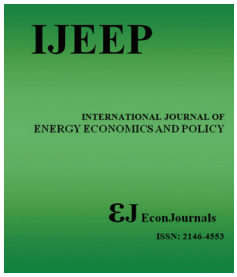

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Influence of Financial Development on Environmental Quality: Research Results from Developing Countries

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ABSTRACT

This study provides evidence supporting the hypothesis that financial development reduces environmental pollution in developing countries. Using an annual dataset of carbon emissions, financial development, and other factors from 1990 to 2020, with the GMM approach, we find that the more developed the financial system, the more advantageous it is for the environment. This conclusion is strengthened when particular facets of financial development are taken into account. Moreover, the impact is also influenced by the countries' wealth levels, in which countries with high average incomes have financial development that has an impact on reducing environmental pollution and the opposite result when viewed. considered in low-middle-income countries. Finally, we offer some policy recommendations regarding financial development to enhance its efficacy in maintaining environmental quality.

Keywords: Environmental Quality, Financial Development, Inverted U-shape, Semi-parametric Test, System GMM
JEL Classifications: C32, F18, O44, Q56

1. INTRODUCTION

Over the past two decades, the relationship between financial development and environmental quality has received attention from both researchers and policymakers (Bayar et al., 2020). First, although humanity has made progress in promoting economic growth, social and sustainable development issues such as poverty, inequality, and environmental pollution have not been resolved satisfactorily, and even more complicated developments (Hübler, 2017; Jiang and Ma, 2019; Jorgenson and Clark, 2012; Uzar, 2020). While the rapidly developing financial system has helped the world economy recover from the 2008 recession (Durusu-Ciftci et al., 2017; Mostafa et al., 2023; Nambie et al., 2023), governments are starting to pay attention to the effects, including positive and negative, of financial development towards sustainable development goals. If the growth of the financial system leads to a decline in environmental quality, policymakers will face a choice between promoting economic growth and protecting the environment. Second, there are two opposing arguments about the impact of financial development on environmental quality. The first argument is that financial development reduces environmental quality because financial development encourages production and consumption activities. These are activities that consume energy, input materials, and emit emissions into the environment. The second argument analyzes the positive role of financial development on environmental quality through financial intermediaries promoting financing activities for environmentally friendly technologies and projects. Although many empirical studies have used different data and methods, there has not been a general and consistent conclusion on the relationship between financial development and environmental quality. The first group of studies shows that developed financial markets, including credit and capital markets, negatively affect environmental quality (Shahbaz et al., 2016; Shahbaz et al., 2013; Zhang 2011). In contrast, another set of studies finds evidence that financial development improves

environmental quality (Lahiani, 2020; Saidi and Mbarek, 2017; Tamazian et al., 2009; Yuxiang and Chen, 2011). This lack of consensus motivates continued research into the relationship between these two important variables.

Since both theory and empirical research show that financial development can have both positive and negative impacts on environmental quality, it is possible to make judgments about the relationship between these two variables depending on economic development. Development of financial markets. At the early stages of financial development, credit, and capital market growth can make the environment more polluted. However, in the later stages of the development process, financial decisions are made based on greater consideration of potential environmental impacts, so the relationship between the two variables changes from negative to positive. Thus, the relationship between financial development and environmental quality can exist in an inverted U shape if the research period is long enough to cover all the shifts in the relationship.

Our research is motivated by the following three important reasons. First, the increasing financial systems in developing countries make concerns about environmental quality more and more apparent. However, most current articles focus on the impact of financial development on environmental pollution in some individual countries such as India, and China. Developing countries have not received much attention. Second, previous studies measuring financial development mainly used single indicators such as credit to the private sector or financial market capitalization. Only using these indicators does not reflect the multidimensional and general nature of financial development. This partly makes the results of previous studies somewhat limited. Third, how the division of countries with different income levels affects the impact of financial development on environmental pollution has not been thoroughly examined in previous studies.

To address these gaps, the study examines the impact of financial development on environmental pollution in 76 developing countries over the period 1990-2021. The financial development index is collected from the International Monetary Fund database, built on two aspects: financial institutions and financial markets in terms of depth, access, and efficiency. Research shows that financial development and environmental pollution are interrelated. Furthermore, the basic findings have robust implications when considering each aspect of financial development. Besides, the impact of financial development on environmental pollution varies depending on the income level of that country. This study contributes to increased awareness of the impact of financial development on environmental pollution in developing countries and examines how countries' income levels influence this impact.

The rest of the paper is organized as follows. The next section summarizes the theoretical basis and research overview. Section 3 introduces data and methodology. Section 4 presents and discusses the results and section 5 concludes.

2. THEORETICAL BASIS AND RESEARCH OVERVIEW

2.1. Theoretical

Financial development can degrade environmental quality through several different channels.

The capitalization impact is the name of the first channel. Businesses can access financial resources through financial development, which motivates them to invest in factories, equipment, and supplies. Energy consumption and emissions into the environment are increased by this investment (Chang, 2015; Dasgupta et al., 2001; Jiang and Ma, 2019; Tamazian et al., 2009); Furthermore, small business establishment and operation are encouraged by development. Because these companies hardly ever follow environmental laws and receive little gain from using eco-friendly technologies, the environmental effects of financial development may worsen (Cole et al., 2005; Sadorsky, 2010; Yuxiang and Chen, 2011). The technology effect is the second channel. Research, development, and technology upgrades are expensive, time-consuming, and dangerous for most businesses. While the financial system's fundamental operations can help to alleviate these issues, funding innovative technology may have detrimental effects on the environment. Technological development strains natural resources and increases emissions into the atmosphere, according to studies by Sanstad et al. (2006) and Brännlund and Ghalwash (2008) (rebound effect). The wealth and income effect is the name of the third channel. Financial development raises people's incomes and encourages economic expansion. People tend to use more energy and save less when their income rises, which has a detrimental impact on the environment's quality (Jiang and Ma, 2019; Ozturk and Acaravci, 2013; Zhang 2011). Furthermore, as income levels rise as a result of financial development, people are more likely to borrow and consume more, both of which can hurt the environment.

On the other hand, financial development also brings positive effects on environmental quality. First, as the financial market grows, companies will be able to obtain finance at more reasonable prices for projects and investment schemes that incorporate more ecologically friendly or protective components. Applying innovative environmentally friendly technology will allow large-scale businesses to realize economies of scale (Cole et al., 2005; Sadorsky, 2010; Yuxiang and Chen, 2011). It is possible to mitigate or even reverse the negative consequences of capitalization effects in a nation with a sophisticated enterprise system. Regarding technological influence, financial development facilitates the realization of environmentally friendly projects and goods by providing funds for research and development as well as technology improvements (Birdsall and Wheeler, 1993; Zakaria and Bibi, 2019); Raising people's environmental consciousness, encouraging them to buy environmentally friendly products, and getting rid of environmentally favorable products are all ways that increased income and affluence can improve the condition of the environment (Lahiani, 2020). Lastly, by applying government rules to lending and investment practices, developed financial markets

can facilitate the easier implementation of environmental laws (Yuxiang and Chen, 2011).

2.2. Research Overview

The impact of financial development on environmental pollution is found in many studies with different perspectives. In terms of how financial growth influences carbon emissions, there are two contrary perspectives in the academic community.

First, financial development, which has structural and technological effects on carbon emissions reduction, helps to reduce emissions (Destek and Sarkodie, 2019). With the gradual improvement of a country's financial system, the government can channel funds to relevant industries, optimize the industrial mix, and reduce carbon emissions by providing green credit funds for low-pollution enterprises. Haseeb et al. (2018) studied the effects of energy use, financial growth, globalization, economic development, and urbanization on environmental degradation in the BRICS countries. Energy use and financial development have a positive impact on environmental deterioration, while globalization and urbanization have a negligible and insignificant impact. Majeed and Mazhar (2019) explore the environmental effects of financial development for a panel of 131 countries over the period 1971-2017. Their findings show that financial development supports environmental quality by reducing the ecological footprint. However, energy use, FDI, and GDP per capita deteriorate environmental quality. Zaidi et al. (2019) determines the dynamic linkages between globalization, financial development, and carbon emissions in Asia Pacific Economic Cooperation (APEC) countries in the presence of energy intensity and economic growth under the framework of Environment Kuznets Curve (EKC). Zaidi et al. (2019) employ the panel data from 1990 to 2016, the Westerlund cointegration technique to find long-run cointegration, and Continuously Updated Bias-Corrected (CUP-BC) and Continuously Updated Fully Modified (CUP-FM) methods to check the long-run elasticities between the variables. Empirical results indicate that globalization and financial development significantly reduce carbon emissions, but economic growth and energy intensity increase them. Cetin et al. (2018) examine the impact of economic growth, energy consumption, trade openness, and financial development on carbon emissions in the case of Turkey by using annual time series data from 1960 to 2013. The cointegration analysis reveals that there exists a long-run relationship between the per capita real income, per capita energy consumption, trade openness, financial development, and per capita carbon emissions in the presence of structural breaks. The results show that in the long run, carbon emissions are mainly determined by economic growth, energy consumption, trade openness, and financial development, in particular, financial development reduces carbon emissions, thereby reducing environmental pollution. Ganda (2019) investigated the environmental effects of financial development in OECD countries from 2001 to 2012 by employing static models and system GMM analysis. The study utilized foreign direct investments, domestic credit to the private sector by banks, and domestic credit to the private sector as the three proxies of financial development. The effects of these measures of financial development were examined on carbon emissions and greenhouse gases (indicators of environmental quality) and environmental sustainability. In this setting, the findings of the research spotlight that domestic credit to the private sector by banks shows a negative and significant relationship with carbon emissions, greenhouse gases, and sustainability. Conversely, domestic credit to the private sector and economic growth indicate a positive and statistically significant relationship with carbon emissions, greenhouse gases, and sustainability.

Second, some other researchers believe that increasing financial development will raise carbon emissions on the contrary. The increase in financial development will not only facilitate the consumption of household loans (Sarkodie and Strezov, 2019) but also lead to the expansion of consumer spending, resulting in a substantial increase in social energy demand (Riti et al., 2017). Zakaria and Bibi (2019), using their panel data technique, analyzed the linkages between political, institutional, and environmental efficiency, demonstrating that financial development substantially lowers the quality of the environment and institutional quality is the reverse of it. Jiang and Ma (2019) examine the relationship between financial development and carbon emissions based on the system generalized moment method and data for 155 countries, and we further analyze the differences differentiate between countries by dividing the sample countries into two subgroups: developed countries, and emerging market and developing countries. Empirical results indicate that from a global perspective, financial development can significantly increase carbon emissions, and analyses of emerging markets and developing countries reach similar conclusions. However, the results indicate that for developed countries, the impact of financial development on carbon emissions is insignificant. More recently, the panel vector autoregressive (PVAR) approach was used (Charfeddine and Kahia, 2019) in twenty-four MENA countries and found that financial development plays a positive contribution towards accelerating carbon emission levels. Majeed et al. (2020) explore linear and nonlinear effects of financial development on CO_2 emissions in Pakistan using time series data over the period 1972-2018. The ARDL estimates show that financial development escalates CO_2 emissions, while nonlinear ARDL estimates show that it does not confirm a positive and significant association between financial development and CO_2 emissions. Samreen and Majeed (2020) investigated the effect of financial development on carbon emissions including economic growth, industrial growth, and renewable energy consumption as control variables for 89 developed and developing countries over the period 1992-2014. The results of their study reveal heterogeneous effects of financial development emissions according to the income group of countries. In particular, financial development mitigates emissions in developed economies while escalating emissions in developing countries.

Supports the idea that there is no discernible relationship between financial development and environmental pollution, research has been done in Turkey by (Ozturk and Acaravci, 2013), Kuwait by (Salahuddin et al., 2018), the USA by (Dogan and Turkekul, 2016), 12 Asian countries by (Lu, 2018). Most recently, our research found that there exists an inverted U relationship between financial development and environmental pollution in 112 countries. This

means that financial development will increase environmental pollution in the early stages, up to a certain threshold when the effectiveness of financial development increases, it will contribute to improving environmental quality.

Consequently, to examine the impact of financial development on CO_2 emissions in developing nations, this study revisits the link mentioned above using GMM estimators. Based on the above analysis and the characteristics of developing countries, we propose the following hypothesis:

H1: Financial development reduces the level of environmental pollution in developing countries.

Because of these reasons and concerns in the literature, our research attempts to extend the discussion about the impact of financial development on environmental degradation. The potential marginal contributions of our study are as follows:

First, the financial market and financial institutions are the two components that make up the financial development indicator. This classification may provide a more accurate picture of developing nations' financial development. They improve the analysis of how financial development affects carbon dioxide emissions.

Second, the relationship between urbanization and carbon emissions or financial development and carbon emissions is the focus of increasing research. Either the model excludes or the impact of additional economic and social factors on carbon dioxide emissions is insufficient. This paper successfully integrates multiple influencing factors (financial development, economic growth, urbanization, trade openness) based on the multi-dimensional commonality, taking into account that it is unable to reach entirely convincing conclusions. It then thoroughly examines the short- and long-term effects of multiple indicators on carbon emissions, making the research conclusion more applicable and relevant.

Third, to test the robustness of the model, the study also divided the large sample into small samples by aspect, income level, or impact assessment by different methods. The results of each method will increase the reliability of the research.

3. DATA AND METHODOLOGY

3.1. Sample and Data

This study examines annual data from 76 countries. Financial development variables are collected from the database of the International Monetary Fund. The remaining variables are collected from the database of the World Bank. The countries that have (1) fewer than 3 years of uninterrupted observations or (2) outlier data, which could lead to measurement errors and hence impact risk assessment, are not included in the data collection. Every variable is gathered and calculated for the years 1990 through 2021. To reduce outliers in our sample, all financial variables are winsorized at the 1% and 99% levels.

3.2. Empirical Models

3.2.1. Baseline estimation

This research applies a dynamic model to describe the relationship between financial development and carbon emissions. The model has the following form:

$$CO_{2(i,t)} = \alpha CO_{2(i,t-1)} + \beta_1 FD_{(i,t)} + \gamma CT_{(i,t)} + \vartheta_{(i)} + \mu_t + \varepsilon_{(i,t)} \quad (3.1)$$

Following the study of Chu (2022), we test whether there exists an inverted U relationship between financial development and environmental pollution in developing countries during the study period, by adding the square of the financial development variable to model 3.1. Accordingly, if the coefficients of these two variables have negative and positive values, respectively, it means that an inverted U relationship exists.

$$CO_{2(i,t)} = \alpha CO_{2(i,t-1)} + \beta_1 FD_{(i,t)} + \beta_2 FD^2_{(i,t)} + \gamma CT_{(i,t)} + \vartheta_{(i)} + \mu_t + \varepsilon_{(i,t)} \quad (3.2)$$

Where:

$CO_2(i,t)$ denotes carbon emissions for the nations (i) in the year (t). Environmental pollution can be measured through air pollution and soil and water pollution. Air pollution is measured by emissions of NO_2, CO_2, SO_2 and dust and noise concentrations. Following (Arouri et al., 2012; Bastola and Sapkota, 2015; Beghin et al., 2002) the study used a measure of environmental pollution as CO_2 emission level per capita (tons/person) to consider the impact of financial development on environmental pollution.

$FD_{(i,t)}$ is financial development for the nation (i) in the year (t). Following Svirydzenka (2016), financial development is measured through two aspects of financial institutions and financial markets with each aspect consisting of three sub-indicators: depth, access, and efficiency. Using this index reflects the multidimensionality of the financial development index (Čihák et al., 2012). Higher FDI indicates that the country has a higher level of financial development, and $CT_{(i,t)}$ are control variables including total population (POP), urbanization rate (URP), energy consumption (ENE), economic growth (GDP), and credit to the private sector (DCP). $\vartheta_{(i)}$ and μ_t are country and time dummy variables. time, $\varepsilon_{(i,t)}$ are the residuals, symbols i and t indicate country and time. Refer to Table 1 for detailed definitions and measurements of all variables.

3.3. Estimation Method

This study used the system GMM estimator of (Blundell and Bond, 1998) and (Arellano and Bover, 1995) to improve efficiency results. We used the lagged levels of independent variables as a tool to avoid simultaneity biases in our study model and tended to convert the model into the first difference for dispensing the nation categorical effect (Arellano and Bover, 1995). On the other hand, Arellano and Bover (1995) proposed merging different equipollence and suggesting the system GMM estimator caliber. Sys-GMM is appropriate for this study for two reasons: first, GMM is used to adjust for endogeneity and country-specific effects, as

Table 1: Definitions and Measurements

Variables	Definitions	Measurement
Ln CO_2	Emissions per capita, representing environmental quality	Natural logarithm CO_2
FD	Financial development	
POP	Total population	Natural logarithm
URP	Urbanization rate	The ratio of the urban population to the total population
GDP	Economic growth	Natural logarithm of per capita income
ENG	Energy consumption	The ratio of energy use per person to the total population
OPE	Trade openness	Total import and export volume per GDP
DCP	Credit to the private sector	The ratio of credit to the private sector to GDP

Table 2: The impact of financial development on environmental pollution

Variables	Coef.	P-value
C02 (1)	0.918	0.000***
FD	−0.426	0.002***
URB	−0.002	0.106
GDP	0.000	0.000***
GDP^2	−2.88e–09	0.000***
TRA	0.004	0.000***
DCP	−0.000	0.054*
ENE	0.004	0.000***
POP	0.033	0.468
Cons	−0.368	0.237
Number of groups	82	
Number of instruments	50	
AR (2)	0.159	
Sargan test	0.213	
Hansen test	0.268	

*,**, and *** represent statistical significance levels of 10%, 5%, and 1%, respectively

well as for partiality of omitted variables on financial development and carbon emission consumption. Second, it is suggested for circumstances in which the study's duration is brief in a study with a sizable sample size (Roodman 2006); nonetheless, this justification is untrue in the present investigation. As a result, we are using system-GMM and two-step GMM.

4. RESULTS RESEARCH

4.1. The Impact of Financial Development on Environmental Pollution-Analysis Based on the Composite FDI Index

To assess how development affects environmental pollution, the study tests model 3.1 using the SGMM approach; the results are shown in Table 2.

Table 2 results show:

First, there is a positive correlation between last year's environmental quality and this year's environmental pollution, as indicated by the positive sign and significance of the coefficient of the lagged variable of the dependent variable at the 1% level. Because of this, environmental pollution has long-term effects, which supports the study's use of dynamic models.

Second, at the 1% significance level, the financial development variable negatively affects environmental quality. This suggests that as emerging nations become more financially developed, environmental contamination will decline and the quality of the environment will increase. The "improving pollution" hypothesis is supported by this outcome, which is also in line with the scientific findings of (Destek and Sarkodie, 2019), Zaidi et al. (2019), Ganda (2019). Financial development will enable companies to quickly and affordably obtain funds from the market to participate in environmentally friendly initiatives following economic development plans in nations. Furthermore, financial development assists companies in securing funding for their R&D and technical innovation endeavors, ultimately leading to the production of eco-friendly goods. schools, better fulfilling the requirements of individuals (Birdsall and Wheeler, 1993; Zakaria and Bibi, 2019). People's wealth and income also rise as a result of financial progress. A rise in money will make people more conscious of their surroundings and provide them with more options. unhealthy consumerism in the direction of eschewing products with elements that are bad for the environment and opting to choose green, tidy, and attractive things instead. The production and business processes of the company are also somewhat impacted by this position (Lahiani, 2020). Lastly, when banks and other financial organizations operate and provide financing for enterprises, the legal system of their operations is further refined by financial development. environmentally friendly production and business practices (Yuxiang and Chen, 2011).

Third, there is some influence of the model's control variables on pollution in the environment. Specifically, factors related to energy consumption and trade openness influence rising CO_2 emissions, whereas factors related to institutional quality lower CO_2 emissions.

Additionally, the SGMM approach can address the research problems because the model's instrumental variables are adequate and the AR2, Hansen, and Sargan tests yield ratios that are all above 0.1.

4.2. Testing the Inverted U Relationship between Financial Development and Environmental Pollution

The study uses the GMM method to test the inverted U relationship between financial development and environmental pollution through model 3.2, the results are presented in Table 3.

The results of Table 3 show that in column 4, the coefficient of the financial development variable and its square are not statistically significant and negative, proving that there is no inverted U-shaped relationship between financial development and the cell. environmental pollution in 76 developing countries.

4.3. Robustness Test

4.3.1. The impact of aspects of financial development on environmental pollution

The study considers the effects of financial development aspects on carbon emissions: the financial market aspects (FMI) and the

financial institution aspect (FII), to assess the influence of financial development on environmental pollution even more. Table 4 presents the findings.

Table 4 demonstrates that lowering the degree of environmental pollution is influenced by both facets of financial development. Within that:

The financial institutions component has a negative FII coefficient that is statistically significant at the 1% level, indicating that the growth of these institutions will have a major positive impact on lowering environmental pollution in developing nations. Nations in development. Commercial banks make up the majority of financial institutions, which also include mutual funds, insurance providers, and other financial institutions. The primary source of capital for enterprises is commercial banks. Commercial banks will use a variety of strategies to offer small and medium-sized businesses funding thanks to the current growth in financial accessibility. Next, establishing the framework so that companies can obtain more loans to invest in machinery and current technologies, enhancing production and reducing pollution to the environment. Furthermore, credit unions have been aggressively finishing up lending procedures and implementing favorable regulations lately, which has encouraged lending in eco-friendly industries and established a foundation for more enterprises. Loan accessibility has improved. As a result, as financial institutions grow, pollution of the environment will decrease.

With a negative FMI variable coefficient that is significant at the 1% level, the financial market component indicates that the developed financial system helps to lower the degree of pollution in the environment. Bonds and stocks are two aspects of the financial market. Businesses might expand their capital investment in machinery as the financial sector grows because it will become easier for them to mobilize capital through the stock and bond markets. The use of contemporary machinery enhances business and production procedures. The green bond and green corporate bond markets have been developed by governments recently, both globally and in poor nations specifically. To limit projects that harm the environment and thereby lower the level of environmental pollution, mechanisms and policies about the development of these markets are constructed in a way that fosters the ability of subjects to mobilize green bond capital for the implementation of green projects.

Moreover, environmental pollution restrictions are becoming increasingly stringent as the financial market grows. Businesses are required to publish environmental and social information, for instance, under Vietnamese stock market regulations on information disclosure. Businesses will specifically be required to disclose their long- and short-term sustainable development goals, encompassing the environment, society, and community, inside their Annual Reports. The implementation of this rule will

Table 3: Testing the inverse U

Variables	Testing the inverse U			
	Coef (1)	P-value (2)	Coef. (3)	P-value (4)
C02 (1)	0.918	0.000***	0.846	0.000***
FD	−0.426	0.002***	−1.157	0.227
FD2			1.874	0.062*
URB	−0.002	0.106	−0.007	0.001***
GDP	0.000	0.000***	0.000	0.000***
GDP^2	−2.88e–09	0.000***	−1.54e–09	0.000***
TRA	0.004	0.000***	0.002	0.002***
DCP	−0.000	0.054*	−0.002	0.000***
ENE	0.004	0.000***	0.004	0.000***
POP	0.014	0.468	−0.095	0.002***
Cons	−0.368	0.237	1.939	0.000
Number of groups	82		82	
Number of instruments	50		50	
AR (2)	0.159		0.150	
Sargan test	0.168		0.107	
Hansen test	0.269		0.219	

*,**, and *** represent statistical significance levels of 10%, 5%, and 1%, respectively

Table 4: The impact of aspects of financial development on environmental pollution

Variables	Financial Development (FD)		Financial institution aspect (FII)		Financial market aspects (FMI)	
	Coef.	P-value	Coef.	P-value	Coef.	P-value
$C0^2$ (1)	0.918	0.000***	0.889	0.000***	0.922	0.000***
FD	−0.426	0.002***				
FII			−0.659	0.000***		
FMI					−0.190	0.062*
URB	−0.002	0.106	−0.001	0.245	−0.001	0.065*
GDP	0.000	0.000***	0.000	0.000***	0.000	0.000***
GDP^2	−2.88e − 09	0.000***	−3.64e − 09	0.000***	−2.51e − 09	0.000***
TRA	0.004	0.000***	0.004	0.000***	0.003	0.000***
DCP	−0.000	0.054*	−0.000	0.078*	−0.000	0.002***
ENE	0.004	0.000***	0.003	0.000***	0.003	0.000***
POP	0.033	0.468	−0.013	0.763	0.226	0.626
Cons	−0.368	0.237	−0.014	0.962	−0.273	0.397
Number of groups	82		82		82	
Number of instruments	50		50		50	
AR (2)	0.159		0.164		0.157	
Sargan test	0.213		0.247		0.197	
Hansen test	0.268		0.375		0.253	

*,**,*** represent statistical significance levels of 10%, 5% and 1%, respectively

help firms become more conscious of environmental preservation. Additionally, it is a factor that investors should take into account when making investments, facilitating the selection of green securities products, boosting funding for companies that make green area investments, and minimizing negative environmental consequences.

4.3.2. The impact of financial development on environmental quality-dividing countries according to different income levels

One of the many variables influencing the effect of financial development on environmental degradation is income. As a result, to assess the impact mentioned above even more, the study split the data set into two categories: lower- and upper-middle-income nations. The outcomes are displayed in Table 5.

Table 5's findings demonstrate that while the financial development coefficient is favorable for developing nations with higher middle incomes, it is negative for those with lower middle incomes. This indicates that while financial development raises carbon emissions in emerging nations with lower middle incomes, it decreases them in those with upper middle incomes. The fact that upper-middle-income emerging nations typically have sophisticated industrial systems and stringent environmental restrictions helps to explain this outcome. As a result, companies frequently invest in technological innovation without growing their operations, and the government places a high priority on encouraging the growth of green financing, which increases funding for environmental protection initiatives. Development in the financial sector can also increase consumption, which increases emissions, although these positive and negative consequences usually offset the negative effects of expansion financial progress on carbon emissions.

On the other hand, developing nations with lower middle-class incomes frequently experience tremendous economic pressure, with output growth taking precedence above environmental preservation. Companies usually use borrowing to increase their production scale instead of creating energy-efficient technologies. Thus, the growth of the financial industry may contribute to an indirect rise in carbon emissions. Comparable to the research of (Jiang and Ma, 2019; Shahbaz et al., 2016; Xiong and Tu, 2017) these empirical findings demonstrate how national variations in the influence of financial development on carbon emissions can be found.

The study specifically discovered that low-income nations have a nonlinear relationship between financial development and environmental pollution, whereas high-middle-income countries do not (Table 6).

In column 2, Table 6 shows that the coefficients of variables FD and FD2 receive positive and negative values at the 5% and 1% significance levels, which proves that there is an inverted U-shaped impact of financial development on pollution. Environment in these groups of countries. Accordingly, financial development is not a threat but a tool to improve the environment in the future. Specifically, environmental pollution increases in the early stages of financial development, when negative factors from the impact of capitalization, technology, income, and assets have a strong impact. However, through a certain development milestone, environmental quality will improve. This relationship is shown in Figure 1

Table 5: The impact of financial development on environmental pollution in different income groups of countries

Variables	Low average income		High average income	
	Coef.	P-value	Coef.	P-value
$C0^2$ (1)	0.637	0.000***	0.625	0.001***
FDI	0.017	0.066*	−5.974	0.000***
URB	−0.051	0.000***	0.003	0.904
GDP	0.001	0.001***	0.000	0.002***
GDP^2	−1.40e−07	0.006***	−1.38e−08	0.049**
TRA	0.006	0.003***	0.010	0.000***
DCP	−0.010	0.005***	0.003	0.350
ENE	−0.110	0.891	0.013	0.165
POP	0.065	0.278	0.350	0.019**
Cons	−0.050	0.964	5.403	0.000
Number of groups	24		29	
Number of instruments	19		17	
AR (2)	0.539		0.153	
Sargan test	0.939		0.981	
Hansen test	0.991		0.845	

*,**,*** represent statistical significance levels of 10%, 5% and 1%, respectively

Table 6: Testing the inverse U

Variables	Low average income	
	Coef (1)	P-value (2)
$C0^2$ (1)	0512	0.000***
FD	0.021	0.023**
FD^2	−4.205	−0.067*
URB	−0.024	0.072*
GDP	0.000	0.055*
GDP^2	−7.38e−08	0.098*
TRA	0.005	0.023**
DCP	−0.005	0.060*
ENE	2.973	0.144
POP	0.055	0.250
Cons	−1.020	0.239
Number of groups	24	
Number of instruments	20	
AR (2)	0.576	
Sargan test	0.968	
Hansen test	0.838	

*,**,*** represent statistical significance levels of 10%, 5% and 1%, respectively

Figure 1: Graph of the relationship between financial development and environmental pollution in developing countries with lower-middle-income

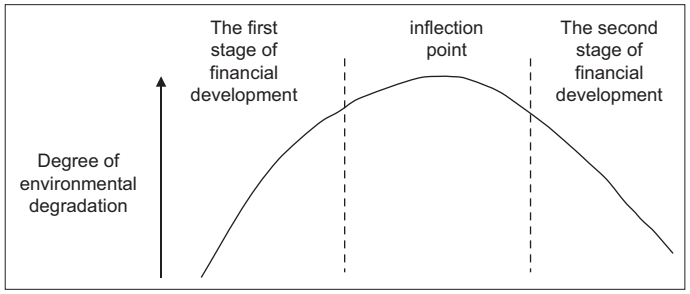

Table 7: Regression results with different methods

	OLS	FEM	REM	GLS
$C0^2$ (1)	0.965***-	0.837***	0.953***	0.965***
FD	0.001***	−0.006***	−0.001***	−0.001***
URB	0.289***	0.161	0.310***	0.289***
GDP	0.000***	0.000***	0.000***	0.000***
GDP^2	−1.366e−09***	−2.837e−09***	−1.669e−09***	−1.366e−09***
TRA	−0.000	0.000	2.834e−06	−0.000
INS	−0.000	−0.000	−0.000*	−0.000
ENE	0.001***	0.004***	0.001***	0.001***
POP	−0.007	0.047	−0.005	−0.007
Cons	0.060	0.505	0.437	0.060
Prob >F	0.000	0.000	0.000	0.000
R2	0.991	0.989	0.991	

*,**,*** represent statistical significance levels of 10%, 5% and 1%, respectively

4.3.3. Test using other estimation methods

The GMM approach is used in the study to estimate the models since it is a useful tool for resolving dynamic panel endogeneity issues. The impact of financial development on carbon emissions and the reliability of our empirical findings were investigated in this section using static panels and conventional estimation techniques, such as OLS, fixed effects (FE), random effects (RE), and regression GSL (Table 7). Per prior findings, all FD coefficients are significant at the 1% level. Although the fixed effect model outperforms the random effects model according to the Hausman test, both of our reported results were quite similar. The study discovered that the values of the coefficients estimated by fixed effects, random effects, and GMM were fairly similar, which further suggests that our model may not have a significant endogeneity issue. These empirical results also show that our conclusions are consistent across various model specifications.

5. CONCLUSION

The findings of this study, which used data from developing nations between 1990 and 2021, demonstrate that financial development affects lowering environmental pollution. Nevertheless, the influence varies based on the countries' income levels. Moreover, the findings indicate that there is an inverse U-shaped association between financial development and environmental degradation in low-income countries. As a result, the governments of these nations may progressively think about implementing policies to make effective use of financial instruments (from the start) to regulate environmental quality standards. credit, capital raising, information transparency, and other factors connected to the objective of environmental preservation.

While it is not feasible to entirely undo the adverse effects of the initial phases of financial development, implementing these strategies can aid in reducing the detrimental influence of financial development on environmental standards. In addition, governments must find ways to foster the growth of financial markets as, as these markets advance, their beneficial effects on the environment will outweigh their detrimental effects. A pole. At that point, synchronizing the aforementioned instruments with financial instruments will optimize environmental protection efficacy.

Although the concerns have been resolved via the research, there are still measurement issues with the independent variable. Consequently, to improve the sustainability of the findings, we will assess environmental contamination in the future using a wide range of variables, including methane, fine dust, and ecological footprint.

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