

Exploring the Relationships among Institutional Quality, Financial Development, and Environmental Pollution in Developing Countries

Yen Nguyen^a

Abstract: *Developing countries are heading towards economic prosperity; however, development also increases carbon emissions and environmental pollution. It is therefore essential to identify the factors that affect carbon emissions to safeguard the environment. This study examines the impact of financial development and institutional quality on carbon dioxide emissions in developing countries. In addition, we investigate the role of institutional quality in financial development, or the CO₂ nexus. We use panel data from 1990 to 2021 and employ the GMM method to assess this relationship. The empirical findings reveal that financial development improves environmental quality by reducing CO₂. Furthermore, institutional quality catalyses greater reductions in environmental pollution as countries increase financial development. Based on these findings, developing economies should promote environmental sustainability by using financial resources efficiently and improving institutional quality.*

Keywords: Financial development; Institutional quality; Environmental pollution; GMM methodology; Carbon emissions

JEL Classification: C32, F18, O44, Q56

^a Faculty of Finance, Ho Chi Minh University of Banking, VietNam. Email: yemndh@hub.edu.vn.
ORCID ID: 0000-0003-1350-9810

1. Introduction

In the past few decades, the world has witnessed strong growth in the financial system, which has positively impacted the reduction of inequality and poverty, and stimulated economic growth (Durusu-Ciftci et al., 2017; Goldsmith, 1969; Kapaya, 2020; Nurazi & Usman, 2019; Shaw, 1973). However, recent studies (e.g., Zhang, 2011) suggest that financial development harms the environment, affecting a country's ability to achieve its sustainable development goals. Climate change poses a serious threat to the development and existence of humanity (Khan et al., 2021; Shahbaz & Sinha, 2019; Wang & Dong, 2019), with its effects becoming more catastrophic due to industrialisation and rapid economic expansion. The atmosphere and biosphere of the world are under extreme stress (Sharif et al., 2020). Data from the International Energy Agency (IEA) shows that, since 1900, global emissions are increasing every year—save for the pandemic year of 2020, which saw a complete suspension of travel—and have done so quickly over that time. The IEA reports that carbon dioxide emissions in 2022 increased by 0.9% to 36.8 billion tons from the year prior. Rising global CO₂ emissions will undermine sustainable development objectives if people do not reduce their resource exploitation and consumption. Certain variables, such as regional variations in consumption patterns and financial and economic development, constantly impact the Earth's ecosystem (Tawiah et al., 2021). Thus, in light of the Paris Agreement (COP21) to limit global warming to less than 2°C, countries are developing policies to address the concerns of rising energy use and environmental degradation.

Recent studies point to the various environmental effects of financial development. Generally, there exist two schools of thought on the relationship between financial development and environmental contamination. On the one hand, a strong financial system makes it easier to obtain funds and encourages investment. This increased economic activity leads to environmental deterioration due to energy consumption (Khan & Hou, 2021b; Sinha, 2021). On the other hand, a robust and effective financial system can finance the procurement of advanced technology and facilitate the adoption of energy-efficient industrial methods, thereby reducing environmental degradation (Sharif et al., 2020; Sinha, 2022). Furthermore, developed financial markets can supply funding for research

and development related to renewable energy, facilitating the transfer of green technology to developing nations (Ahmed et al., 2021; Khan & Hou, 2021a). This encourages nations to adopt cutting-edge technologies in clean and green production.

Institutional quality is another critical aspect that can directly or indirectly influence environmental quality. A strong institutional framework improves the management of public finance, helps enforce law and order, hinders corruption, and minimises military interference in politics (Danish & Ulucak, 2020). As a result, the institutional role in environmental sustainability is imperative, supporting the belief that countries can lower the cost of increasing growth and achieving high-income status by improving environmental quality (Hassan et al., 2020). Solid institutional guidelines and a rigid rule of law can compel organisations to curtail their carbon emissions (Shahbaz et al., 2022). Thus, a country's institutional quality is crucial to minimise ecological degradation and achieve its sustainable development goals.

The present study focuses on developing economies for several reasons. Firstly, environmental pollution is a serious problem for developing countries today because they face a contradiction between economic growth and environmental protection. According to the IQAir report for 2022, nine developing countries are among the world's top 10 most polluted countries based on the average annual concentration of PM_{2.5}. These countries are Chad, Iraq, Pakistan, Bahrain, Bangladesh, Burkina Faso, Kuwait, India, and Egypt. Although environmental degradation persists, many Organization for Economic Cooperation and Development (OECD) countries in the have had high economic growth rates. Countries around the world are interested in financial instruments to promote economic development and achieve optimal environmental quality (Kaifeng & Chuanzhe, 2011), in line with the United Nations' (UN) Sustainable Development Goals (SDGs), which aim to protect the environment and ensure a more sustainable future for all. However, developing economies face internal and external pressure to reduce environmental degradation because rapid economic growth creates far-reaching CO₂ issues. Secondly, there is disagreement in the scant literature on the link between financial development and environmental pollution. Earlier studies used single or traditional financial development proxies, which may produce biased results. Svirydzhenka (2016) claims that conventional measures of financial development, such as stock market capitalisation and domestic credit, cannot capture all dimensions and sectors

in the financial system. Thirdly, the influence of a country's institutions and the impact of external factors—such as financial development—on environmental pollution has not received much attention. As noted above, institutional quality is an important factor that can directly or indirectly impact the environment.

To address these existing gaps, our study investigates how institutional quality influences the impact of financial development on environmental pollution in developing countries over the period of 2004 to 2021. We consider six dimensions of institutional quality: control of corruption, government effectiveness, political stability, regulatory quality, voice and accountability, and rule of law. Our empirical evidence suggests that institutional quality has a positive effect on reducing environmental pollution in developing countries, while also increasing the effect of financial development on environmental pollution. Furthermore, our main findings remain robust to the use of an alternative measure of environmental pollution and different estimates for a panel sample. Overall, the empirical analysis of this paper extends the scope of existing studies and provides new insights into the impact of institutional quality and financial development on environmental pollution in developing countries. These countries can use the evidence in this study as a basis for developing strategies to reduce environmental pollution as they promote financial system development.

The remaining sections of this paper are structured as follows: Section 2 presents a literature review focusing on the relationship between uncertain factors and bank stability. In Section 3, a detailed description of the data employed in the study is provided. Section 4 outlines the empirical models used for the analysis and the subsequent interpretation of the empirical results. Finally, Section 5 offers concluding remarks and policy suggestions stemming from the research findings.

2. Literature Review

2.1 Financial development and environmental pollution

There are several studies on the relationship between financial development and environmental quality; however, the findings are inconsistent. According to the first line of research, financial development considerably improves environmental sustainability by halting environmental deterioration.

For example, Tamazian et al. (2009) look at how financial development affects carbon emissions in BRICS economies, and discover that financial development improves environmental quality by lowering carbon emissions. Similarly, Jalil and Feridun (2011) reveal a favourable correlation between financial development and declining environmental quality. Salahuddin et al. (2018) show that financial development has a moderating effect on carbon emissions in China. In a similar vein, Dogan and Turkekul (2016) investigate the relationship between financial development and environmental quality in 23 countries using fully modified ordinary least squares (FMOLS) and dynamic ordinary least squares (DOLS), and find that financial development reduces environmental deterioration. Cetin and Ecevit (2017) examine the impact of financial development on carbon emissions in Türkiye from 1960 to 2011 using the autoregressive distributed lag (ARDL) bounds test and Granger causality analysis, and show that financial development reduces carbon emissions in the long run.

The second strand of the literature documents a negative relationship between financial development and environmental degradation. For instance, Zhang (2011) uses the cointegration method, the Granger causality test, and variance decomposition to explore the impact of financial development on carbon emissions in China. The findings demonstrate that foreign direct investment (FDI) increases carbon emissions, indicating that an increase in financial development leads to higher emissions. In addition, the study emphasises that most aspects of financial development—such as the financial intermediation scale, stock market scale, and FDI—negatively affect environmental quality, but to different degrees. Shahbaz et al. (2016), in their review the disproportionate impact of financial development on environmental quality in Pakistan from Q1 1985 to Q4 2014, created a comprehensive index of financial development based on the stock market and banking sectors. Their results show that both aspects of financial development adversely affect environmental quality.

The third strand of literature suggests that financial development does not significantly affect environmental quality, but that this is dependent on the characteristics of the country. For instance, Ozturk and Acaravci (2013) examine the causal relationship between financial development, trade, economic growth, energy consumption, and carbon emissions in Türkiye over the period 1960 to 2007. The *F*-test for cointegration shows that financial development has no significant impact on carbon emissions. Bayar

et al. (2020) provide evidence that financial development and CO₂ emissions have no relationship in 11 European economies during the period of 1995 to 2017. Similarly, Destek and Sarkodie (2019) find no significant relationship between financial development and environmental quality. Xiong et al. (2017), meanwhile, point out that the impact of financial development on carbon emissions depends on the characteristics of countries. For example, in China from 1997 to 2011, financial development reduced carbon emissions in developed regions while increasing emissions in less developed regions. Abbasi and Riaz (2016) look at the long-term link between carbon emissions and financial development using ARDL, the error correction model (ECM), and Granger causality in an augmented vector autoregression (VAR) framework. The study looks at the full sample period (1971–2011) and a smaller sample sub-period (1988–2011) that corresponds to more liberalisation and financial sector development. The result shows that the financial development variables play a role in emission mitigation only in the latter period, where a greater degree of liberalisation and financial sector development occurred.

2.2 Institutional quality and environmental pollution relationship

Regarding the literature examining the connection between CO₂ emissions and institutional quality, researchers have come to differing conclusions. Some researchers find that an institution's quality increases CO₂ emissions (Hassan et al., 2020; Yamineva & Liu, 2019). Others contended that several institutional quality elements, such as democracy and the eradication of corruption, have a favorable impact on environmental quality (Adams & Klobodu, 2017; Danish & Ulucak, 2020; Rizk & Slimane, 2018). For example, while some note that institutional quality factors can lower CO₂ emissions (Wang et al., 2018), others have found that they may raise CO₂ emissions (Hosseini & Kaneko, 2013; Yamineva & Liu, 2019). Additionally, Zakaria and Bibi (2019) looked at how South Asian countries' institutional quality and economic development related to CO₂ emissions and discover a negative relationship between the two. Abid (2016) notes that there is a negative correlation between CO₂ emissions and political and social instability, government efficacy, corruption, and democracy. In a similar vein, Hassan et al. (2020) use an ARDL model for data from 1984 to 2016 in Pakistan to show that institutions lead to increased CO₂ emissions in

Pakistan. Furthermore, there exists a correlation between the quality of institutions and CO₂ emissions. Using econometric techniques, Dasgupta and De Cian (2016) discover that governance and institutions are to blame for environmental deterioration and the impact of institutional quality on the environment. Zhang et al. (2016) discover that institutional quality may have both an indirect and direct detrimental impact on the environment, adding that Asia-Pacific Economic Cooperation (APEC) countries' environments are better when institutional corruption is controlled. Ibrahim and Law (2016) contend that improvements in institutional quality have the effect of reducing pollution in the environment because countries cannot benefit from trade's positive environmental effects without institutional reform.

In summary, research on financial development and environmental pollution is still limited. Unlike earlier studies that focused on isolated indicators such as private credit or market capitalisation to GDP, which do not adequately reflect the multifaceted nature of financial development, our method aims to provide more reliable results. By utilising the financial development index developed by Svirydzhenka (2016)—which is based on two indices, financial institutions and financial markets—along with six component indicators, we offer a more comprehensive view of financial development in terms of depth, accessibility, and efficiency. Secondly, there is no consensus regarding the impact of financial development on environmental pollution. Some studies indicate negative impacts, while others reveal positive impacts, and some even suggest that financial development has no effect or exhibits nonlinear effects on environmental pollution. This lack of consistency highlights the need for updated time series analyses to reassess the impact. Third, unlike previous studies that examine the effects of financial development and institutional quality on environmental pollution separately, this study investigates both factors concurrently, emphasising the role of institutional quality on how financial development impacts environmental pollution. We achieved this by incorporating an interaction variable that connects institutional quality and financial development within our model. Fourth, we ensured the reliability of our findings by employing a new alternative dependent variable. In this study, we use the ecological footprint as a secondary measure to test the robustness of our model, and the results remained consistent, reinforcing the credibility of our research conclusions. Finally, much of the existing literature has concentrated on developed regions such as European countries,

or specific nations like China, the United Arab Emirates, or the United States, leaving a gap in empirical research focused on developing countries. These nations are currently experiencing rapid financial development alongside significant environmental pollution. Therefore, understanding the effects of financial development and institutional quality on the environment is vital for policymakers, and helps achieve sustainable development goals in the future.

3. Data and Methodology

3.1 *Sample and database*

This study uses a balanced panel dataset comprising 82 selected developing countries from 1991 to 2021. The choice of the time and country is based on data availability, particularly for our key variable of interest. Regarding data reflecting environmental quality, we use CO₂ emissions, in line with Shahbaz and Sinha (2019). Accordingly, high emissions mean that the environmental quality of that country is deteriorating. This data is collected from the World Bank's World Development Indicators (WDI) database. Turning to financial development, relative to earlier studies that rely on either bank-based or market-based measures, we employ a recently developed multidimensional index of financial sector development which is based on the depth, access, and efficiency of the financial markets and institutions of countries. The index is computed using six sub-indices and is subsequently normalised to a range between 0 and 1 (Svirydzenka, 2016). Data on financial development is collected from the database of the International Monetary Fund (IMF). We follow existing studies to include key control variables, notably real GDP per capita, urbanisation, trade openness, energy consumption, and population growth, with data collected from the World Bank database. Finally, for institutional quality data, we use six dimensions of institutional quality in the World Governance Indicators (WGI) dataset. Refer to Table 1 for detailed definitions and measurements of all variables.

Table 1: Variable definition and measurement

Variables	Definition	Summary description	Source of data
Dependent variables			
Ecological footprint (EF) CO ² emissions	Environmental pollution	Ecological footprint per capita	Global Footprint Network (GFN)
		CO ₂ emissions (kg per PPP \$ of GDP)	World Development Indicators (WDI)
Independent variables			
FD	Financial development	Computed as an index of financial access, financial depth, and financial efficiency of both financial markets and financial institutions	International Monetary Fund (IMF)
INS	Institutional quality	Average of six indexes CC, GE, PL, RQ, and VA, with a bloom from -2.5 to 2.5	Worldwide Governance Indicator (WGI)
CC	Control of corruption index		WGI
GE	Government effectiveness		WGI
PS	Political stability	Bloom from -2.5 to 2.5	WGI
RQ	Regulatory quality		WGI
RL	Rule of law		WGI
VA	Voice and accountability		WGI
Control variables			
URB	Urbanisation	Urban population (% of total population)	WDI
TRA	Trade openness	Imports plus exports (% of GDP)	WDI
ENE	Energy consumption	Energy use (kg of oil equivalent per capita)	WDI
POP	Population growth	Population growth (annual %)	WDI
DCP	Private sector credit	Private sector credit/GDP	WDI

3.2 Models specifications

Model 1 is used to assess the impact of financial development on environmental pollution in developing countries. Based on the stochastic impacts by regression on population, affluence, and technology (STIRPAT) model and the studies of Abid (2016) and Shahbaz and Sinha (2019), we establish the following equation:

$$CO_{2it} = \alpha_{it} + \beta_1 ENV_{it-1} + \beta_2 FD_{it} + \beta_3 CON_{it} + \eta_i + \xi_{it} \quad (1)$$

where i and t represent the country and time, CO_{2it} the variable of environmental pollution measured by emissions of CO_2 per capita per year in the country i , FD_{it} the variable of financial development, and CON_{it} the controlling variables such as trade openness, energy consumption, per capita income, infrastructure development, inflation, and urbanisation. The selection and use of control variables are based on the theoretical basis and the scheme of previous studies. More likely, according to Halkos (2003) and Tamazian and Rao (2010), personal income and environmental pollution have a non-linear relationship, so in equation (1), we add the variable $lnrgdp_{it}^2$.

To assess the impact of institutional quality on the correlation between financial development and environmental pollution, we added the institutional variations and variables of interaction between the two factors, as well as the variable of public expenditure and variable interaction among the two elements in model (1). Accordingly, model (2) and (3) are as follows:

$$CO_{2it} = \alpha_{it} + \beta_1 CO_{2it-1} + \beta_2 FD_{it} + \beta_3 INS_{it} + \beta_4 CON_{it} + \eta_i + \xi_{it} \quad (2)$$

$$CO_{2it} = \alpha_{it} + \beta_1 CO_{2it-1} + \beta_2 FD_{it} + \beta_3 INS_{it} + \beta_4 (INS * FD)_{it} + \beta_5 CON_{it} + \eta_i + \xi_{it} \quad (3)$$

where INS_{it} represents the variable of institutional quality of the country in the year t . Institutional variation is determined by taking the mean of six indicators: corruption control, government effectiveness, political stability and non-violence, quality of regulation, rule of law, voice, and accountability. $INS*FD$ is the interaction variable between financial development and institutional quality.

We use the stochastic GMM (SGMM) method proposed by Arellano and Bover (1995), and Blundell and Bond (1998) to address the research objectives due to its advantages for the dataset in this study. Firstly, the study has a small T ($T = 30$) and a large N ($N = 82$). Secondly, there is endogeneity among the variables in the model, specifically between the dependent variable and its lagged variable. The addition of the lag can eliminate the influence of unobservable factors, enhancing the reliability of the regression results. Due to the presence of the lag, the model cannot be estimated using ordinary estimation methods. Accordingly, based on the characteristics analysed above, SGMM is used for all estimate models here. In addition, in order to verify the reliability of the GMM certification results, Hansen/Sargan certifications on tool variables and AR(2) binary chain correlation are also carried out.

3.3 Descriptive statistics

Summary Statistics regarding the variables used are displayed in Table 2. CO₂ and ecological footprint (EF) averages for 82 nations in developing countries during the period if 1990 to 2021 are 3.207 tons per year and 2.898 gha respectively. CO₂ reaches a minimum of 0.025, a maximum of 23.157, and has a standard deviation of 3.860. EF reaches a minimum of 0.467, and a maximum of 11.754. Financial development (FD) and institutional quality (INS) have an average value of 0.248, and 2.898 respectively. The basic statistics of other control variables display relevance.

Table 2: Summary statistics

Variables.	Obs.	Mean.	Std. dev.	Min.	Max.
CO ₂	2543	3.207	3.860	0.025	23.157
EF	2624	2.898	1.893	0.467	11.754
FD	2624	0.248	0.154	0	0.797
GDP	2578	4676.196	5442.118	60.235	34218.21
URB	2623	52.608	19.183	8.854	95.603
TRA	2544	79.330	42.417	4.529	343.362
ENE	2624	53.595	73.394	0.225	605.444
DCP	2608	43.124	49.899	0.001	525.703
POP	2624	7.004	0.776	5.153	9.149
CC	2624	-0.27	0.72	-1.53	1.72

Variables.	Obs.	Mean.	Std. dev.	Min.	Max.
GE	2624	-0.16	0.73	-1.85	1.98
PS	2624	-0.26	0.90	-2.81	1.60
RQ	2624	-0.07	0.72	-1.86	1.68
RL	2624	-0.24	0.74	-1.81	1.63
VA	2624	-0.16	0.81	-1.78	1.48

Notes: Table 2 shows summary statistics of all variables, used in the baseline Model (1). All financial variables are winsorised at the 1% and 99% levels.

4. Empirical findings

4.1 Baseline analysis

Table 3 presents the empirical results from the baseline model (1) for the entire sample, focusing on the CO₂-dependent variables.

Table 3: The impact of financial development on environmental pollution

Variable	
CO ₂ (1)	0.918***
FD	-0.426***
URB	-0.002
GDP	0.000***
GDP2	-2.88e-09***
TRA	0.004***
DCP	-0.000*
ENE	0.004***
POP	0.033
Cons	-0.368
AR(2)	0.159
Sargan test	0.213
Hansen test	0.268

Note: *** p < 0.01, ** p < 0.05, * p < 0.1

The negative and significant coefficients of the FD variable indicate that increased financial development impairs environmental pollution in

developing countries. These results are robust to the findings in the paper of (Destek & Sarkodie, 2019; Ganda, 2019; Zaidi et al., 2019). Financial development will make it easy to access market capital at a reasonable cost to invest in environmentally friendly projects in line with national economic development policies (Cole et al., 2005; Tamazian & Rao, 2010; Yuxiang & Chen, 2011). In addition, financial development also allows access to capital to fund research, development, and technological innovation that can produce environmentally friendly products that better meet people's needs (Birdsall & Wheeler, 1993; Zakaria & Bibi, 2019), besides increasing their income and wealth. As incomes rise, environmental awareness will increase as well, and people can choose to consume green products over environmentally damaging products. This has an impact on the production process of the business (Lahiani, 2020). Finally, financial development also contributes to the honing of the legal system relating to the business activities of enterprises, banks, and financial institutions in the operation and support of capital to enterprises that incorporate environmentally friendly practices (Yuxiang & Chen, 2011).

Control variables embedded in the model, such as trade openness, energy use, and private-sector credit, all have an impact on environmental pollution. Accordingly, trade openness, and energy consumption (ENE) have the same impact on environmental pollution at a significant level of 1%. This means greater trade openness, increasing trade development, and increasing exchange between countries, which increases the demand for fossil fuel consumption for commercial operations, results in increased carbon emissions (Abdouli & Hammami, 2017; Abid, 2016; Solarin et al., 2017) thereby increasing pollution. Furthermore, one of the reasons for the increased emissions of CO₂ in developing countries when opening up trade is that developed countries 'export' environmental pollution to developed countries by developed countries with higher environmental standards (Hakimi et al., 2016). Besides, excessive energy consumption in production and livelihood generates massive emissions, leading to a greenhouse effect that contributes to climate change (Ezzati et al., 2004). Eventually, greater urbanisation creates big business production and consumption demand, thereby increasing CO₂ (Canh et al., 2018; Canh et al., 2019). In contrast, credit to the private sector (DCP) has a reverse impact on environmental pollution at a significance level of 1%. In developing countries, the private sector is often small in size, and lacks experience, credibility, and business

capacity, so it is difficult to improve machinery to ensure environmental quality. Therefore, as credit for the private sector increases, bank loans can facilitate private enterprises to innovate equipment, improve product quality, and maintain and expand the market. It is this factor that helps the private sector improve their production and business, which can reduce CO₂ emissions. In addition, both Hansen and Sargan accreditations match, and the ratios are above 0.1; this means that the tool variables used in the model are appropriate and the SGMM methodology can solve the research problems posed.

Table 4 presents the empirical results from the baseline model (2) for the entire sample, focusing on the CO₂-dependent variables. All estimated coefficients for the six aspects of institutional quality variables are respectively shown in columns 1 to 6.

The table shows the impact of the six aspects of institutional quality on environmental pollution. These aspects are the key explanatory variables: control of corruption (CC), government effectiveness (GE), political stability (PS), regulatory quality (RQ), rule of law (RL), and voice and accountability (VA).

The negative coefficients of CC, GE, PS, RQ, and RL are significant in columns 1 to 5. In column 1, the negative relationship between CC and CO₂ indicates that control of corruption reduces carbon emissions, which means that it reduces environmental pollution. Corruption almost always involves conflicts of interest (Goel & Nelson, 1998; La Porta et al., 1999), which result in officials being bribed and rules not adhered to, including environmental standards. Accordingly, many studies conclude that corruption hurts environmental policies, leading to an increase in environmental pollution (Welsch, 2004). Countries that control corruption will contribute to increased accountability of officials in the implementation of environmental protection tasks, increase environmental policy rigour, and reduce environmental pollution (Biswas et al., 2012; Damania et al., 2004). In column 2, an inverse relationship between government effectiveness and environmental pollution is observed. This result is consistent with Bernauer and Koubi (2006) and Li and Chan (2016). Government effectiveness plays an important role in protecting the environment and reducing pollution, to create a clean working environment, limit corruption, make administrative processes public and transparent, and facilitate public supervision. Furthermore, an effective government builds and strictly

enforces environmental policies and regulations, fostering a healthy business and social environment and promoting environmental protection behaviours.

Table 4: The impact of institutional aspects on environmental pollution

Variable	CC	GE	PS
CO ₂ (1)	0.921***	0.917***	0.933***
FD	- 0.025***	- 0.038***	- 0.016*
URB	0.001***	0.003***	0.005***
GDP	0.000***	0.000**	0.000**
GDP ²	-1.57e-09***	-2.08e-09***	-1.80e-09***
TRA	0.000***	0.000***	0.000**
DCP	0.002*	0.001**	0.004
ENE	0.000***	0.000**	0.001***
POP	0.008***	0.008***	0.005***
CC	-0.024***		
GE		-0.028***	
PS			-0.006***
Hansen	0.437	0.433	0.356
Sargan	0.501	0.518	0.442
AR(2)	0.9191	0.896	0.868
Variable	RQ	RL	VA
CO ₂ (1)	0.931***	0.920***	0.939***
FD	- 0.013**	- 0.036***	- 0.002
URB	0.003***	0.002***	0.002***
GDP	0.002***	0.001***	0.002***
GDP ²	-2.18e-09***	-1.72e-09***	-2.08e-09***
TRA	0.000***	0.000***	0.000***
DCP	0.009**	0.005	0.001***
ENE	0.000**	0.000**	0.001***
POP	0.002***	0.002***	0.002***
RQ	-0.024***		
RL		-0.025***	
VA			-0.056
Hansen	0.408	0.407	0.436
Sargan	0.528	0.503	0.515
AR(2)	0.885	0.8843	0.878

Note: *** p < 0.01, ** p < 0.05, * p < 0.1

In column 3, it can be seen that political instability can negatively impact carbon emissions in developing countries, which aligns with Fredriksson and Svensson (2003). Political stability plays an important role in protecting the environment and reducing pollution. When a country is politically stable, economic and social activities take place smoothly, creating favourable conditions for implementing environmental protection policies. Furthermore, political fluctuations do not disrupt the government's ability to develop and implement long-term plans for environmental protection, ensuring the stable maintenance of environmental policies that facilitate business and community adaptation. In column 4, the negative relationship between regulatory quality and CO₂ indicates that it plays an important role in reducing environmental pollution, consistent with Porter and Linde (1995). High-quality regulations can significantly reduce environmental pollution. These regulations must be clear, enforceable, and regularly updated. They should set clear pollution limits, have transparent enforcement mechanisms, and be accessible to the public. This approach encourages businesses to adopt cleaner practices and promotes public participation in environmental protection. Column 5 shows that a strong rule of law can help reduce environmental pollution. This finding is in line with Chen et al. (2022), Fredriksson and Svensson (2003), and Povitkina, (2015). The rule of law sets limits on pollution and requires businesses to comply with these limits. This helps to reduce polluting behaviours and raise public awareness about environmental protection. When laws are well-designed and strictly enforced, they can significantly contribute to reducing pollution and protecting the environment.

Table 5 presents the empirical results from the baseline model (3) for the entire sample, focusing on the CO₂-dependent variables. Moreover, these six indicators are consistent in their environmental impact dimensions. Therefore, we use a composite institutional quality variable, constructed by taking the average of the six dimensions.

Table 5: The role of institutions, FDs to CO₂ emissions in developing countries

Variable	FD	INS*FD
CO ₂ (1)	0.933***	0.941***
FD	- 0.024	- 0.038***
URB	0.005***	0.001
GDP	0.002***	0.001
GDP2	0.007***	0.006***
TRA	0.000***	0.000**
DCP	0.007*	0.003
ENE	0.000***	0.002***
POP	0.007***	0.003***
INS	-0.015***	-0.017**
FD*INS		-0.008*
Hansen	0.409	0.544
Sargan	0.498	0.541
AR(2)	0.878	0.759

Note: *** p < 0.01, ** p < 0.05, * p < 0.1

The negative and significant coefficients of the INS variable indicate that a country with good institutional quality contributes to lowering carbon emissions, thereby reducing environmental pollution. The results are similar when compared to the impact of various aspects of institutional quality. This confirms that the institutional quality of a country plays an important role in policies to reduce environmental pollution levels. Furthermore, the interaction variable between financial development and institutions (*FD*INS*) is also negative and has a lower coefficient than the effect of financial development on environmental pollution. This means that in a high-quality institutional environment, financial development will be an effective tool for reducing environmental pollution. The improvement in institutional quality, in addition to reducing CO₂ emissions directly, also reduces emissions indirectly through the impact on financial development. As institutional quality increases, government policies and regulations related to financial development become tighter. As such, the interaction between financial development and institutional quality has an impact on reducing CO₂ emissions and improving environmental quality in developing countries.

4.2 Robustness test

4.2.1 Robustness test 1: Alternative environmental pollution variable

In this context, we use the ecological footprint as the second dependent variable to test the robustness of the assertion that financial development reduces environmental pollution. The ecological footprint is a composite measure that indicates the extent of human impact on the Earth's ecosystem. Although it does not directly measure pollution levels, it reflects the relationship between human consumption and environmental issues such as pollution, climate change, and biodiversity loss. As the ecological footprint increases, we consume more natural resources, and the overexploitation of these resources leads to many environmental problems. Furthermore, this index is also widely used in studies (Chowdhury et al., 2021; Doytch, 2020; Kassouri & Altıntaş, 2020; Nathaniel & Khan, 2020; Wang, Yang, et al., 2018). The results are presented in Table 6.

Table 6: Robustness test 1: Using alternative variable of environmental pollution (EF)

Variable	FD	INS*FD
EF (1)	0.917***	0.911***
FD	-0.007***	-0.008***
URB	0.068***	0.065***
GDP	0.007***	0.008***
GDP ²	-1.306e-09***	-2.537e-09***
TRA	0.004***	0.001
DCP	0.000	0.002***
ENE	0.003***	0.003***
POP	0.009***	0.001***
INS	-0.013**	-0.019*
INS*FD		-0.0001***
Hansen	0.494	0.454
Sargan	0.287	0.211
AR(2)	0.979	0.761

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

The results show that with the dependent variable being ecological footprint, financial development has an impact on reducing ecological footprint in developing countries. This can be explained by the fact that when financial systems develop, businesses have access to loans and can invest in advanced, environmentally friendly production technologies. This helps reduce energy consumption and waste, leading to a decrease in the need to exploit ecological assets. This conclusion aligns with the findings of previous studies. The coefficient of the interaction variable between institutional quality and financial development, which hurts the ecological footprint, further strengthens this impact in an environment of good institutional quality. A good institutional environment closely regulates and monitors the activities of organisations, enhancing societal awareness and benefiting the environment.

4.2.2 Robustness test 2: OLS, FEM, REM, GLS

In this section, we applied static panel and traditional estimation strategies, including ordinary least squares (OLS), fixed effects (FE), random effects (RE), and generalised least squares (GSL) regression to test model (3), which assesses how institutional quality influences the impact of financial development on carbon emissions, the results are presented in Table 7. The results indicate that financial development and institutional quality are statistically significant to environmental pollution across all four methods. Thus, for developing countries, our study supports the hypothesis that financial development and advancing institutional quality will reduce environmental pollution.

Table 7: Using OLS, FEM, REM, and GLS regression results with different methods

	OLS	FEM	REM	GLS
CO ₂ (1)	0.945***	0.827***	0.951***	0.975***
FD	-0.023***	-0.016***	-0.023***	-0.023***
URB	0.271***	0.261	0.210***	0.269***
GDP	0.000***	0.000***	0.000***	0.000***
GDP ²	-1.356e-09***	-2.537e-09***	-1.769e-09***	-1.266e-09***
TRA	-0.000	0.000	0.000	-0.000
DCP	-0.000	-0.000	-0.000*	-0.000

	OLS	FEM	REM	GLS
ENE	0.002***	0.004***	0.002***	0.002***
POP	-0.007	0.047	-0.005	-0.007
INS	-0.001***	-0.003***	-0.001***	-0.001***
INS*FD	-0.006***	-0.006***	-0.010***	-0.015***
Cons	0.060	0.505	0.437	0.060
Prob>F	0.000	0.000	0.000	0.000
R ²	0.991	0.989	0.991	

Note: *** p < 0.01, ** p < 0.05, * p < 0.1

5. Conclusion

This study examines how institutional quality influences the impact of financial development on environmental pollution in 82 developing economies from 1990 to 2021. Using the GMM method, we demonstrate that financial development is among the factors that help reduce environmental pollution. Notably, this study provides evidence that institutions play a crucial role in a country's efforts to promote financial development to achieve sustainable development goals.

From the results, we propose two main groups of solutions related to financial development and institutional quality to minimise environmental pollution. To promote financial development, developing countries must focus on fostering green finance. By aligning financial activities with environmental protection objectives, green finance stimulates investment in eco-friendly projects such as renewable energy, sustainable agriculture, and green technologies. This approach not only aids in reducing pollution but also generates new business opportunities and boosts competitiveness. Additionally, it is essential for developing nations to create a comprehensive policy framework that incorporates incentive structures, including tax incentives, credits, and stringent regulations, on polluting activities. Additionally, banks and financial institutions are instrumental in promoting green finance. By offering green financial products such as green bonds and favourable loans for environmentally sustainable projects, these institutions can mobilise capital for such initiatives.

In terms of institutional quality, there is a need to enhance the legal framework through the reform and amendment of laws related to financial

development and environmental pollution, for example, updates to the environmental protection, investment, and financial legislation. Furthermore, institutional reforms are necessary to simplify administrative processes, improve coordination among government agencies overseeing environmental management, and enhance the skills and capabilities of officials in this area. It is vital to ensure transparency by disclosing information about environmental quality and investment initiatives to facilitate public and business engagement in oversight.

Data Availability Statement

The data is available upon reasonable request.

CRedit Author Statement

Yen Nguyen: Conceptualisation/ formulation of ideas; Development/ design of methodology; Data collection/ curation; Formal analysis/ techniques; and Writing—original draft.

References

- Abbasi, F., & Riaz, K. (2016). CO₂ emissions and financial development in an emerging economy: An augmented VAR approach. *Energy Policy, 90*, 102–114. <https://doi.org/10.1016/j.enpol.2015.12.017>
- Abdoui, M., & Hammami, S. (2017). Investigating the causality links between environmental quality, foreign direct investment and economic growth in MENA countries. *International Business Review, 26*(2), 264–278. <https://doi.org/10.1016/j.ibusrev.2016.07.004>
- Abid, M. (2016). Impact of economic, financial, and institutional factors on CO₂ emissions: Evidence from sub-Saharan Africa economies. *Utilities Policy, 41*, 85–94. <https://doi.org/10.1016/j.jup.2016.06.009>
- Adams, S., & Klobodu, E. K. M. (2017). Urbanization, democracy, bureaucratic quality, and environmental degradation. *Journal of Policy Modeling, 39*(6), 1035–1051. <https://doi.org/https://doi.org/10.1016/j.jpmod.2017.04.006>
- Ahmed, Z., Nathaniel, S. P., & Shahbaz, M. (2021). The criticality of information and communication technology and human capital in environmental sustainability: Evidence from Latin American and

- Caribbean countries. *Journal of Cleaner Production*, 286, 125529. <https://doi.org/10.1016/j.jclepro.2020.125529>
- Arellano, M., & Bover, O. (1995). Another look at the instrumental variable estimation of error-components models. *Journal of Econometrics*, 68(1), 29–51. [https://doi.org/10.1016/0304-4076\(94\)01642-D](https://doi.org/10.1016/0304-4076(94)01642-D)
- Bayar, Y., Diaconu, L., & Maxim, A. (2020). Financial development and CO₂ emissions in post-transition European Union countries. *Sustainability*, 12(7), 2640. <https://doi.org/10.3390/su12072640>
- Bernauer, T., & Koubi, V. (2006). States as providers of public goods: How does government size affect environmental quality? *CIS Working Paper*, 14. https://www.files.ethz.ch/isn/16719/WP_14_Bernauer_GovSizeEnvT.pdf
- Birdsall, N., & Wheeler, D. (1993). Trade policy and industrial pollution in Latin America: Where are the pollution havens? *Journal of Environment Development*, 2(1), 137–149. <https://doi.org/10.1177/107049659300200107>
- Biswas, A. K., Farzanegan, M. R., & Thum, M. (2012). Pollution, shadow economy and corruption: Theory and evidence. *Ecological Economics*, 75, 114–125. <https://doi.org/10.1016/j.ecolecon.2012.01.007>
- Blundell, R., & Bond, S. (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics*, 87(1), 115–143. [https://doi.org/10.1016/S0304-4076\(98\)00009-8](https://doi.org/10.1016/S0304-4076(98)00009-8)
- Canh, N. P., Nguyen, N. A., Schinckus, C., & Su, T. D. (2018). The ambivalent role of institutions in the CO₂ emissions: The case of emerging countries. *International Journal of Energy Economics and Policy*, 8(5), 7–17. www.econjournals.com/index.php/ijeep/article/view/6773
- Canh, N. P., Thanh, S. D., Schinckus, C., Bensemann, J., & Thanh, L. T. (2019). Global emissions: A new contribution from the shadow economy. *International Journal of Energy Economics and Policy*, 9(3), 320–337. <https://www.econjournals.com/index.php/ijeep/article/view/7244>
- Chen, Z., Hao, X., & Zhou, M. (2022). Does institutional quality affect air pollution? *Environmental Science and Pollution Research*, 29(19), 28317–283381. <https://doi.org/10.1007/s11356-021-17934-0>
- Chowdhury, M. A. F., Shanto, P. A., Ahmed, A., & Rumana, R. H. (2021). Does foreign direct investment impair the ecological footprint? New evidence from the panel quantile regression. *Environmental Science and*

- Pollution Research*, 28, 14372–14385. <https://doi.org/10.1007/s11356-020-11518-0>
- Cole, M. A., Elliott, R. J., & Shimamoto, K. (2005). Industrial characteristics, environmental regulations and air pollution: An analysis of the UK manufacturing sector. *Journal of Environmental Economics Management*, 50(1), 121–143. <https://doi.org/10.1016/j.jeem.2004.08.001>
- Damania, R., Fredriksson, P. G., & Mani, M. (2004). The persistence of corruption and regulatory compliance failures: Theory and evidence. *Public Choice*, 121(3–4), 363–390. <https://doi.org/10.1007/s11127-004-1684-0>
- Danish, & Ulucak, R. (2020). The pathway toward pollution mitigation: Does institutional quality make a difference? *Business Strategy and the Environment*, 29(8), 3571–3583. <https://doi.org/10.1002/bse.v29.810.1002/bse.2597>
- Dasgupta, S., & De Cian, E. (2016). Institutions and the environment: Existing evidence and future directions. *FEEM Working Paper*, 41. <https://doi.org/10.2139/ssrn.2800948>
- Destek, M. A., & Sarkodie, S. A. (2019). Investigation of environmental Kuznets curve for ecological footprint: The role of energy and financial development. *Science of the Total Environment*, 650, 2483–2489. <https://doi.org/10.1016/j.scitotenv.2018.10.017>
- Dogan, E., & Turkekul, B. (2016). CO2 emissions, real output, energy consumption, trade, urbanization and financial development: Testing the EKC hypothesis for the USA. *Environmental Science Pollution Research*, 23, 1203–1213. <https://doi.org/10.1007/s11356-015-5323-8>
- Doytch, N. (2020). The impact of foreign direct investment on the ecological footprints of nations. *Environmental and Sustainability Indicators*, 8, 100085. <https://doi.org/10.1016/j.indic.2020.100085>
- Durusu-Ciftci, D., Ispir, M. S., & Yetkiner, H. (2017). Financial development and economic growth: Some theory and more evidence. *Journal of Policy Modeling*, 39(2), 290–306. <https://doi.org/10.1016/j.jpolmod.2016.08.001>
- Ezzati, M., Bailis, R., Kammen, D. M., Holloway, T., Price, L., Cifuentes, L. A., Barnes, B., Chaurey, A., & Dhanapala, K. N. (2004). Energy management and global health. *Annual Review of Environment and Resources*, 29, 383–419. <https://infospace.mrc.ac.za/handle/11288/595258>

- Fredriksson, P. G., & Svensson, J. (2003). Political instability, corruption and policy formation: The case of environmental policy. *Journal of Public Economics*, 87(7-8), 1383–1405. [https://doi.org/10.1016/S0047-2727\(02\)00036-1](https://doi.org/10.1016/S0047-2727(02)00036-1)
- Ganda, F. (2019). The environmental impacts of financial development in OECD countries: A panel GMM approach. *Environmental Science Pollution Research*, 26(7), 6758–6772. <https://doi.org/10.1007/s11356-019-04143-z>
- Global Footprint Network (2022). Open data platform. *Global Footprint Network*. <https://data.footprintnetwork.org>
- Goel, R. K., & Nelson, M. A. (1998). Corruption and government size: A disaggregated analysis. *Public Choice*, 97(1-2), 107–120. <https://www.jstor.org/stable/30024416>
- Goldsmith, R. W. (1969). *Financial structure and development*. Yale University Press.
- Hakimi, A., Hamdi, H. J. R., & Reviews, S. E. (2016). Trade liberalization, FDI inflows, environmental quality and economic growth: A comparative analysis between Tunisia and Morocco. *Renewable and Sustainable Energy Reviews*, 58, 1445–1456. <https://doi.org/10.1016/j.rser.2015.12.280>
- Halkos, G. E. (2003). Environmental Kuznets curve for sulfur: Evidence using GMM estimation and random coefficient panel data models. *Environment and Development Economics*, 8(4), 581–601. <https://doi.org/10.1017/S1355770X0300317>
- Hassan, S. T., Khan, S. U.-D., Xia, E., & Fatima, H. (2020). Role of institutions in correcting environmental pollution: An empirical investigation. *Sustainable Cities and Society*, 53, 101901. <https://doi.org/10.1016/j.scs.2019.101901>
- Hosseini, H. M., & Kaneko, S. (2013). Can environmental quality spread through institutions? *Energy Policy*, 56, 312–321. <https://doi.org/10.1016/j.enpol.2012.12.067>
- Ibrahim, M. H., & Law, S. H. (2016). Institutional quality and CO₂ emission–trade relations: Evidence from Sub-Saharan Africa. *South African Journal of Economics*, 84(2), 323–340. <https://doi.org/10.1111/saje.12095>
- International Monetary Fund (IMF) (2022). IMF data portal. *IMF*. <https://data.imf.org>

- Jalil, A., & Feridun, M. (2011). The impact of growth, energy and financial development on the environment in China: A cointegration analysis. *Energy Economics*, 33(2), 284–291. <https://doi.org/10.1016/j.eneco.2010.10.003>
- Kaifeng, L., & Chuanzhe, L. (2011). Construction of carbon finance system and promotion of environmental finance innovation in China. *Energy Procedia*, 5, 1065–1072. <https://doi.org/10.1016/j.egypro.2011.03.188>
- Kapaya, S. M. (2020). Financial development and economic growth in Tanzania: An ARDL and bound testing approach. *Asian Journal of Economics and Banking*, 5(1), 46–65. <http://doi.org/10.1108/AJEB-09-2020-0063>
- Kassouri, Y., & Altıntaş, H. (2020). Human well-being versus ecological footprint in MENA countries: A trade-off? *Journal of Environmental Management*, 263, 110405. <https://doi.org/10.1016/j.jenvman.2020.110405>
- Khan, I., & Hou, F. (2021a). Does multilateral environmental diplomacy improve environmental quality? The case of the United States. *Environmental Science and Pollution Research*, 28(18), 23310–23322. <https://doi.org/10.1007/s11356-020-12005-2>
- Khan, I., & Hou, F. (2021b). The dynamic links among energy consumption, tourism growth, and the ecological footprint: The role of environmental quality in 38 IEA countries. *Environmental Science and Pollution Research*, 28(5), 5049–5062. <https://doi.org/10.1007/s11356-020-10861-6>
- Khan, I., Hou, F., & Le, H. P. (2021). The impact of natural resources, energy consumption, and population growth on environmental quality: Fresh evidence from the United States of America. *Science of the Total Environment*, 754, 142222. <https://doi.org/10.1016/j.scitotenv.2020.142222>
- La Porta, R., Lopez-de-Silanes, F., Shleifer, A., & Vishny, R. (1999). The quality of government. *Journal of Law, Economics, and Organization*, 15(1), 222–279. <https://doi.org/10.1093/jleo/15.1.222>
- Lahiani, A. (2020). Is financial development good for the environment? An asymmetric analysis with CO2 emissions in China. *Environmental Science Pollution Research*, 27, 7901–7909. <https://doi.org/10.1007/s11356-019-07467-y>
- Li, X., & Chan, C. G.-W. (2016). Who pollutes? Ownership type and environmental performance of Chinese firms. *Journal of Contemporary China*, 25(98), 248–263. <https://doi.org/10.1080/10670564.2015.1075718>

- 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. <https://doi.org/10.1016/j.jclepro.2020.122709>
- Nurazi, R., & Usman, B. (2019). Impact of financial development on income inequality and poverty in ASEAN. *Institutions and Economies*, 1–38. <https://ijie.um.edu.my/article/view/18612>
- Ozturk, I., & Acaravci, A. (2013). The long-run and causal analysis of energy, growth, openness and financial development on carbon emissions in Turkey. *Energy Economics*, 36, 262–267. <https://doi.org/10.1016/j.eneco.2012.08.025>
- Porter, M. E., & Linde, C. v. d. (1995). Toward a new conception of the environment-competitiveness relationship. *Journal of Economic Perspectives*, 9(4), 97–118. <https://doi.org/10.1257/jep.9.4.97>
- Povitkina, M. (2015). Democracy, bureaucratic capacity and environmental quality. *QoG Working Paper Series*, 13. https://www.gu.se/sites/default/files/2020-05/QoGWP_2015_13_Povitkina_MP_changes.pdf
- Rizk, R., & Slimane, M. B. (2018). Modelling the relationship between poverty, environment, and institutions: A panel data study. *Environmental Science and Pollution Research*, 25(31), 31459–31473. <https://doi.org/10.1007/s11356-018-3051-6>.
- Salahuddin, M., Alam, K., Ozturk, I., & Sohag, K. (2018). The effects of electricity consumption, economic growth, financial development and foreign direct investment on CO₂ emissions in Kuwait. *Renewable Sustainable Energy Reviews*, 81, 2002–2010.
- Shahbaz, M., Shahzad, S. J. H., Ahmad, N., & Alam, S. (2016). Financial development and environmental quality: The way forward. *Energy Policy*, 98, 353–364. <https://doi.org/10.1016/j.enpol.2016.09.002>
- Shahbaz, M., & Sinha, A. (2019). Environmental Kuznets curve for CO₂ emissions: A literature survey. *Journal of Economic Studies*, 46(1), 106–168. <https://doi.org/10.1108/JES-09-2017-0249>.
- Shahbaz, M., Sinha, A., Raghutla, C., & Vo, X. V. (2022). Decomposing scale and technique effects of financial development and foreign direct investment on renewable energy consumption. *Energy*, 238, 121758. <https://doi.org/10.1016/j.energy.2021.121758>
- Sharif, A., Saha, S., Campbell, N., Sinha, A., & Ibrahim, D. M. (2020). Tourism, environment and energy: An analysis for China. *Current Issues*

- in Tourism*, 23(23), 2930–2949. <https://doi.org/10.1080/13683500.201.1703913>
- Shaw, E. S. (1973). Financial deepening in economic development. *Journal of Finance*, 29(4), 1345–1348. <https://doi.org/10.2307/2978421>
- Sinha, A. (2022). The nexus between urbanization, renewable energy consumption, financial development, and CO₂ emissions: Evidence from selected Asian countries. *Environment, Development and Sustainability*, 24, 6556–6576. <https://doi.org/10.1007/s10668-021-01716-2>
- Solarin, S. A., Al-Mulali, U., Musah, I., & Ozturk, I. (2017). Investigating the pollution haven hypothesis in Ghana: An empirical investigation. *Energy*, 124, 706–719. <https://doi.org/10.1016/j.energy.2017.02.089>
- Svirydzhenka, K. (2016). Introducing a new broad-based index of financial development. *IMF Working Paper*, 5. <https://www.imf.org/en/Publications/WP/Issues/2016/12/31/Introducing-a-New-Broad-based-Index-of-Financial-Development-43621>
- Tamazian, A., Chousa, J. P., & Vadlamannati, K. C. (2009). Does higher economic and financial development lead to environmental degradation: Evidence from BRIC countries. *Energy Policy*, 37(1), 246–253. <https://doi.org/10.1016/j.enpol.2008.08.025>
- Tamazian, A., & Rao, B. B. (2010). Do economic, financial and institutional developments matter for environmental degradation? Evidence from transitional economies. *Energy Economics*, 32(1), 137–145. <https://doi.org/10.1016/j.eneco.2009.04.004>
- Tawiah, V. K., Zakari, A., & Khan, I. (2021). The environmental footprint of China-Africa engagement: An analysis of the effect of China–Africa partnership on carbon emissions. *Science of the Total Environment*, 756, 143603. <https://doi.org/10.1016/j.scitotenv.2020.143603>
- Wang, J., & Dong, K. (2019). What drives environmental degradation? Evidence from 14 Sub-Saharan African countries. *Science of the Total Environment*, 656, 165–173. <https://doi.org/10.1016/j.scitotenv.2018.11.354>
- Wang, Z., Yang, L., Yin, J., & Zhang, B. (2018). Assessment and prediction of environmental sustainability in China based on a modified ecological footprint model. *Resources, Conservation and Recycling*, 132, 301–313. <https://doi.org/10.1016/j.resconrec.2017.05.003>
- Wang, Z., Zhang, B., & Wang, B. (2018). The moderating role of corruption between economic growth and CO₂ emissions: Evidence from BRICS economies. *Energy*, 148, 506–513. <https://doi.org/10.1016/j.energy.2018.01.167>

- Welsch, H. (2004). Corruption, growth, and the environment: A cross-country analysis. *Environment and Development Economics*, 9(5), 663–693. <http://doi.org/10.1017/S1355770X04001500>
- World Bank (2022). World development indicators. *World Bank*. <https://databank.worldbank.org/source/world-development-indicators>
- World Bank (2022). World governance indicators. *World Bank*. <https://www.worldbank.org/en/publication/worldwide-governance-indicators>
- Xiong, L., Tu, Z., & Ju, L. (2017). Reconciling regional differences in financial development and carbon emissions: A dynamic panel data approach. *Energy Procedia*, 105, 2989–2995. <https://doi.org/10.1016/j.egypro.2017.03.716>
- Yamineva, Y., & Liu, Z. (2019). Cleaning the air, protecting the climate: Policy, legal and institutional nexus to reduce black carbon emissions in China. *Environmental Science and Policy*, 95, 1–10. <https://doi.org/10.1016/j.envsci.2019.01.016>
- Yuxiang, K., & Chen, Z. (2011). Financial development and environmental performance: Evidence from China. *Environment Development Economics*, 16(1), 93–111. <https://doi.org/10.1017/S1355770X10000422>
- Zaidi, S. A. H., Wei, Z., Gedikli, A., Zafar, M. W., Hou, F., & Iftikhar, Y. (2019). The impact of globalization, natural resources abundance, and human capital on financial development: Evidence from thirty-one OECD countries. *Resources Policy*, 64, 101476. <https://doi.org/10.1016/j.resourpol.2019.101476>
- Zakaria, M., & Bibi, S. (2019). Financial development and environment in South Asia: The role of institutional quality. *Environmental Science Pollution Research*, 26, 7926–7937. <https://doi.org/10.1007/s11356-019-04284-1>
- Zhang, Y.-J., Jin, Y.-L., Chevallier, J., & Shen, B. (2016). The effect of corruption on carbon dioxide emissions in APEC countries: A panel quantile regression analysis. *Technological Forecasting and Social Change*, 112, 220–227. <https://doi.org/10.1016/j.techfore.2016.05.027>
- Zhang, Y. (2011). The impact of financial development on carbon emissions: An empirical analysis in China. *Energy Policy*, 39(4), 2197–2203. <https://doi.org/10.1016/j.enpol.2011.02.026>