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Financial Development and CO2 Emission: An Empirical Analysis

Owais Ibni Hassan[1] and Tajamul Rehman Sofi[1]
[1]*Department of Economics, Jamia Millia Islamia, New Delhi.*
E-mail: owaisibnihassan@gmail.com, tajamulsofi.eco@gmail.com

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Abstract: The purpose of this study is to explore the relationship between financial development and carbon dioxide (CO_2) emissions in India from 1960 to 2020. The Vector Error Correction Model (VECM) is used to determine the causal direction. As per the findings of the study, financial development has a significant effect on CO_2 emissions. Moreover, economic development and investment, have a detrimental effect on environmental quality because it releases a significant amount of CO_2 emissions into the environment. Our empirical findings confirmed the presence of an environmental Kuznets curve. The outcomes of the VECM show that the long-run causality can be noticed in CO_2 emissions, financial development, and investment. Furthermore, the validity and reliability of the results were verified by using a variety of diagnostic tests. This research presents novel results that add to the current literature and may be of particular importance to the country's policymakers regarding the financial system and its importance in environmental problems.

INTRODUCTION

The relationship between economic development and pollution has a vast complex history and its understanding has been fragmented by disciplinary biases. Environmental scientists and economists have diverged on the urgency of diminution mechanisms and the marginal returns on investment in control technologies and social adaptations.

A more integrated framework is needed when considering the path to a circular economy where pollution itself can be used as a tangible asset for use in products to reduce waste. This is especially true in developing countries, where pollution rates have risen most dramatically and governments and businesses often face conflicting explanations about the

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impact of environmental regulations on economic growth and overall human development. The relationship between pollution and economic development is complex, with multiple potential feedback loops based on economic growth, ecosystem resilience, and ultimately the driving force and consequences of financial capital dependence on nature. .. The goal for achieving the Sustainable Development Goals (SDGs) is an opportunity to revise and organize the debate between pollution and economic development.

Historically, the modern environmental movement, which began in the industrialized world in the 1960s, has blamed economic development as a major cause of pollution. Studies such as the Club of Rome Report (Meadows *et al.* 1972) the economy continued depleting natural resources and reached unpredictable and perhaps unacceptable levels of pollution when the economy continues in the same pattern, resulting in large environmental and human consequences. Over the years Economic growth and a clean environment seemed to be the opposite and interchangeable, so zero or negative economic growth could be a solution to the ecological problems of avid environmentalists, especially in the more industrialized countries of the time. The environmental economic conflict pervaded the debate at the United Nations Conference on Human Development in Stockholm in 1972.

Figure 1: these are connections that focus on the five basic compounds identified in paths A, B, C, D, and E from the literature in this figure, and

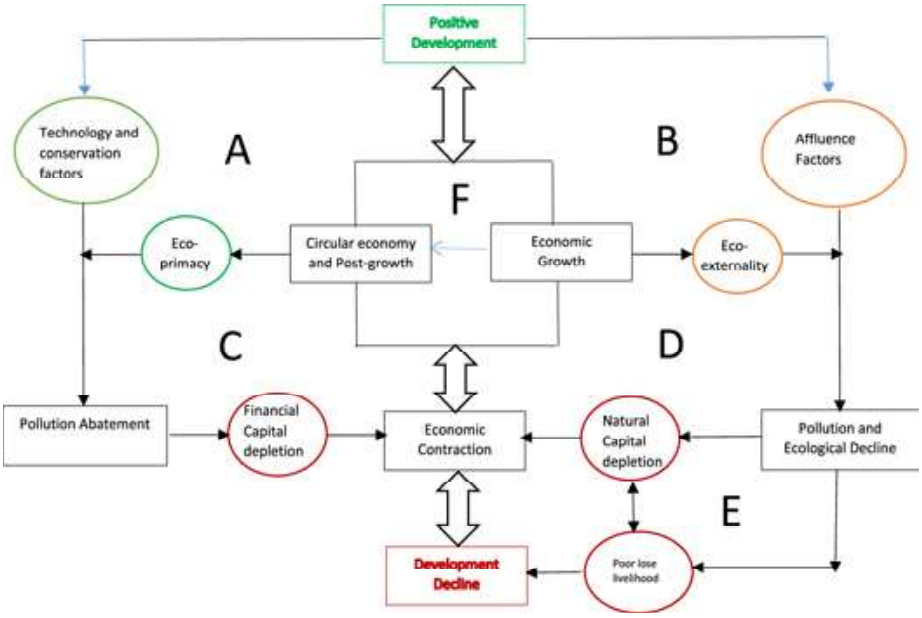

Figure 1

also describe some of the other feedback loops. Link. This figure is intended to reflect the various debates and controversies in the field represented by the possible causal pathways and is intended to represent an exhaustive or deterministic diagram of all possible causal mechanisms. I have not. Some of the most common intervening variables that can guide us in either way are further presented and explained in the attached text.

The extreme nodes of the vertical development axis of the figure are anticipated to reflect the range of established and accepted development goals. Economic growth is the primary route to achieving positive development goals, but alternative approaches concerning urgent environmental challenges may guide us through the circular economy or post-growth development models. Is also being considered. Opportunity for "win-win" results. This figure is intended to provide a variety of possible pathways and impact categories as a heuristic exercise rather than a deterministic model.

2. BRIEF REVIEW

Haseeb, Enjun Xia, Danish, *et al.*, (2018) study was to examine the impact of energy consumption, financial development, globalization, economic growth, and urbanization on carbon dioxide emission in the presence of the EKC model for BRICS countries by adopting the different econometric techniques

Dogan E & Turkeku B (2016) investigated the relationship between carbon dioxide (CO_2) emissions, energy consumption, real output (GDP), the square of real output (GDP^2), trade openness, urbanization, and financial development in the USA for the period 1960–2010. In the long run, energy consumption and urbanization increase environmental degradation while financial development has no effect on it, and trade leads to environmental improvements. In addition, this study does not support the validity of the US Ecological Kuznets Curve (EKC) hypothesis, as GDP^2 increases gas emissions while actual production leads to environmental improvements. The causal relationship between CO_2 and GDP, CO_2 and energy use, CO_2 and urbanization, GDP and urbanization, and GDP and trade openness was two-way. No causal link is found between CO_2 and trade openness, Gas emissions, and financial development. In addition, there is ample evidence to support a one-way causal link from GDP to energy use, financial development to output, and urbanization to financial development. It should be noted that efficient energy policy development is likely to contribute to the reduction of CO_2 emissions without affecting actual production.

U. K. Pata, (2018) this study followed three three cointegration tests, results stated that there was a long-run relationship between these variables.

The coefficients obtained from the ARDL, fully modified least squares (FMOLS) and canonical cointegrating regression (CCR) estimators showed that economic growth, financial development, and urbanization increase environmental degradation, while total renewable energy consumption, hydropower consumption, and alternative energy consumption had no effect on CO2 emissions for Turkey during 1974–2014. In addition, the findings showed that economic growth caused the utmost increases in CO2 emissions, followed by urbanization and financial development. While renewable energy consumption was not at a desirable level to reduce CO2 emissions. The study also supports the environmental Kuznets curve (EKC) hypothesis, which establishes an inverted U-shaped relationship between economic growth and CO2 emissions. The overall effects indicated that Turkey has not reached the level of per capita GDP that can minimize environmental pollution and the renewable energy consumption is not a solution to reduce CO2 emissions.

Nasreen. S, & Anwar. S, (2015) this study examined the impact of financial development and energy consumption on environmental degradation using panel data for the period 1980 to 2010. The results reveal that financial development reduces the degradation of the environment in the high-income panel and increases the degradation in the low-income panel. EKC is valid at all income levels. Causality results show the evidence of bidirectional causality between financial development and CO_2 emission in the high-income panel, and unidirectional causality from financial development to CO_2 emission in the middle- and low-income panels.

Nitin Koshta, Hajam Abid Bashir, & Taab Ahmad Samad (2020) The purpose of this study was to analyse the presence of the EKC hypothesis in emerging economies, to explore the existence of the "resource curse hypothesis" (RCH), and the causal relationship among the variables for a panel of selected emerging economies for the period between 1990 and 2014. The Findings Reveal that the long-run estimates obtained from DOLS and FMOLS techniques support the presence of the EKC (inverted U-shape) and the RCH.

Mahmood T, Shireen S, Mumtaz M (2021) this study has tested the Environmental Kuznets Curve (EKC) hypothesis within the STIRPAT and applied the Stochastic Impact by Regression on Population, Affluence, and Technology (STIRPAT) framework to examine the impact of population, economic growth, economic development, urbanization, and energy use on per capita carbon emissions for India and China. Results further show that the existence of EKC for China and India has been found and population and energy are is positively related to CO2 discharges. In the case of India, urbanization positively affects CO2 discharges whereas for China our

findings show that urbanization helps in reducing CO2 discharges. However, domestic loan to the private sector has resulted in environmental degradation in case of both countries.

The EKC literature mostly uses energy consumption as a control variable. Thus, many researchers use financial development as an important determinant of environmental performance. Indeed, the most obvious reason to use financial development as an important determinant in this relationship is that the existence of a well-developed financial sector improves the efficiency of the allocation of capital which promotes economic growth and thus affects the environmental quality as Frankel and Romer (1999).

Tamazian *et al.* (2009) study empirically whether financial development affects carbon emissions for BRIC countries. They argue that developed capital markets help reduce financing costs and channel financial resources to purchase new equipment and finance new projects, which, in turn, create energy demand and affect CO2 emissions. Moreover, their analysis indicates that financial development supports effective technologies in the energy plan and therefore reduces carbon dioxide emissions. In the same context

Tamazian and Rao (2010) examine the association between financial development and environmental degradation by integrating institutional quality into carbon dioxide emission functions. They find that financial development improves environmental quality by reducing CO2 emissions in countries with strong institutions.

Zhang and Lin (2010) show that financial development encourages listed companies to use energy-efficient technology, which in turn helps reduce carbon emissions.

Ozturk and Acaravci (2013) study the causal relationship between financial development, trade, economic growth, energy consumption, and carbon emissions in Turkey. Their results show that there is a long-term causal relationship between per capita energy consumption, real per capita income, the square of real per capita income, openness and financial development, and per capita carbon emissions.

Shahbaz *et al.* (2013a) examine the causal links between economic growth, energy consumption, financial development, trade openness, and CO2 emissions in Indonesia. They show, in turn, that economic growth and energy consumption increase CO2 emissions, while financial development and trade openness reduce it.

Al-Mulali *et al.* (2016) empirically study the link between financial development and carbon dioxide emissions in European countries; they show that financial development reduces the quality of the environment by increasing carbon dioxide emissions.

Abbasi and Riaz (2016) re-evaluate the association of financial development with carbon dioxide emissions by including foreign direct investment in the carbon dioxide emission equation.

Salahuddin *et al.* (2015) examine the relationship between carbon dioxide emissions, economic growth, electricity consumption, and financial development in the Gulf Cooperation Council (GCC) countries using panel data for the period 1980-to 2012. The results suggest that electricity consumption and economic growth stimulate CO2 emissions in GCC countries while financial development reduces them.

Shahbaz *et al.* (2016) examined the asymmetric impact of financial development on the quality of the environment in Pakistan for the period from the first quarter of 1985 to the fourth quarter of 2014. They concluded that bank-based financial development is detrimental to the environment.

Nasreen *et al.* (2017) show that financial stability improves the quality of the environment, while economic growth, energy consumption, and population density are detrimental to the quality of the environment in the long run in South Asian countries over the period 1980-to 2012.

Ali-Bekhet *et al.* (2017) study the causal relationships between carbon emissions, financial development, economic growth, and energy consumption of the gulf cooperation council (GCC) countries from 1980 to 2011. The results suggest long-term and causal relationships between carbon emissions, financial development, gross domestic product (GDP), and energy consumption in all GCC countries.

3. METHODS AND MATERIALS

3.1. Data Source

The data used for this study is secondary data. The data is obtained from the World Development Indicators for all the variables used in the study from the period 1960 to 2020.

3.2. Model Specification

Earlier analyses use a variety of specifications to estimate the relationship between economic growth and environmental degradation. Here the study develops the specifications that are consistent with both previous studies and theoretical framework. In the theoretical part of this research, the study specifies that environmental degradation uses a proxy variable of total CO2 emission per capita, which has a non-linear functional relationship with growth. Non-linear means that the graph is not a straight line. The graph of a non-linear function is a curved line whose direction constantly changes. A functional relationship refers to a class of statistical models in which a

functional relationship is assumed to exist between two arithmetic variables, but the two arithmetic variables can only be viewed with measurement error and/or natural variability (Kimura, 2000). In previous research, the Environmental Kuznets Curve of conventional inverted-U shape is modelled as a second-degree polynomial in logarithmic terms (Hilton & Levinson, 1998). Therefore, using this concept the model is specified as follows:

$$EC = f(GDP, GDPS, FD, I)$$

Where GDP stands for Gross Domestic Product, GDPS is the square term of GDP, FD stands for financial development and I stand for Investment.

$$EC = b0 + b1Yt + b2Y2\,t + \ldots\ldots\ldots + biXt + ei$$

Where E is the total CO2 emission per capita, Y is the income per capita, X refers to other factors (Financial Development and Investment), the subscript t is a time index, and e is a normally distributed error term. According to a prior expectation, the signs of the coefficients must be as follows:

(1) If B1 = B2= 0, it means that there is no relationship between growth and environmental degradation.

(2) If B1 > 0 and B2 = 0, it means that there is a monotonical increase or linear relationship between growth and environmental degradation.

(3) If B1 < 0 and B2 = 0, there is a monotonically decreasing relationship between growth and environmental degradation.

(4) If B1 > 0 and B2 < .0, there is an inverted-U-shaped relationship, i.e. Environmental Kuznets Curve.

(5) If B1 < 0 and B2 > 0, there is a U-shaped relationship

3.3. Estimation of models

The commonly accepted ADF (Augmented Dickey-Fuller) and PP (Phillips-Perron) unit root tests are adopted to the stationary test of all the variables. The test results are shown in Table 1. This is because if a time series data is non-stationary, the study indicates only the behavioural relationship at the period under consideration. A stationary (time) series is one whose statistical characteristics (such as mean, variance, and autocorrelation) are all constant over time. Thus, a non-stationary series is one whose statistical properties change over time (Chatfield, 2003). In this context, the ADF test is a unit root test for stationarity. Unit roots can cause unpredictable results in the time series analysis. Therefore, each set of time series data can be used for a particular episode. As a consequence, it is not possible to generalize it to other periods. Therefore, for forecasting, the non-stationary series may be

of little practical value. To discover the long-run relationships between the appropriate variables, a cointegration test was conducted using the Engle-Granger test, and the number of cointegration vectors was tested using the Johansen test. The Engle-Granger method first constructs residuals (errors) based on a static regression. Residuals are tested for the presence of unit roots using ADF or similar tests. If the time series is merged, the residuals will be practically stationary. A major issue with the Engle-Granger method is that the choice of the dependent variable may lead to different conclusions (Armstrong, 2001), as corrected by more recent tests such as Johansen's. Johansen's test is another improvement over the Engle-Granger test. It avoids the issue of choosing a dependent variable as well as issues created when errors are carried from one step to the next. As such, the test can detect multiple cointegrating vectors. In addition, different related diagnoses have been tested like heteroskedasticity, autocorrelation, and the Ramsey model specification test. To be clear, the Ramsey model is designed to detect whether there are any neglected nonlinearities in the model. The results of the data analyses and model diagnostic tests were achieved using STATA 13.

4. RESULT AND DISCUSSION

4.1. Econometrics analysis

Stationary Test: According to Table, the null hypothesis of no unit-roots for all the time series is rejected at the first differences. The reason is that the ADF test statistic values are less than the critical values at a 1% level of significance except for the GDP per capita variable, which is significant at 5%. Thus, the variables are stationary and integrated in the same order, i.e. I (1). In short, all variables have become stationary and do not contain a unit root in the first difference. Determination of Lags: As proposed by Hussain (2009), there are different criteria to determine the number of lags. These are Akaike Information Criterions (AIC), Hanna-Quinn Information criteria (HQIC), and Schwarz Information Criterions (SBIS) which strongly advise the inclusion of the appropriate lag in the analysis. All the three lag selection criteria were used to choose the appropriate lag lengths, and the result recommended including three lags for all variables in the model.

4.2. Vector error correction model estimation

The study showed that all variables are cointegrated in the first difference or I (1). This indicates that there is a long-run equilibrium or long-run relationship among the variables. Of course, in the short run, there may be disequilibrium. Therefore, the error term can be treated as the 'equilibrium error'. The study used this error term to tie the short-run behaviour of

Table 1

	ADF		*PP*	
VARIABLES	*T-STATISTIC*	*P-VALUE*	*T-STATISTIC*	*P-VALUE*
LC	-0.130	0.9464	-0.063	0.9444
LG	2.272	0.9989	1.016	0.9990
LGS	2.546	0.9991	1.135	0.9991
LF	-1.338	0.6114	-1.066	0.6517
LI	-1.729	0.4165	-2.290	0.4108
ΔLC	-6.641	0.0000	-64.147	0.0000
ΔLG	-5.672	0.0000	-51.912	0.0000
ΔLGS	-5.191	0.0000	-48.052	0.0000
ΔLF	-6.704	0.0000	-58.402	0.0000
ΔLI	-8.628	0.0000	-70.722	0.0000

environmental degradation with the long-run value. The error correction model states that the long-run equilibrium depends on the equilibrium error term. If the error term is nonzero and positive, then the model is out of equilibrium. This means that there is a very high possibility to be in equilibrium. Thus, the study preferred to use the error correction model (ECM) rather than the Autoregressive Distributed Lag Model (ARDLM). The presence of cointegration among the variables indicates a long-term relationship between the CO2 emission level, GDP per capita, and population growth rate. Therefore, the VEC model was applied to forecast the long-run relationship among these variables from 1960 to 2020.

In Table, all the coefficients are significant at a 1% level of significance and positively influence the environmental quality. In addition, GDP per capita square is significant at a 1% level of significance but negatively related to the CO2 emission level per capita in the long run. This result confirms the Environmental Kuznets Curve hypothesis that in states with a lower level of economic growth, the economy positively contributes to environmental pollution, whereas in the long-run economic growth, it contributes to the reduction of environmental degradation. This means that at the early stage, economic growth inevitably contributes to environmental degradation. Later on, environmental degradation starts to decrease with the increase in economic growth.

Financial development is another variable included in the model to show its influence on environmental degradation. Thus, the result shows that financial development has a positive and significant contribution to environmental degradation. The results imply that financial development promotes business activities and adds to the demand for energy via cheaper credit. Easy credit facilitates the purchase of auto, home, and appliances;

and adds to energy use hence carbon emission. Moreover, Investment has a significant but negative impact on carbon emission. The results suggest that as investment increases, the level of carbon dioxide emission decreases.

Table 2

beta	*Coeff.*	*Std. Err.*	*Z*	*P>|z|*	*[95% Conf.*	*Interval]*
Lc	1	.	.	.	.	.
Lg	-15.80932	1.375094	-11.50	0.000	-18.50446	-13.11419
Lgs	.687695	.0626781	10.97	0.000	.5648483	.8105417
Lf	-.1487546	.0464168	-3.20	0.001	-.2397299	-.0577793
Li	.9387728	.1637274	5.73	0.000	.617873	1.259673
_cons	87.67561	.	.	.	.	.

CONCLUSION

This study examines the impact of financial development with economic growth and investment on CO2 emissions in the period 1960–2020 for India. The VECM approach to cointegration is used to investigate the long-run relationship among the variables.

Our findings confirm the long-run relationship between the variables. Economic growth, financial development, and Investment are shown to retard environmental quality. Moreover, the study confirms the EKC hypothesis in the Indian context for the given period. The results further reveal that financial development increases CO2 emissions for the Indian economy. This implies that financial development can play a negative and significant role in causing environmental degradation in the country as greater financial sector development can facilitate more financing at lower costs (as the country's financial institution is dominated by commercial banks, the main function is to provide loans to both public and private sectors for various developmental projects) hence polluting the environment.

The policy advice is therefore that India should improve the country's financial development through the development of bond and securities markets, which will boost financial services and provide more funds for investments in the research and development of modern and efficient technologies relating to clean energy. Financial markets, together with the banking sector, play a key role in this respect. Moreover, e, the financial sector must adopt a device of environmental, and social risk management and governance to identify risks and measure the impacts of projects financed by the environment. Then, as advisers, these financial institutions have the role of sensitizing and educating economic operators on environmental, social, and sustainability concerns. They must be as exemplary as possible in this area by promoting the emergence of a genuine

internal culture of environmental and social risks and by regularly communicating the actions undertaken in this domain.

Finally, the government should also encourage the banking sector to invest in the renewable energy sector. In this respect, the banking sector should allocate financial resources to R & D for eco-energy technologies.

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