.021	0.02	0.984
Population Growth	1.563**	0.785	1.99	0.047
Constant	0.483	5.229	0.09	0.926

Author's Calculation: *** and * indicate 1 % and 5 % of significant level.

The Hausman specification test results are shown in Table 3, which helps choose between fixed effects and random effects panel estimation methods. The test results demonstrate strong evidence against the null hypothesis, which states that the estimators do not show systematic differences because the random effects model produces inconsistent results. The results show that unobserved country-specific characteristics become linked to the explanatory variables because they specifically relate to how corruption functions, which breaks the fundamental principle that underpins the random effects model. The study needs fixed effects model results because this method produces superior and more reliable estimation results. The theoretical justification for this selection exists because institutional variables like corruption control show country-specific characteristics that become linked to unobserved structural elements of governance traditions, regulatory systems, and socio-political systems. The random effects model becomes invalidated because the

model needs to include additional unobserved factors, which create distorted measurements of the complete connection between the two measured variables. The results show that researchers need to analyze the positive connection between the mechanism of corruption and green economic growth under the random effects model cautiously because it may stem from unexamined cross-country differences instead of actual causal relations. The fixed effects model establishes that domestic development through time provides stronger evidence that demonstrates the improved corruption control results in enhanced environmental outcomes. The finding shows that institutional quality determines how green economic growth develops, while the study's empirical method successfully demonstrates its validity.

Table 3: ***Table Hausman Test***

$Chi^2(6)$	=	33.50
Prob > chi^2 =		0.000

The fixed effects estimation showed its results in Table 4, which used country-clustered robust standard errors and year fixed effects to handle worldwide economic fluctuations during specific time periods. The specification establishes enhanced result reliability through its ability to handle three types of statistical issues, which include heterogeneous variance, serial correlation, and time-invariant unobserved factors, while the study itself tracks common global environmental, technological, and macroeconomic development patterns. The model shows improved performance through its temporal control mechanisms, which enable it to better track green economic development patterns within individual countries (de Oliveira et al., 2013; Ogunkan, 2022).

Corruption mechanism as a determinant, which shows a positive relationship that reaches at least a basic significance level with green economic growth, which confirms that institutional quality functions as an essential factor driving environmental performance outcomes. The results show that improved governance, together with corruption control measures, results in better execution of environmental regulations, which leads to fair resource distribution and complete sustainability policy adherence. The relationship stays constant because advanced estimation techniques still show that institutional reforms lead to lasting green economic development in all nations. The study demonstrates that trade openness produces a negative effect, which remains statistically insignificant because trade operations inside countries do not influence green economic development. The finding shows that trade activities produce uncertain environmental effects because countries that increase their trade will either obtain cleaner technologies or face environmental protection losses according to their existing regulatory

systems. The result establishes a connection with the pollution haven hypothesis, which states that trade expansion will cause environmental damage when countries lack proper environmental regulations instead of achieving sustainable development results (Fischer, 2010; Bringezu et al., 2016; Chen et al., 2024).

The green economic growth relationship with poverty rate shows a negative impact, which exhibits weak statistical validity yet confirms its role as a fundamental barrier to environmental sustainability achievement. Economies must delay their green technology investments and environmental protection efforts because the high poverty rate makes essential resource needs critical for survival. The general theoretical perspective holds that people with lower income levels demonstrate less ability to achieve environmental progress, which results in their delayed movement toward sustainable development pathways. The results found that foreign direct investment lacks statistical significance because it does not establish any link between its existence and green economic growth. The examination found that capital inflows require targeted allocation toward green sectors, which need institutional support to achieve environmental sustainability outcomes. Foreign investment will not lead to cleaner production methods when countries lack proper environmental rules, which shows that governance practices determine how investment deals develop (Falcone, 2020; Jiang et al., 2025). The research shows that green economic growth decreases with population growth, but this effect does not reach statistical significance because demographic changes within a country do not directly affect environmental performance according to this model (Reilly, 2012; Qamruzzaman & Karim, 2024; Abbas et a., 2024). The research shows that population pressure causes natural resource demand increases, but green economic growth depends on technological progress, urban planning, and institutional capacity development (Scherr, 1997; Lead et al., 2005; Khalil et al., 2024). The results show that demographic factors cannot explain the changes in green economic growth rates for different countries.

Table 4: ***Final Fixed Effects Model (Clustered SE & Year Dummies)***

Variables	Coefficient	Robust SE	t	p-value
Mechanism of Corruption Percentile	0.105*	0.054	1.95	0.053
Trade	-0.068	0.064	-1.07	0.285
Poverty Rate	-0.209*	0.112	-	0.064

			1.86	
FDI	-0.002	0.012	-0.14	0.892
Population Growth	-1.108	1.427	-0.78	0.439

Author's Calculation: *** and * indicate 1 % and 5 % of significant level.

The dynamic specification shown in Table 5 uses lagged explanatory variables to investigate whether past institutional and structural conditions cause delayed effects on present green economic growth. The method enables researchers to observe how governance systems, socio-economic elements, and environmental results maintain their intertemporal links and persistent connections throughout time. The corruption lag mechanism establishes a positive link with green economic growth, which lacks statistical significance because prior governance advancements fail to produce measurable environmental benefits in the present. The results show that corruption control mechanisms primarily through present-day effects, which institutional advancements create direct impacts on green economic outcomes for the current fiscal period (El Maachi et al., 2025). Theoretical expectations predict a specific direction, but the statistical insignificance shows that institutional reforms need continual enforcement and reinforcement to sustain their effects, which will result in lasting impacts. The lagged poverty rate demonstrates a statistically significant negative impact on green economic growth because structural constraints maintain their strength throughout time. Past poverty conditions continue to harm present environmental results because socio-economic restrictions produce long-lasting effects on environmental outcomes. Higher poverty levels in earlier times limit available funds for sustainable technology and environmental protection investments, which creates a barrier to green growth in future periods. Poverty serves as an immediate obstruction because it operates as a continuous element that hampers progress to sustainable development thus demonstrating the necessity for ongoing poverty reduction initiatives that will enable environmental sustainability (Kamoun et al., 2020; Imran et al., 2021).

Table 5: ***Lagged Effect on The Green Economic Growth***

Variables	Coefficient	Robust SE	p-value
Mechanism of Corruption (t-1)	0.077	0.061	0.211
Poverty Rate(t-1)	-0.318***	0.114	0.006

Author's Calculation: *** and * indicate 1 % and 5 % of significant level.

Table 6 displays the Variance Inflation Factor values, which were calculated for all regression explanatory variables to determine the existence of multicollinearity. The Variance Inflation Factor assesses how much estimated coefficient variance increases because of linear correlation between regression variables, which mathematically is expressed as $VIF_j=1/1-R^2_j$, where R^2_j represents the determination coefficient that results from regressing each explanatory variable against all other independent variables (Craney & Surles, 2002; O'brien, 2007).

The poverty rate exhibits the highest Variance Inflation Factor among the regressors; however, its value remains within acceptable limits, indicating that it is not strongly correlated with other explanatory variables. The model shows poverty as a separate structural element that exists because socioeconomic constraints remain unexplained through other macroeconomic or institutional indicators. The estimated effect, which impacts green economic growth, possesses a reliable interpretation because collinearity factors do not interfere with its measurement.

The corruption mechanism shows a low variance inflation factor, which demonstrates that it has weak linear relationships with trade, foreign direct investment, and population growth. The model shows that institutional quality functions as an independent element that exists because corruption control serves as its surrogate measurement. The variable maintains stability, which reinforces the reliability of its estimated relationship with green economic growth because it does not share explanatory power with other regressors.

Population growth shows a relatively low Variance Inflation Factor, suggesting that demographic dynamics are only weakly correlated with other economic and institutional variables. The model establishes population growth as a distinctive factor that enables it to demonstrate environmental resource pressure and sustainability outcomes. The low collinearity property prevents interactions with other explanatory factors from creating bias in the estimated effect.

The trade and foreign direct investment sectors display very low variance inflation factor values, which show that there are no multicollinearity issues. The model demonstrates complete independence between both variables, which means they lack major explanatory connections with any other regressors. The estimated effects of the model on green economic growth remain unaffected by variance inflation, which establishes the model specification as robust. The variance inflation factor of the regression model stays below critical thresholds, which enables the model to fulfill its multicollinearity requirements. The estimation reveals that the standard

errors have not been raised because of the linear interrelationship between explanatory variables. The model preserves its strong identification capabilities, which allows coefficient estimates to function as stable and dependable elements for inference.

Table 6: ***Multicollinearity (VIF Method)***

Variables	VIF
Poverty Rate	1.99
Control of Corruption	1.81
WBLINDEX	1.73
Population Growth	1.47
Trade	1.18
FDI	1.05
Mean VIF	1.54

Author's Source:

The ARDL-style fixed effects model results shown in Table 7 display short-term green economic growth patterns and their related persistence and delayed development. This model helps researchers to differentiate between immediate and long-term effects of institutional and structural factors on environmental performance. The lagged dependent variable shows a positive relationship with green economic growth, which has statistical significance because it proves that environmental performance shows dynamic persistence. The results demonstrate that past green economic growth levels create positive effects on current performance because economic systems develop through path dependency and gradual adjustment. The findings show that environmental performance improvements become permanent over time because green growth transitions develop through continuous policy and structural transformations (Razzaq et al, 2023; Cevik & Jalles, 2024).

The corruption mechanism demonstrates a positive relationship with statistical insignificance according to this dynamic specification because better governance theoretically should lead to better environmental results, but its immediate effects appear to be weakly pronounced. The institutional improvements will achieve better results in the long term because immediate changes will not deliver effective outcomes as governance reforms need time to produce effects on regulatory systems, compliance behavior, and environmental investments. The finding supports the idea that corruption control helps sustainability through structural mechanisms that operate across time instead of showing immediate effects (Tacconi & Williams, 2020; Meyer et al., 2026). The World Bank institutional indicator demonstrates a positive and statistically significant association with green economic growth, highlighting the broader role of institutional effectiveness beyond corruption

control alone. The result shows that better governance quality, more effective regulatory frameworks, and stronger institutional capacity lead to improved environmental results. The variable demonstrates its significance because sustainable growth requires complete institutional development instead of only implementing individual governance initiatives.

The poverty rate displays a direct relationship with green economic growth, which establishes it as a structural obstacle that prevents progress. People living in poverty create financial barriers that stop them from making environmental investments while they need to spend their resources on their present-day needs (Hollander, 2003; Ehresman & Okereke, 2015). The research shows that poverty reduction programs need to happen before communities can develop sustainable environmental systems because social progress and environmental health depend on each other. The results show that population growth creates a positive effect that reaches statistical significance, thus showing that demographic expansion can drive green economic growth under specific circumstances. The larger population size enables people to work more and generate greater economic activity, which creates a bigger market for sustainable technology and infrastructure investments (Mahmood et al. 2025). The positive effect depends on two requirements, which include strong institutional frameworks and efficient resource management, because population growth will create environmental pressure when governance is weak systems do not exist.

The findings of Table 7 demonstrate that green economic growth exhibits dynamic persistence while institutional and structural variables create different effects during the initial period of their existence. Governance quality functions as a positive factor, yet it delivers only minor short-term benefits, while institutional effectiveness and socio-economic factors, including poverty and population changes, serve as major determinants of environmental results. The research indicates that green economic growth results from continuous dynamic changes and existing structural factors, rather than short-term policy changes that operate in isolation.

Table 7: ***ARDL Style Fixed Effects Model***

Variables	Coefficient	Robust SE	p-value
Green Economic Growth t-1	0.091**	0.042	0.029
Control of Corruption	0.071	0.128	0.579
WBLI	0.021	0.117	0.03
Poverty Rate	-0.412**	0.172	0.018
Population Growth	3.437**	1.395	0.015

Author's Calculation: *** and * indicate 1 % and 5 % of significant level.

Table 8 presents Generalized Method of Moments (GMM) estimation results, which demonstrate their capability to handle three challenges that emerge in research about institutional quality and green economic growth. The method proves effective for panel data analysis because the dependent variable maintains consistent patterns of behavior, and reverse causality exists between governance indicators and environmental outcomes. The model achieves parameter estimation through internal instruments that use lagged values to maintain consistent and unbiased results. The lagged dependent variable green economic growth displays a positive and statistically significant result, which proves that environmental performance shows strong dynamic persistence as a fundamental trait. The significance of the lagged dependent variable confirms the presence of dynamic persistence in green economic growth. Current green economic growth levels stem from past green economic growth levels, which demonstrates the existence of path dependency that previous model specifications showed (Lee & He, 2022). The result remains consistent across fixed effects and ARDL models, which means that green economic growth undergoes a stable adjustment process that develops throughout time without sudden shifts.

The GMM framework shows that corruption mechanisms positively relate to green economic growth with a strong and crucial effect. The results provide strong evidence that when researchers control for endogeneity, corruption control improvements lead to better environmental results. Institutional quality improves environmental resource management through its effects on policy execution and regulatory enforcement (Oteng-Abayie et al., 2022). The dynamic estimation of this variable shows that governance functions as a fundamental driver that creates green economic growth through its role in governing, instead of existing between static models that established permanent links between the two variables. The poverty rate continues to demonstrate a negative and statistically significant association with green economic growth, even after accounting for endogeneity and dynamic effects (Tacconi & Williams, 2020; Meyer et al., 2026). Economies need to transition toward sustainable development because poverty acts as a structural barrier that prevents this process from occurring. People living in poverty will spend less money on green technologies and environmental protection activities because they will need to use more resource-intensive methods to stay alive (Hollander, 2003; Ehresman & Okereke, 2015). Environmental policy frameworks require socio-economic disparity solutions, which this finding demonstrates as essential according to all model specifications (Mahmood et al. 2025).

Overall, GMM shows the strongest econometric proof because it provides complete evidence of institutional quality, which includes corruption control mechanisms as evidence that institutional quality determines green economic growth under dynamic relationship testing and endogeneity testing. The presence of poverty as a persistent obstacle shows that sustainable environmental results demand both effective governance systems and economic development approaches that include all citizens.

Table 8: ***System Generalized Method of Moments (Instruments Reduced)***

Variables	Coefficient	Robust SE	p-value
Green economic growth (t-1)	0.091**	0.042	0.029
Mechanism of Corruption	0.146***	0.023	0.000
Poverty Rate	-0.135***	0.050	0.007

Author's Calculation: *** and * indicate 1 % and 5 % of significant level.

5. Conclusion and Policy Implications

5.1. Conclusions

The study examines how corruption mechanisms impact green economic growth among developing 141 countries by using both static and dynamic panel econometric methods. The empirical strategy establishes a strong foundation to determine the structural factors that drive green economic growth in countries across the world through dynamic scientific research. The results show that corruption mechanisms have a major structural effect on environmental performance. The static estimations show small effects for within-country analysis, but dynamic results show that corruption control significantly affects green economic growth after researchers resolved both endogeneity and reverse causality issues. The results demonstrate that institutional quality drives sustainability through its impact on long-term governance systems, while short-term policy changes have no effect. The results show that green economic growth demonstrates dynamic persistence because environmental performance development relies on previous environmental achievements, which determine current environmental performance. The process of enhancing environmental sustainability requires continuous institutional and policy implementation efforts because progress occurs through incremental steps. The continuing harmful impact of poverty functions as a permanent obstacle that blocks all sustainable development efforts according to all model specifications. Countries with high poverty rates face fiscal limitations that obstruct their capacity to adopt advanced technologies and invest in environmental projects needed for sustainable development. Different models demonstrate trade openness and foreign direct

investment effects that arise from specific environmental conditions. The combination of trade and environmental technology transfer, together with market access improvements, creates environmental benefits, which face challenges because trade weakens institutional controls to operate pollution-intensive manufacturing processes. The process of sustainable development requires foreign direct investment to focus on environmentally sustainable industries, while complete regulatory systems provide necessary support. Environmental pressure increases from population growth because more people lead to more serious environmental damage, but the environmental effects depend on how well cities manage their resources through their urban planning and institutional resource management systems. The research results show that green economic growth depends on institutional quality, which operates through its corruptive mechanisms and is influenced by the existing economic structures of the nations. Environmental sustainability requires multiple policy interventions to be implemented together with a governance framework that connects environmental management with economic development and governance systems. Environmental sustainability depends on institutional reliability because it supports accountability processes and regulatory enforcement activities while also making resource distribution more effective.

5.2. Policy Implications

The study provides empirical evidence that demonstrates that green economic growth requires an integrated approach that combines institutional reforms with comprehensive economic and structural policy development. Environmental sustainability develops when economic measures operate together with governance systems, regulatory frameworks, and socioeconomic conditions. The research shows that institutional integrity, together with poverty reduction, trade regulation, and investment governance, should function as the essential elements of a sustainability system.

The first, to enhance environmental governance, requires countries to establish better institutional systems that include better mechanisms to stop corrupt practices. Corruption mitigation failures lead to two major problems, which include decreasing adherence to regulations and creating obstacles for environmental licensing and enabling the unlawful use of natural resources. The institutional reforms should focus on two goals, which include establishing independent anti-corruption institutions and granting these institutions operational independence and financial autonomy.

The second, solving poverty problems is necessary for society to move toward green economic development. The research demonstrates that poverty functions as an unbreakable systemic obstacle that stops economies from

allocating funds towards the development of sustainable technologies and the preservation of environmental resources. Environmental policies need to establish connections with development strategies that reach out to all social groups.

The third is for countries to establish trade policies that support their environmental goals because this approach enables them to use trade partnerships for sustainable green economic development. Trading activities enable the international spread of clean technology systems, yet without effective governance systems, trade activities result in increased pollution through carbon-intensive production methods. Multilateral and bilateral trade agreements must include environmental standards, while trade activities require stronger monitoring systems to verify environmental compliance.

Fourth, governments need to create regulations that guarantee that foreign direct investment operations will decrease their negative environmental impacts. The research shows that foreign investment can either help or harm green economic growth because existing regulations already determine how foreign investment operates in specific regions. The government needs to promote green foreign direct investment into renewable energy projects together with sustainable infrastructure developments and environmentally friendly industrial operations.

The fifth, governments need to create environmental policy frameworks, which include both demographic trends and urbanization patterns. The rising population demands more natural resources, which leads to environmental damage in areas that experience fast urban development. Urban planners need to create environmentally friendly cities through their work on public transit systems, which will help reduce their environmental footprint.

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