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Impact of Financial Development on Environment; Comparison of Low-, Middle- and High-Income Countries

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ABSTRACT

Environmental degradation has emerged as a matter of concern for both the developed and developing countries. Sparing public finances only to mitigate climate change seems a time taking and unsustainable solution, hence combined social efforts are required. In the modern settings, financial development (FD) is among the primary driving force of strong economic growth and is believed to help sustainable development. In this study, herein, we investigate the results of FD on the improvement of environmental indicators namely carbon dioxide, nitrous oxide, and methane, symbolically known as (N_2O), (CO_2) and (CH_4). The research uses panel statistics analysis employing data (1990-2018) for countries with low-, middle-, and high-income status. Moving forward, the empirical findings interestingly shows that FD increases CO_2, N_2O, and CH_4 emissions in countries with low income, whereas in countries with middle-come, FD raises CO_2 and N_2O emissions but reduces CH_4 emissions. While in countries with high-income, FD posits a substantial negative impact on CO_2 and N_2O emissions. Analysis indicate that the pollution haven hypothesis prevails in countries with low and middle-income (CO_2 and N_2O). Whereas in high-income countries, evidence points to pollution halo hypothesis. The findings suggests that the financial sector should be obliged to dedicate more resources for clean energy projects, otherwise, the growth estimates (associated with FD) might require a revisit in wake of damage to environment.

KEYWORDS: Environmental Deterioration, Financial Development, Environment, Carbon Dioxide, Nitrous Oxide, Methane

1. INTRODUCTION

Environmental deterioration has emerged as a matter of concern for both developed and developing countries. Climate change is raising concerns among global leaders throughout the world. An understanding of the relationship between environment and the economic activity is essential in order to make optimal policies. Normally, there is a trade-off between the two since policies targeted to increase growth lead to facilitate production through rapid industrialization which finally translates in higher incomes. With the rise in economic activity and consumption, eventually increases the emissions and concentration of pollutants. Thus, the climate change challenges and rise in global emissions of greenhouse gases have raised concerns of policymakers over the recent past.

Within the given settings, the role of financial markets is very interesting. Financial Development (FD) on one side stimulates economic development and thus raises energy consumption as well as CO_2 emissions. However, on the other side, FD provides people the resources to shift to energy-efficient products and appliances through consumer financing. Thus, it can boost environmental quality by facilitating the adoption of green and sustainable technology, and reduces CO_2 emissions (Shahbaz, 2013). To have a wholesome picture, it is important to analyze the contributory and offsetting roles of FD and come up with informed policy-making.

Despite available research on environmental issues, existing evidence on the impact of FD is not conclusive. Studies have found that FD lowers carbon emissions and helps in reducing environmental degradation. Halicioglu (2009); Tamazian (2009); Tamazian and Rao (2010) proposed that the growth of the FD results in environmentally friendly programs and therefore reduces pollution in the energy sector. A substantial number of other research have revealed that the evolution of financial organizations contributes toward the reduction of CO_2 emissions and optimize energy usage (Tamazain and Rao, 2010; Park et al., 2018). In contrast, Javid (2016) found that in Pakistan, FD exists at the expense of the environment. Nevertheless, studies like Shahbaz et al. (2012) and Alam et al. (2013) have also demonstrated that advancements in the financial sector facilitate access to finance and thus increase carbon emissions.

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Environmental degradation and global rising temperature are two major problems that the world is experiencing right now. The reason behind the environmental degradation and global climate change is multifaceted and needs a holistic assessment. Therefore, there is need to consider environmental externalities and account for the potential positive and negative influences on it. The purpose of this research is to determine the impact of FD on three pollution indices in low-income, middle-income, and high-income economies. This research is distinguishing in the sense that it provides a thorough comparison of FD and its impact on three key environmental indicators, i.e., carbon dioxide (CO_2), Nitrous oxide (N_2O) and Methane (CH_4). In comparison, the previous studies are either conducted for limited number of countries or for specific years, mostly analyzing CO_2 only, hence, this study carries a greater mandate.

2. LITERATURE REVIEW

There is a growing body of study investigating the relationship between FD and environmental quality. The validation of the environmental Kuznets curve, as well as evidence of an early departure[1], have led researchers to analyzed the issues differently.

A number of studies suggested that technological advancement has resulted in more productive and energy-efficient technologies that are employed among the nation's development practices (Jalil and Feridun, 2012); (Shahbaz, 2013) ; (Alam et al., 2013); (Al-Mulali et al., 2015). On the contrary, Shoaib et al., (2020), in a panel of selected developing and developed countries found a growth in CO_2 emissions (by 0.499% and 1.204%, respectively) due to financial development in the long run, despite having an insignificant short run impact. Sadi et al. (2019), revealed that economic expansion has a large long-term beneficial influence on carbon emissions. Ghorashi and Alavi (2018) and Xu et al. (2018) showed that in the long term, financial development degrades the environment.

Analysing Turkey, Cetin et al. (2018) provided the evidence that in the long run, FD and carbon dioxide emissions are correlated positively in the sense that a 1% surge in FD will lead to raising carbon emissions by 0.04%. In another study, on the Turkish economy, FD caused environmental degradation (Cetin and Ecevit, 2017). Siddique and Muhammad (2017) analyzed data from Pakistan and found link over time between CO2 emissions and FD, however in the short term, the effect was insignificant. Moghadam and Lotfalipour (2014) found similar results for Iran.

In contrast to the data presented above, a number of research have found that FD has a favourable influence on environmental indicators. Uyi and Hooi (2019) examined the impact of financial patterns on carbon dioxide emissions in 122 countries from 1990 to 2014.The research found that financial growth helped in minimizing CO_2 emissions in advanced countries, however, it was not the case for less developed and developing countries. Similarly, Ganda and Fortune (2019) argued that FD is helping in reducing the CO_2 emissions and GHGs in OECD countries.

Moreover, Qi et al. (2017) worked on a panel of 30 regions of China from the years 1997 to 2011. Using spatial panel econometrics approaches, the study found that as financial development increases, CO2 per capita declines, promoting the environment at the provincial level. Saidi and Ben (2017) studied 19 developing countries and findings revealed that the FD coefficient is negative in all models, implying that FD benefits the environment and hence can be used to improve the environmental indicators.

Discussing the transition mechanism, Charfeddine and Ben (2015) showed that FD increase the growth of the economy, which promotes energy usage. In the case of Indonesia, FD shrinks carbon emission, whereas the energy sector and GDP were found to be the main contributors to CO_2 emissions (Shahbaz, 2013). Haseeb et al. (2018) examined the effects of FD in 59 countries along the Belt and Road Initiative (BRI). The data revealed that FD had varying implications on environmental quality, with some developing countries seeing beneficial effects while others saw negative consequences.

In another study, Faiza and Khalid (2016) suggested that other mitigation strategies need to be implemented to minimize carbon footprints in such developing countries where there has not yet been a significant level of growth in the financial sector. Different variables of FD had played an essential part in mitigating emissions in the later stage only when there was a large degree of liberalization and growth of the FD. Meanwhile, Jalil (2011) confirmed that FD and pollution has a negative relationship and hence improves the environment in China. Similarly, Zhang (2011) are in the favor that FD increases emissions, whereas Park et al. (2018) are in the favor that FD decreases emissions. To sum up, evidence is inconclusive as both the positive and negative impact of FD on CO_2 emission is reported and hence necessitates further investigation.

One limitation of the literature though is that all the past and current research concerns the carbon emissions solely, which is not a single serious pollutant. It is true that emissions of carbon dioxide have recently been considered

[1] before achieving the highest point on the inverted U-curve

a major problem internationally due to its negative effect on climate. However, there is gap in the literature as other important environment pollutants namely nitrous oxide, and methane are not explored optimally. Therefore, this study contributes to the literature by filling this gap.

3. DATA AND METHODOLOGY

The purpose of this study is to investigate the impact of economic expansion on the environment in low, medium, and high-income nations. This research analyzes the environmental pollution indicators namely CO_2, N_2O, and CH_4 To assess the effect of FD on environmental pollution indicators, a functional relationship is stated in the logarithmic form below, following Boopendra et al. (2018), Saud et al. (2018), Shahbaz et al. (2013), Boutabba (2014) and Jalil (2011). Equation 1 presents the empirical model.

$$P_{kit} = \alpha_0 + \alpha_1 lnGDP_{it} + \alpha_2 lnFD_{it} + \alpha_3 lnTO_{it} + \alpha_4 lnEC_{it} + e_{it} \quad \text{Eq.1}$$

Where P_k stands for the dependent variable, 'k' representing the given three pollutants namely $ln$$CO_2$ (natural logarithm of CO_2 emissions), $ln$$N_2O$ (natural logarithm of N_2O emissions), or $ln$$CH_4$ (natural logarithm of CH_4 emissions). The set of independent variables include lnGDP is a natural logarithm of gross domestic product while lnFD is a natural logarithmic form of domestic credit to the private sector; $lnTO$ represents log of trade openness and, lnEC is a natural logarithmic form of energy consumption. In this equation, α_0 is the intercept and e are an error term. Hence with Eq. (1), this study analyzes three environmental pollution indicators by countries (i) at period (t).

4. Construction of variables

For the period 1990-2018, statistics from the World Bank's Development Indicators for low-, middle-, and high-income nations are utilized. These countries are chosen based on their categorization by World Bank. The variables are used in logarithmic forms. Table 1 presents the set of dependent variables while Table 2 presents the list of independent variables along with projected symbols.

Table 1: Dependent Variables (Environmental pollution Indicators)

Variable name	Variable Measure	Symbol
Carbon Dioxide emissions	Metric tons per capita	CO_2
Nitrous emissions	Thousand metric tons of CO_2 equivalent	N_2O
Methane	Kt of CO_2 equivalent	CH_4

Table 2: Independent Variables

Variable name	Variable measure	Symbol	Expected Sign	Economic Implication
Financial Development	Domestic credit to the private sector (% of GDP)	FD	+/-	A positive coefficient would indicate that FD boosts the unchecked industrial production and consumption hence causes an increase in environmental indicators (CO_2, N_2O, CH_4). On the contrary, if the coefficient of FD is negative, it would indicate that FD promotes green technology and hence improves the environment.
Gross Domestic Product	GDP (constant 2010 US$)	GDP	+/-	If the coefficient of GDP is positive, it means that it is degrading the environment as higher per capita income level increases environmental indicators (CO_2, N_2O, CH_4). If the coefficient of GDP is negative, it means that it is improving the environment. Technological innovation aims to reduce emissions of contaminants by incorporating green technology.
Trade Openness	Trade (% of GDP)	TO	+/-	If the TO coefficient is positive, it means that the pollutant factories of developed economies are generating a significant amount of CO_2 emissions by their production processes. If the TO coefficient is negative, this implies that the production of pollution producing goods are limited due to environmental protection legislation.
Energy Consumption	Energy consumption (kg of oil equivalent per capita)	EN	+/-	If the coefficient of EN is negative, it means that energy is utilized efficiently in green technology. It helps in reducing environmental degradation (Stern et al. 2006). If the coefficient of EN is positive, it means that there is more demand for fuels and gas, and it will ultimately lead to pollution and will deteriorate the environmental quality.

5. ESTIMATION STRATEGY

By combining cross-section and time-series statistics with panel data, it is often instructive to examine the relationships between variables. The main advantage of panel data is the expansion of degrees of freedom and power through the simultaneous use of additional information regarding the behavior of numerous entities. Panel data also helps to reduce multicollinearity issues that might arise when time-series are individually modelled, as well as the inclusion of heteroscedasticity in cross-sectional data. Such an issue can be solved successfully by the panel data method. Nonetheless, when we analyze the panel data, heterogeneity between entities/units is a central issue. The study employs the Fixed effect model and Random effect model, which are the two most used estimate approaches, to deal with heterogeneity.

6. EMPIRICAL RESULTS

Correlation Metrix

The tables in Appendix-B contain the correlation matrices for the groups of low-income, middle-income, and high-income countries. B1 illustrates correlation between environmental indicators (CO_2, N_2O, CH_4) and FD as well as other independent variables in low-income countries. There exists a positive correlation between FD and carbon emissions, whereas a negative correlation with nitrous oxide and methane emissions.

Table B2 shows the correlation between environmental indicators (CO_2, N_2O, CH_4) and FD as well as other explanatory variables in middle income countries. A positive correlation is found between FD and the three environmental indicators (carbon dioxide, nitrous oxide, and methane).

Table B3 shows the correlation between environmental indicators (CO_2, N_2O, CH_4) and FD as well as other explanatory variables in high income countries. A positive correlation is found between FD and carbon emissions and nitrous oxide emissions, whereas negative correlation is found between FD and methane emissions.

Results for Hausman test

The findings of the fixed effect model are described in Table 3. In a panel of low-income countries,10 countries are selected, which includes 286 observations. In three models on environmental pollution indicators, the fixed effect is preferred according to the Hausman test as P-value is less than 0.05.

An increase in GDP level creates environmental degradation as it happens at the expense of natural resources. This implies that the increase of 1 % in GDP indicates to 0.550% rise in CO_2 emissions. The positive relation among carbon emissions and GDP is showing that GDP affects the quality of the environment negatively. This could be due to the reason that revolution of the industrial sector has worsened the environment in different ways, such as to gain maximum growth natural resources are exploited. Also, there is no plan for sustainability of resources for our next generation, etc. which also have an indirect effect on the well-being of people. Our results that GDP causes an increase in carbon emissions are similar to the findings of Lean (2010); Smyth (2008); Salahuddin (2014). Our findings showed that financial development increases carbon emissions indirectly by increasing the use of the energy sector such that FD is showing a positive and significant impact on carbon emissions; that is when FD increases, carbon emissions increase by 0.124%. The development of the financial sector makes it easy for people to take loans from the banks and buy energy-intensive products, i.e., vehicles. Taspinar (2017) pointed out that the expansion of the financial sector would make countries continue to count on energy that could raise CO_2 emissions. This result is in line with Hafeez et al. (2018), Coban (2013). Trade openness has a trivial but positive influence on carbon emissions. On the other hand, the demand for energy consumption increases when there is an introduction of a higher level of FD, It ultimately leads to more carbon emissions from countries with low incomes. Reduced carbon dioxide emissions are a direct result of reduced energy use (1.180%), and the results are similar to Ozturk (2013). The positive coefficient shows that energy consumption increases environmental degradation in a panel of a low-income group such that if there is an expansion in the growth of the economy, consumption of non-renewable energy increases, which further increases carbon emissions.

With the percentage rise in economic growth, nitrous oxide emissions decrease by 0.191%. This could be attributed to the technological advancement or usage of green technology, which decreases nitrous oxide emissions. Financial development degrades the environment by 0.077%, with a 1% increase in FD but the change is insignificant. The coefficient of trade openness has a negative and significant effect on nitrous oxide; that is, a percentage rise in trade openness leads to a 0.177% decrease in nitrous oxide in a panel of low-income countries. The negative relation of trade may be due to the effective process of production. Lastly, energy consumption degrades the environment in such a way that a rise in energy consumption raises the emissions of nitrous oxide by 0.460%. This can be because of using traditional and pollution-intensive technology, which increases the level of nitrous oxide in the environment.

There exists a positive relationship among GDP and methane, that is with a 1% increase in the level of GDP, methane emissions increase by 0.219% and thus degrade the environment. This is because low-income countries use non-renewable energy sources for their economic activities which increases GDP as well as methane emissions. FD has a negative but insignificant impact on methane (0.057). Methane is released by biomass burning, rice-growing, etc., so when people get loans from the banks, they utilize the same procedures for their company, which increases methane emissions in the environment. Trade has a small but detrimental influence on methane emissions (0.043). Energy consumption has a positive but small influence on methane emissions.

Table 3: Regression Results for Low-Income Countries

Dependent Variables	**CO_2**	**N_2O**	**CH_4**
Independent Variables	Fixed Effect	Fixed Effect	Fixed Effect
ℓnGDP	0.5507 (0.000)	-0.191 (0.005)	0.2190 (0.000)
ℓnFD	0.1248 (0.002)	0.077 (0.149)	-0.0578 (0.180)
ℓnTO	0.0809 (0.086)	-0.177 (0.006)	-0.0436 (0.397)
ℓnEN	1.180 (0.000)	0..460 (0.003)	0.1262 (0.300)
Constant	-21.835 (0.000)	10.693 (0.000)	3.755 (0.003)
Number of Observations	286	286	286
Number of countries	10	10	10
R-Squared	0.717	0.0840	0.0875
Prob>F	0.0000	0.0001	0.0001
P-Value	0.0000	0.0000	0.0000

The fixed effect model results are described in Table 4. In a panel of middle-income countries, fifty-four countries are selected, and established on the accessibility of the data, which includes 1504 observations. In three models on environmental pollution indicators, the fixed effect is preferred according to the Hausman test as P-value is less than 0.05.

A percentage rise in economic growth in middle-income countries causes a 0.185% rise in carbon emissions which degrades the environment. Many of natural resources are exploited in the course of economic expansion. Which puts pressure on the environment as emissions increases and degrades the environment. Zhang (2009) gave empirical analysis that an upsurge in GDP can boost energy usage and eventually exacerbates CO_2 emissions. The FD coefficient is positive and impacts significantly on the emissions of CO_2, that is, an increase in FD assists in 0.028% growth in carbon emissions. An effective financial system can provide a favorable environment for customers to purchase more loans that enable them to raise their demand for CO_2-emitting products. Our findings are similar to Jalil (2011). On the other side, if there are weak environmental standards, it will cause trade to contribute to environmental deprivation. The trade (0.088) and energy consumption (0.845) coefficients are positive and significant, showing that both variables contribute to environmental degradation. Our results are similar to Tamazian and Rao (2010); Shahbaz et al. (2013).

A percentage rise in financial growth causes a 0.071% increase in nitrous emissions and degrades the environment. This may be because of the non-sustainability of the resources, as more and more resources are used on a daily basis for the rise in GDP, but it initiates an adverse impact on the environment. Coefficient of FD (0.11) and trade openness (0.054) is positive but insignificant. While the coefficient of energy consumption is positive and significant (0.345), showing that it contributes to environmental degradation. If countries use old sources of energy, it will cause deterioration of quality of environment.

A percentage increase in GDP in middle-income countries causes a 0.233% increase in methane emissions and hence degrades the environment. The degradation of the environment is due to economic growth, which causes the excess burning of biomass, which is used in production processes. The coefficient of FD (0.008) has a negative but insignificant influence on methane emissions. While trade openness (0.035) has a negative but insignificant influence on methane emissions, energy consumption (0.112%) has a considerably positive impact, indicating that the variable leads to environmental deterioration.

The results of the fixed effect model are described in Table 5. In a panel of high-income countries, twenty-six countries are selected, established on the accessibility of the data, which includes 702 observations. In three models on environmental pollution indicators, the fixed effect is preferred according to the Hausman test as P-value is less than 0.05.

A percentage rise in GDP in high-income countries causes 0.183% rise in carbon emissions and hence degrades the environment, results are similar to Lean (2010), Narayan (2008), Salahuddin et al. (2015), Tamazian and

Rao (2010). With increased inflows of financial development, new monetary funds and trainings could be introduced for environmental developments which try to lessen expenses as well as enhance the general situation of their environments. The FD coefficient has a negative and sizeable influence on CO_2 emissions, such that an increase in FD is leading to 0.054% fall in carbon emissions. A properly performing financial structure establishes a carbon trading mechanism that produces occasions to reduce carbon emissions. This included Findings that are like Claessens and Feijen (2007). An effectual financial system allows nations to execute environmentally friendly laws, and it also influences companies and house level economic procedures to reduce CO_2 emissions. Findings are similar to Omri et al. (2015); Yuxiang (2010). An improved version of the finance structure can have a favorable impact on environmental performance; FD will allow for more cost-effective funding. On the other hand, coefficient of trade, openness has a negative impact on the CO_2 emissions, such that 1% growth in trade openness leads to 0.226% reduction in carbon emissions and hence improves the environment, this is advocated by Shahbaz et al., (2013)

although the energy consumption coefficient has no significant influence on CO2 emissions

Table 4: Regression Results for Middle-Income Countries

Variable name	CO_2	N_2O	CH_4
	Fixed Effect	Fixed Effect	Fixed Effect
ℓnGDP	0.185 (0.000)	0.071 (0.007)	0.233 (0.000)
ℓnFD	0.028 (0.005)	0.011 (0.461)	-0.008 (0.456)
ℓnTO	0.088 (0.000)	0.054 (0.119)	0.035 (0.176)
ℓnEN	0.845 (0.000)	0.345 (0.000)	0.123 (0.000)
Constant	-10.263 (0.000)	4.550 (0.000)	3.103 (0.000)
Number of Observations	1,700	1,698	1,699
Number of countries	59	59	59
R-Squared	0.657	0.119	0.218
Prob>F	0.0000	0.0000	0.0000
P-Value	0.0000	0.0000	0.0000

A percentage increase in economic growth in high-income countries, causes 0.234% increase in nitrous oxide emissions and hence degrades the environment. The coefficient of FD is significant and has a negative impact on N_2O emissions, such that a growth in FD is leading to a 0.135% fall in nitrous oxide emissions. While the trade coefficient plays a significant negative part on the nitrous oxide such that an enhancement in trade openness, reduces in nitrous oxide by 0.303%. The negative coefficient indicates that high-income countries are more open to trade, but this is not the cause of the high level of nitrous oxide emissions, whereas the coefficient of energy consumption is significantly negative, indicating that a one percentage point increase in energy consumption leads to a 0.139% decrease in nitrous oxide emissions.

The percentage rise in GDP causes a 0.338% rise in methane emissions and hence degrades the environment. If the economic activity contains the burning of biomass etc. it would lead towards an increase in methane emissions in the environment. FD do not hold significant effect on methane emissions in the panel of high-income countries. While the trade coefficient is significantly negative effect, which means that high-income countries are accessible to trade, it does not contribute to environmental degradation hence improves the environment. Contrary, the coefficient of energy consumption degrades the environment because more non-renewable resources are used, that is a percentage rise in energy consumption causes an increase in methane emissions by 0.029.

Table 5: Regression Results for High-Income Countries

Variable name	CO_2	N_2O	CH_4
	Fixed Effect	Fixed Effect	Fixed Effect
ℓnGDP	-0.085 (0.001)	-0.003 (0.920)	0.201 (0.000)
ℓnFD	-0.0359 (0.032)	-0.131 (0.000)	-0.011 (0.536)
ℓnTO	-0.113 (0.000)	-0.148 (0.000)	-0.239 (0.000)
ℓnEN	0.876 (0.000)	0.556 (0.000)	0.455 (0.000)
Constant	-2.237 (0.000)	5.362 (0.000)	1.673 (0.002)
Number of Observations	777	777	777
Number of countries	27	27	27
R-Squared	0.550	0.196	0.412
Prob>F	0.000	0.0000	0.0000
P-Value	0.000	0.0000	0.0000

According to the findings of this study, the role of FD in the two groups is the same, that is in low- and middle-income groups, FD is degrading the environment except for CH_4 in the middle-income group, which is enhancing the environmental quality. But in high-income countries, the effect of FD is different; FD is promoting the environment quality (CO_2, CH_4).

7. DISCUSSION AND POLICY RECOMMENDATIONS

The overall study's findings can be summed up as follows.: GDP raises CO_2 and CH_4 and reduces N_2O emissions in low income countries, In middle income countries, GDP raises CO_2, N_2O, and CH_4 whereas in high income countries, GDP raises CH_4 emissions and reduces CO_2 emissions. The increase in emissions might be because extreme growth of the economy leads to environmental deprivation. The result of carbon emissions is like Narayan (2008) and Salahuddin et al. (2015). All three income groups must adopt efficient means of capital and move towards green technology in order to reduce their emissions, as the environment is degrading at a high pace.

FD has a positive impact on CO_2 emissions in low-income and middle-income countries. Our results are similar to Farhani and Ozturk. (2015); Zhang (2011). Contrary, in a panel of high-income countries, FD decreases CO_2 and N_2O. Results are like Shahbaz et al. (2013). The influence of FD on carbon emissions in different income-groups is different because of dissimilar levels of financial development. Our results are similar with (Yuxiang and Chen, 2010), he stated that the countries which have developed financial sector offer a chance to firms to adopt advanced and green technology in order to reduce carbon emissions. Hence, policy recommendation for low-income countries is that they should focus on their financial sector and make it advance and sound in order to reduce their emissions. On the other side, the negative impact of FD posits that those countries have already started advanced and green technology, but the positive impact of FD posits that those countries have not started any adoption of green policies to protect their environment. Countries must grow economically, but they should not neglect the quality of the environment. Trade openness enhances the environment in case of low-income countries, as it affects environmental pollution indicator (N_2O) negatively. In middle income countries, trade increases CO_2 emissions (0.088). The trade of the big-ticket item must be reduced in order to decrease emissions. Environmentally responsive excise duties can be introduced to essential industries. Optimal industrial taxes must be levied on pollution-intensive factories. Trade openness promotes the environment quality in high-income countries. Our finding is similar to Shahbaz et al. (2013). While energy consumption is a degrading environment (CO_2, N_2O and CH_4) in low-middle and high-income countries. Our findings are similar to Arouri et al. (2012). In this situation, countries must implement the use of renewable energy sources. This might be because of an increase in usage of renewable energy sources which reduce CO_2 emissions. So, the government must focus on making those policies that would ensure an adequate energy supply by rising steadily the number of renewable sources of energy in the aggregate of the electricity supply. On the other hand, energy consumption decreases N_2O in high-income countries; our results are similar to Mirza and Kanwal (2017).

8. CONCLUSION

We have investigated the impact of FD on environment pollution indicators, namely carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), and) in low, middle- and high-income countries. We employed FE on all three regressions for low, middle- and high-income countries to analyze the existence of correlation between α_i and xit in all periods of time. The study discovered a link between FD and environmental indicators in poor and middle-income nations, implying that FD promotes pollution since low and middle-income countries have problems in accessing green or environmentally friendly technologies and instead rely on conservative tactics. While high-income nations deploy green technology, the impact of FD on carbon emissions is negative. This disparity is due to the amount of FD these nations receive. A high FD level reduces emissions, whereas a low FD level raises emissions.

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Table B1 Correlation Metrix of low-income countries								
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1)ℓnCO_2	1.000							
2)ℓnN_2O	-0.537	1.000						
3)ℓnCH_4	-0.577	0.908	1.000					
4)ℓnGDP	-0.038	0.620	0.742	1.000				
5)ℓnFD	0.669	-0.609	-0.457	-0.112	1.000			
6)ℓnFDI	0.008	0.000	-0.029	0.022	-0.100	1.000		
7)ℓnTO	0.372	-0.412	-0.441	-0.406	0.302	0.326	1.000	
8)ℓnEn	0.396	0.050	0.042	0.193	0.259	0.067	0.104	1.000

Table B2 Correlation Metrix of middle-income countries								
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ℓnCO_2	1.000							
ℓnN_2O	0.071	1.000						
ℓnCH_4	0.091	0.963	1.000					
ℓnGDP	0.340	0.821	0.854	1.000				
ℓnFD	0.410	0.166	0.159	0.372	1.000			
ℓnFDI	0.081	-0.157	-0.160	-0.130	0.109	1.000		
ℓnTO	0.232	-0.509	-0.517	-0.491	0.172	0.373	1.000	
ℓnEn	0.911	0.084	0.093	0.296	0.290	0.079	0.246	1.000

Table B3 Correlation Metrix of middle-income countries								
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ℓnCO_2	1.000							
ℓnN_2O	0.020	1.000						
ℓnCH_4	0.219	0.880	1.000					
ℓnGDP	0.315	0.778	0.744	1.000				
ℓnFD	0.157	0.039	-0.049	0.426	1.000			
ℓnFDI	-0.224	-0.177	-0.262	-0.197	0.063	1.000		
ℓnTO	-0.002	-0.707	-0.701	-0.473	0.125	0.491	1.000	
ℓnEn	0.064	-0.290	-0.194	-0.148	0.268	0.073	0.110	1.000

Appendix-A

Low-Income Countries	Middle-Income Countries		High-Income Countries
1. Benin	1. Albania	30. Kazakhstan	1. Argentina
2. Congo, Dem. Rep.	2. Algeria	31. Kenya	2. Australia
3. Haiti	3. Armenia	32. Kyrgyz Republic	3. Bahrain
4. Mozambique	4. Bangladesh	33. Libya	4. Chile
5. Nepal	5. Belarus	34. Malaysia	5. Croatia
6. Senegal	6. Bolivia	35. Mauritius	6. Czech Republic
7. Tajikistan	7. Botswana	36. Mexico	7. Denmark
8. Tanzania	8. Brazil	37. Moldova	8. Hong Kong SAR, China
9. Togo	9. Bulgaria	38. Mongolia	9. Hungary
10. Zimbabwe	10. Cambodia	39. Morocco	10. Iceland
	11. Cameroon	40. Namibia	11. Israel
	12. China	41. Nicaragua	12. Japan
	13. Colombia	42. Nigeria	13. Korea, Rep.
	14. Congo, Rep.	43. Pakistan	14. Kuwait
	15. Costa Rica	44. Paraguay	15. New Zealand
	16. Cote d'Ivoire	45. Peru	16. Norway
	17. Dominican Republic	46. Philippines	17. Oman
	18. Ecuador	47. Romania	18. Panama
	19. Egypt, Arab Rep.	48. South Africa	19. Poland
	20. El Salvador	49. Sri Lanka	20. Saudi Arabia
	21. Gabon	50. Sudan	21. Singapore
	22. Ghana	51. Switzerland	22. Sweden
	23. Guatemala	52. Thailand	23. Switzerland
	24. Honduras	53. Tunisia	24. United Kingdom
	25. India	54. Turkey	25. United States
	26. Indonesia	55. Ukraine	26. Uruguay
	27. Iran, Islamic Rep.	56. Vietnam	
	28. Jamaica		
	29. Jordan		