RETRACTED: Combing Effects of Economic Development and Globalization Towards Energy Efficiency and Environmental Degradation: Fresh Analysis From Energy Efficient Resources

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How much environmental pollution can be reduced by the efficient use of financial, natural, and energy resources in the current globalization. Thus, this study provides empirical evidence in support of the theoretical argument by investigating the impact of financial development, environmental assets, globalization, coal, natural gas, and sustainable carbon emissions in 32 developed countries from 1990 to 2018. Ecological degradation (estimated by carbon dioxide emissions) experienced a structural shift that was considerably more pronounced in 2000–2011 than in 1991–1998. A broad variety of econometric methodologies (such as the Chow test, Cross-country regression, and the Generalized Method of Moments (GMM)) were applied. As a consequence, environmental deterioration is strongly linked to economic development and urbanization, according to the findings. These nations' ecological footprints are favorably influenced by financial development, environmental assets, and non-renewable energy, whereas globalization and sustainable sources have a negative impact. Environmental degradation may be slowed by combining globalization's impact on financial growth with the conservation of natural resources such as renewable energy sources. In order to improve their economic and ecological resource frameworks, these nations will need to increase their use of solar and other renewable energy.

Keywords: CO$_2$ emission, globalization, financial inclusion, Chow and GMM estimator, energy effciency

1 INTRODUCTION

There was a 1.37-fold rise in global carbon emissions in 2018 as compared to 1970, reaching 33,890.80 million tonnes. The 32 developed countries members are among the world's leading polluters. In 2018, the 32 developed countries nations' carbon emissions were 8611.80 million tonnes, or 25.41% of world emissions (Kordej-De Villa and Slijepcevic, 2019). A thorough investigation of the G7 nations' carbon dioxide emissions is essential to reducing world pollution, throughout the globe for more than 30 years because of the devastating implications for human lives, such as the devastating earthquake and the tsunami that struck Indonesia. The Intergovernmental Panel on Climate Change (IPCC) (2007) report was published a little over

10 years ago and indicated that global warming is the most unparalleled and difficult challenge facing the planet's population. Global climate change is evident, as shown by rising ocean temperatures and sea levels, a rise in greenhouse gas emissions, as well as a decrease in the quantity of snowfall. In industrialized countries, the UN estimates that about half of the world's population is economically alienated; in emerging countries, however, the number is much higher. There are several advantages to an organization's financial statements that eliminate obstacles to access for the most underprivileged members of society (Zhang Ke et al., 2021). Inequalities in the holding of bank accounts by gender in underdeveloped nations are enormous. For example, the percentage of males who have a regular account is 46%, while the percentage of females is 37% (Charity et al., 2021).

As business investment grows, so do CO_2 emissions, making it the most prevalent global warming gas, (Kong and He, 2020; Wang and Hou, 2020; Lei et al., 2021). There's been a steady rise in CO_2 emissions in emerging nations over the years, with 32 developed countries becoming the world's biggest producer of the gas. Because its per capita total emissions are just approximately a quarter of the global average of 4.6 tonnes, Africa has been dubbed a greenhouse gas emission model. With the world's lowest GDP, safe drinking water, and construction and transportation activities in the country, as a result, it is critical to investigate the factors that lead to these releases in order to implement measures to prevent them from reaching catastrophic levels. It is possible to decrease unemployment and weather climate resilience through increasing financial inclusion. Financial inclusion raises the topic of how it affects CO_2 emissions. According to rational thought, providing families and small businesses broader access to financing would inevitably lead to a rise in carbon dioxide emissions (Yun et al., 2017; Arenliu et al., 2021).

Financial inclusion has been shown to have a positive influence on the economy and society, but less is known about how it affects the efficiency of the banking sector (Bai et al., 2018; Kordej-De Villa and Shijepcevic, 2019). Economic development may be encouraged by banks' vital role in distributing limited financial capital, which they do as an integral element of banking institutions (Bai et al., 2010; O'Neill et al., 2020). Credit ratings and corresponding economic upheaval drew interest in recent years in financial deepening and unhealthy behaviors, although this was before the economic meltdown (Wang et al., 2020). In order to avoid systemic crises, it is essential to analyses the connectivity between financial inclusivity and credit worthiness (Wu et al., 2021). To reap the benefits of the developing financial industry (Sellitto et al., 2020) is not inexpensive, though. Effective use of energy can be achieved thanks to a well-developed banking system, and environmental standards may be enacted with little expense and maximum funding (Ahmad et al., 2021). In the present research, there is a clear connection between certain robust banking systems and sustainability inadequacy (Salahodjaev 2016; Paksersht et al., 2020). Furthermore, financial inclusion helps strengthen banks. A significant ideological authority and a sophisticated banking culture may encourage banks to take more risks, whereas a thriving business

and favorable regulatory conditions are more likely to foster this type of linkage. As a result, we conclude that increasing financial inclusion may improve financial reporting quality by enhancing asset diversification and securing financing sources. The study's second goal is to examine how resources affect the contribution to climate change. Resources with a low ecological footprint, such as crops, woods, developed lands, fishing waters, and livestock areas, offset the greenhouse gas emissions caused by humans and ease the flow of money for energy production (Wang et al., 2018). Environmental performance is negatively impacted by several conventional natural resources such as coal, gas, and hydrocarbons. Environmental habitats, on the other hand, have been shown to have a significant impact on economic growth and actual income. Natural resources like oil and gas are used in the early stages of economic expansion without regard to their environmental impact (Mohsin et al., 2021; Zhang Dongyang et al., 2021).

The focus of the present research will be to analyses the role of sustainable and non-renewable energy requirements in re-evaluating the contamination function as well as determining the ecological integrity of financially resource-rich nations (Li et al., 2021; Iqbal et al., 2021). Similar to the awareness of sustainable integrity, fossil fuels also have a significant influence. The empirical statistics were performed to better understand the impact of non-renewable and ecofriendly carbon emissions on the contribution to global warming. This allows us to make more appropriate policy suggestions. For the present form of economic growth to continue and accomplish the SDG objectives, it is necessary to identify the differences in environmental conservation between sustainable and non-renewable energy use. There is still a major vacuum in the empirical literature when it comes to considering the various impacts of different kinds of energy sources. To sum up, this work contributes to the empirical literature in the fields of budgeting and operational finance as well as ecological finance.

There are five ways in which this study differs from previous studies: Furthermore, this research examines the connections between economic development, natural resources and ecological footprints, comprising non-renewable energy, concurrently throughout the paradigm of globalization. To the best of the author's knowledge, this is the first study to examine the relationship between these characteristics and the wealthiest nations in the world. (iii) Rather than carbon dioxide emissions, the entire ecosystem is used as a yardstick for environmental damage. Appropriate environmental data is provided by the six environmental indicators (i.e., built up land (buildings), grazing, fishing ground, forests, and carbon footprint. Furthermore, this research employed the International Monetary Fund's (IMF) recommended financial development index to encompass the many aspects of economic advancement, such as the comparative country ranking in terms of experience, availability, and efficiency of government advancement. It also gives a new way to examine the influence of financial growth, globalization, and renewable energy on land and resources as potential moderators. A complete knowledge base for formulating policies pertaining to financial advancement, environmental resource use, and alternative energy use during globalization can be found by

investigating the vague associations between economic growth, globalization, sustainable energy demand, and biological capital. This will be helpful to help policymakers recognize a new understanding of environmental viability. This investigation was based on the fact that the Chow test, and the Generalized Method of Moments (GMM) were all used in this study (v) Eventually, G-7 will have a lot of financial resources and be able to actually implement the SDGs. To sustain ecological quality, it is essential to know how this nation with a great quantity of economic, ecological, and resource utilization uses these resources. This study's important results underline the need for effectual and environmentally sound strategies for recently introduced business and monetary advancement and sustainable and clean energy and emission development that do not pose detrimental ecological problems for this country.

The remainder of the article is arranged as follows: **Section 2** is a review of the literature. **Section 3** presents the data sources and methods. **Section 4** contains the results and commentary. Conclusions and policy implications are covered in **Section 5**.

2 LITERATURE REVIEW

Analysis of the effect of financial accessibility among nations is done in two key ways in the effect of financial inclusion. Financial inclusion indices may be constructed in two ways: 1) by evaluating relevant financial factors independently, and 2) by generating multivariate indexes. By creating comprehensive financial inclusion indexes employing specific measures of financial services accessibility, scholars like (Wu et al., 2020; Omri and Bel Hadj, 2020) have begun to explore collective data on financial availability. They said that complex and multifaceted compound indexes may be used as a meter for measuring context's effectiveness. Scholars and practitioners can compare nations holistically using a multivariate financial inclusion index since it comprises collected data about several characteristics of direct investment in a country. According to the World Bank, "there is surprisingly little empirical research investigating the particular connection between financial inclusion and greenhouse gas emissions" (Fonseca et al., 2015; Ahmadi et al., 2017). Relevant data on financial inclusion across nations is rare and inconsistent, which is one of the reasons behind this assumption (Samimi et al., 2012; Li et al., 2018).

In the aftermath of the global financial crisis, scientific literature has been pushed to the forefront, although the findings are mixed. Prior research believes that business access and use has a long-term effect on financial stability. In (Barbier, 2016; Ikram et al., 2020) they do a cross-country study. Ecological deterioration and infrastructure prosperity have been studied in a variety of ways since Grossman and Krueger's classic study (1994). According to the authors, in the preliminary stages, industrial development is closely linked to a rise in carbon dioxide emissions. However, when the degree of expansion is above a specific threshold, the opposite occurs. However, although some of these investigations have shown evidence for

the EKC (Irfan et al., 2021) and several others have found no support for the EKC (Morrow and Rondinelli, 2002).

To compensate for unobserved heterogeneity in light of multiple research's inconsistent findings, many now add monetary development. This is because the capital structure is expected to have positive impacts on economic emissions and water quality. Accelerated market production (the wealth impact) should, in theory, lead to higher energy use and carbon dioxide emissions. Finances may also lead to involvement in more modern technology (technical impact), resulting in lower greenhouse gas emissions and better energy consumption (effectiveness) (Park and Pyun, 2020). In order to have a good impact on the environment, financial growth relies on attracting foreign direct investment (FDI) and its accompanying R & D (Hutson and Laing, 2014). Energy consumption and ecological impact are linked by looking at the nations' real income growth patterns. There is a massive market for coal and oil as a result of rising income levels. It emits air pollutants into the environment as a result of increasing greenhouse gas emissions after this technique. Thus, environmental quality is a worry to some degree because of the significant income growth trend. After a certain point in this expansion, a gain in environmental understanding encourages businesses, government agencies, and lawmakers to priorities conventional energy sources and less polluting technology.

Energy consumption and ecological impact may be explained by looking at the nation's gross domestic product. There is a growing demand for energy production as a result of rising income levels. It emits air pollutants into the environment as a result of enhanced non-renewable sources after this technique. Thus, ecological perfection is a worry to some degree because of the significant income projection growth. A rise in ecological expertise endures among businesses, supranational institutions, and governments when this development process reaches a minimum threshold. If a well-functioning, efficient, and well-developed financial sector contributes to the gross domestic product, it is logical to speculate that something has ecological impacts. (Allayannis and Ofek, 2001) Similarly, effectual and well-functioning economic growth helps the gross domestic product (Kim et al., 2020). It is possible, though, that the hopeful role of a well-developed financial framework in promoting economic development may lead to increased energy consumption and ecological concerns (Bodnar and Wong, 2003). Financial growth and the destruction of the environment are intertwined, but the research information on this dynamic relationship is overloaded with scientific findings that are inconsistent, contradictory, and conflicting.

3 DATA AND METHODOLOGY

Our model of the causes of ecological degradation is obtained through various reviews (White, 1980; Storn and Price, 1997) looks like this:

$$\ln CO2_{it} = \beta_1 + \beta_2 \ln GDP_{it} + \beta_3 \ln URB_{it} + \beta_4 \ln TR_{it}$$
$$+ \beta_5 \ln FD_{it} + \beta_6 IQ_{it} + \beta_7 \ln FD_{it} * IQ_{it} + \varepsilon_{it} \quad (1)$$

where the subscripts i and t represent the country and era, respectively; is the logarithm of greenhouse gas emissions $\ln CO2_{it}$, is the logarithm of gross domestic product $\ln GDP_{it}$, is the logarithm of urbanization $\ln URB_{it}$, is the logarithm of globalisation $\ln TR_{it}$, is the logarithm of economic development, IQ and is the measurement error ε_{it}. The Chow test is used to confirm that our framework is dependable by accounting for possible failure mechanisms. The analysis is used in a multiple regression situation to see whether the slope of two-time intervals varies. The following is a summary of the Chow test's mechanism. This allows us to use a joint F-test to determine the structural stability of regression slopes, which becomes significant when there is a fundamental breakdown or shift in the statistics. When we apply the Chow test to **Eq. 1**, we get:

$$\ln CO2_{it} = \beta_0 + \beta_1 \ln GDP_{it-1} + \psi_0 D_t + \psi_1 D_t * \ln CO2_{it-1}$$
$$+ \psi_2 D_t * \ln GDP_{it-1} + \varphi_i Z_i + \varepsilon_{it} \quad (2)$$

The significant differential variable is financial inclusion, which is measured by producers and consumers. But the social investment metrics use various units, scales, and variants. To standardize these variables before transforming them into a composite measure, two techniques are used: z-score and min-max. Then Principal component analysis is used to these normalized indicators.

$$ZGLO_{it} = \sum_{j=0}^{k/2} (j+1) GLO_{it-j} + \sum_{j=k/2+1}^{k=4} (k-j+1) GLO_{it-j} \quad (3)$$

To include the four lag distributions of the globalisation factor into the framework, we modify **Eq. 1** into **Eq. 4**:

$$\ln(EFP_{it}) = \beta_0 + \beta_1 \ln(FD_{it}) + \beta_2 \ln(NRR_{it}) + \beta_3 \ln(NREC_{it})$$
$$+ \beta_4 \ln(REC_{it}) + \lambda_1(GLO_{it-1}) + \lambda_2(GLO_{it-2})$$
$$+ \lambda_3(GLO_{it-3}) + \lambda_4(GLO_{it-4}) + \mu_{it} \quad (4)$$

Where,

$$\lambda_j = \begin{cases} (j+1)\lambda 0 \leq j \leq k/2 \\ (k-j+1)\lambda k/2 + 1 \leq j \leq k \end{cases}$$

This extra association parameter (FDitZGLOit) will allow for a considerably more thorough examination of the influence of financial methodologies on environmental stewardship maintenance. This research explores **Eq. 6** as followed in an attempt to prove this research hypothesis:

$$\ln(EFP_{it}) = \beta_0 + \beta_1 \ln(FD_{it}) + \beta_2 \ln(NRR_{it}) + \beta_3 \ln(ZGLO_{it})$$
$$+ \beta_4 \ln(NREC_{it}) + \beta_5 \ln(REC_{it})$$
$$+ \beta_6 \ln(FD_{it} * ZGLO_{it}) + \mu_{it} \quad (5)$$

Where financial inclusion is concerned i, t represents the growth of bank I in country j in year t, and FI, t represents the financial inclusion indicator, namely FI mm or FI sf in country j. Banki, j, t-

1 is a set of bank individual characteristics of a bank i. A one-year lag of bank characteristics is employed to ease the endogeneity issue j, t represents parameters defining the macroeconomic stability of a nation. The year denotes the year of dummies. The idiosyncratic error is i, j, t.

$$\ln(EFP_{it}) = \beta_0 + \beta_1 \ln(FD_{it}) + \beta_2 \ln(NRR_{it}) + \beta_3 \ln(ZGLO_{it})$$
$$+ \beta_4 \ln(NREC_{it}) + \beta_5 \ln(REC_{it})$$
$$+ \beta_6 \ln(NRR_{it} * REC_{it}) + \mu_{it} \quad (6)$$

On the other hand, it is clear that a large majority of the examined sequences have a direct impact on performance. Furthermore, the averages for lnEFP, the average for lnNRR, the averages for the other variables, lnGLO, the averages for the other variables, and lnREC were all different from the averages by .6214, .2125, 3.6547, .0842, .3117, .8766, .25436, and 3.594 accordingly.

According to bivariate correlation analysis, all factors have somewhat favorable correlations with CO_2 emissions, as shown in **Table 1**. There is also a negative association between economic development, globalization, renewable energy, and the reduction of financial services for non-renewable power consumption. Furthermore, positive bivariate relationships between economic development, globalization, sustainable and non-renewable energy, and energy wealth have been established. Renewable sources and both of globalization's interaction variables have an allowable bivariate association.

3.1 Data Sources

According to this study, the 32 developed countries financially resource-rich nations, which include the United States, United Kingdom, France, Italy, Germany, Japan, and Canada, are analyzed using data from 1990 to 2016. The following parameters are used in this article's empirical analysis: As per the ecological footprint (EFP) and financial development index (FD), countries are ranked based on the complexity, accessibility, and performance of their financial systems. We have modified this financial development index to a scale of 0–100 (Genest et al., 2009) in order to make it interoperable with certain other sequences. It is quantified in terms of aggregate cultural, geopolitical, and reporting data from international globalization. (GLO) Comprehensive resource rents are calculated as a percentage of gross domestic product by combining the rents for fossil fuels. Because of this, NRR was chosen because it takes into account the prices for consumers of domestic manufacturing and extracting. Energy consumption measured in kilos of oil equivalency per capita (NREC) and as a percent of total final energy usage (REC) from thermal, solar, hydroelectrical, and nuclear power plants is included in REC. FD and GLO data are sourced from the IMF, GLO data from (Magnus and Vasnev, 2015) and NRR, NREC, and REC data are sourced from the World Bank database (Shen et al., 2020). **Table 2** defines Stability of the structure with the help Chow test. Chow test can accurately described it.

TABLE 1 | Descriptive and inferential statistics of variables.

Stats	lnEFP	LnFD	lnNRR	lnZGLO	lnNREC	lnREC	lnFD∗lnZGLO	lnNRR∗lnREC
Mean	2.534	3.674	−2.7854	5.754	3.643	2.665	12.956	.112
Median	2.894	5.804	−3.595	5.098	3.779	3.568	12.6745	−0.511
Maximum	1.784	3.675	1.884	5.685	5.095	4.647	12.8747	5.794
Minimum	−2.757	2.795	−3.795	4.895	4.786	−0.765	9.7567	−3.795
Std. Dev.	.621	.212	3.654	.084	.311	.8766	.25436	3.594
Skewness	−2.646	−1.684	.578	−2.646	−1.795	−0.874	−2.684	0.374
Kurtosis	8.685	5.765	2.987	6.565	4.656	5.678	5.956	3.679
lnEFP	1.000							
lnFD	.212∗	1.000						
t-Statistic	2.757	–						
lnNRR	.654∗	.289∗	1.000					
t-Statistic	12.675	4.756	–					
lnZGLO	.367∗	.612∗	.321∗	1.000				
t-Statistic	5.476	12.746	4.796	–				
lnNREC	.521∗∗	−.364∗∗	0.637∗	−0.553∗	1.000			
t-Statistic	3.575	−3.756	8.686	−8.907	–			
lnREC	.525∗	.311∗	.212∗∗	.611∗	−.533∗	1.000		
t-Statistic	8.678	4.897	3.686	11.685	−7.785	–		
lnFD∗lnZGLO	.321∗	.643∗	.385∗	.656∗	−0.542∗	0.622∗	1.000	
t-Statistic	2.685	17.9576	2.8567	12.8567	−3.6895	8.6636	–	
lnNRR∗lnREC	.764∗	.302∗	.711∗	0.511∗	.122∗	.611∗	0.421∗	1.000
t-Statistic	12.563	5.786	11.764	8.858	3.9577	11.656	7.0846	–

*Analysis factors in natural log are presented in **Table 1** with their descriptive and inferential statistics and association matrixes shown below. As has been said, **Table 1** shows that the empirical evidence for all factors is based on average, mean average, max, lowest variance, deviation, and other tests. lnEFP, lnFD, lnNRR, lnGLO, lnNREC, lnREC, lnFDlnZGLO, and lnNRRlnREC are all potential factors with average scores of 1.2153, 4.3832, 1.8401, 6.5583, 4.3312, 1.9431, 10.9415, and .1029, respectively.*

TABLE 2 | Chow Test for structural stability.

Dependent variable = ln CO$_{2it}$	[1]
Variable	
lnCO$_{2it-1}$	.8256∗∗∗(.2576)
Lngdp$_{it-1}$	−.0032 (.0423)
D$_t$	−.2137 (.4658)
D$_t$∗lnCO$_{2it-1}$	.0503 (.0522)
D$_t$∗lnGDP$_{it-1}$	.0441 (.0711)
Cons	−.1144∗(.3122)
Country fixed effects	YES
N	711
Adjusted R2	87.55%
F-test for joint null hypothesis	
(a) D$_t$ = 0	
(b)D$_t$∗lnCO$_{2it-1}$ = 0	
(c) D$_t$∗lnGDP$_{it-1}$ = 0	
1st Period Observation (1985–1999)	411
2nd Period Observation (2000–2011)	397
Structural Change Tests	
Chow Test (F test)	F (3,783) = 3.21 [.0041]
Wald Test (Chi Square Test)	8.7755 [.0085]
LM Test (Chi Square Test)	8.7685 [.0091]

TABLE 3 | Summary statistics.

Variable	Mean value	
	1990–1998	2001–2012
lnCO$_{2it}$	−2.31	−1.55
lnGDP$_{it}$	7.12	7.08
lnURB$_{it}$	4.45	4.98
lnTR$_{it}$	5.00	5.15
lnDC$_{it}$	3.56	3.78
lnLLQ$_{it}$	3.05	4.03
lnPC$_{it}$	3.09	3.89
IQ$_{it}$	0.58	0.41
POLITY2$_{it}$	−2.55	3.98

explains summary of the Statistical analysis carried out in this study. Due to these considerations, we divide the sample into distinct time intervals $T_1 = 1990 − 1999$ and $T_2 = 2000 − 2011$. Chow tests for $T_1 = 1990 − 1999$ and $T_2 = 2000 − 2011$ are substantially distinct; the F test rejects the null hypothesis for both eras at the 1% level of significance. As a result, we may infer that the calculated value in time is meaningfully distinct from. As a result, the Chow test shows that Dioxide emissions from 2001 to 2012 underwent a rapid transition that was significantly more pronounced than the one from 1990 to 1998. As a result, we change the study period from 2001 to 2012.

4 RESULTS AND DISCUSSION

4.1 Empirical Result for Chow Test

As a result of the Chow test, we were able to identify a fundamental transformation in 1999. Dioxide emissions in United states have grown dramatically over the last decade, and this year was chosen as a break point because of this trend, according to the theory (Stulz, 1996). **Table 3** briefly

4.2 Results for Cross Country Regression

To account for nation fixed effects in our cross-country regressions, we partition the dataset into two stages. As a result, our systems' capacity to assign probabilities is improved, and regression estimates are free of bias and heterogeneity bias (Mima and Hallett, 1999).

TABLE 4 | Cross Country regression.

Dependent variable: ln CO_{2it}

Variable	[1]	[2]	[3]	[4]	[5]	[6]
$\ln GDP_{it-1}$	0.6913***(.1078)	0.6978***(.1148)	1.0206***(.1243)	1.0232***(.1243)	.7958***(.1323)	.8234***(.1425)
$\ln URB_{it}$	0.5978**(.2135)	0.6087***(.2189)	0.0078 (.2376)	0.2132 (.2567)	.4879*(.2456)	.5129**(.2328)
$\ln TR_{it}$	.0784 (.2470)	.0411 (.2438)	−.0511 (.2725)	−0.0944 (.2567)	.0906 (.2569)	.0079 (.2321)
$\ln DC_{it}$	.4988***(.0965)	.4987***(.1274)	—	—	—	—
$\ln LLQ_{it}$	—	—	.7566 (.6169)	0.8976***(0.1978)	—	—
$\ln PCit$	—	—	—	—	.2389 (0.3987)	.4122***(.1678)
IQ_{it}	.0511 (0.6955)	—	−1.6654 (4.7786)	—	−.1324 (3.8750)	—
$POLITY2_{it}$	—	.0007 (.5976)	—	.1866 (0.1978)	—	.0321 (.0622)
$\ln DC_{it}*IQ_{it}$	.0021 (0.0017)	—	—	—	—	—
$\ln DC_{it}*POLITY2_{it}$	—	.0039 (0.0199)	—	—	—	—
$\ln LLQ_{it}*IQ_{it}$	—	—	.7122 (2.5632)	—	—	—
$\ln LLQ_{it}*POLITY2it$	—	—	—	−.0402 (.0605)	—	—
$\ln PC_{it}*IQ_{it}$	—	—	—	—	.3978 (.8976)	—
$\ln PC_{it}*POLITY2_{it}$	—	—	—	—	—	.0012 (.0332)
Cons	−8.7886***(.8765)	−8.6658***(.8977)	−12.6698***(3.6659)	−10.6753***(2.6596)	−8.7809***(2.6687)	−8.7869***(.7809)
Country Fixed Effect	YES	YES	YES	YES	YES	YES
N	44	44	41	43	42	44
Adjusted R2	86.44%	86.44%	83.76%	86.45%	86.44%	86.09%

Tables 4–6 demonstrate the cross-county regression relationships between variables.

TABLE 5 | Environment kuznets curve (EKC).

Dependent variable: ln CO_{2it}

Variable	[1]	[2]	[3]	[4]	[5]	[6]
$\ln GDP_{it-1}$	.6913***(.1078)	.6978***(.1148)	1.0206***(.1243)	1.0232***(.1243)	0.7958***(.1323)	0.8234***(.1425)
$\ln URB_{it}$	.5978**(.2135)	.6087***(.2189)	0.0078 (.2376)	0.2132 (.2567)	0.4879*(.2456)	0.5129**(.2328)
$\ln TR_{it}$	.0784 (.2470)	0.0411 (.2438)	−0.0511 (.2725)	−0.0944 (.2567)	0.0906 (.2569)	0.0079 (.2321)
$\ln DC_{it}$	.4988***(0.0965)	.4987***(.1274)	—	—	—	—
$\ln LLQ_{it}$	—	—	.7566 (.6169)	.8976***(.1978)	—	—
$\ln PCit$	—	—	—	—	.2389 (.3987)	.4122***(.1678)
IQ_{it}	.0511 (0.6955)	—	−1.6654 (4.7786)	—	−.1324 (3.8750)	—
$POLITY2_{it}$	—	.0007 (.5976)	—	.1866 (.1978)	—	.0321 (.0622)
$\ln DC_{it}*IQ_{it}$	.0021 (.0017)	—	—	—	—	—
$\ln DC_{it}*POLITY2_{it}$	—	.0039 (.0199)	—	—	—	—
$\ln LLQ_{it}*IQ_{it}$	—	—	.7122 (2.5632)	—	—	—
$\ln LLQ_{it}*POLITY2it$	—	—	—	−.0402 (.0605)	—	—
$\ln PC_{it}*IQ_{it}$	—	—	—	—	.3978 (.8976)	—
$\ln PC_{it}*POLITY2_{it}$	—	—	—	—	—	.0012 (.0332)
Cons	−8.7888***(.8765)	−8.6658***(.8977)	−12.6698***(3.6659)	−10.6753***(2.6596)	−8.7809***(2.6687)	−8.7869***(.7809)
Country Fixed Effect	YES	YES	YES	YES	YES	YES
N	44	44	41	43	42	44
Adjusted R2	86.44%	86.44%	83.76%	86.45%	86.44%	86.09%

Table 5 shows the following information. Strong positive and significant Gross domestic product correlations may be found everywhere. From .6913 to 1.0232, they're in the ballpark. Economic development and Carbon dioxide emission seem to be tightly linked, as seen by this finding. It is a mixed bag when it comes to trade and urbanization. When the sociocultural context is taken into account, financial intermediation and cash equivalents have a significant impact. In all economies, though, internal lending to the corporate companies is considerable. Lastly, eliminating organizational performance indicators will seem to have very little effect on Pollutant emissions, despite the fact that their incorporation enhanced the model's fit. As a result, many nations have not yet met the necessary threshold for macroeconomic variable to provide a positive and measurable influence on Carbon dioxide emission. We are really pleased with the adjusted R-square in all of our simulations, which shows that our model has an excellent ability to accurately forecast the dataset.

As shown in **Table 6** (which includes the square component of GDP), gross domestic product, financial sector development, and urbanization all play a significant role in determining carbon dioxide emissions. In all equations, the squared component of gross domestic product is small, which shows that there is no EKC. GMM modelling is thus based on economic output and macroeconomic variable indices as well as urbanization and carbon dioxide emissions. There is a pressing requirement to examine the stationarity and integration order of the relevant variables after assessing the potential

TABLE 6 | Unit root tests results.

Series	Level			First Difference			Order of Integration
	CADF		CIPS	CADF		CIPS	I (1)
lnEFP	−2.674		−1.675	−3.786*		−4.096*	I (1)
lnFD	−2.449		−1.546	−4.896∗		−3.789*	I (1)
lnNRR	−1.667		−3.885	−3.756*		−2.596*	I (1)
lnZGLO	−1.495		−2.785	−4.967**		−3.797*	I (1)
lnNREC	−1.634		−2.757	−3.775*		−3.686*	I (1)
lnREC	−2.875		−1.968	−3.509*		−4.795*	I (1)
lnFD∗lnZGLO	−2.586		−1.633	-4.756∗		−2.576*	I (1)
lnNRR∗lnREC	−2.553		−1.678	−3.882*		−3.957*	I (1)
Critical Values	1%	5%	10%	1%	5%	10%	
	−2.48	−2.26	−2.17	−2.39	−2.22	−2.11	

TABLE 7 | GMM estimates.

Dependent variable = ln CO_{2it}

Variables	GMM [1]	GMM [2]	GMM [3]
$lnCO_{2it-1}$	.7611***(.0884)	.7433***(.0813)	.7433***(.0811)
$lnGDP_{it-1}$	.1978***(.0812)	.2356***(.0805)	.2218***(.0803)
$lnURB_{it-1}$	.0923 (.1427)	.0911 (.0612)	.0811 (.1422)
$lnDC_{it-1}$	0.0421 (0.0301)	—	—
$lnLLQ_{it-1}$	—	0.0877 (.0602)	—
$lnPC_{it-1}$	—	—	0.0112 (.01827)
Cons	−1.532***(.6987)	−1.4894***(.7065)	−1.7844***(.6089)
Year2002	−.0389 (.0411)	.0422 (.0412)	−.0389 (.0367)
Year2003	−.0611 (.0441)	.0071 (.0422)	−.0711*(.0422)
Year2004	−.0081 (.0351)	.0621 (.0376)	−.0155 (.0342)
Year2005	−.0143 (.0443)	.0443 (.0351)	−.0287 (.0322)
Year2006	−.0298 (0.0361)	.0281 (.0422)	−.0367 (.0321)
Year2007	−.0387 (0.0354)	.1431 (.0341)	−.0511 (.0331)
Year2008	−.0182 (0.0332)	.0411 (.0342)	−.0229 (.0321)
Year2009	−.0389 (0.0411)	.0089 (.0278)	−.0421 (.0298)
Year2010	−.0522 (0.0412)	.0154 (.0308)	−.0684*(.0388)
Year2011	+	+	+
Year2012	−.0411 (.0301)	.0472 (.0303)	−.0384 (.0277)
Sargan Test of Overidentification	[.2498]	[.2087]	[.1749]
N	276	273	275

CSD throughout cross-sections. The present research performs two s-generation panel stationary tests based on this perspective (i.e., hereafter CADF and CIPS). As shown in **Table 7**, the results of panel unit root testing are summarized. A look at **Table 5** reveals that, despite the fact that all of the parameter combinations have unit root problems at the level, all of them are really static following the initial differences in I (1) modification. Using this method, it is possible to determine whether long-term cointegration occurs or not.

4.3 Results for Generalized Method of Moments Estimator

The positive and substantial lag in carbon dioxide emission correlation shows that the present level of carbon dioxide emission is heavily influenced by its previous levels. Secondly, environmental costs are linked to gross domestic product per capita in a significant way. To put it another way, as GDP per capita rises, so do emissions of carbon dioxide. From .02088 to .02351,

the statistic is consistent. Emissions of carbon dioxide, on the other hand, have no relevant correlation with urbanization and banking sector development metrics. **Table 7** shows GMM estimates.

The bottom panel diagnoses The GMM estimates all cleared the Sargan overidentification test. A non-significant p-value indicates that almost all the instrumentation is legitimate. The year's dummy estimations were weak. Long-run results by elasticity has been explained precisely in **Table 8**. The regressions did not provide a year dummy for 2001. So the change in CO_2 emissions between 2001 and the later years was not considerable. As the most important predictor of greenhouse gas emissions, we next analyses the short and long-run elasticity of demand for gross domestic product per capita.

4.4 Results for Long-Run Elasticity Estimates

Table 8 lists the long-run AMG and CCE-MG coefficients and elasticity estimates. These three estimating methods yield the same

TABLE 8 | Results of long-run elasticity.

Variable	Model 1: EFP = f (FD, NRR, ZGLO, NREC, REC)				Model 2: EFP = f (FD, NRR, ZGLO, NREC, REC, lnFD∗lnZGLO)				Model 3: EFP = f (FD, NRR, ZGLO, NREC, REC, lnNRR∗lnREC)			
	AMG		CCE-MG		AMG		CCE-MG		AMG		CCE-MG	
	Coeff	p-value	Coeff	p-value	Coeff	p-value	Coeff	p-value	Coeff	p-value	Coeff	p-value
lnFD	.231∗	.000	.218∗	.000	.321∗∗	.020	.369∗∗∗	.084	.278∗	.001	.452∗	.004
lnNRR	.278∗∗	.049	.358∗	.004	.423∗∗	.024	.745∗∗	.010	.166∗	.000	.156∗∗	.021
lnZGLO	−.618∗	.001	−.566∗∗	0.016	−0.251∗	.000	−.145∗	.005	−.151∗∗∗	.092	−.156∗∗∗	.061
lnNREC	.163∗∗∗	.087	.017∗∗∗	0.052	0.132∗∗∗	.080	.002	.489	.147∗∗	.044	.029	.131
lnREC	−.141∗∗	.013	−.161∗	0.007	−0.391∗	.005	−.676∗∗∗	.054	−.223∗∗	.026	−.598∗	.000
lnFD∗lnZGLO	—		—		−.722∗∗	.032	−.559∗	.001	—		—	
lnNRR∗lnREC	—		—		—		—		−0.876∗	.001	−2.7845∗	.001
Constant	5.875∗∗	.019	5.8760∗	0.001	10.218∗	.007	16.843∗	.000	−8.575∗	.000	−14.7853∗	.000
Wald χ^2	60.786∗	.000	89.56∗	0.000	151.678∗	.000	89.686∗	.000	16.894∗	.000	26.684∗	.000
RMSE	.0285	.0269	.0341	.026	.027	.0311						

coefficient sign but vary in quantity and significance level. Apart from globalization, the conversion factor of the parameters predicted by AMG is smaller than those predicted by CCE-MG. Due to its factors which determine the accuracy, the variable may be understated or exaggerated. Furthermore, this work used both cross-country regression and GMM estimators as benchmarks, with the CCE-MG method being used to test robustness. Both methods give consistent results despite cross-sectional dependence and slope variation.

According to the AMG estimating technique, nations with a measure of financial development have a considerable contribution to environmental degradation, increasing it by .231 percent over time. Models 2 and 3 also support these results. The nation's economic banking market is responsible for promoting the cost of labour (capital), and this advanced financial infrastructure disburses financial assets to local firms, which in turn leads to greater amounts of hazardous waste and the combustion of more atmospheric CO_2. The fact that industrialized countries are putting more money into micro and major manufacturing facilities is also encouraging. Financiers might use this opportunity to increase funding for new enterprises, such as paying lower or environmental mitigation. Because of this, the monetary service's growth and the consequent increase in environmental pollution are both under the thumb of the capitalized consequences. Another possible reason may be that the banking sector's growth may have increased the spending power of consumers by offering low-interest loans. Air conditioners, cars, and industrial spaces, which put a significant strain on the environment, are made more accessible to customers in this way. For this reason, the world's most technologically advanced nations should take a strong stance against the banking sector's impact on the environment. It is consistent with (Li et al., 2010; Shiogai et al., 2010; Faes et al., 2014). This contradicts previous studies that found that the established financial sector of an economy reduces environmental harm in ASEAN and 15 severely polluted nations, accordingly, based on the results of (Dempster, 1967; Kroll and Stedinger, 1998).

It is clear that the use of natural resources has a substantial impact on the environment. A 1% increase in natural resources would increase the ecological deficit by .3021 percent over time in resource-rich nations. This is consistent with the findings of Models 2 and 3 (with interaction terms). This shows that the depletion of natural resources is the primary cause of increased harm to the environment in these nations. Earlier studies on Pakistan (Basu and Srinivas, 2015) and China (Douglas et al., 2000) support these conclusions as well. According to (Kjeldsen and Jones, 2007; Rahman et al., 2020), the use of natural resources has a considerable impact on environmental performance. The results of this analysis, on the other hand, contradict those studies. Because of their richness in natural resources, these economies are often predicted to gain foreign currency. Natural resources have a helpful function in enhancing economic pollution if they are well managed and used in a well-organized manner. The local environment decreases and the rate of natural resource depletion speeds up. As a result, natural resources may be redeveloped. This shift from old equipment that relied on land and resources to greener equipment (technology) that incorporates inventiveness, repurposing, continuous improvement, remanufacturing, and synthetic resources has occurred throughout the globalization age. Natural resource extraction has a positive impact on economic growth and environmental degradation, which is why this is justified (El-Jabi and Turkkan, 2016).

According to empirical evidence, these countries' entire ecosystems have been reduced dramatically over the long term, contrary to what was predicted above. If all other factors remain constant, one percent of a globalization effect reduces environmental deterioration by .6249 percent, according to Hardy. Models 2 and 3 also support these results. These nations might benefit from the relocation of parts of their commercial transactions to other nations, thus reducing the emission of carbon dioxide and depleting their natural resources *via* increased FDI and trade openness. (Griffis and Stedinger, 2007; Castellarinet al., 2008) are in disagreement with the present study's results. The environmental footprint is positively affected by the results of the use of non-renewable energy. For every 1% increase in non-renewable energy usage, there is a .1561% increase in the impact on the planet. Non-renewable energy has been linked to environmental damage in these countries, as evidenced by the findings of (Kjeldsen and Jones, 2009); the high demand for traditional energy resources in these (developed) countries goes hand-in-hand with their high offshore

economic activity, which will contribute immensely to the success of an environmental collision. According to the studies, using renewable energy has a significant negative impact on the environment. This demonstrates how renewable energy sources have a lower environmental impact than fossil fuels. In the long run, a 1% increase in renewable energy use reduces carbon emissions by .1386 percent. There is a consistent pattern of sustainable and non-renewable energy use in all models (either with or without interaction effects). That renewable energy technology is being developed and used is evidence that these countries are on the correct track to meet the Sustainable Development Goals (SDGs). (Zrinji and Burn, 1994; Ouarda et al., 2001; Neves and Gomes, 2011) find similar results.

AMG and CCE-MG results with estimated coefficients are shown in **Table 5**. (in **Table 5**, Models 2 and 3). Models 2 and 3 now include both interaction components, and all of the correlations are in the same direction as they were in Model 1. The coefficient of lnFDlnZGLO is positively accurate with the opposite sign (= .7198 and p .05) in Model 2, where we incorporate the interaction of capital formation with globalisation (lnFDlnZGLO). When this interaction variable is included, financial integration has an even more significant impact on the ecological footprint in Model 2 than in Model 1. There is evidence to suggest that the integration of globalisation has a positive impact on developed nations' financial systems, which in turn boosts the amount of money being invested in more environmentally friendly and effective technology. This is due to the fact that these countries are economically developed and have a broad perspective as a result. When these nations' financial sectors are nearing their optimum level, they spend their assets in third world countries *via* FDI, where the pollution halo concept dominates, which in turn reduces emissions, particularly during globalization mode. This is another argument. Increasing financial resources and constructing additional environmental pollution mitigation institutions are a must for these nations!

5 CONCLUSION AND POLICY IMPLICATIONS

The current study measure the combining effects of economic development and globalization towards energy efficiency and environmental degradation in 32 developing countries by using data from 1990 to 2018. The findings show that panel data has undergone a structural shift Rom 1990 to 2016, the Chow test has shown that the amount of carbon dioxide emissions has been steadily increasing, whereas the rate from 2000 to 2011 has been steadily decreasing. According to cross-country regressions, environmental problems in the 32 developed countries are heavily influenced by factors such as economic growth, urbanization, and banking sector development, while the consequences have little impact on air quality. It is evident that financial development and ecological degradation are linked in a strong and consistent way after accounting for possible endogeneity, structural breakdowns, and simultaneity bias. Financial advancement, increasing energy use, and urbanization procedures have led to a rise in the exploitation and use of natural resources in the 32 developed countries of today. According to experts, one of the

most important aspects of reducing greenhouse gas emissions is a shift toward renewable energy. As a result, from 1990 to 2016, this research examines the ecological impact of the ten most economically developed nations' use of energy sources—non-renewable energy and renewable energy. While globalization and renewable energy use reduce environmental pollution in this area, financial growth, ecological systems and nonrenewable energy usage increase the CO_2 emission level. A selected macroeconomic function is beneficial to environmental deterioration in a second model that includes the interplay between economic development in the developing world and environmental regulators. According to this study, financial institutions in these nations have an important function as mediator variables of globalization in addition to protecting sustainability practices.

Finally, in the third model, we incorporate a natural resource-based moderator. The findings suggest that air quality can be controlled more effectively when both factors are taken into consideration. So, the findings of this study on economic development, energy, natural resources, and the environment are essential because of the two interaction factors. The cross-country regression test results reveal a bidirectional causation correlation between corporate development, non-renewables, and renewable sources, as well as environmental consequences, natural resources, solar and wind, and banking sector development.

(i) Even so, there is a one-way causality link between natural resources and ecological footprint, between contribution to global warming and globalizations, between globalizations and stock market development, between direct investment and non-renewables, and eventually between globalizations, non-renewables, and renewables, in conserving natural resources. In light of the above observational assumptions and econometric results, this paper proposes a number of policy recommendations that are compatible with these findings. It is imperative that the banking system be restructured in resource-rich nations since financial growth has been linked to a decrease in sustainability practices. Furthermore, it is necessary to provide additional financing for investments in the manufacturing sector that is better than the majority of non-renewable energy use. The environmental contamination in this area may be mitigated by ensuring that clean financing options are available.

(ii) These countries have a large supply of capital that is used domestically and sometimes earns money that is transferred from these countries. Natural resource rents have a favorable effect on the impact on the planet because of the volatility in the use of these resources. Oil and gas, hydrocarbons and coal may be reduced while renewable energy sources like producing energy and waves can be bolstered in these nations' policymaking and governance. The utilization of renewable energy sources has the potential to reduce pollution, promote long-term productivity expansion, and keep the environment safe. In order to protect their species, these governments must allocate these funds for rejuvenation.

(iii) By balancing producers and consumers to prevent the natural depletion of natural resources, policymakers should ensure that research, training, innovation, safety, conferences, workshops, R&D, expenditure on skills courses, and sustainable development are maintained.

(iv) Playmakers and economy-wide bodies should also concentrate on policies relating to the elimination of tariffs, immigration tariffs, as well as taxation and promoting FDI in resource-rich nations since globalizations has been shown to minimize pollution. For the sake of globalization's environmental quality, trade and FDI in traditional technologies should be prohibited. To speed up globalizations, an expanded role for economic quality is required. As a result of this, economic growth initiatives should also focus on the amount of trash that is generated. It is possible to acquire the necessary experience and abilities to manage trash throughout globalizations. The only viable answer to this problem is to increase the use of renewable energy sources, given the detrimental implications of climate change resources and non-renewable energy use on

environmental stewardship. Renewable energy sources are the only long-term solution to environmental degradation and energy potential vulnerabilities; hence they must be prioritized in the post-COVID-19 period.

DATA AVAILABILITY STATEMENT

The datasets presented in this study can be found in online repositories. The names of the repository/repositories and accession number(s) can be found in the article/supplementary material.

AUTHOR CONTRIBUTIONS

The author confirms being the sole contributor of this work and has approved it for publication.

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