Journal of Advanced Environmental Research and Technology

Vol. 1, No.4
page 85-97 ,fall 2023
***
Received 05 augest 2023
Accepted 21 augest 2023

Financial development and environment: Evidence of consumption-based CO_2 emissions

Fariba osmani, Mahdi Cheshomi, Ali Akbar Naji Meidani*

Department of Economics of Faculty of Economics and Administrative sciences, Ferdowsi University of Mashhad, Iran.

[DOI: 10.22034/JAERT.1.4.85]

Abstract

Financial development is widely recognized as a key catalyst for economic growth and progress today. With developing nations prioritizing accelerated economic expansion, they have increasingly turned their attention to fostering financial market growth. However, the impact of financial development on environmental sustainability remains uncertain. Furthermore, in certain countries, there is a notable distinction between carbon dioxide emissions generated from production and those arising from consumption, this article examines the impact of financial development on consumption-based CO_2 emissions for a panel of 17 developing countries during the period of 1990–2019 with a Panel-Quantile approach. Empirical findings show that the effect of financial development on consumption-based CO_2 emissions is positive and significant in all quantiles. In addition, this study considers gross domestic product, rental rates of natural resources, trade openness, and globalization as control variables. The results of this study provide new evidence for policymakers to maintain environmental quality by focusing on the link between financial development and consumption-based CO_2 emissions.

key words

financial markets

consumption-based CO_2 emissions

production -based CO_2 emissions

developing countries

*To whom correspondence should be addressed:
naji@um.ac.ir

1 Introduction

Today, global warming is one of the most important and controversial challenges that the world has faced. On the other hand, one of the main and most important factors in global warming is carbon emission. In recent decades, CO_2 emissions have increased from about 22 billion metric tons in 1990 to about 34 billion metric tons in 2019 [1]. As a result, nations must place greater emphasis on addressing environmental challenges linked to rising carbon emissions. Numerous countries have already enacted policies to mitigate global warming. Moreover, a significant body of research has explored the various factors that influence environmental quality [2, 3, 4, 5]. Moreover, after the global financial crisis, studies focused on the effects of financial development on carbon emissions [6, 7, 8, 9]. Some studies reported that financial development can help reduce carbon emissions [10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20]. Financial development through the growth of financial resources can help employ advanced low-carbon technologies to further protect the environment [21]. [8] argued that the growth and development of the stock market will reduce the financing costs of companies' fixed capital, which will help to increase new investments and increase innovative low-carbon technologies. So, it can help preserve the environment.

Some studies also argue that financial development by accelerating economic growth causes an increase in carbon emissions [6, 22, 23, 24, 25, 26, 27, 28, 29, 30]. In addition, the increase in financial development causes an increase in the purchase of durable goods, which can affect the quality of the environment [6, 31]. Furthermore, financial development, which fosters economic growth, also drives a rise in consumer loans, leading to higher purchases of energy-intensive durable goods. Consequently, this surge in energy consumption negatively impacts environmental quality [27]. Some studies also did not find a significant relationship between financial development and carbon emissions [6, 32, 33]. As a result, previous research has yet to reach a definitive consensus on the effects of financial development on environmental quality. Additionally, earlier studies primarily focused on carbon dioxide emissions measured through production. However, this study evaluates environmental quality by considering CO_2 emissions based on per capita consumption.

Consumption-based CO_2 emissions are emissions produced for business. This measurement criterion includes production-based greenhouse gas emissions minus export-based greenhouse gas emissions. In addition, greenhouse gas emissions caused by imports are also added to it. Since the CO_2 emission index, which is considered an environmental measure in most previous studies, is measured in terms of production, some of the products of each country are exported. So, consumption-based CO_2 emissions can well show the carbon emission of each geographical region based on the consumption and consumption patterns of that region. This change of attitude from carbon emissions based on consumption instead of production is important because the carbon emissions of production and consumption in some countries are drastically different. For example, China's consumption-based carbon emissions are 14% lower than its production-based carbon emissions [1]. So this shows that while China is one of the biggest carbon exporters, the consumption style of the citizens of this country does not emit much carbon. Therefore, studying the effect of financial development on carbon emissions based on consumption can provide a new perspective on the consumption style of countries in environmental protection, which can change the direction of policies. In the following, the average CO_2 emission based on con-

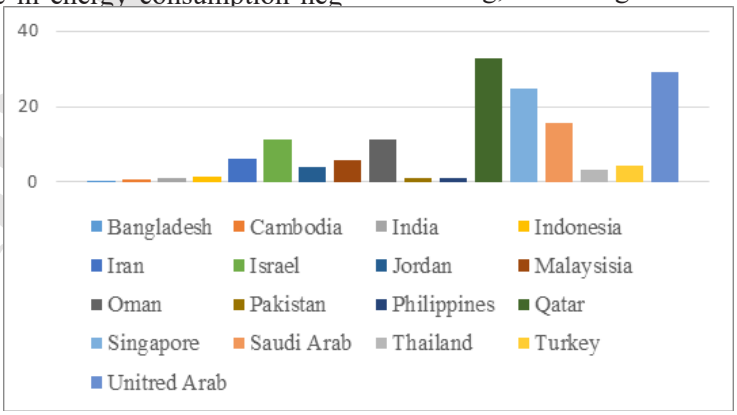

Fig 1: The average C- CO_2 of the studied countries during the years 1990-2019
Source: Authors' Compilations

[DOI: 10.22034/JAERT.1.4.85]

sumption of the studied countries is presented in Fig. 1.

Fig. 1 shows the average consumption-based emissions of carbon dioxide in the studied countries during the years 1990 to 2019. Annual carbon dioxide emissions are measured based on consumption in tons per person. If a country's consumption-based carbon dioxide emissions are greater than its production-based carbon dioxide emissions, that country is a net importer of CO_2. Fig. 1 shows that Qatar ranks first, and then Iran ranks second in terms of CO_2 emissions based on consumption. In addition, the countries with the lowest consumption-based carbon dioxide emissions are Bangladesh and Cambodia. So, it can be concluded that the consumption style of the citizens of Qatar and Iran causes much damage to the environment.

Although developing countries have a high share of the world economy, they are also responsible for 53% of global carbon dioxide emissions [1]. [34] argued that reducing consumption-based CO_2 emissions in low-income countries is an important factor in reducing greenhouse gas emissions. Therefore, to reduce global warming, appropriate policies should be provided to reduce carbon in this region. Moreover, developing economies have prioritized financial development as a means to spur economic growth, aiming to boost other sectors through the expansion of their financial systems. However, these countries often overlook the importance of environmental quality. To combat rising global temperatures, it is essential for developing nations to actively participate in international efforts to reduce carbon emissions. Therefore, more research is needed on the CO_2 emissions and financial development link in developing countries. In addition, while previous researchers have conducted extensive and in-depth research on the relationship between financial development and production-based CO_2 emissions, new research should focus on the relationship between financial development and consumption-based CO_2 emissions. Some countries have reduced their consumption-based carbon but exported more carbon due to global pressures to reduce carbon from consumer goods. In the following, the average financial development index of developing countries is presented in Fig. 2.

Fig 2 shows the average financial development index of developing countries during the studied period. According to the fig above, Singapore ranks first and Malaysia ranks second in terms of financial development. The lowest rank belongs to Cambodia, followed by Bangladesh.

As seen, previous studies investigating the impact of financial development on the environment in different countries have been conducted using different assumptions and methods, but they did not reach a definite conclusion in this case. In addition, previous studies mostly focused on carbon emissions from production. Therefore, this study studies the relationship between financial development and consumption-based CO_2 emissions in developing countries. In addition, developing countries are on the fast path of economic growth and do not pay much attention to the environmental consequences of growth. In addition, there are significant differences in the link between financial development and CO_2 emissions in different developing countries, and therefore, the impact of financial development on CO_2 emissions in different developing countries may be heterogeneous. Hence, quantile regression focuses on the significant heterogeneity at the country level among developing countries by classifying countries into six groups based on carbon emissions. This research offers valuable in-

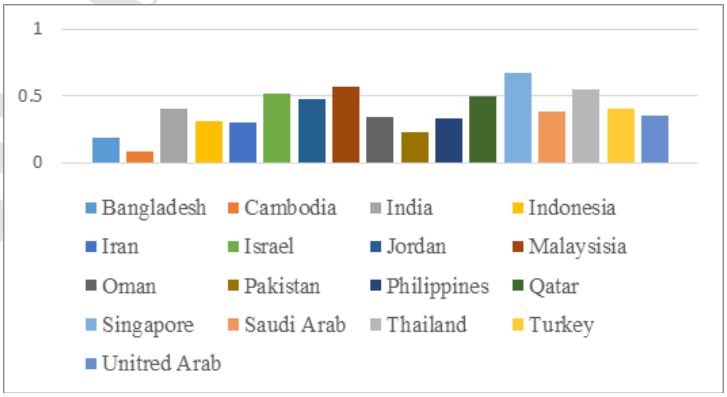

Fig 2: The average financial development of the studied countries during the years 1990-2019
Source: Authors' Compilations.

[DOI: 10.22034/JAERT.1.4.85]

sights for policymakers to shape targeted policies aimed at enhancing environmental quality while fostering financial sector development in the aforementioned countries. The remainder of the paper is organized as follows: the next section outlines the materials and methods, followed by a discussion of the experimental findings, and the final section presents the conclusion.

2. Materials & Methods

In this study, annual time series data from 1990 to 2019 has been used according to data availability. This research assesses the relationship between financial development and consumption-based carbon dioxide emission intensity in developing countries. To reduce skewness, all series are transformed into the natural logarithm [8]. The variables and their sources are reported in Table 1.

After describing the variables and their sources, we describe the statistics of the variables used in this study. In this context, Table 2 below shows the descriptive statistics of the variables.

After presenting the data and variables utilized in this research, the methodology under investigation is introduced. While OLS regression is one of the most commonly applied methods, it tends to perform inadequately in situations where the error distribution deviates from normality, particularly in cases with long or asymmetric tails. To address these limitations, quantile regression was introduced by Koenker and Bassett in 1978. This regression is a comprehensive method for statistical analysis of linear and non-linear models of dependent variables in different contexts [35, 36].

Quantile regression provides a comprehensive model that evaluates the dependent variable and provides the possibility of including independent variables in different parts of the distribution, espe-

Table 1. Variable acronyms, definitions, and sources

Variables	Definition	Sources
C- CO_2	Annual consumption-based CO_2 emissions (per capita), in metric tons per person	Our World in Data (2020)
GDP	Gross domestic product per capita (GDP) (constant= 2010 $)	WBD (2020)
FD	Financial Development Index	IMF (2020)
RE	Total natural resources rents (% of GDP)	WBD (2020)
TO	Total economic openness = Import+Export (constant=2010 $)	WBD (2020)
G	Globalization	WBD (2020)

Source: Authors' Compilations.

Table 1. Variable acronyms, definitions, and sources

Variables	Obs.	Mean	Std.-Dev.	Min.	Max.
C- CO_2	510	9.032	10.795	0.175	57.792
GDP	510	15029.31	18811.51	364.8811	66023.63
FD	510	0.389	0.162	0	0.793
RE	510	10.655	13.956	0.00016	55.475
TO	510	95.536	76.685	15.506	437.326
G	510	59.815	13.431	19.410	85.343

Source: Authors' Compilations. Obs. is the number of observations in the model, Std. Dev. is the standard deviation, Min and Max are the minimum and maximum, respectively.

[DOI: 10.22034/JAERT.1.4.85]

cially the endpoints of the distribution. In addition, quantile regression does not have the limitations of ordinary regression. Quantile regression can calculate and draw different regression curves according to different percentiles to provide a comprehensive picture of the data. In addition, quantile regression allows measuring the relationship between independent and dependent variables without the need for data to be normal, even in the presence of outliers [37].

Therefore, this research applies the quantile panel regression method to evaluate the effect of financial development on consumption-based CO_2 emissions. The mathematical formula of the quantile regression model is as follows (Eq. 1).

$$y_i = x_i b_{\theta i} + \mu_{\theta i}. 0 < \theta < 1 Quant_{i\theta}(y_i/x_i) = x_i \beta_\theta \quad (1)$$

X: the vector of independent variables; Y: the vector of dependent variables; μ: a random error; $Quant_{i\theta}$ (y_i/x_i) is the θth quantile of the independent variable; the βθ estimate shows the quantile regression θth and solves the Eq 2:

$$min \sum_{yi \geq x_i'\beta} \theta |y_t - x_i'\beta| + \sum_{yi < x_i'\beta} (1-\theta)|y_t - x_i'\beta| \quad (2)$$

Given that, θ is equal to different values. Therefore, the estimation of different parameters is obtained [38]. Econometric theories state that model variables should be logarithmically used to eliminate possible heterogeneities. Therefore, the model is as follows:

$$LC - CO^2_{it} = La + \beta_1 LGDP_{it} + \beta_2 LFD_{it} + \beta_3 LRE_{it} + \beta_4 LTO_{IT} + \beta_5 LG_{it} + \delta_{it} \quad (3)$$

C- CO_2 represents consumption-based CO_2 emissions in metric tons per person; GDP is Gross domestic product per capita; FD is Financial Development Index; RE is Total natural resources rents; TO is trade openness; G denotes Globalization. Given in this study was used panel quantile regression to measure C- CO_2, Eq 4 is converted to the following form:

$$Q_\tau(LC - CO^2_{it}) = (La)_\tau + \beta_{1\tau} LGDP_{i\tau} + \beta_{2\tau} LFD_{i\tau} + \beta_{3\tau} LRE_{i\tau} + \beta_{4\tau} LTO_{i\tau} + \beta_5 LG_{it} + \delta_{i\tau} \quad (4)$$

In this regard, Q_rmeans the estimation of the quantile regression τthin the ecological footprint, and$(la)_r$ is the constant component. The coefficients$\beta_{1\tau}.\beta_{2\tau}.\beta_{3\tau}.\beta_{4\tau}.\beta_{5\tau}$ are the quantile regression parameters and show the influencing factors.

3. Empirical results and discussion

Before estimating any model, it is necessary to check pre-tests to be able to be sure of the results. Therefore, pre-tests are presented in this section. First, the multicollinearity test of the dependent variables is checked with the variance inflation factor [39]. The results of Table 3 show that there is no serious multicollinearity problem between the variables. In the next step, the LM test [40] is performed to examine cross-sectional dependence (CSD) in the panel data because the number of countries is equal to 17 and the number of years is equal to 30 (t>n). The null hypothesis in this test indicates cross-sectional independence. The LM test results are presented in Table 3.

The results in Table 3 show that the null hypothesis is rejected. Therefore, in this section, the panel unit root test [41] was used to examine the stationary variables.

Table 3.VIF test and Breusch- Pagan (LM test)

Variables	VIF-test		Breusch- Pagan (LM test)	
	VIF	Mean VIF	t-statistic	Prob.
C-CO_2	n.a	2.16	1094.869	0.0000
GDP	1.93			
FD	2.61			
RE	1.18			
TO	1.89			
G	3.20			

[DOI: 10.22034/JAERT.1.4.85]

The results in Table 4 show that after first-order differences, all variables were fixed at the 1% level. Next, the cointegration test is used to examine long-term relationships between variables [42]. To examine long-term relationships, [43] and [44] cointegration tests are used. The null hypothesis in both tests is the absence of collinearity.

The results in Table 5 show that there is a long-term equilibrium relationship between

consumption-based CO_2 emissions (C-CO_2) and independent variables.

effects panel is also used to evaluate the robustness of the results. In the following, 17 developing countries under study are classified into 6 groups based on the consumption-based CO_2 emissions.

After classifying countries based on consumption-based CO_2 emissions, the results of the quantile panel estimation are presented in Table 8.

The results in Table 8 show there is a positive and significant relationship between carbon dioxide emissions based on consumption and GDP per capita in all quantiles. Additionally, the findings

Table 4. Panel unit root test (CIPS)

Variables	**CIPS***	**Variables**	**CIPS***
C-CO_2	-0.787	LC-CO_2	-2.260**
GDP	-0.807	LGDP	-2.410***
FD	-2.143*	LFD	-2.388***
RE	-2.460***	LRE	-2.672***
TO	-1.864	LTO	-2.315***
G	-2.472***	LG	-2.562***

Source: Authors' Compilations. Significant critical values: -2.11, -2.20, and -2.38 respectively for levels 10%, 5%, and 1%.

Since the results of quantile regression estimation are slightly more robust than OLS estimation if the data are non-normally distributed [45], the normality of all variables is checked first. In this study, the normality of the data is checked with Shapiro-Wilk and Shapiro-France tests. The results of Table 6 show that all variables have a non-normal distribution. Therefore, a panel quantile model can be used for analysis.

In various studies, quantile values of 10th, 25th, 50th, 75th, and 90th are used as representative values for experimental analysis. In addition, the fixed

show that the most significant impact occurs at the 90th quantile, where a one percent rise in economic growth leads to an approximate 0.920 percent increase in consumption-based carbon dioxide emissions. In developing countries, economic growth is consistently linked to higher energy consumption, which in turn drives up carbon dioxide emissions. As these nations are in the early stages of growth and development, they prioritize rapid expansion, often neglecting the environmental consequences of such accelerated growth. In addition, an increase

Table 5.Kao and Pederoni cointegration test

Kao cointegration test			Pedroni cointegration test		
Estimators	t-Statistic	Prob.	Estimators	t-Statistic	Prob.
Modified Dickey-Fuller t	-5.9825	0.000	Modified Phillips-Perron t	-3.2717	0.000
Dickey-Fuller t	-6.5777	0.000	Phillips-Perron t	-8.0248	0.000
Augmented Dickey-Fuller t	-4.5462	0.000	Augmented Dickey-Fuller t	-8.2211	0.000
Unadjusted modified Dickey-Fuller t	-12.9882	0.000			
Unadjusted Dickey-Fuller t	-8.8325	0.000			

Source: Authors' Compilations.

[DOI: 10.22034/JAERT.1.4.85]

Table 6.Normal distribution test

Variables	Shapiro-Wilk test		Shapiro-France test	
	Statistic		Statistic	
LC-CO_2	0.96674	0.00000	0.96876	0.00001
LGDP	0.95044	0.00000	0.95288	0.00001
LFD	0.89410	0.00000	0.89362	0.00001
LRE	0.85037	0.00000	0.85164	0.00001
LTO	0.98287	0.00001	0.98393	0.00005
LG	0.90832	0.00000	0.90849	0.00001

Source: Authors' Compilations.

Table 7.Country distribution of C-CO_2

Quantile	Country
The lower 10th quantile group	Bangladesh, Cambodia
The 10th - 25th quantile group	Pakistan, India
The 25th - 50th quantile group	Philippines, Indonesia, Thailand, Jordan
The 50th - 75th quantile group	Turkey, Malaysia, Iran, Israel
The 75th - 90th quantile group	Oman, Saudi Arab, Singapore
The upper 90th quantile group	United Arab, Qatar

Source: Authors' Compilations. According to the level of C-CO_2, we divided the panel of 17 countries into six grades.

Table 8. Estimation results from panel quantile regression model and panel fixed effects

Variables	Quantiles					OLS
	10th	25th	50th	75th	90th	Fixed Effects
LGDP	0.788***	0.829***	0.877***	0.857***	0.920***	0.862***
LFD	0.381***	0.315***	0.330***	0.435***	0.407***	0.440***
LRE	0.058***	0.052***	0.038***	0.031***	0.022***	0.039***
LTO	0.334***	0.227***	0.131***	0.242***	0.160***	0.178***
LG	-0.186	-0.035	-0.529***	-0.869***	-0.838***	-0.565***
Cons	-6.207***	-6.641***	-4.321***	-2.927***	-3.103***	-4.150***
R^2	0.7985	0.7893	0.7874	0.7849	0.7573	0.9514

Source: Authors' Compilations. ***, **, * denote statistically significant at the 1%, 5%, and 10% levels, respectively; "L" denotes variables in natural logarithms.

[DOI: 10.22034/JAERT.1.4.85]

in GDP means an increase in household income. Also, an increase in income increases the demand for goods and services, which can lead to more consumption-based carbon emissions. Therefore, to support global policies to reduce carbon emissions, the governments and authorities of these countries must make more efforts to approve and implement sustainable development regulations. For this, governments can use punitive tools such as taxes for sectors that pollute the environment and subsidies to encourage low-carbon sectors. Some studies between carbon emissions and economic growth support our results [4, 30, 46, 47].

The results in Table 8 show that financial development has a positive and significant effect on consumption-based CO_2 emissions in all quantiles. The results show that with an increase in financial development by 1% in the 75th quantile, consumption-based carbon dioxide emissions increase by about 0.435%. In reality, as financial development accelerates, economic growth in developing countries intensifies, resulting in greater energy use and higher carbon emissions. Moreover, as the financial sector expands, corporate profits rise, leading to increased household incomes. This additional income is often spent on purchasing more goods, contributing to a further increase in consumption-based CO_2 emissions. Therefore, in order to protect the environment, the policymakers of these countries should plan financial sector development policies with a focus on reducing carbon emissions. Some studies support our results [5, 7, 8, 26, 27, 29, 48]. A group of studies also found that increasing financial development helps reduce carbon dioxide emissions [14, 15, 17]. Some studies also did not find a significant relationship between financial development and carbon emissions [8, 33, 48].

The results show that there is a positive and significant relationship between the rental rate of natural resources and CO_2 emissions based on consumption. However, as we go higher in the quantile level, this effect decreases. The greatest effect is related to quantile 10, which is about 0.058. In other words, with a one percent increase, consumption-based carbon emissions increase by about 0.058 percent.

There is a strong and significant correlation between trade openness and consumption-based CO_2 emissions across all quantiles in developing countries (see Table 8). This suggests that as trade liberalization grows, CO_2 emissions from consumption rise in these nations. It can be argued that many developing countries import environmentally harmful goods, effectively "importing carbon" through trade expansion. Conversely, their exports tend to consist of products that generate lower carbon emissions. Therefore, the authorities of developing countries should apply stricter environmental laws to their international trade. Some studies have found a positive relationship between trade expansion and carbon dioxide emissions [49, 50, 51]. Some studies found a negative relationship between trade development and environmental quality [52, 53, 54].

As shown in Table 8, there is no significant relationship between globalization and carbon emissions at the 10th and 25th quantile levels. There is a negative and significant relationship between globalization and consumption-based CO_2 emissions in the quantiles of 50th, 75th, and 90th; So that 1% increase in globalization in the 75th quantile causes consumption-based CO_2 emissions of about 0.869%. In fact, by moving at the level of quantiles, the effect of globalization on the quality of the environment increases. The development of globalization increases the income of societies, and wealthier societies demand a healthier environment. In addition, joining the global village places more importance on the environment and the implementation of stricter environmental guidelines. Therefore, globalization paves the way for environmental protection. Some studies support our results [55].

4. Conclusion and policy implications

Today, the development of financial markets is one of the most important factors in economic development, especially for developing countries. However, the consequences of financial development on environmental quality are not clear. In addition, since the carbon dioxide emissions from production differ significantly from the carbon dioxide emissions from consumption in some developing countries, this article aims to investigate the impact of financial development on consumption-based CO_2 emissions in a group of developing countries during the period of 1990–2019 with a panel-quantitative approach.

The results of this study showed that financial development plays an important role in increasing consumption-based carbon dioxide emissions. In other words, the development of the financial sector causes an increase in the consumption of energy-consuming and polluting goods. Consump-

[DOI: 10.22034/JAERT.1.4.85]

tion-based carbon emissions reflect the consumption habits and lifestyles of a society that contribute to environmental pollution. Therefore, individuals should adopt consumption patterns that support environmental sustainability. Governments in developing countries must also prioritize improving the quality of consumer products. Additionally, policymakers should create opportunities to redirect financial resources from environmentally harmful sectors to eco-friendly ones through strategic tax incentives and subsidy policies. In addition, additional revenues from financial development should be used for low-carbon technological projects, the discovery of renewable energy sources, and the financing of investments in the green economy to ensure sustainability. Therefore, to reverse the destructive environmental consequences of financial development, facilities should be provided for companies to move along with the green transformation.

The results showed that GDP per capita leads to an increase in consumption-based carbon emissions. Since economic growth in developing countries causes environmental degradation, government authorities should establish stricter policies and regulations to increase economic growth in these countries. In the case of economic growth, measures should be taken to direct additional incomes towards the purchase of low-carbon goods and clean energy users. In addition, tax incentives and subsidies that encourage investment in the clean energy sector should be increased. The growth of trade in these countries also contributes to rising carbon emissions. Alongside focusing on domestic regulations and policies, officials must give considerable attention to foreign policy. Governments should enact environmental laws that regulate trade expansion and ensure strict enforcement. Moreover, they should promote the adoption of eco-friendly technologies and the use of renewable energy sources. The empirical results of this study indicated that increasing globalization in developing countries can help improve the environment. Policymakers in developing countries need to adopt policies to increase globalization to improve the environment.

In conclusion, it is important to offer some recommendations for future research. Conducting time-varying analyses on the relationship between financial development and consumption-based carbon dioxide emissions could yield more precise and insightful results [8, 56]. In addition, comparing the effects of financial development on consumption-based carbon dioxide emissions and production-based carbon emissions will provide interesting results.

[DOI: 10.22034/JAERT.1.4.85]

References

[1] https://ourworldindata.org/co2-emissions

[2] Albulescu C., Tiwari A.K., Yoon S.M., Kang S.H. (2019). FDI, income, and environmental pollution in Latin America: Replication and extension using panel quantiles regression analysis. Energy Econ, 84:104504. https://doi.org/10.1016/j.eneco.2019.104504

[3] Zhao, B., & Yang, W. (2020). Does financial development influence CO2 emissions? A Chinese province-level study. Energy, 200, 117523. https://doi.org/10.1016/j.energy.2020.117523

[4] Osmani, F., Homayounifar, M., & Javad Gorjipour, M. (2022). Do export quality, urbanization and fertility rate affect the ecological footprint?: case study: a panel of developing countries. Do export quality, urbanization and fertility rate affect the ecological footprint?: case study: a panel of developing countries, 51-67. https://www.torrossa.com/it/resources/an/5375298

[5] Li, S., Tauni, M. Z., Afshan, S., Dong, X., & Abbas, S. (2024). Moving towards a sustainable environment in the BRICS Economies: What are the effects of financial development, renewable energy and natural resources within the LCC hypothesis?. Resources Policy, 88, 104457.https://doi.org/10.1016/j.resourpol.2023.104457

[6] Acheampong, A. O. (2019). Modelling for insight: does financial development improve environmental quality?. Energy Economics, 83, 156-179. https://doi.org/10.1016/j.eneco.2019.06.025

[7] Shahbaz, M., Destek, M. A., Dong, K., & Jiao, Z. (2021). Time-varying impact of financial development on carbon emissions in G-7 countries: Evidence from the long history. Technological Forecasting and Social Change, 171, 120966. https://doi.org/10.1016/j.techfore.2021.120966

[8] Sunday-Adebayo, T., Saint Akadiri, S., Haouas, I., & Rjoub, H. (2023). A time-varying analysis between financial development and carbon emissions: evidence from the MINT countries. Energy & Environment, 34(5), 1207-1227. https://doi.org/10.1177/0958305X221082092

[9] Saqib, N., Usman, M., Ozturk, I., & Sharif, A. (2024). Harnessing the synergistic impacts of environmental innovations, financial development, green growth, and ecological footprint through the lens of SDGs policies for countries exhibiting high ecological footprints. Energy Policy, 184, 113863.

[10] Dogan, E., & Seker, F. (2016). The influence of real output, renewable and non-renewable energy, trade and financial development on carbon emissions in the top renewable energy countries. Renewable and Sustainable Energy Reviews, 60, 1074-1085. https://doi.org/10.1016/j.rser.2016.02.006

[11] Abbasi, F., & Riaz, K. (2016). CO2 emissions and financial development in an emerging economy: an augmented VAR approach. Energy Policy, 90, 102-114. https://doi.org/10.1016/j.enpol.2015.12.017

[12] Shahabadi, A., & Feyzi, S. (2016). The relationship between natural resources abundance, foreign direct investment and environmental performance in selected oil and developed countries during 1996-2013. International Journal of Resistive Economics, 4(3), 101-116.

[13] Saidi K., Mbarek MB. (2017). The impact of income, trade, urbanization, and financial development on CO2 emissions in 19 emerging economies. Environmental Science and Pollution Research, 24(14):12748-12757. https://doi.org/12710.11007/s11356-12016-16303-12743

[14] Park, Y., Meng, F., & Baloch, M. A. (2018). The effect of ICT, financial development, growth, and trade openness on CO 2 emissions: an empirical analysis. Environmental Science and Pollution Research, 25, 30708-30719.

[15] Seetanah, B., Sannassee, R. V., Fauzel, S., Soobaruth, Y., Giudici, G., & Nguyen, A. P. H. (2019). Impact of economic and financial development on environmental degradation: evidence from small island developing states (SIDS). Emerging Markets Finance and Trade, 55(2), 308-322. https://doi.org/10.1080/1540496X.2018.1519696

[16] Zafar, M. W., Saud, S., & Hou, F. (2019). The impact of globalization and financial development on environmental quality: evidence from

[DOI: 10.22034/JAERT.1.4.85]

selected countries in the Organization for Economic Co-operation and Development (OECD). Environmental science and pollution research, 26, 13246-13262.

[17] Abdouli, M., & Hammami, S. (2020). Economic growth, environment, fdi inflows, and financial development in Middle East countries: Fresh evidence from simultaneous equation models. Journal of the Knowledge Economy, 11(2), 479-511.

[18] Umar, M., Ji, X., Kirikkaleli, D., & Xu, Q. (2020). COP21 Roadmap: Do innovation, financial development, and transportation infrastructure matter for environmental sustainability in China?. Journal of environmental management, 271, 111026. https://doi.org/10.1016/j.jenvman.2020.111026

[19] Khan, Z., Ali, S., Dong, K., & Li, R. Y. M. (2021). How does fiscal decentralization affect CO2 emissions? The roles of institutions and human capital. Energy Economics, 94, 105060. https://doi.org/10.1016/j.eneco.2020.105060

[20] Zhao, J., Shahbaz, M., Dong, X., & Dong, K. (2021). How does financial risk affect global CO2 emissions? The role of technological innovation. Technological Forecasting and Social Change, 168, 120751. https://doi.org/10.1016/j.techfore.2021.120751

[21] Mu, R. (2018). Bounded rationality in the developmental trajectory of environmental target policy in China, 1972–2016. Sustainability, 10(1), 199. https://doi.org/10.3390/su10010199

[22] Shahbaz, M., Khan, S., Ali, A., & Bhattacharya, M. (2017). The impact of globalization on CO2 emissions in China. The Singapore Economic Review, 62(04), 929-957. https://doi.org/10.1142/S0217590817400331

[23] Salahuddin, M., Alam, K., Ozturk, I., & Sohag, K. (2018). The effects of electricity consumption, economic growth, financial development and foreign direct investment on CO2 emissions in Kuwait. Renewable and sustainable energy reviews, 81, 2002-2010. https://doi.org/10.1016/j.rser.2017.06.009

[24] Xu, Z., Baloch, M. A., Meng, F., Zhang, J., & Mahmood, Z. (2018). Nexus between financial development and CO 2 emissions in Saudi Arabia: analyzing the role of globalization. Environmental Science and Pollution Research, 25, 28378-28390.

[25] Zakaria, M., & Bibi, S. (2019). Financial development and environment in South Asia: the role of institutional quality. Environmental Science and Pollution Research, 26, 7926-7937.

[26] Koengkan, M., Santiago, R., Fuinhas, J. A., & Marques, A. C. (2019). Does financial openness cause the intensification of environmental degradation? New evidence from Latin American and Caribbean countries. Environmental Economics and Policy Studies, 21, 507-532.

[27] Shahbaz, M., Haouas, I., Sohag, K., & Ozturk, I. (2020). The financial development-environmental degradation nexus in the United Arab Emirates: the importance of growth, globalization and structural breaks. Environmental Science and Pollution Research, 27, 10685-10699.

[28] Ling, G., Razzaq, A., Guo, Y., Fatima, T., & Shahzad, F. (2022). Asymmetric and time-varying linkages between carbon emissions, globalization, natural resources and financial development in China. Environment, Development and Sustainability, 24(5), 6702-6730.

[29] Wang, Z., Yan, H., Gao, X., Liang, Q., Mi, Z., & Liu, L. (2024). Have consumption-based CO2 emissions in developed countries peaked?. Energy Policy, 184, 113894. https://doi.org/10.1016/j.enpol.2023.113894

[30] Nuţă, F. M., Sharafat, A., Abban, O. J., Khan, I., Irfan, M., Nuţă, A. C., ... & Asghar, M. (2024). The relationship among urbanization, economic growth, renewable energy consumption, and environmental degradation: A comparative view of European and Asian emerging economies. Gondwana Research, 128, 325-339. https://doi.org/10.1016/j.gr.2023.10.023

[31] Yin, W., Kirkulak-Uludag, B., & Zhang, S. (2019). Is financial development in China green? Evidence from city level data. Journal of Cleaner Production, 211, 247-256. https://doi.org/10.1016/j.jclepro.2018.11.106

[32] Bekhet, H. A., Matar, A., & Yasmin, T. (2017). CO2 emissions, energy consumption, economic growth, and financial development in GCC countries: Dynamic simultaneous equation models. Renewable and sustainable energy reviews, 70, 117-132. https://doi.org/10.1016/j.rser.2016.11.089

[33] Koshta, N., Bashir, H. A., & Samad, T. A. (2021). Foreign trade, financial development, agriculture, energy consumption and CO2

[DOI: 10.22034/JAERT.1.4.85]

emission: testing EKC among emerging economies. Indian Growth and Development Review, 14(1), 50-80. https://doi.org/10.1108/IGDR-10-2019-0117

[34] Wang, C., Zhou, D., Guo, X., & Kayani, U. N. (2024). Role of natural resource rents, financial development and technological research in achieving sustainable development: A study of South Asian Countries. Resources Policy, 89, 104632. https://doi.org/10.1016/j.resourpol.2023.104632

[35] Buhari DO., Lorente DB., Ali-Nasir M. (2020). European commitment to COP21 and the role of energy consumption, FDI, trade and economic complexity in sustaining economic growth. Journal of Environmental Management, 273. DOI: 10.1016/j.jenvman.2020.111146

[36] Gómez M., Rodríguez JC. (2020). The Ecological Footprint and Kuznets Environmental Curve in the USMCA Countries: A Method of Moments Quantile Regression Analysis. Moments Quantile Regression Analysis Energies, 13(24):6650. https://doi.org/10.3390/en13246650.

[37] Koenker R. (2004). Quantile regression for longitudinal data. J. Multivar. Anal, 91:74–89. https://doi.org/10.1016/j.jmva.2004.05.006.

[38] Xu B., Lin B. (2018). What cause large regional differences in PM2. 5 pollutions in China? Evidence from quantile regression model. Journal of Cleaner Production, 174: 447-461. https://doi.org/410.1016/j.jclepro.2017.1011.1008.

[39] Belsley DA., Kuh E., Welsch RE. (2005). Regression diagnostics: Identifying influential data and sources of collinearity. John Wiley & Sons, 571. http://dx.doi.org/10.1002/0471725153.

[40] Breusch TS., Pagan AR. (1980). The Lagrange multiplier test and its applications to model specification in econometrics. The review of economic studies, 47(1): 239-253. https://doi.org/210.2307/2297111.

[41] Pesaran MH. (2007). A simple panel unit root test in the presence of cross-section dependence. Journal of Applied Econometrics, 22(2): 265-312. https://doi.org/210.1002/jae.1951.

[42] Al-Mulali U., Ozturk I. (2016). The investigation of environmental Kuznets curve hypothesis in the advanced economies: the role of energy prices. Renewable and Sustainable Energy Reviews, 54:1622-1631. https://doi.org/1610.1016/j.rser.2015.1610.1131.

[43] Pedroni P. (1999). Critical values for cointegration tests in heterogeneous panels with multiple regressors. Oxford Bulletin of Economics and statistics, 61(S1): 653-670. https://doi.org/610.1111/1468-0084.0610s1653.

[44] Kao C. (1999). Spurious regression and residual-based tests for cointegration in panel data. Journal of Econometrics, 90(1):1-44. https://doi.org/10.1016/S0304-4076(1098)00023-00022.

[45] Koenker R., Xiao Z. (2002) Inference on the quantile regression process. Econometrica, 70(4):1583-1612. https://doi.org/1510.1111/1468-0262.00342.

[46] Hassan ST., Baloch MA., Mahmood N., Zhang J. (2019). Linking economic growth and ecological footprint through human capital and biocapacity. Sustainable Cities and Society, 47:101516. https://doi.org/101510.101016/j.scs.102019.101516.

[47] Saud S., Chen S., Haseeb A. (2019). Impact of financial development and economic growth on environmental quality: an empirical analysis from Belt and Road Initiative (BRI) countries. Environmental Science and Pollution Research, 26(3):2253-2269. https://doi.org/2210.1007/s11356-11018-13688-11351.

[48] Acheampong, A. O., Amponsah, M., & Boateng, E. (2020). Does financial development mitigate carbon emissions? Evidence from heterogeneous financial economies. Energy Economics, 88, 104768. https://doi.org/10.1016/j.eneco.2020.104768

[49] Al-Mulali U., Solarin SA., Sheau-Ting L., Ozturk I. (2016). Does moving towards renewable energy cause water and land inefficiency? An empirical investigation. Energy Policy, 93:303-314. https://doi.org/310.1016/j.enpol.2016.1003.1023.

[50] Ali S., Yusop Z., Kaliappan SR., Chin L. (2020). Dynamic common correlated effects of trade openness, FDI, and institutional performance on environmental quality: evidence from OIC countries. Environmental Science and Pollution Research, 1-12. https://doi.org/10.1007/s11356-11020-07768-11357.

[51] Azimi, M. N., Rahman, M. M., & Nghiem, S. (2023). Linking governance with environmental quality: a global perspective. Scientific Reports, 13(1), 15086. https://www.nature.com/

[DOI: 10.22034/JAERT.1.4.85]

articles/s41598-023-42221-y

[52] Zhang S., Liu X., Bae J. (2017). Does trade openness affect CO2 emissions: evidence from ten newly industrialized countries? Environmental Science and Pollution Research, 24(21): 17616-17625. https://doi.org/17610.11007/s11356-17017-19392-17618.

[53] Ahmed K., Shahbaz M., Kyophilavong P. (2016). Revisiting the emissions-energy-trade nexus: evidence from the newly industrializing countries. Environmental Science and Pollution Research, 23(8): 7676-7691. DOI 7610.1007/s11356-11015-16018-x

[54] Sbia R., Shahbaz M., Hamdi H. (2014). A contribution of foreign direct investment, clean energy, trade openness, carbon emissions and economic growth to energy demand in UAE. Economic Modelling, 36:191-197. https://doi.org/110.1016/j.econmod.2013.1009.1047.

[55] Pata, U.K. (2020). Renewable and non-renewable energy consumption, economic complexity, CO2 emissions, and ecological footprint in the USA: testing the EKC hypothesis with a structural break. Environmental Science and Pollution Research, 1-16. https://doi.org/10.1007/s11356-11020-10446-11353.

[56] Wu, Y., Wang, P., Liu, X., Chen, J., & Song, M. (2020). Analysis of regional carbon allocation and carbon trading based on net primary productivity in China. China Economic Review, 60, 101401. https://doi.org/10.1016/j.chieco.2019.101401

[DOI: 10.22034/JAERT.1.4.85]