International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2025, 15(6), 667-679.

Drivers Influencing Green Growth in ASEAN Countries: The Role of Corruption Control, Foreign Direct Investment, Energy Consumption, and Financial Development

Lam Dinh Mai[1], Oanh Kim Thi Mai[2], Tran Thai Ha Nguyen[3]*

[1]Faculty of Socio-Economic Development Management, Academy of Public Administration and Governance - Ho Chi Minh City Campus, Ho Chi Minh City, Vietnam, [2]Department of Training Administration, Ho Chi Minh City Cadre Academy, Ho Chi Minh City, Vietnam, [3]Department of Science, Technology and International Projects, Ho Chi Minh City University of Economics and Finance, Ho Chi Minh City, Vietnam. *Email: hantt@uef.edu.vn

Received: 23 May 2025 **Accepted:** 26 September 2025 **DOI:** https://doi.org/10.32479/ijeep.20903

ABSTRACT

This study analyzes the impact of control of corruption, foreign direct investment, energy consumption, and financial development on green growth in ASEAN countries during the period 2002-2021. Applying panel data with feasible generalized least squares regression and quantile regression, the results show that control of corruption and financial development positively impact green growth. In contrast, foreign direct investment negatively and inconsistently impacts green growth. Quantile regression results show that the positive impacts of control of corruption and financial development are more pronounced in countries with high green growth. In contrast, foreign direct investment shows a substantial negative impact at high quantiles, implying the need to be more cautious with foreign direct investment projects during green growth aims. Factors such as population growth, urbanization level, service sector value added, and forest area all have negative impacts in most quantiles, emphasizing the urgency of effectively managing these factors to ensure sustainable green growth. Based on the empirical results, policy implications are recommended for ASEAN countries and emerging nations.

Keywords: Corruption, Foreign Direct Investment, Energy Consumption, Financial Development, Green Growth, Association of Southeast Asian Nations

JEL Classifications: D78, G21, Q43, Q50

1. INTRODUCTION

Climate change and environmental degradation pose serious challenges to sustainable development. International agreements such as the Paris Agreement and the 2030 Sustainable Development Goals (SDGs) have emphasized the importance of balancing economic development and environmental protection (Basheer et al., 2022). While the SDGs targets are specified in 17 global development goals to be achieved by 2030 (Soretz et al., 2023), the Paris Agreement aims to strengthen national capacity to respond to the impacts of climate change (Feng et al., 2022). Therefore, countries around the world have been making efforts to shift to a green growth model, to ensure efficient use of resources and reduce negative impacts on the environment without slowing down economic growth (Fernandes et al., 2021; Lin et al., 2024). In this context, the Association of Southeast Asian Nations (ASEAN) region emerges as a highlight because it is one of the regions with high economic growth rates (Mohd Suki et al., 2022), but is heavily dependent on fossil energy and the third largest emitter of greenhouse gases in the world (Mohd Suki et al., 2022) and its energy demand is expected to increase by 80% by 2035 (Nathaniel and Khan, 2020). Furthermore, the ASEAN region is considered vulnerable to the impacts of climate change (Overland et al., 2021). Therefore, balancing growth and maintaining environmental sustainability becomes one of the important goals of this region on the path towards sustainable development, highlighting the need for green growth in the whole region.

However, the journey towards green growth is not only dependent on economic and technological factors but also influenced by institutional factors, among which corruption plays an important role (Tawiah et al., 2024; Gu et al., 2024; Tao et al., 2023; Zhou et al., 2021). Corruption, defined as the abuse of power for private gain, can negatively impact the environment and growth by weakening environmental protection regulations and creating barriers to resource management (Triatmanto and Bawono, 2023). However, this relationship is not yet fully understood, especially in the context of each country with different economic and institutional characteristics. Economic and environmental theory indicates that corruption can affect green growth through various mechanisms. On the one hand, corruption can undermine environmental protection policies, reduce the stringency of environmental regulations, lead to inefficient use of resources, and increase pollution (Pei et al., 2021; Wu et al., 2021). On the other hand, some studies suggest that corruption can have positive effects in specific contexts. Specifically, corruption can help "lubricate" the system in countries with bureaucratic and inefficient administrative systems, helping businesses quickly overcome bureaucratic barriers to implement environmental projects (Méon and Weill, 2010; Mendoza et al., 2015).

Some studies also suggest that the relationship between corruption and green growth may not be straightforward but rather depends on factors such as the level of financial development, foreign direct investment, or primary energy consumption (Le et al., 2024; Bello et al., 2024; Nguyen et al., 2023; Emako et al., 2022; Ahmad et al., 2022; Quang and Thao, 2022). According to the *"pollution halo hypothesis,"* foreign direct investment encourages the application of environmentally friendly technology, improves environmental quality, and supports the development of renewable energy (Apergis et al., 2023; Mert and Caglar, 2020). According to the *"pollution haven hypothesis,"* some foreign direct investment recipient countries tend to relax environmental regulations to attract investment, leading to the relocation of polluting industries from developed countries to less developed countries (Ashraf et al., 2022; Faheem et al., 2022; Aust et al., 2020). Increased production to meet foreign direct investment demand may increase fossil fuel consumption, leading to higher CO_2 emissions and environmental degradation (Le et al., 2024; Emako et al., 2022). In some developing countries, foreign direct investment is mainly concentrated in resource extraction and heavy industry, increasing the depletion of natural resources and environmental pollution (Pan et al., 2025). In this context, an unclear question is whether corruption facilitates foreign direct investment by lowering environmental standards, thereby undermining the country's green growth, while foreign direct investment continues to flow in. This is similar to the debate surrounding the role of financial development. On the positive side, financial institutions can support businesses in transitioning to sustainable production through green credit, green bonds, and environmentally friendly investment funds (Ahmad et al., 2022; Quang and Thao, 2022). However, the expansion of credit and investment can lead to overexploitation of resources and increased consumption of fossil fuels, thereby exacerbating CO_2 emissions (Sun et al., 2023; Ma and Fu, 2020). Financial instruments can be misused in the context of corruption, thereby hindering the country's green growth.

Although green growth has become a priority and has attracted the attention of many scholars and policymakers, there are still significant gaps in the research. Most previous studies have focused on the relationship between corruption and environmental pollution rather than considering green growth, a factor that combines growth and the environment (Sohag et al., 2019; Arzova and Şahin, 2024). In addition, several studies have shown that the impact of corruption on green growth may differ between developed and developing countries, but none have yet looked specifically at the regional context. As such, ASEAN is an interesting choice for studying green growth due to its combination of positive growth and high levels of environmental degradation. The results of this study aim to provide important empirical evidence for policy makers, especially in the ASEAN region.

This study thus adds to the literature on the impact of corruption on green growth in the ASEAN context by identifying the mechanisms by which corruption, financial development, foreign direct investment, or energy consumption can affect green growth policies. Specifically, the study seeks to answer the following research questions:
- How do corruption, financial development, foreign direct investment, and energy consumption affect green growth in ASEAN countries?
- How do corruption, financial development, foreign direct investment, and energy consumption influence green growth within the quantile context?

This study contributes its novelty in both theoretical and methodological aspects. Unlike previous studies that focused on the direct relationship between corruption and environmental pollution, this study expands the theoretical perspective by taking a deeper look at the relationship between corruption control and green growth, a concept that harmoniously combines economic development and environmental protection. The following contribution of this study lies in combining economic factors such as foreign direct investment, primary energy consumption, and financial development into the same analytical model, thereby clarifying the specific mechanisms by which these factors affect green growth. This study applies quantile regression (QR) and feasible generalized least squares (FGLS) methods, helping to clarify the heterogeneous impacts according to different levels of green growth in the ASEAN region; hence, they address potential issues of heteroskedasticity and autocorrelation common in panel datasets, enhancing the reliability and validity of the empirical results. In addition, the study uses an extended spatial and temporal dataset (2002-2021), increasing the generalizability and practical value of the results, thereby providing solid empirical evidence to help policymakers propose more specific and effective solutions in promoting green growth in the ASEAN region. Apart from the introduction, the rest of the study is organised as follows: (ii) theoretical overview, (iii) data and research methods, (iv) results and discussion, (v) conclusions and limitations.

2. LITERATURE REVIEW

2.1. Corruption and Green Growth

Green growth is an economic development model that combines economic growth and environmental protection, aiming at sustainable development (Javed et al., 2024). This model not only helps improve environmental quality but also optimizes resource use and benefits humans (Tawiah et al., 2024). Thus, green growth plays an important role in supporting the implementation of the SDGs, especially those related to sustainable economic growth (SDG 8), clean energy (SDG 7), sustainable cities (SDG 11), responsible production and consumption (SDG 12), and climate action (SDG 13). This is because green growth not only requires innovation and enhances greener manufacturing for economic growth, but also creates sustainable employment opportunities, improves the quality of life and reduces environmental risks, thereby ensuring the long-term development of countries (Teklie and Yağmur, 2024; Sarkodie et al., 2023). However, the ability to effectively implement green growth policies depends not only on economic and technological factors but is also significantly affected by institutional quality and the level of corruption control (Gu et al., 2024; Tao et al., 2023; Zhou et al., 2021). While transparency is demonstrated through accessible information and transparent mechanisms, which fosters accountability and strengthens public trust in institutions (Liu and Lyu, 2024), corruption undermines sustainability by distorting resource allocation, discouraging investment, and weakening public confidence in institutions (Triatmanto and Bawono, 2023). Corruption can occur at many levels, from grand corruption, which undermines confidence in governance and destabilises the economy, to petty corruption, which affects individual citizens in different sectors such as health, education, police, and public administration (Goutte et al., 2022; Beesley and Hawkins, 2022).

According to previous theoretical approaches, corruption was often considered to cause economic growth through two opposing views. The "sand the wheels" theory argues that corruption weakens institutions, hinders economic growth, and reduces labour productivity because it increases the cost of doing business and reduces the competitiveness of the economy (Rodrik et al., 2004; Méon and Sekkat, 2005). Many empirical studies have confirmed the negative impact of corruption on economic growth, such as Gründler and Potrafke (2019) with data from 175 countries from 2012 to 2018, Yuan and Ishak (2022) with data from five ASEAN countries (Singapore, Malaysia, Thailand, Indonesia, and the Philippines) or Spyromitros and Panagiotidis (2022) with data from 83 developing countries from 2012 to 2018. In contrast, the "grease the wheels" theory argues that in some cases, corruption can help bypass bureaucracy and promote growth, especially in countries with weak institutions (Leff, 1964; Leys, 1965). Several studies support this view, including Kaufmann and Wei (2000), Jiang and Nie (2014), and Sundarasen et al. (2024), who argue that under certain conditions, corruption can help businesses quickly access resources and develop. However, most studies argue that controlling corruption is the optimal solution to promote economic growth.

Recently, corruption has been connected with sustainability through two approaches: (i) The approach to corruption (institutional quality) with pollution, and (ii) the approach to corruption (institutional quality) with green growth represented by many different measures. Most previous studies have often focused on the relationship between corruption and environmental degradation. Indeed, corruption weakens the effectiveness of environmental policy enforcement, reduces the ability to control pollution, and exacerbates the degradation of natural resources (Pei et al., 2021; Wu et al., 2021). Supporting this argument, Hao et al. (2021) studied the impact of corruption on environmental projects in China from 2000 to 2018 using panel data analysis. The results show that corruption reduces the efficiency of capital allocation for environmental projects, causing many green projects to stall or operate inefficiently due to budget leakage. Similarly, Zhou et al. (2023) argued that the anti-corruption policy in China since 2013 contributed to reducing pollution emissions from enterprises through the toughening effect of environmental regulations. In addition to weakening environmental regulations, corruption also diverts the purpose of government and citizens for environmental projects, increasing project risks and negative environmental and societal impacts (Lapatinas et al., 2019; Williams and Dupuy, 2017). Conversely, a minor number of studies have shown that in countries with less effective systems, corruption can act as a 'lubricating' mechanism, helping firms quickly access resources and overcome bureaucratic obstacles (Méon and Weill, 2010; Mendoza et al., 2015; Bologna and Ross, 2015). For example, Van Hung and Doanh (2025) assessed the impact of corruption on environmental quality in 163 countries over the period 2005-2020, and they found that control of corruption had a significant positive impact on the environment in high- and middle-income countries, but this impact was not statistically significant in low-income countries. Meanwhile, Sulemana and Kpienbaareh (2020) showed that increased corruption leads to poorer air quality (PM2.5), but corruption was negatively associated with CO_2 emissions in both Africa and the OECD.

Hence, while most recent studies focus on the relationship between corruption and pollution, research on corruption and green growth remains very limited. Some recent studies include Yang et al. (2024), found evidence of a positive impact of institutional quality on green growth in South Asian countries over the period 1990-2021 using CS-ARDL, where green growth is measured by adjusted net savings and institutional quality is measured by ICRC's composite risk scores aggregate the political, financial, and economic. Using the green energy development and corruption index assessed by WGI, Gu et al. (2024) found that increased corruption will reduce green energy deployment in six East Asian economies over the period 1995-2021. Using the OECD green growth index, Tawiah et al. (2024) also found that corruption reduces green growth in 123 countries over the period 2000-2017 using system GMM and TSLS methods but found no differences between developing and developed countries. Liu and Lyu (2024) also provided similar results for 21 emerging economies during 2010-2021 with green growth index measurements based on green energy deployment, carbon footprint, R&D expenditure, and imports of green components. Despite different approaches to green growth, most studies support the role of corruption control in the journey to sustainable development.

2.2. Foreign Direct Investment and Green Growth

Previous studies have acknowledged that foreign direct investment plays an important role in promoting economic growth, especially in developing countries (Le et al., 2024; Emako et al., 2022; Demir and Lee, 2022). However, the impact of foreign direct investment on green growth - a development model that combines economic growth and environmental protection - remains lacking. Most previous studies focus on the relationship between foreign direct investment and the environment with two opposing views: (i) Foreign direct investment can help reduce pollution through the transfer of clean technology and promote pollution control systems from developed countries to host countries - "pollution halo hypothesis" (Apergis et al., 2023; Mert and Caglar, 2020) and (ii) foreign direct investment can increase emissions and resource degradation because host countries often have lower environmental standards and increase resource exploitation for economic growth purposes - "pollution haven hypothesis" (Ashraf et al., 2022; Faheem et al., 2022; Aust et al., 2020). Previous studies have provided diverse results around these hypotheses. While studies supporting foreign direct investment attraction mostly focus on economic aspects, such as the studies by Le et al. (2024) in 90 middle-income countries from 1990 to 2020 with dynamic-system GMM, Choi and Kim (2024) with 93 countries from 1981 to 2020 using a two-stage least squares (2SLS) estimation, or Emako et al. (2022) in 19 developing countries over the period 2005-2018 with 2steps-system GMM; studies supporting restricting foreign direct investment inflows due to its harmful effects on the resource, environmental degradation, and sustainable development of the receiving country such as the studies by Sreenu (2025) for OECD and BRICS nations from 2000 to 2003, Padhan and Bhat (2024) with BRICS and Next-11 economies during the period of 1992-2018, or Aust et al. (2020) in 44 African countries over the period from 2014 to 2017. Whether studies support or restrict foreign direct investment inflows, one thing to acknowledge is that considering foreign direct investment through the lens of environment or economic growth cannot bring comprehensive implications.

Recent approaches try to connect foreign direct investment with green growth, implying a balance between economic growth and environmental protection. For example, Caetano et al. (2022) argued that foreign direct investment is a driver of green growth, but it is only achieved through energy transition, especially in developing countries. Based on data from 23 African countries for the period 2000-2020 and dynamic GMM estimation, Ofori et al. (2023) found that foreign direct investment hinders green growth while energy efficiency promotes green growth. However, Wani et al. (2024) find a positive role of foreign direct investment on green growth in both the long-run and short-run for the G7 countries from 1995 to 2020 using the CS-ARDL method and Westerlund cointegration test. Using the GMM method combined with Bayesian regression, Bui and Doan (2024) also found evidence for the positive support of foreign direct investment inflows to green GDP of 6 ASEAN countries, but depending on the level of financial development. Despite the efforts, gaps in this relationship still exist and need to be filled. The differences in green growth measures and the paucity of studies in the ASEAN context are key points that need to be addressed in this paper.

2.3. Energy Consumption and Green Growth

Energy consumption plays an important role in promoting production and consumption, then enhancing economic growth and human development (Bello et al., 2024; Nguyen et al., 2023; Sumaira and Siddique, 2023). In the context of moving towards green growth, the issue of energy consumption has become a focus in research and policy-making; however, its impact is still controversial. On the one hand, many studies have shown that energy consumption, especially from fossil fuels, is closely related to environmental degradation and climate change (Voumik et al., 2023; Eregha et al., 2022). In developing countries, dependence on this energy source increases greenhouse gas emissions and aggravates pollution problems. Bekun (2024) found that fossil energy consumption had a negative impact on environmental sustainability in South Africa over the period 1975-2020, similar to the results of Bello et al. (2024) for ASEAN countries over the period 1981-2022, and the results of Achuo et al. (2022) for 173 countries over the period 1996-2020 with an emphasis on particularly negative effects in developing countries. Furthermore, in some cases, renewable energy is not effective in reducing emissions due to technological limitations and intermittency in energy supply (Menyah and Wolde-Rufael, 2010). For instance, Nguyen et al. (2024a) found that renewable energy consumption reduces CO_2 emissions, especially in countries with low per capita CO_2 emissions, but is ineffective in countries with high per capita emissions when considering a sample of 115 countries. In addition, the high investment costs of renewable energy can put significant financial pressure on developing economies, slowing down the sustainable energy transition (Mensah et al., 2019).

On the other hand, energy consumption – primarily based on clean energy – can contribute positively to green growth by improving labour productivity, promoting industrialisation, and supporting sustainable economic development (Aquilas et al., 2024; Chou et al., 2023; Mentel et al., 2022; Kebede and Heshmati, 2020). The transition from fossil fuels to renewables reduces greenhouse gas emissions and contributes to building a low-carbon economy (Bello et al., 2024; Nguyen et al., 2022; Mohsin et al., 2021). Using a mediator in economic growth, Nguyen et al. (2024b) found that both renewable and non-renewable energy have effects on ecological footprint; however, renewable energy consumption in developing countries can contribute to reducing ecological degradation. In addition, improving energy efficiency can help reduce overall energy consumption without affecting economic growth rates while supporting more sustainable economic models (Akram et al., 2020; Emir and Bekun, 2018). For example, Aquilas et al. (2024) provided empirical evidence that fossil fuel consumption can still provide economic growth without significant environmental harm in 46 African countries during the period 2000-2022. Furthermore, Qiu et al. (2022) emphasise that effective energy governance - through improving institutional quality and promoting technological innovation - can play an important role in supporting green growth.

Thus, energy consumption is one of the factors that determine the level of green growth in a country. Besides the debate on whether to switch to renewable energy at significant costs to protect the environment, another important challenge is to optimize energy efficiency to minimize environmental impacts while maintaining economic growth. This is particularly important for ASEAN countries where energy transformation and resource efficiency are being pushed to achieve green growth (Qiu et al., 2022).

2.4. Financial Development and Green Growth

While green growth refers to the combination of growth and environmental protection (Hao et al., 2021), financial development becomes a positive factor by supporting investment in green technology, optimising capital allocation (Ahmad et al., 2022; Quang and Thao, 2022), and promoting innovation, or becomes a negative factor by promoting fossil energy consumption and unsustainable resource exploitation (Sun et al., 2023; Ma and Fu, 2020). On the one hand, financial development makes it easier for companies to access capital to invest in renewable energy, clean production technology, and more efficient resource management systems (Alshagri et al., 2024; Akpanke et al., 2024). Financial development can also facilitate the development of green financial instruments, such as green bonds, sustainable investment funds, and clean energy financing mechanisms (Tang et al., 2024). These instruments help mobilise capital from private investors to finance environmentally friendly projects, thereby supporting green growth more effectively. A study by Jianguo et al. (2022) on 37 OECD countries from 1998 to 2018 found that developed financial markets have the potential to reduce CO_2 emissions due to increased green investment. In addition, the development of the financial system can help optimise resource allocation, thereby reducing waste and improving energy efficiency. Enterprises with access to preferential capital for energy-saving and clean technology projects tend to shift their business models to be more environmentally friendly. Therefore, Zhao et al. (2023) concluded that financial development supports green growth to varying degrees when studying the case of China from 1994 to 2020, similar to the study of Yang et al. (2024) for South Asian countries from 1990 to 2021, and Arzova and Şahin (2024) for 15 emerging countries from 1995 to 2019.

On the contrary, there are also studies that suggest that financial development leads to increased environmental pollution (Mukhtarov et al., 2024; Qin et al., 2021; Boufateh and Saadaoui, 2020). Credit expansion can encourage unsustainable exploitation of natural resources, encouraging businesses to focus on short-term profits instead of investing in sustainable innovation (Zhuo and Qamruzzaman, 2022; Liu et al., 2022). Although this may promote economic growth at the expense of the environment, financial development is believed to undermine the green growth of the economy (Pan et al., 2021; Mardani et al., 2019). For example, Li et al. (2015) argue that when financial development exceeds a certain level, economic growth begins to decline with the increase of environmental degradation, at which point environmental improvement priorities are prioritised to sustain economic growth. Tran (2023) implies that high- and middle-income countries should promote green financial policies to maintain environmental quality and economic growth by studying 148 economies over the period 1990-2019. Overall, previous studies acknowledge that financial development is an important tool to promote green growth, although the empirical results remain controversial.

2.5. Gaps and Hypotheses

Despite the growing body of research on green growth, there are still several gaps in the ASEAN context. First, the relationship between control of corruption and green growth has not been thoroughly explored, especially in terms of how control can promote sustainable development. This is quite different when considering the relationship between control of corruption and growth, as green growth needs to ensure both growth and environmental protection. Second, foreign direct investment can support green growth through the transfer of clean technology, but can also increase pollution, and its impact in the ASEAN region is not yet clear. Third, energy consumption, especially from fossil fuels, can hinder green growth, but the role of energy consumption in green growth in ASEAN has not yet been fully explored. Finally, financial development can support green investment but also risks promoting unsustainable resource exploitation, so further research on the impact of finance on green growth in the region is needed. This poses a new approach when considering the relationship between corruption control and other economic factors to green growth, in which corruption control plays an important role. Therefore, the hypothesis of this study is as follows:

- Hypothesis 1: Controlling corruption has a positive impact on green growth.
- Hypothesis 2: Foreign direct investment has a positive impact on green growth.
- Hypothesis 3: Energy consumption has a negative impact on green growth.
- Hypothesis 4: Financial development has a positive impact on green growth.

3. DATA, METHOD, AND ECONOMETRIC MODELS

3.1. Data

The research sample includes the countries of the ASEAN region for the period from 2002 to 2021 due to the availability of green growth and corruption data. After missing data issues were dealt with, the final sample consisted of an unbalanced panel dataset covering 11 countries, with 202 observations over the 2002-2021 period. Given corruption's complexity and difficulty in direct measurement, the study employs several proxy indicators obtained from reputable global databases. First, the Control of Corruption Index (COR_W), developed by Kaufmann et al. (2011) for the World Bank, measures perceptions of corruption through the misuse of public power; its values range between −2.5 (high corruption) and +2.5 (low corruption). Second, the Corruption Perceptions Index (COR_T), provided by Transparency International, reflects expert and business perceptions of corruption, scored from 0 (high corruption) to 100 (low corruption). Third, the Bayesian Corruption Index (COR_B), from the Quality of Government Institute Data, is derived from opinions collected via 20 diverse surveys from NGOs, companies, and officials. Similar to COR_T, it ranges from 0 to 100, where higher values indicate greater corruption. To ensure consistency with the other corruption indices, COR_B scores are inverted; hence, higher adjusted values indicate higher corruption control (lower corruption). Economic data is derived from available databases, such as the World Development

Indicators, Worldwide Governance Indicators from the World Bank, and Our World Data.

3.2. Method

This study employs quantile regression due to its robustness, flexibility, and ability to capture heterogeneity across different quantiles of the dependent variable. While traditional methods like OLS regression are widely used in previous studies, QR is chosen for this research due to its greater flexibility, robustness to outliers, and ability to capture heterogeneous effects across different quantiles of the dependent variable. Typically, OLS regression estimates the conditional mean of the dependent variable given a set of independent variables. However, this approach assumes a normal distribution and homoscedasticity of residuals, which may not always hold in empirical data (Gujarati et al., 2017). In contrast, QR estimates the conditional quantiles, allowing for a more detailed examination of the distributional effects of economic variables on green growth, which is particularly advantageous in situations where the relationship between variables is not uniform across different levels of the dependent variable (Koenker and Bassett, 1978; Hao and Naiman, 2007). For instance, the effect of corruption, financial development, or energy consumption on green growth may vary among countries. It is particularly useful in policy analysis, as it helps identify which economies are most affected, allowing for more targeted and effective policy implications. Hence, QR enhances the findings' reliability, robustness, and interpretability, making it the most appropriate method for this study.

Let y_i represents the dependent variable (green growth) and X_i shows the vector of independent variables (economic variables). According to Koenker and Bassett (1978), the conditional quantile function is specified as:

$$Q_\tau(Y_k \mid X_k) = X_k\beta_\tau + \varepsilon_k \quad (1)$$

In Equation (1), $Q_\tau(Y_k \mid X_k)$ represents the τ-th quantile of the dependent variable ($\tau \in (0,1)$), X_k is the matrix of independent variables, β_τ is the vector of quantile-specific regression coefficients, and ε_k is the error term. To estimate β_τ, the quantile regression estimators for a chosen quantile τ minimize the following objective function:

$$\min_{\beta \epsilon R^K} \left\lfloor \sum_{k:y_k\, x_k\beta} \tau \left|y_k - x_k\beta\right| + \sum_{k:y_k < x_k\beta} (1-\tau)\left|y_k - x_k\beta\right| \right\rfloor \quad (2)$$

Equation (2) represents the optimization problem for QR, and R presents the dimensions of the independent variables (K). It assigns differential weights to residuals based on their position relative to the quantile regression line: observations below the line receive a weight of τ and observations above receive a weight of $1-\tau$. To estimate the standard errors of the QR coefficients, the covariance matrix $\hat{V}(\hat{\beta}_\tau)$ is computed as:

$$\hat{V}(\hat{\beta}_\tau) = \frac{\tau(1-\tau)}{\Gamma}\left[\frac{1}{\Gamma}\sum_{k=1}^{\Gamma} x_k x_k^{'}\right]^{-1}\frac{1}{f_{\varepsilon^\tau}(0)^2} \quad (3)$$

In Equation (3), $f_{\varepsilon^\tau}(0)^2$ is the density function of the error terms at the τ-th quantile (Hao and Naiman, 2007). The standard error of a coefficient is the square root of the respective diagonal entry of this covariance matrix.

3.3. Econometric Models

This study develops a research model to examine the impact of corruption and economic variables on green growth, presented as follows:

$$\begin{aligned} Green\ growth_{it} &= \beta_0 + \beta_1 * Corruption_{it} \\ &+ \sum_{m=2}^{4} \beta_m Economic\ variable_{it} \\ &+ \sum_{n=1}^{4} \gamma_n Control\ variable_{it} + \varepsilon_{it} \end{aligned} \quad (4)$$

where green growth is based on the measurement framework proposed by Sohag et al. (2019) and Arzova and Şahin (2024). A nation achieves green growth – positive, sustainable economic growth – by ensuring the efficient use of renewable resources while accounting for the damage caused by greenhouse gas effects, natural resource exploitation, and other negative externalities. Precisely, if we set *GRG* represents a country's green growth; *GDP* denotes gross domestic product; *EDU_EXP* refers to education expenditure; *NRE* accounts for the depletion of coal, crude oil, natural gas, and other minerals; *NFD* indicates forest depletion; and CO_2 reflects emissions-related damage, hence green growth is calculated using the following formula:

$$GRG = GDP + EDU\_EXP - NRE - NFD - CO_2 \quad (5)$$

The primary objective of this research is to analyze how corruption and economic variables influence to green growth, hence Equation (4) is rewritten as:

$$\begin{aligned} GRG_{it} &= \beta_0 + \beta_1 * COR_{it} + \beta_2 * FDI_{it} \\ &+ \beta_3 * ECG_{it} + \beta_4 * FD_{it} \\ &+ \sum_{n=1}^{4} \gamma_n Control\ variable_{it} + \varepsilon_{it} \end{aligned} \quad (6)$$

In this study, 3 proxies are used to present the corruption controlling (*COR*), including the control of corruption index (*COR_W*), the corruption perceptions index (*COR_T*), and the Bayesian corruption index (*COR_B*). Economic variables that influence green growth include foreign direct investment (*FDI*), measured as the ratio of net investment inflows to GDP; energy consumption (*ECG*), measured as the growth of primary energy consumption (TWh); financial development (*FD*), measured as total domestic credit outstanding from banks as a percentage of GDP; meanwhile control variables include urban population ratio (*URB*); population growth rate (*POPG*); service sector value added (*SERV*), as a percentage of GDP; and forest area (*FRA*), as a percentage of total land area (Tawiah et al., 2024; Raihan and Tuspekova, 2022; Sohag et al., 2019). Table 1 below details the variables used in equation (6).

4. RESULTS AND DISCUSSIONS

4.1. Results

The following section details the empirical results obtained with a dataset of Southeast Asian countries for the period 2002-2021.

In Table 2, GRG has an average value of 24.98 with a standard deviation of 1.87, ranging from 19.96 to 27.80. The mean value of CORR_T is 38.1089 (standard deviation = 20.2445), with Myanmar having the highest (13) and Singapore having the lowest corruption level (94), corresponding to their COR_T. Similarly, the mean value of COR_B is 51.3704 (standard deviation = 18.5553), with Indonesia having the highest (33.7093) and Singapore having the lowest corruption level (100), corresponding to their COR_B. The final proxy for corruption (COR_W) has a mean value of −0.2872 (standard deviation = 0.9864), with Myanmar having the highest (−1.6728) and Singapore having the lowest corruption level (2.3011), corresponding to their COR_W. FDI averages 5.29 but has a large variation (standard deviation 6.92), ranging from −32.96% to 32.39%. FD averages 57.40% of GDP with a high standard deviation (43.89%), ranging from 0% to 166.24%, and ECG has an average value of 6.03%, a large standard deviation (10.57%), with a wide range from −33.66% to 70.09%.

Table 3 analyzes the impact of different corruption indices (COR_T, COR_B, and COR_W) on green growth (GRG). All three corruption indices demonstrate a significant positive effect at the 1% significance level, with regression coefficients of 0.0196 (COR_T), 0.0230 (COR_B), and notably more significant at 0.3211 (COR_W). These findings suggest that improving perceptions and control of corruption substantially benefits green growth. FDI variable exhibits a slight negative impact across all three models, with coefficients of −0.0184 ($P = 0.054$), −0.0166 ($P = 0.071$), and −0.0174 ($P = 0.069$), respectively. These results indicate that the influence of FDI on green growth is unstable and only marginally statistically significant. Additionally, the ECG variable consistently shows no significant impact in any regression model, with very small and statistically insignificant coefficients: 0.0013 ($P = 0.658$), 0.0024 ($P = 0.408$), and 0.0015 ($P = 0.643$). In contrast, FD demonstrates the most robust and positive influence on green growth, with highly significant coefficients ranging from 0.0180 to 0.0182 ($P < 0.01$), emphasizing its critical role in supporting green growth in ASEAN countries. Other control variables, including urban population (URB), forest area (FRA), and population growth rate (POPG), exhibit significant negative impacts on green growth, highlighting the importance of these factors in policy considerations.

The normality test in Table 4 shows that the GRG variable does not follow a normal distribution, as shown by the very small P-values ($P < 0.01$) in the Shapiro-Wilk, Shapiro-Francia and Doornik-Hansen tests, reinforcing the choice of QR instead of OLS.

In Tables 5-7, quantile regression is employed to examine the impact of corruption and other control variables on green growth across various quantiles (0.1, 0.25, 0.5, 0.75, 0.9). The results consistently indicate that corruption indices positively influence GRG. Specifically, the corruption perception index (COR_T) demonstrates a significant and stable positive effect, with coefficients ranging from 0.0219 ($P < 0.01$) at lower quantiles to 0.0964 ($P < 0.01$) at the highest quantile (0.9). Likewise, the Bayesian corruption index (COR_B) presents a similar pattern, with positive coefficients ranging from 0.0217 to 0.0725, especially pronounced at the highest quantile (0.9, $P < 0.01$). Among these indices, the control of corruption index (COR_W) exhibits the strongest positive impact, with notably higher coefficients (0.3500-1.8100, $P < 0.01$) at higher quantiles.

Regarding other economic variables, FDI consistently shows a significant negative effect, particularly at the highest quantile (0.9), while the variable ECG does not show statistical significance in any quantile regression. Conversely, FD exhibits a consistently significant positive impact at lower to middle quantiles (0.1-0.75) but becomes insignificant at the highest quantile (0.9). Comparing these findings with Table 3 (FGLS regression), the directions of impact remain consistent. Corruption indices consistently indicate a positive impact on GRG across both QR and FGLS regressions. However, QR provides further insight into the pronounced negative effect of FDI at higher GRG quantiles, a nuance not fully captured by the FGLS approach. The stability of FD's positive influence across

Table 1: Variables, measures, and sources

Variable	Measures	Source
GRG	Calculated by the suggestion of Sohag et al. (2019) and Arzova and Şahin (2024): $GRG=GDP+EDU\_EXP-NRE-NFD-CO_2$	Calculated from data in world development indicators
COR	Control of corruption (COR_W): Corruption measurement as part of governance indicators, ranging from+2.5 to−2.5	Worldwide governance indicators
	Corruption perceptions index (COR_T): Perception-based measurement of corruption, which ranges between 0 and 100	Transparency international
	Bayesian corruption (COR_B): The corruption index also ranges between 0 and 100	The quality of government institute data
FDI	The net inflow of foreign direct investment as a percentage of GDP	World development indicators
ECG	The growth of consumption of primary energy per year	World our data
FD	The domestic credit by banks as a percentage of GDP	World development indicators
URB	The urban population as a percentage of the total population	World development indicators
POPG	The growth of the total population per year	World development indicators
SERV	The net value added of the service sector as a percentage of GDP	World development indicators
FRA	The forest area as a percentage of the total land	World development indicators

Source: authors

Table 2: Statistical descriptions

Variable	Obs	Mean	Standard deviation	Min	Max
GRG	202	24.982	1.874	19.960	27.798
COR_T	202	38.109	20.244	13.000	94.000
COR_B	202	51.370	18.553	33.709	100.000
COR_W	202	−0.287	0.986	−1.673	2.301
FDI	202	5.287	6.917	−32.955	32.390
ECG	202	6.032	10.574	−33.659	70.090
FD	202	57.398	43.894	0.000	166.240
URB	202	40.239	15.195	12.978	71.560
POPG	202	1.305	0.775	−4.170	5.322
SERV	202	47.386	13.019	0.000	72.140
FRA	202	48.492	15.949	21.435	74.449

Source: Authors

Table 3: FGLS estimation: GRG with corrections for autocorrelation and heteroskedasticity

Variable: GRG	COR: COR_T	COR: COR_B	COR: COR_W
COR	0.020***	0.023***	0.321***
	[5.53]	[5.98]	[4.58]
FDI	−0.018**	−0.017*	−0.017**
	[−1.92]	[−1.81]	[−1.82]
ECG	0.001	0.002	0.001
	[0.44]	[0.83]	[0.46]
FD	0.018***	0.018***	0.018***
	[12.73]	[13.04]	[12.26]
URB	−0.037***	−0.042***	−0.035***
	[−7.67]	[−8.27]	[−7.07]
POPG	−0.179***	−0.154***	−0.152***
	[−2.98]	[−2.75]	[−2.63]
SERV	−0.011	−0.010	−0.006
	[−1.63]	[−1.53]	[−0.82]
FRA	−0.032***	−0.031***	−0.030***
	[−6.30]	[−6.27]	[−5.88]
Const_	27.008***	26.582***	27.350***
	[59.88]	[61.55]	[54.26]
Wooldridge test for autocorrelation	342.886***	427.376***	402.608***
Modified wald test for heteroskedasticity	484.69***	1951.55***	471.71***

z statistics in [ ], and * P<0.1, ** P<0.05, ***P<0.01

Table 4: Normality tests and Multivariate normality for green growth

Skewness and Kurtosis tests for normality		
Pr (skewness)	**Pr (kurtosis)**	**P-value**
0.0001	0.210	0.001
Shapiro–Wilk W test for normal data		
W	**V**	**P-value**
0.9227	11.640	0.000
Shapiro–Francia W' test for normal data		
W'	**V'**	**P-value**
0.9256	12.214	0.000
Doornik-Hansen for multivariate normality		
chi2 (2)		**P-value**
49.074		0.000

Source: authors

methods further supports its robust relationship with GRG, while ECG remains consistently insignificant.

Other control variables, such as URB, exhibit a strong negative impact primarily at lower and middle quantiles, becoming weaker at higher quantiles. POPG most prominently shows a clear negative influence at the median (0.5) and high (0.9) quantiles. SERV demonstrates its strongest negative effects at both low (0.1) and very high (0.9) quantiles, whereas FRA consistently maintains a significant negative influence across all quantiles. Overall, the quantile regression analysis effectively clarifies how each variable's impact varies according to the specific quantile level of green growth.

4.2. Discussions

The results from Tables 3 and 5-7 show a consistent positive relationship between COR and GRG. This aligns with previous research indicating that better corruption control improves institutional quality, enhances resource allocation, and promotes environmental protection, thus supporting green growth (Teklie and Yağmur, 2024; Gu et al., 2024). These findings also support the "sand the wheels" theory, which argues that corruption negatively affects sustainable development, being consitent to Gründler and Potrafke (2019) and Yuan and Ishak (2022). Meanwhile, the regression results show that FDI exhibits a primarily negative and significant effect on GRG. This outcome contradicts the original hypothesis but aligns with the "pollution haven hypothesis," suggesting FDI may increase environmental degradation due to weaker environmental standards in host countries (Ashraf et al., 2022; Faheem et al., 2022; Aust et al., 2020). The impact of FDI varies across different quantiles, particularly showing stronger negative effects at higher green growth levels. This suggests countries with higher green growth may be more vulnerable to environmental degradation from foreign investments. Previous studies have also reported mixed outcomes, with some indicating FDI supports clean technology and environmental improvements (Wani et al., 2024; Bui and Doan, 2024), while others highlight negative environmental impacts (Ofori et al., 2023; Caetano et al., 2022).

FD consistently demonstrates a significant positive relationship with GRG in almost all regression models, especially prominent at lower quantiles. These results support prior findings that financial development encourages investment in clean technology and sustainable infrastructure (Jianguo et al., 2022; Zhao et al., 2023). However, the reduced significance at higher quantiles may indicate limited additional benefits for countries already experiencing high green growth. Literature has previously suggested that excessive financial development might lead to resource overuse and environmental damage if resources are not effectively allocated (Mukhtarov et al., 2024; Qin et al., 2021). The regression analyses do not show a significant impact of ECG on GRG. Although existing studies highlight both positive and negative impacts of energy consumption depending on the energy source (Bello et al., 2024; Nguyen et al., 2023), the findings here indicate possible complexities or offsetting effects from renewable and fossil fuels in ASEAN countries. Future research should analyze different energy sources separately to clarify these relationships.

In addition, the regression results from the tables clearly show the significant negative impact of the control variables POPG,

Table 5: QR estimation: GRG with corruption perception index (COR_T)

Variable: GRG	0.1	0.25	0.5	0.75	0.90
COR_T	0.0261**	0.0318***	0.0219***	0.0274**	0.0964***
	[−2.49]	[−2.64]	[−4.31]	[−2.28]	[−13.56]
FDI	0.0007	−0.0414	−0.0145	−0.0405	−0.1088***
	[−0.03]	[−1.24]	[−1.03]	[−1.22]	[−5.52]
FD	0.0261***	0.0229***	0.0196***	0.0157***	0.0021
	[−6.61]	[−5.06]	[−10.26]	[−3.49]	[−0.80]
URB	−0.0543***	−0.0251	−0.0439***	−0.0368**	−0.0349***
	[−3.86]	[−1.56]	[−6.43]	[−2.28]	[−3.65]
POPG	−0.0894	−0.2692	−0.3231***	−0.2683	−0.8962***
	[−0.47]	[−1.23]	[−3.49]	[−1.23]	[−6.94]
SERV	−0.0263*	−0.0562***	−0.0334***	−0.0213	−0.1371***
	[−1.92]	[−3.58]	[−5.04]	[−1.36]	[−14.80]
ECG	−0.006	−0.0061	−0.0067	−0.0037	−0.0126
	[−0.43]	[−0.38]	[−0.99]	[−0.23]	[−1.33]
FRA	−0.0522***	−0.0596***	−0.0397***	−0.0298**	−0.0615***
	[−4.18]	[−4.16]	[−6.57]	[−2.09]	[−7.27]
Constant	27.1242***	29.0169***	28.9196***	28.0162***	35.4800***
	[−29.80]	[−27.79]	[−65.57]	[−26.93]	[−57.56]
Observations	202	202	202	202	202

t statistics in [ ], and *P<0.1, **P<0.05, ***P<0.01

Table 6: QR estimation: GRG with Bayesian corruption index (COR_B)

Variable: GRG	0.1	0.25	0.5	0.75	0.90
COR_B	0.0344***	0.0339***	0.0217***	0.0267*	0.0725***
	[−2.74]	[−2.61]	[−3.37]	[−1.82]	[−3.98]
FDI	−0.0026	−0.0332	−0.024	−0.0275	−0.1073**
	[−0.09]	[−1.05]	[−1.53]	[−0.77]	[−2.43]
FD	0.0246***	0.0233***	0.0205***	0.0171***	−0.0057
	[−6.03]	[−5.51]	[−9.74]	[−3.57]	[−0.96]
URB	−0.0540***	−0.0306*	−0.0438***	−0.0428**	−0.0171
	[−3.55]	[−1.94]	[−5.60]	[−2.40]	[−0.77]
POPG	−0.0519	−0.0813	−0.2258**	−0.2301	−0.4786*
	[−0.27]	[−0.40]	[−2.25]	[−1.01]	[−1.69]
SERV	−0.0237*	−0.0564***	−0.0324***	−0.0179	−0.0678***
	[−1.72]	[−3.96]	[−4.58]	[−1.11]	[−3.40]
ECG	−0.0062	−0.0054	−0.0066	−0.0036	−0.0327
	[−0.42]	[−0.36]	[−0.88]	[−0.21]	[−1.54]
FRA	−0.0455***	−0.0563***	−0.0423***	−0.0262*	−0.0347*
	[−3.52]	[−4.20]	[−6.35]	[−1.73]	[−1.85]
Constant	26.0069***	28.1940***	28.5794***	27.3715***	30.2063***
	[−27.33]	[−28.59]	[−58.41]	[−24.54]	[−21.88]
Observations	202	202	202	202	202

t statistics in [ ], and *P<0.1, **P<0.05, ***P<0.01

URB, SERV, and FRA on GRG. Specifically, population growth and urbanization put great pressure on the environment, while the expansion of the service sector can be accompanied by high energy consumption, limiting green growth. Forest areas are urgently required for ASEAN countries to integrate forest exploitation with sustainable development effectively. This requires policies on population management, urbanization, sustainable service development, and forest protection to be integrated into sustainable development strategies towards green growth.

5. CONCLUSION AND IMPLICATIONS

The study analyzes the impact of control of corruption, foreign direct investment, energy consumption, financial development, and control variables such as population growth, urbanization, service sector value-added, and forest cover on green growth in ASEAN countries over the period 2002-2021. The results of using panel data and applying feasible generalized squares regression and quantile regression methods show that control of corruption and financial development positively impact green growth. In contrast, foreign direct investment has a slight and inconsistent negative impact, while population growth, urbanization, service sector expansion, and forest cover loss significantly impact green growth. Quantile regression results add a more detailed perspective, showing that the positive impacts of control of corruption and financial development are more pronounced in countries with high levels of green growth. In contrast, foreign direct investment shows the strongest negative impact at higher quantiles, suggesting that greater caution is needed with large foreign direct investment

Table 7: QR estimation: GRG with control of corruption index (COR_W)

Variable: GRG	0.1	0.25	0.5	0.75	0.90
COR_W	0.4616**	0.5116**	0.3500***	0.4850**	1.8100***
	[−2.31]	[−2.12]	[−3.51]	[−2.20]	[−7.55]
FDI	0.0005	−0.0116	−0.0243*	−0.0365	−0.1660***
	[−0.02]	[−0.36]	[−1.82]	[−1.24]	[−5.17]
FD	0.0277***	0.0246***	0.0200***	0.0160***	−0.0012
	[−7.67]	−5.63	−11.08	−4.04	[−0.29]
URB	−0.0351***	−0.0287*	−0.0380***	−0.0373***	−0.0029
	[−2.73]	[−1.85]	[−5.91]	[−2.64]	[−0.19]
POPG	−0.0406	−0.0521	−0.2359***	−0.2238	−0.5967***
	[−0.23]	[−0.25]	[−2.71]	[−1.17]	[−2.85]
SERV	−0.0294**	−0.0593***	−0.0240***	−0.0145	−0.0922***
	[−2.31]	[−3.86]	[−3.78]	[−1.04]	[−6.04]
ECG	0.0012	−0.0088	−0.0068	−0.0069	−0.0133
	[−0.09]	[−0.57]	[−1.06]	[−0.48]	[−0.86]
FRA	−0.0500***	−0.0525***	−0.0387***	−0.0257**	−0.0581***
	[−4.35]	[−3.77]	[−6.72]	[−2.03]	[−4.20]
Constant	27.3422***	29.7492***	29.0455***	28.6448***	36.2311***
	[−28.35]	[−25.52]	[−60.25]	[−26.97]	[−31.29]
Observations	202	202	202	202	202

t statistics in [ ], and *P<0.1, **P<0.05, ***P<0.01

projects in the context of green growth. Factors such as population growth, urbanization level, value added of the service sector, and forest area all maintain strong negative impacts at most quantiles, emphasizing the urgency of effectively managing these factors to ensure sustainable green growth.

Based on the research results, the following policy implications are proposed: First, ASEAN countries need to strengthen anti-corruption policies to create a transparent environment and promote efficient use of resources towards green development. Corruption control should be strengthened through the development of transparent institutions, enhanced accountability, and strict monitoring measures to optimize the efficiency of green investment. This suggestion is necessary regardless of whether the country is at a low or high level of green growth. Second, it is necessary to be cautious in attracting foreign direct investment, prioritizing foreign direct investment projects towards clean and sustainable technology to limit negative environmental impacts, especially in countries with high green growth rates. Building and applying strict environmental policies when attracting FDI, focusing on selecting environmentally friendly investment projects, and limiting polluting industries are necessary when considering foreign direct investment flows. Third, financial development policies need to focus on supporting more green investment projects while at the same time, taking advantage of financial development to expand green financial funds and preferential credit for businesses applying clean technology. Fourth, countries need to minimize population growth and urbanization while encouraging the development of services towards using clean energy to limit their negative impacts on green growth. Finally, effectively exploiting forest resources to ensure long-term ecological benefits, but still not reducing economic growth. Despite the findings, the study has some limitations. The limited data set within ASEAN countries may not fully reflect the region's different economic and institutional characteristics. Furthermore, using indicators to measure corruption and green growth may not capture the full complexity of these phenomena. Future studies should expand the geographic scope, consider a variety of indicators, and incorporate additional analysis of institutional and technological factors to draw more comprehensive and in-depth conclusions.

6. DATA AVAILABILITY STATEMENT

Data sources are reported in the methodology section. The data supporting this study's findings are available from the corresponding author (*) upon reasonable request.

REFERENCES

Achuo, E.D., Miamo, C.W., Nchofoung, T.N. (2022), Energy consumption and environmental sustainability: What lessons for posterity? Energy Reports, 8, 12491-12502.

Ahmad, M., Ahmed, Z., Bai, Y., Qiao, G., Popp, J., Oláh, J. (2022), Financial inclusion, technological innovations, and environmental quality: Analyzing the role of green openness. Frontiers in Environmental Science, 10, 851263.

Akpanke, T.A., Deka, A., Ozdeser, H., Seraj, M. (2024), Ecological footprint in the OECD countries: Do energy efficiency and renewable energy matter? Environmental Science and Pollution Research, 31(10), 15289-15301.

Akram, R., Chen, F., Khalid, F., Ye, Z., Majeed, M.T. (2020), Heterogeneous effects of energy efficiency and renewable energy on carbon emissions: Evidence from developing countries. Journal of Cleaner Production, 247, 119122.

Alshagri, R., Alsabhan, T.H., Binsuwadan, J. (2024), Investigating the role of financial development in encouraging the transition to renewable energy: A fractional response model approach. Sustainability, 16(18), 8153.

Apergis, N., Pinar, M., Unlu, E. (2023), How do foreign direct investment flows affect carbon emissions in BRICS countries? Revisiting the pollution haven hypothesis using bilateral FDI flows from OECD to BRICS countries. Environmental Science and Pollution Research, 30(6), 14680-14692.

Aquilas, N.A., Ngangnchi, F.H., Mbella, M.E. (2024), Industrialization and environmental sustainability in Africa: The moderating effects of renewable and non-renewable energy consumption. Heliyon, 10(4), e25681.

Arzova, S.B., Şahin, B.Ş. (2024), Macroeconomic and financial determinants of green growth: an empirical investigation on BRICS-T countries. Management of Environmental Quality: An International Journal, 35(3), 506-524.

Ashraf, S., Podikkalathil, J., Umar, Z. (2022), The asymmetric relationship between foreign direct investment, oil prices and carbon emissions: Evidence from Gulf Cooperative Council economies. Cogent Economics and Finance, 10(1), 2080316.

Aust, V., Morais, A.I., Pinto, I. (2020), How does foreign direct investment contribute to Sustainable Development Goals? Evidence from African countries. Journal of Cleaner Production, 245, 118823.

Basheer, M., Nechifor, V., Calzadilla, A., Ringler, C., Hulme, D., Harou, J.J. (2022), Balancing national economic policy outcomes for sustainable development. Nature Communications, 13(1), 5041.

Beesley, C., Hawkins, D. (2022), Corruption, institutional trust and political engagement in Peru. World Development, 151, 105743.

Bekun, F.V. (2024), Race to carbon neutrality in South Africa: What role does environmental technological innovation play? Applied Energy, 354, 122212.

Bello, M.O., Jimoh, S.O., Ch'ng, K.S., Oyerinola, D.S. (2024), Environmental sustainability in ASEAN: what roles do energy consumption, economic growth, and foreign direct investment play? Environment, Development and Sustainability, Jul(2024), 1-27.

Bologna, J., Ross, A. (2015), Corruption and entrepreneurship: Evidence from Brazilian municipalities. Public Choice, 165(1/2), 59-77.

Boufateh, T., Saadaoui, Z. (2020), Do asymmetric financial development shocks matter for CO_2 emissions in Africa? A nonlinear panel ARDL-PMG approach. Environmental Modeling and Assessment, 25(6), 809-830.

Bui, N.T., Doan, T.T.T. (2024), Foreign direct investment and green GDP: The thresholds of financial development for economic policies. Cogent Economics and Finance, 12(1), 2437011.

Caetano, R.V., Marques, A.C., Afonso, T.L. (2022), How can foreign direct investment trigger green growth? The mediating and moderating role of the energy transition. Economies, 10(8), 199.

Choi, Y.J., Kim, S.N. (2024), Do foreign direct investment and foreign aid accelerate economic growth in developing countries? International Journal of Development Issues, 23(2), 348-357.

Chou, C.H., Ngo, S.L., Tran, P.P. (2023), Renewable energy integration for sustainable economic growth: Insights and challenges via bibliometric analysis. Sustainability, 15(20), 5030.

Demir, F., Lee, S. (2022), Foreign direct investment, capital accumulation, and growth: The rise of the Emerging South. International Review of Economics and Finance, 80, 779-794.

Emako, E., Nuru, S., Menza, M. (2022), The effect of foreign direct investment on economic growth in developing countries. Transnational Corporations Review, 14(4), 382-401.

Emir, F., Bekun, F.V. (2018), Energy intensity, carbon emissions, renewable energy, and economic growth nexus: New insights from Romania. Energy and Environment, 30(3), 427-443.

Eregha, P.B., Nathaniel, S.P., Vo, X.V. (2022), Economic growth, environmental regulations, energy use, and ecological footprint linkage in the next-11 countries: Implications for Environmental Sustainability. Energy and Environment, 34(5), 1327-1347.

Faheem, M., Hussain, S., ArsalanTanveer, Safdar, N., Anwer, M.A. (2022), Does foreign direct investment asymmetrically affect the mitigation of environmental degradation in Malaysia? Environmental Science and Pollution Research, 29(5), 7393-7405.

Feng, C.C., Chang, K.F., Lin, J.X., Lee, T.C., Lin, S.M. (2022), Toward green transition in the post Paris Agreement era: The case of Taiwan. Energy Policy, 165, 112996.

Fernandes, C.I., Veiga, P.M., Ferreira, J.J.M., Hughes, M. (2021), Green growth versus economic growth: Do Sustainable technology transfer and innovations lead to an imperfect choice? Business Strategy and the Environment, 30(4), 2021-2037.

Goutte, S., Péran, T., Porcher, T. (2022), Corruption, economy and governance in Central Africa: An analysis of public and regional drivers of corruption. Finance Research Letters, 44, 102086.

Gründler, K., Potrafke, N. (2019), Corruption and economic growth: New empirical evidence. European Journal of Political Economy, 60, 101810.

Gu, W., Yan, W., Yu, S. (2024), Rule of law, corruption and transparency impacts on green growth of East Asian economies. Humanities and Social Sciences Communications, 11(1), 1169.

Gujarati, D., Porter, D., Gunasekar, S. (2017), Basic Econometrics. India: McGraw Hill Education.

Hao, L., Naiman, D., editors. (2007), Quantile regression. In: Quantitative Applications in the Social Sciences. Vol. 149. London: SAGE Publications, Inc.

Hao, Y., Gai, Z., Yan, G., Wu, H., Irfan, M. (2021), The spatial spillover effect and nonlinear relationship analysis between environmental decentralization, government corruption and air pollution: Evidence from China. Science of The Total Environment, 763, 144183.

Javed, A., Subhani, B.H., Javed, A., Rapposelli, A. (2024), Accessing the efficacy of green growth, energy efficiency, and green innovation for environmental performance in top manufacturing nations in the framework of sustainable development. Quality and Quantity, 58(6), 5829-5863.

Jiang, T., Nie, H. (2014), The stained China miracle: Corruption, regulation, and firm performance. Economics Letters, 123(3), 366-369.

Jianguo, D., Ali, K., Alnori, F., Ullah, S. (2022), The nexus of financial development, technological innovation, institutional quality, and environmental quality: Evidence from OECD economies. Environmental Science and Pollution Research, 29(38), 58179-58200.

Kaufmann, D., Wei, S.J. (2000), Does "Grease Money" Speed Up the Wheels of Commerce? IMF Working Papers, 00(64). p1.

Kaufmann, D., Kraay, A., Mastruzzi, M. (2011), The Worldwide Governance Indicators: Methodology and Analytical Issues. Hague Journal on the Rule of Law, 3(2), 220-246. doi:10.1017/S1876404511200046

Kebede, S.G., Heshmati, A. (2020), Energy use and labor productivity in Ethiopia: The case of the manufacturing industry. Energies, 13(11), 2714.

Koenker, R., Bassett, G. (1978), Regression quantiles. Econometrica, 46(1), 33.

Lapatinas, A., Litina, A., Sartzetakis, E.S. (2019), Environmental projects in the presence of corruption. International Tax and Public Finance, 26(1), 103-144.

Le, H.T.P., Pham, H., Do, N.T.T., Duong, K.D. (2024), Foreign direct investment, total factor productivity, and economic growth: Evidence in middle-income countries. Humanities and Social Sciences Communications, 11(1), 1388.

Leff, N.H. (1964), Economic development through bureaucratic corruption. American Behavioral Scientist, 8(3), 8-14.

Leys, C. (1965), What is the problem about corruption? The Journal of Modern African Studies, 3(2), 215-230.

Li, S., Zhang, J., Ma, Y. (2015), Financial development, environmental quality and economic growth. Sustainability, 7(7), 9395-9416.

Lin, Y., Mahmood, M.A., Meng, W., Ali, Q. (2024), Green economy transition in Asia Pacific: A holistic assessment of renewable energy production. Journal of Cleaner Production, 437, 140648.

Liu, B., Lyu, Y. (2024), Economic corruption, green recovery, and mineral trade relationships in emerging economies. Resources Policy, 90, 104725.

Liu, G., Khan, M.A., Haider, A., Uddin, M. (2022), Financial development and environmental degradation: Promoting low-carbon competitiveness in E7 economies' industries. International Journal of Environmental Research and Public Health, 19(23), 6336.

Ma, X., Fu, Q. (2020), The influence of financial development on energy consumption: Worldwide evidence. International Journal of Environmental Research and Public Health, 17(4), 1428.

Mardani, A., Streimikiene, D., Cavallaro, F., Loganathan, N., Khoshnoudi, M. (2019), Carbon dioxide (CO_2) emissions and economic growth: A systematic review of two decades of research from 1995 to 2017. Science of The Total Environment, 649, 31-49.

Mendoza, R.U., Lim, R.A., Lopez, A.O. (2015), Grease or sand in the wheels of commerce? Firm level evidence on corruption and SMES. Journal of International Development, 27(4), 415-439.

Mensah, C.N., Long, X., Dauda, L., Boamah, K.B., Salman, M., Appiah-Twum, F., Tachie, A.K. (2019), Technological innovation and green growth in the organization for economic cooperation and development economies. Journal of Cleaner Production, 240, 118204.

Mentel, G., Tarczyński, W., Dylewski, M., Salahodjaev, R. (2022), Does renewable energy sector affect industrialization-CO_2 emissions nexus in Europe and Central Asia? Energies, 15(16), 5877.

Menyah, K., Wolde-Rufael, Y. (2010), CO_2 emissions, nuclear energy, renewable energy and economic growth in the US. Energy Policy, 38(6), 2911-2915. doi: 10.1016/j.enpol.2010.01.024

Méon, P.G., Sekkat, K. (2005), Does corruption grease or sand the wheels of growth? Public Choice, 122(1-2), 69-97.

Méon, P.G., Weill, L. (2010), Is corruption an efficient grease? World Development, 38(3), 244-259.

Mert, M., Caglar, A.E. (2020), Testing pollution haven and pollution halo hypotheses for Turkey: A new perspective. Environmental Science and Pollution Research International, 27(26), 32933-32943.

Mohd Suki, N., Mohd Suki, N., Afshan, S., Sharif, A., Ariff Kasim, M., Rosmaini Mohd Hanafi, S. (2022), How does green technology innovation affect green growth in ASEAN-6 countries? Evidence from advance panel estimations. Gondwana Research, 111, 165-173.

Mohsin, M., Kamran, H.W., Atif Nawaz, M., Sajjad Hussain, M., Dahri, A.S. (2021), Assessing the impact of transition from non-renewable to renewable energy consumption on economic growth-environmental nexus from developing Asian economies. Journal of Environmental Management, 284, 111999.

Mukhtarov, S., Karacan, R., Humbatova, S. (2024), The long-run effect of financial development on carbon emissions in Kazakhstan. Energy Efficiency, 17(3), 17.

Nathaniel, S., Khan, S.A.R. (2020), The nexus between urbanization, renewable energy, trade, and ecological footprint in ASEAN countries. Journal of Cleaner Production, 272, 122709.

Nguyen, H.T., Nguyen, S.V., Dau, V.H., Le, A.T.H., Nguyen, K.V., Nguyen, D.P., Bui, X.T., Bui, H.M. (2022), The nexus between greenhouse gases, economic growth, energy and trade openness in Vietnam. Environmental Technology and Innovation, 28, 102912.

Nguyen, T.T.H., Le, T.A., Le-Dinh, T., Pham, T.H., Phan, G.Q., Vuu, T.M., Bui, H.M. (2024a), Nexus of globalization and environmental quality: Investigating heterogeneous effects through quantile regression analysis. Polish Journal of Environmental Studies, 33(1), 767-779.

Nguyen, T.T.H., Phan, G.Q., Pham, V.K., Bui, M.H. (2024b), The nexus of renewable, non-renewable energy and ecological footprint with mediating effects of economic development: evidence from a global sample. In: Reference Module in Social Sciences. Netherlands: Elsevier.

Nguyen, T.T.H., Phan, G.Q., Tran, T.K., Bui, H.M. (2023), The role of renewable energy technologies in enhancing human development: Empirical evidence from selected countries. Case Studies in Chemical and Environmental Engineering, 8, 100496.

Ofori, I.K., Gbolonyo, E.Y., Ojong, N. (2023), Foreign direct investment and inclusive green growth in Africa: Energy efficiency contingencies and thresholds. Energy Economics, 117, 106414.

Overland, I., Sagbakken, H.F., Chan, H.Y., Merdekawati, M., Suryadi, B., Utama, N.A., Vakulchuk, R. (2021), The ASEAN climate and energy paradox. Energy and Climate Change, 2, 100019.

Padhan, L., Bhat, S. (2024), Nexus between foreign direct investment and ecological footprint in BRICS and Next-11: The moderating role of green innovation. Management of Environmental Quality: An International Journal, 35(4), 799-817.

Pan, W.T., Zhuang, M.E., Zhou, Y.Y., Yang, J.J. (2021), Research on sustainable development and efficiency of China's E-Agriculture based on a data envelopment analysis-Malmquist model. Technological Forecasting and Social Change, 162, 120298.

Pei, Y., Zhu, Y., Wang, N. (2021), How do corruption and energy efficiency affect the carbon emission performance of China's industrial sectors? Environmental Science and Pollution Research, 28(24), 31403-31420.

Qin, L., Hou, Y., Miao, X., Zhang, X., Rahim, S., Kirikkaleli, D. (2021), Revisiting financial development and renewable energy electricity role in attaining China's carbon neutrality target. Journal of Environmental Management, 297, 113335.

Qiu, W., Zhang, J., Wu, H., Irfan, M., Ahmad, M. (2022), The role of innovation investment and institutional quality on green total factor productivity: Evidence from 46 countries along the "Belt and Road." Environmental Science and Pollution Research, 29(11), 16597-16611.

Quang, P.T., Thao, D.P. (2022), Analyzing the green financing and energy efficiency relationship in ASEAN. The Journal of Risk Finance, 23(4), 385-402.

Raihan, A., Tuspekova, A. (2022), Dynamic impacts of economic growth, renewable energy use, urbanization, industrialization, tourism, agriculture, and forests on carbon emissions in Turkey. Carbon Research, 1(1), 20.

Rodrik, D., Subramanian, A., Trebbi, F. (2004), Institutions rule: The primacy of institutions over geography and integration in economic development. Journal of Economic Growth, 9(2), 131-165.

Sarkodie, S.A., Owusu, P.A., Taden, J. (2023), Comprehensive green growth indicators across countries and territories. Scientific Data, 10(1), 413.

Sohag, K., Taşkın, F.D., Malik, M.N. (2019), Green economic growth, cleaner energy and militarization: Evidence from Turkey. Resources Policy, 63, 101407.

Soretz, S., Nodehi, M., Taghvaee, V.M. (2023), Sustainability and sustainable development concepts: Defining the perspectives and pillars. In: Reference Module in Social Sciences. Netherlands: Elsevier.

Spyromitros, E., Panagiotidis, M. (2022), The impact of corruption on economic growth in developing countries and a comparative analysis of corruption measurement indicators. Cogent Economics and Finance, 10(1), 2129368.

Sreenu, N. (2025), Analysing FDI inflow effects on CO_2 emissions: A comparative study of OECD and BRICS nations with PHH and PHE models. International Journal of Energy Sector Management, 19(1), 80-100.

Sulemana, I., Kpienbaareh, D. (2020), Corruption and air pollution: A comparative study of African and OECD countries. Air Quality, Atmosphere and Health, 13(12), 1421-1429.

Sumaira, Siddique, H.M.A. (2023), Industrialization, energy consumption, and environmental pollution: Evidence from South Asia. Environmental Science and Pollution Research, 30(2), 4094-4102.

Sun, Z., Zhang, X., Gao, Y. (2023), The impact of financial development on renewable energy consumption: A multidimensional analysis based on global panel data. International Journal of Environmental

Research and Public Health, 20(4), 3124.
Sundarasen, S., Ibrahim, I., Alsmady, A.A., Krishna, T. (2024), Corruption's crossroads: Exploring firm performance and auditors' role in emerging markets. Economies, 12(9), 239.
Tang, P., Ma, H., Sun, Y., Xu, X. (2024), Exploring the role of fintech, green finance and natural resources towards environmental sustainability: A study on ASEAN Economies. Resources Policy, 94, 105115.
Tao, Z., Ren, Z., Chen, Y., Huang, X., Liu, X. (2023), Pathway to sustainable economic growth: Linkage among energy consumption, carbon emissions, climate change and technological innovation. Energy Strategy Reviews, 50, 101253.
Tawiah, V., Zakari, A., Alvarado, R. (2024), Effect of corruption on green growth. Environment, Development and Sustainability, 26(4), 10429-10459.
Teklie, D.K., Yağmur, M.H. (2024), The role of green innovation, renewable energy, and institutional quality in promoting green growth: Evidence from African countries. Sustainability, 16(14), 6166.
Tran, T.K. (2023), Financial development and environmental quality: Differences in renewable energy use and economic growth. Polish Journal of Environmental Studies, 32, 2855-2866.
Triatmanto, B., Bawono, S. (2023), The interplay of corruption, human capital, and unemployment in Indonesia: Implications for economic development. Journal of Economic Criminology, 2, 100031.
Van Hung, H., Doanh, N.K. (2025), Is corruption an input material for environmental pollution? Journal of International Development, 37(1), 172-201.
Voumik, L.C., Hossain, M.I., Rahman, M.H., Sultana, R., Dey, R., Esquivias, M.A. (2023), Impact of renewable and non-renewable energy on EKC in Saarc countries: Augmented mean group approach. Energies, 16(6), 2789.
Wani, M.J.G., Loganathan, N., Esmail, H.A.H. (2024), Impact of green technology and energy on green economic growth: Role of FDI and globalization in G7 economies. Future Business Journal, 10(1), 43.
Williams, A., Dupuy, K. (2017), Deciding over nature: Corruption and environmental impact assessments. Environmental Impact Assessment Review, 65, 118-124.
Wu, H., Xia, Y., Yang, X., Hao, Y., Ren, S. (2021), Does environmental pollution promote China's crime rate? A new perspective through government official corruption. Structural Change and Economic Dynamics, 57, 292-307.
Yang, C., Qi, H., Jia, L., Wang, Y., Huang, D. (2024), Impact of digital technologies and financial development on green growth: Role of mineral resources, institutional quality, and human development in South Asia. Resources Policy, 90, 104699.
Yuan, T.K., Ishak, S. (2022), Relationship between corruption, governance, and economic growth in ASEAN. In: Abdul Karim, S.A., editor. Shifting Economic, Financial and Banking Paradigm: New Systems to Encounter COVID-19. Cham: Springer International Publishing. p119-130.
Zhao, W., Huangfu, J., Chang, M., Yu, L., Sohail, S. (2023), Financial development-green growth nexus in China: The role of technological capital. Environmental Science and Pollution Research, 30(25), 67676-67685.
Zhou, X., Wang, L., Du, J. (2021), Institutional environment and green economic growth in China. Complexity, 2021(1), 6646255.
Zhou, Z., Han, S., Huang, Z., Cheng, X. (2023), Anti-corruption and corporate pollution mitigation: Evidence from China. Ecological Economics, 208, 107795.
Zhuo, J., Qamruzzaman, M. (2022), Do financial development, FDI, and globalization intensify environmental degradation through the channel of energy consumption: Evidence from belt and road countries. Environmental Science and Pollution Research, 29(2), 2753-2772.