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Impact of Financial Globalization on Environmental Degradation in the E7 Countries: Application of the Hybrid Nonparametric Quantile Causality Approach

Wpływ globalizacji finansowej na degradację środowiska w krajach E7: zastosowanie hybrydowego nieparametrycznego podejścia kwantylowej przyczynowości

Tomiwa Sunday Adebayo

Cyprus International University, Faculty of Economics and Administrative Science, Nicosia, Northern Cyprus, Mersin 10, Turkey
E-mail: twaikline@gmail.com, ORCID: 0000-0003-0094-1778

Abstract
Despite their economic success, the E7 countries have not been able to provide environmental protection. These countries, on the other hand, will not be able to maintain their economic progress if they do not also protect their natural resources. In this regard, the goal of this research is to examine the impact of financial globalization on CO_2 emissions in the E7 countries. Utilizing a quarterly dataset between 1990Q1 and 2018Q4, we applied the novel quantile-on-quantile regression (QQR) and nonparametric causality in quantiles approaches to assess these interconnections. Furthermore, the quantile cointegration outcomes revealed cointegration between financial globalization and CO_2 in each of the E7 nations. Furthermore, the QQR outcomes disclosed that in the majority of the quantiles, the effect of financial globalization on CO_2 is positive for Brazil, China, India and Turkey, thus validating the pollution-haven-hypothesis. Moreover, for Indonesia, Russia and Mexico, in the majority of the quantiles, the effect of financial globalization on CO_2 is negative, therefore validating the pollution-halo hypothesis. Moreover, the novel causality in quantiles approach disclosed that financial globalization can predict CO_2 emissions for the E7 nations. Therefore, any policy channeled towards financial globalization will have a significant influence on CO_2 emissions in the E7 economies. In light of these significant observations, the research suggests that Mexico, Russia, and Indonesia should be more financially interconnected, whereas China, India, Turkey, and Brazil should reevaluate their financial globalization policies.

Key words: financial globalization, CO_2 emissions, environmental sustainability; E7 nations; Quantile-on-Quantile Regression
Słowa kluczowe: globalizacja finansowa, emisje CO_2, zrównoważoność środowiskowa, kraje E7, regresja kwantylowa

1. Introduction
The notion of sustainable development can be viewed in several ways, but at its foundation, it is a strategy of development that attempts to reconcile many, often conflicting needs against an understanding of our society's environmental, social, and economic constraints (Adebayo & Kirikkaleli, 2021). All too frequently, development is powered by a single need, without taking into account the broader or future consequences. Over the years, humans have witnessed the consequences of this strategy, from large-scale financial crises induced by reckless banking to global climate changes induced by our reliance on fossil-fuel based energy sources (Shahbaz et al. 2018). As a result, the longer we chase unsustainable development, the more common and severe its repercussions will become, necessitating immediate action.
Global warming is often regarded as the most serious ecological issue that civilization has ever encountered. This phenomenon will have disastrous implications on human lives, the environment and economies if it is not properly

controlled (Fareed et al. 2021). These repercussions will be long-term and far-reaching. Climate change is the outcome of human activity and behavior, and CO_2 emissions (CO_2) are the primary cause of global warming. The significant upsurge in CO_2 from emerging and developed nations is one of the primary causes of the recent fast growth in global CO_2 emissions. Climate change, on the other hand, has serious effects on nations (Adebayo and Kirikkaleli, 2021). Recognizing the need to act against global warming, leaders of the world gathered together in 2015 to sign the Paris Agreement, committing to collaborate on combatting this issue. This cooperation between people from other nations sharing expertise and ideas, as well as governments cooperating, is an example of globalization at its best.

Furthermore, globalization is the most contentious issue in the 21st century, specifically in the area of global financial integration. The most important aspects of accelerating openness and economic liberalization are finance, investment, and trade (Koengkan et al., 2020). By lowering rules and expanding their economies, all governments are promoting foreign investment and the international stock of liabilities and assets (Shahbaz et al., 2018). The growth of financial markets is aided by financial globalization. It offers extra resources that may be utilized to invest in ecologically-friendly initiatives in agriculture, construction, communications and information, renewable energy, technology and other sectors (Ahmed and Le, 2021). Financial globalization, on the other hand, may supply funding to polluting industries and boost economic activity, leading to the deterioration of the environment. Globalization can also enhance environmental conservation movements globally, and these efforts are helpful for the protection of the environment in nations at various stages of development (Rahman, 2020).

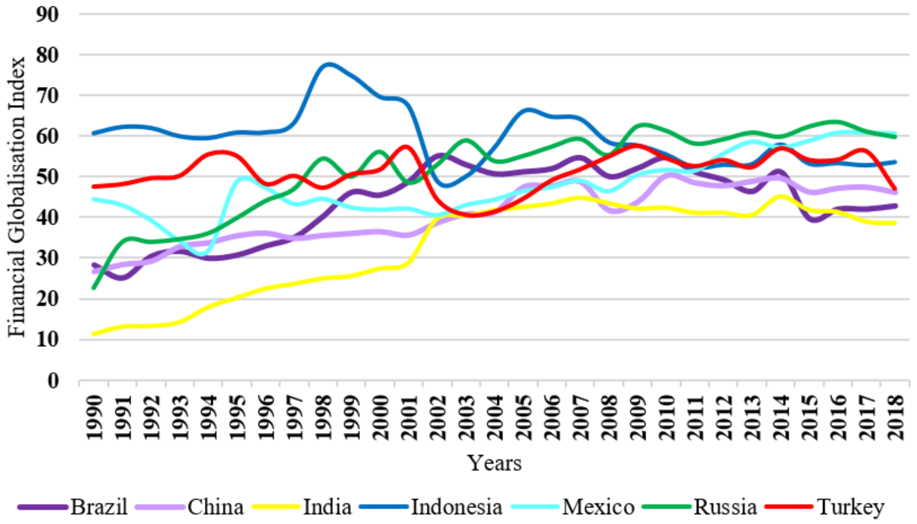


Figure 1. Trend of Financial Globalisation between 1990 and 2018

In the E7 countries, the degree of financial globalization has risen over time (Brazil, China, Mexico, India, Indonesia, Russia and Turkey) nations. The E7 nations' financial globalization index has grown on average from 33.589 in 1990 to 50.096 in 2018 (See Figure 1). With a score of 60.471 in 2018, Mexico is the most financially open economy amongst the E7 nations. Furthermore, the average financial globalization index of the E7 nations during the previous 29 years was 46.776. As a result of the rapid increase in the levels of financial globalization, it is meaningful to presume that financial globalization (FGLO) will play a significant role in impacting ecological quality across the E7 nations. Furthermore, it should be emphasized that these nations account for a significant share of overall worldwide FDI inflows (World Bank, 2021). As FDI is a primary mechanism of FGLO, ecological problems connected with financial globalization in the E7 nations can also be investigated using the Pollution Haven Hypothesis (PHH) as a theoretical framework. Per the PHH, an increase in foreign financial inflows causes host nations' environmental quality to degrade (Adebayo et al., 2021). The PHH would apply in this case if financial globalization has negative environmental consequences in the E7 nations.

The relationship between globalization and environmental deterioration has been examined in the current environmental economics literature. For instance, the studies of Yuping et al., (2021), He et al., (2021), and Ahmad et al., (2021) established a negative interconnectedness between globalization and environmental degradation, thus validating the pollution-halo-hypothesis. On the other hand, some studies such as Cole, (2004), Solarin et al., (2017), Murshed et al., (2021) and Balsalobre-Lorente et al., (2021) established a positive interconnectedness between globalization and environmental degradation, therefore validating the pollution haven hypothesis. Thus, it is clear that the prior literature unveils an unstable relationship between globalization and environmental degradation. The mixed outcomes above warrant additional investigation. Specifically, none of the prior studies have examined the impact of globalization on CO_2 in the E7 nations utilizing the KOF Swiss Economic Institute's newly constructed financial globalization (de facto and de jure) index (Gygli et al., 2019).

In light of the foregoing, the purpose of this research is to examine the ambiguous relationship between financial globalization and CO_2 emissions in the E7 nations. The E7 nations are chosen for analysis for a multitude of reasons. As a result, the present investigation bridges the gap by assessing the impact of financial globalization on CO_2 in the E-7 countries from 1990Q1 to 2018Q4. The E7 nations are chosen primarily because they are huge developing nations that have achieved significant progress during the previous two decades. The margin between the E7 and the G7 countries is closing, and by 2032, the E-7's economic expansion may surpass that of the G7. The E7 nations are forecasted to grow at a pace of 3.5% per year over the next 40 years, compared to 1.6 % for the G7 nations (Hamilton, 2011). Furthermore, the E-7 countries are major energy users, contributing to more than 40% of global energy consumption. Resultantly, examining the variables that contribute to CO_2 in the E7 nations is crucial.

Furthermore, advanced econometric methodologies are employed to determine the relationship between financial globalization and CO_2 in this study, as well as to gain a deeper insight into the impact of financial globalization on CO_2 emissions. Several empirical works have endeavored to create a linkage between globalization and CO_2. The results, on the flipside, are frequently limited to traditional empirical approaches (Ahmad et al., 2021; He et al., 2021; Solarin et al., 2017; Yuping et al., 2021). Addressing this dilemma, Balciliar et al. (2016) asserted that techniques are critical in producing impartial research results and emphasized the need to use creative econometric approaches.

Based on the above understanding, the current research utilized the cutting-edge quantile-on-quantile regression (QQR) technique to evaluate the financial globalisation-CO_2 emissions nexus in E7 economies. The primary intention of the research is to contribute to the ongoing body of studies in 3 folds. (i) This research assess the financial globalization-CO_2 emissions nexus by applying the novel QQR approach initiated by Sim and Zhou (2015). The distinctiveness of QQR approach lies in its capacity to amalgamate the fundamentals of non-parametric estimation and analysis of quantile regression. Therefore, the technique regress one variable the quantile into another and the outcomes have the prospect to react the inquiries probing the association between financial globalisation and CO_2 emissions. (ii) Moreover, the results gathered from the current paper will offers an inclusive illustration of the vital financial globalization–CO_2 emissions interrelationship which the traditional approaches cannot detect. (iii) This research also utilizes the causality in mean and variance initiated by Balciliar et al. (2018) to capture the causality between the two time series in all quantiles of the conditional distribution. This approach has the following novelties: first, it is resistant to misspecification issues since it recognizes the inherent dependency structure between the time series in question; this could be especially useful because high-frequency data is known to have nonlinear dynamics. Second, we can use this approach to test for causality not just in the mean (1st instant), but also in the tails of the joint distribution of the variables, which is extremely noteworthy if the dependent variable has a fat tail.

The next section presents the synopsis of related studies followed by the theoretical framework in Section 3. Data and methodology is presented in Section 4, findings and discussion are depicted in Section 5.

2. Summary of Past Studies

The evidence sufficiently supports the long-run relationship between globalization and the environment; yet, the path of their impacts is always contested. This is because the link between globalization and ecological deterioration is intertwined with business practices, degree of innovation, renewable energy utilization, and the capacity of the nation's natural resource (Kirikkaleli et al., 2021). On the flipside, the contentious issue over whether the expansion of worldwide economic connections in the form of globalization is linked to enhanced quality of the environment or if a high degree of globalization has culminated in ecological degradation merits more examination. Grossman and Krueger, (1991) provided a fascinating justification for the theoretical relationship between globalisation and ecological pollution, stating that globalization in the form of trade openness has both detrimental and favorable consequences on the environment. The positive relationship, also referred as the income effect, is observed as a result of increased economic activity resulting from international trade, which spreads dangerous CO_2 around the globe and, as a corollary, has severe environmental consequences (Cole, 2004). Globalisation, on the other hand, can have a beneficial impact on the environment due to the technique effect. It is accomplished as a consequence of globalisation-induced energy efficient technology all over the globe, which underpins the ability to increase local output while lowering CO_2 without limiting usage of energy (Cole, 2004; Shahbaz et al., 2018). As a result, empirical studies into the causal interrelationships between globalization and CO_2 are littered with both negative and positive (Acheampong et al., 2019; Cole, 2004) causal claims, resulting in a lack of consistency in identifying the appropriate interrelationship between the variables, limiting the power to assess the connection using sophisticated econometrics approaches.

In Australia, Shahbaz et al., (2015) explored the globalization-emission interrelationship using Bayer-Hanck and VECM approaches between 1970 and 2012. The study outcome disclosed a positive interrelationship between globalization and CO_2; thus validating the pollution-haven-hypothesis. Likewise, Acheampong and Adebayo, (2021) assessed the globalization-emission nexus in Australia utilizing a dataset from 1970 to 2018 and novel QQR approach. The outcome from the research uncovered positive globalization-emission interconnectedness

across all quantiles (0.1-0.95). Using developing and developed countries, Leal and Marques, (2021) assessed the nexus between globalization and CO_2 using a dataset from 1995 to 2017. The outcomes from the research disclosed that in developed nations, globalization impact CO_2 negatively while for developing nations, the effect of globalization on CO_2 is positive. Likewise, the study of Solarin et al., (2017) on the emissions-globalization interconnection in Malaysia utilizing yearly datasets from 1980-2013 demonstrated that a surge in globalisation in CO_2.
On the flip side, some studies established a negative globalization-emission association. For instance, (Rahman, 2020) in their research on the globalization-emissions nexus in top 10 electricity consuming countries using a dataset from 1971 to 2013 reported that globalization helps in curbing emissions. Similarly, data from using 1990 to 2014 and 18 Latin American and Caribbean countries as a case study, the research of Koengkan et al., (2020) reported negative emissions-globalization connection. Similarly, globalization contribute to sustainability of the environment as disclosed by the study of Yuping et al., (2021). Similarly, Bashir et al., (2021) found that globalization is adversely connected to the emissions of harmful gases in nations in a panel of top 10 new globalized nations.
In general, the literature on the relationship between globalization and environmental deterioration is ambiguous. The absence of definitive results necessitates further academic investigation, potentially using a more precise scientific approach. Identifying the path of interaction could provide policymakers with extra information to help them create appropriate environmental policies in a globalized society.

3. Theorethical Underpinning, Data and Methods

3.1. Theoretical Framework

Aside from economic growth, several other variables, such as globalization, may impact the technique, scale and composition effects, which may specifically influence these effects. Globalization, as a result, is a significant element that can influence the association between CO_2 and economic progress. CO_2 rise in a variety of ways as a result of financial globalization. Firstly, due to scale effects, FGLO may promote economic activity and consumption. Financial globalization fosters cross-border economic operations that boost industrial activity, which, in turn, worsens ecological degradation. Furthermore, the stock exchange's strong performance suggests an increase in economic development, which promotes consumer and business confidence, promotes spending and production and contributes to ecological deterioration. Financial globalization, on the other hand, may improve the quality of the environment by offering more eco-friendly initiatives as a result of technique and composition effects. Based on the above idea, the following economic function is formulated as follows:

$$CO_{2t} = f(FGLO_t) \qquad (1)$$

3.2. Data

The current paper assesses the effect of financial globalization on carbon emissions in E-7 nations (Brazil, China, Mexico, India, Indonesia, Russia and Turkey) using a dataset stretching between 1990Q1 and 2018Q4. The data for financial globalization (FGLO) is gathered from KOF database and it includes the international stocks of assets and liabilities and capital flows. The dependent variable is carbon emission (CO_2) which is calculated as metric tons per capita is gathered from the British Petroleum database.

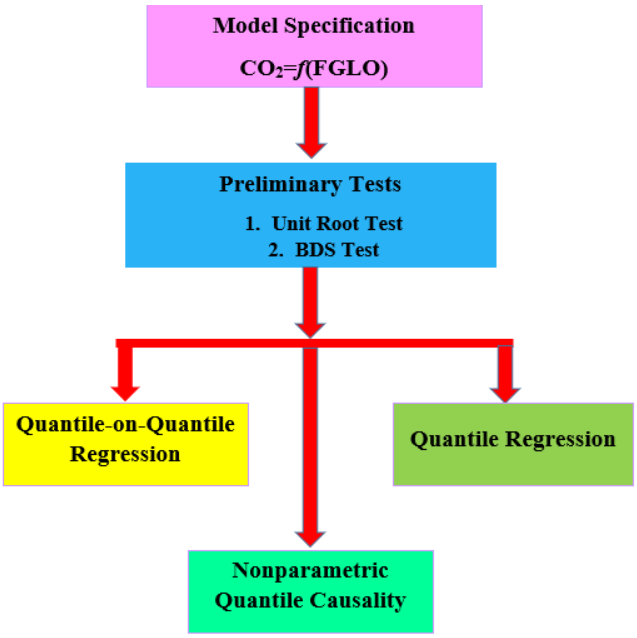


Figure 2. Flow of Analysis

3.3. Methodology

As previously stated, the current investigation adopts the Quantile-on Quantile (QQ) approach in accordance with the description and guidelines provided by (Sim and Zhou, 2015). This approach, also known as the modification of the conventional quantile regression approach, allows for the evaluation of the impacts of the quantile of one parameter over the other. Furthermore, it is a blend of two processes: first, quantile regression, in which the approach examines the influence of a parameter on the quantiles of another parameter, while the second, as to do with the estimating in a non-parametric process. The quantile regression analysis, introduced by (Bassett and Koenker, 1978) is an improved extension of classic OLS-based regression analysis wherein the estimate of one variable is pales in comparison to the estimate of another parameter, although the Quantile regression can clarify more fluctuation of the quantiles and thus allows statisticians to anticipate with minimal errors. Furthermore, standard regression, as explained and advocated by (Stone, 1977) and (Cleveland, 1979) consolidates the dimension of the feature in order to match a linear regression framework, hence reducing predictive capacity. On the contrary, whenever the quantiles of a parameter are evaluated to the quantiles of another variable, as permitted by the QQ approach, the predictive potential improves as more variance among the components is addressed. According to the study's goal, the nonparametric QQ regression analysis is:

$$CO_{2t} = \beta^{\theta} FGLO_t + \mathcal{E}_t^{\theta} \quad (2)$$

From Equation (1), CO_2 indicates carbon emission of a country over the period under review and FGLO indicates the financial globalization of a country over the period under review (t). θ Indicates the conditional distribution of CO_2 in the qth quantile, and Ɛ indicates the error term of the quantile wherein the conditional qth is exactly zero. Finally, β^{θ} depicts a function that is unknown due to inadequate of knowledge on the association between CO_2 and FGLO. The QQ approach is based on the aggregate behavior of the constructs when assessing the association between two variables. Also, in a situation where there are any disturbances in FGLO, either favorable or adverse, they will have a proportional impact on CO_2. For illustrate, the pattern of disruptions in FGLO can be either favorable or unfavorable, and in such a case, the CO_2 may respond properly or asymmetrically. As a result, in evaluating the impacts of the qth quantile of CO_2 on the tth quantile of the FGLO, symbolized as $FGLO_{t}$t (equation (1), $FGLO_t$ is estimated alongside the $FGLO_t$ using linear regression. Furthermore, because β^{θ} is uncertain, the estimated first-order Taylor advanced function is indicated in equation (2).

$$\beta^{\theta}(\mathrm{FGLO}_t) \approx \beta^{\theta}(FGLO^t) + \beta^{\theta\prime}(FGLO^t)(FGLO_t - FGLO^t). \quad (3)$$

Where: $\beta^{\theta\prime}$ indicates the partial derivative of $\beta^{\theta}(\mathrm{FGLO}_t)$ in relation of $FGLO_t$ that is referred to as the marginal influence, which denotes the standard regression analysis' slope. Also, it is observed in equation (2) that the indicators were indexed doubly i.e. $\beta^{\theta}(FGLO^t)$ and $\beta^{\theta\prime}(FGLO^t)$ in relation of θ and τ. However, the function of θ and $FGLO^t$ are $\beta^{\theta}(FGLO^t)$ and $\beta^{\theta\prime}(FGLO^t)$. However, $FGLO^t$ is a function of t, that reveals that $\beta^{\theta}(FGLO^t)$ and $\beta^{\theta\prime}(FGLO^t)$ can be expressed as:

$$\beta^{\theta}(\mathrm{FGLO}_t) \approx \beta_{\theta}(\theta,\tau) + \beta_1(\theta,\tau)(FGLO_t - FGLO^t). \quad (4)$$

In addition, by substituting Equation 4 for Equation 1, the subsequent equation is displayed:

$$(\mathrm{FGLO}_t) \approx \beta_{\theta}(\theta,\tau) + \beta_1(\theta,\tau)(FGLO_t - FGLO^t) + \mathcal{E}_t^{\theta} \quad (*) \quad (5)$$

In Equation 5, (*) indicates the CO_2's qth provisional quantile. The provisional quantile differs from the ordinary conditional quantile in that the variables are indexed doubly, i.e., β_0 and β_1 in regards of q and t, respectively, and it reflects the qth quantile of CO_2 with the tth quantile of FGLO. There is a potential of a discrepancy in variables between the qth quantile of CO_2 and the tth quantile of FGLO. Furthermore, a linear relationship between parameters is expected at all times. As a result, equation (4) analyzes the model's aggregate interconnections depending upon that distribution-based reliance of the researched variables. Furthermore, in equation (4), $FGLO_t$ and $FGLO^t$ should be substituted by their computed equivalents, $\widehat{FGLO}_t$ and $\widehat{FGLO}^t$. As a result, the evaluations from the localized linear regression analysis of the variables β_0 and β_1, which are evaluated by β_0 and $\beta_1$that may be computed as the minimization issue illustrated below:

$$Min_{\delta_0\delta_1} \sum_{t=1}^{n} \sigma_{\emptyset} \left[CO_{2t} - \delta_0 - \delta_1(\widehat{FGLO}_t - \widehat{FGLO}^{\tau})\right] \times L\left[\frac{M_n(\widehat{FGLO}_t) - \tau}{h}\right] \quad (6)$$

Where: $\sigma_{\emptyset}$ indicates the loss of the quantile, which is explained as $\sigma_{\emptyset}(u) = u(\theta - 1(u < 0))$, $L(*)$ is the kernel function and the kernel parameter bandwidth is indicated as h. The Gaussian kernel is employed in this research to determine the weight of the neighborhood observations of CO_{2t}, which is among the most commonly adopted, prominent, and discussed kernel functions, due to its ease of computation and processing. The advantage of this kernel is that it is symmetrical as it reaches zero, and the distant samples are assigned minimal weights. In this current research, the previously stated weights and the distance between the function's distributions of $\widehat{FGLO}_t$ are negatively proportionate, and are symbolized as $F_n(\widehat{FGLO}_t) = \frac{1}{n}\sum_{k-1}^{n} I(\widehat{FGLO}_k > \widehat{FGLO}_t$, wherein the reward of the stochastic process that will come to terms with the quantile FGLOt is symbolized by t. Choosing bandwidth is critical when utilizing non-parametric approaches. This is because it controls the smoothing of the computed results by determining the magnitude whereby the neighborhood estimates fluctuate around the specified position. Furthermore, if the bandwidth is set to a little amount, it will result in more variation, whilst setting it to a big value would result in prejudice. As a result, while determining the bandwidth, the values that fall between variance and biasness must be chosen. Following the suggestions of Sim and Zhou (2015), the current investigation used the bandwidth parameter value of h = 0.05.

4. Findings and discussion

4.1. Pre-Estimation Outcomes

Table 2 presents the summary of CO_2 and financial globalization (FGLO) for the E7 nations. For CO_2, the mean of Russia (11.412) is the highest which ranges from 9.858 to 17.194. This is accompanied by China (4.365) which ranges from 2.031 to 7.046, Mexico (4.024), which ranges from 3.553 to 4.471, Turkey (3.908) which ranges from 2.781 to 5.259, Brazil (1.908) which ranges from 1.359 to 2.595, Indonesia (1.519) which ranges from 0.762 to 2.278 and India (1.146) which ranges from 0.652 to 1.957. The skewness value uncovered that all the CO_2 values for the E7 economies are skewed positively. Furthermore, all the kurtosis values of the E7 economies are leptokurtic with the exemption of Russia which is platykurtic. The JB probability outcomes unveiled that CO_2 for China, India, Indonesia, Russia and Turkey do not conform to normality while Brazil and Mexico align with normality. Regarding financial globalisation (FGLO), the mean of Indonesia (59.712) is the highest which ranges from 46.398 to 78.694, Russia (51.783) which ranges from 16.010 to 63.595, Turkey (50.982) which ranges from 40.163 to 58.259, Brazil (43.493) which ranges from 24.732 to 55.500, China (40.860) which ranges from 25.861 to 50.990 and India (32.811) which ranges from 10.084 to 45.524. Furthermore, Brazil, China, India, Russia and Turkey are skewed negatively while Mexico and Indonesia are positively skewed as disclosed by the skewness value. In addition, Brazil, China, Mexico and India are leptokurtic while Indonesia, and Russia are platykurtic. Moreover, FGLO for all the E7 nations does not align with normality with the exemption of Mexico. We also assess the variables (CO_2 and FGLO) stationarity attribute for all the E7 nations using both ADF and PP unit root tests and the outcomes unveiled that all the variables are I(1) (see Table 3).

Table 2. Descriptive Statistics

	Carbon Emissions (CO_2)						
Country	Brazil	China	India	Indonesia	Mexico	Russia	Turkey
Mean	1.908	4.365	1.146	1.519	4.024	11.412	3.908
Median	1.839	3.875	0.996	1.502	4.015	11.166	3.658
Maximum	2.595	7.046	1.957	2.278	4.471	17.194	5.259
Minimum	1.359	2.031	0.652	0.762	3.553	9.858	2.781
Std. Dev.	0.329	1.926	0.383	0.380	0.238	1.612	0.750
Skewness	0.306	0.261	0.630	0.205	0.030	2.434	0.169
Kurtosis	2.247	1.364	2.060	2.047	2.263	8.637	1.689
JB	4.550	14.253*	11.944*	5.197***	2.641	268.120*	8.862**
	Financial Globalisation (FGLO)						
Mean	43.493	40.860	32.811	59.712	47.792	51.783	50.982
Median	46.011	41.154	39.742	59.680	46.321	55.312	51.443
Maximum	55.500	50.990	45.524	78.694	61.075	63.595	58.259
Minimum	24.732	25.861	10.084	46.398	29.693	16.010	40.163
Std. Dev.	9.149	7.100	11.437	6.951	7.683	10.748	4.698
Skewness	-0.529	-0.313	-0.631	0.691	0.126	-1.129	-0.595
Kurtosis	1.928	1.852	1.828	3.173	2.452	3.412	2.648
JB	10.953*	8.257**	14.339*	9.378*	1.762	25.471*	7.452**

Note: 1%, 5% and 10% level of significance are denoted by *, ** and *** respectively

Table 3. ADF and PP Unit root Tests

Country	**Financial Globalisation (FGLO)**				**Carbon Emissions (CO_2)**			
	ADF		**PP**		**ADF**		**PP**	
	Level	Δ	Level	Δ	Level	Δ	Level	Δ
Brazil	-3.761**	-4.284**	-2.036	-4.276*	-1.021	-3.327***	-2.793	-7.601*
China	-1.471	-4.514*	-2.560	-4.562	-2.562	-4.4497	-1.747	-4.362*
India	2.0676	-3.706**	-1.229	-6.003*	-0.414	-3.691**	-0.4762	-6.055*
Indonesia	-2.331	-3.516**	-2.587	-5.371	-2.741	-6.206	-3.398***	-5.479
Mexico	-0.081	-3.289***	-0.3814	-5.865*	-2.987	-3.671**	-3.017	-5.870*
Russia	-1.252	-4.696*	-3.730**	-6.488*	-6.837	-3.248***	-3.416***	-5.650
Turkey	-2.537	-5.001*	-2.088	-5.054*	-2.109	-3.787**	-2.720	-5.614*

Note: 1%, 5% and 10% level of significance are denoted by *, ** and *** respectively

We proceed by exploring the variables (CO_2 and FGLO) nonlinearity attribute for the E7 economies. As a result, we utilized the BDS nonlinearity test suggested by Broock et al. (1996). The BDS results are presented in Table 4 and the outcomes disclosed that all the variables (CO_2 and FGLO) are nonlinear for all the E7 economies. Based on this understanding, utilizing linear approaches such as OLS, VECM, DOLS, ARDL, FMOLS and others will produce outcomes that are bias. Therefore, we use quantile approaches (quantile-on-quantile regression and non-parametric causality) to scrutinize the effect of financial globalisation on CO_2 emissions in the E7 economies.

Table 4. BDS Test Outcomes

	Financial Globalisation (FGLO)						
Country	Brazil	China	India	Indonesia	Mexico	Russia	Turkey
M2	37.131*	50.102*	37.881*	23.785*	30.957*	25.427*	24.306*
M3	39.502*	53.092*	40.348*	24.342*	32.002*	26.947*	24.819*
M4	42.359*	56.684*	43.371*	25.127*	33.620*	28.851*	26.001*
M5	46.481*	61.884*	47.735*	26.519*	36.269*	31.690*	28.140*
M6	52.038*	69.249*	53.705*	28.708*	40.142*	35.691*	30.817*
	Carbon Emissions (CO_2)						
M2	36.982*	42.400*	36.785*	40.485*	35.446*	16.992*	50.160*
M3	39.117*	45.157*	38.904*	42.316*	36.444*	17.926*	52.920*
M4	41.761*	48.796*	41.822*	45.034*	38.032*	19.052*	56.602*
M5	45.668*	54.216*	46.246*	49.230*	40.881*	20.706*	62.239*
M6	51.295*	61.722*	52.452*	55.134*	45.172*	23.001*	70.194*

Note: 1% level of significance is denoted by *

4.2. Cointegration Outcomes

In the next phase, we assess the cointegration between financial globalisation and CO_2 emissions for each E7 nation using the Quantile Cointegration suggested by Xiao, (2009). Table 5 reports the Quantile Cointegration outcomes. We observed that the null hypothesis of *no cointegration* is rejected for each E7 nation. Therefore we confirmed proof of interconnection between financial globalisation-CO_2 emissions for each E7 nation in the long-run.

Table 5. Quantile Cointegration Test Outcomes

Model	Coefficient	$Sup_{\tau}\lvert V_{\pi}(\tau)\rvert$	CV-1%	CV-5%	CV-10%
Brazil	β	5661.08	4170.29	2702.19	1670.29
$\mathbf{CO_{2t}}$ **Vs** $\mathbf{FGLO_t}$	γ	857.537	680.825	470.129	277.506
China	β	7961.35	5808.25	4380825	2175.04
$\mathbf{CO_{2t}}$ **Vs** $\mathbf{FGLO_t}$	γ	966.108	770.129	574.237	377.504
India	β	4309.24	3684.69	2156.15	1654.94
$\mathbf{CO_{2t}}$ **Vs** $\mathbf{FGLO_t}$	γ	566.675	461.469	291.522	152.773
Indonesia	β	7355.57	5043.94	3919.22	2674.56
$\mathbf{CO_{2t}}$ **Vs** $\mathbf{FGLO_t}$	γ	866.675	642.833	492.954	227.973
Mexico	β	2864.66	1966.29	1261.59	954.752
$\mathbf{CO_{2t}}$ **Vs** $\mathbf{FGLO_t}$	γ	365.627	278.495	190.558	103.139
Russia	β	3013.96	2824.66	2062.57	1356.34
$\mathbf{GDP_t}$ **Vs** $\mathbf{TO_t}$	γ	403.588	318.475	206.479	99.933
Turkey	β	5617.21	3919.15	2628.57	1756.34
$\mathbf{CO_{2t}}$ **Vs** $\mathbf{FGLO_t}$	γ	760.735	610.998	492.171	278.473

4.3. Quantile-on-Quantile Outcomes

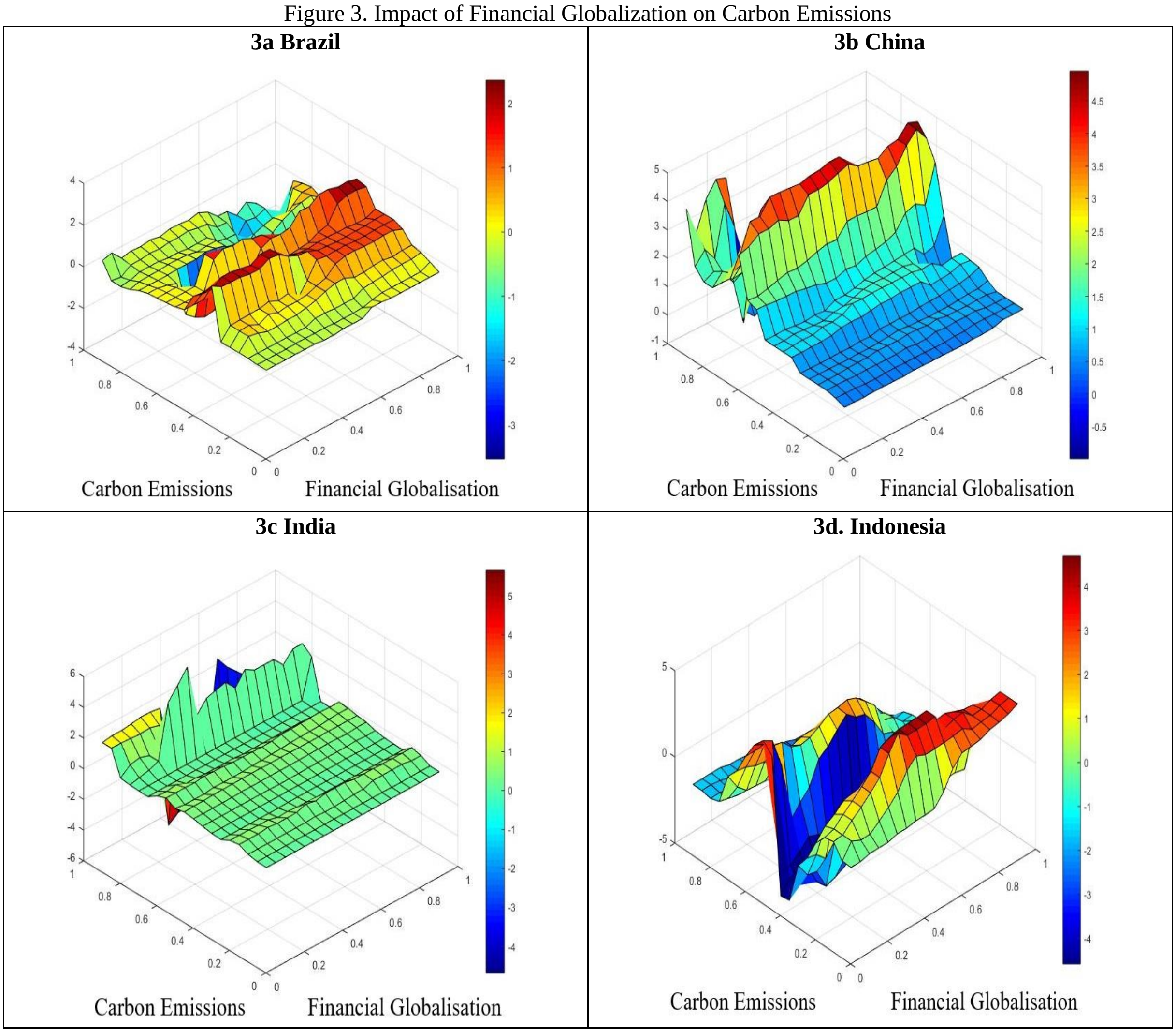
After the cointegration between financial globalisation and CO_2 emissions has been established, we proceed by assessing the effect of financial globalisation (FGLO) on carbon emissions (CO_2) in each E7 nations. Figure 3 (a-f) presents the FGLO effect on CO_2 in each E7 nations. Fig 3a presents the FGLO effect on CO_2 in Brazil. Across all quantiles (0.1-0.95) of both FGLO and CO_2, the effect of financial globalization on CO_2 is positive and weak; however, in the middle tail (0.45-0.75) of both financial globalization on CO_2, the influence of financial globalization on CO_2 is positive and strong. This implies that in all quantiles financial globalization contribute to degradation of the environment across all quantiles (0.1-0.95). The effect of financial globalization on CO2 in China is presented in Figure 3b. Across all tails (0.1-095) of financial globalization and lower and middle tails (0.1-0.65) of CO2, the effect of financial globalization on CO_2 is positive and weak. Furthermore, in the upper tail (0.70-0.90) of CO_2 and all quartiles (0.1-0.95) of financial globalization, increase in CO_2 is caused by financial globalization. In summary, we observed that financial globalization contribute to decrease in environmental quality in China.

Figure 3c disclosed impact of financial globalization on CO_2. Across all tails (0.1-0.95) of both financial globalization and CO_2, the effect of financial globalization on CO_2 is weak and positive; though in the upper tail (0.80-0.95) of CO_2 and all quantiles (0.1-0.95) of financial globalization, we observed positive and significant impact of financial globalization on CO_2. In summary, the financial globalization contribute to India's ecological deterioration across all quantiles. Figure 3d presents influence of financial globalization on CO_2 in Indonesia. In the lower tail (0.1-0.30) of both financial globalization and CO_2, the financial globalization on influence on CO_2 is positive and weak. However, in the middle and upper tails (0.35-0.95) of CO_2 and across all tails (0.1-0.95) of financial globalization, an upsurge in financial globalization enhance the quality of the environment. Therefore financial globalization play a crucial role in improving the quality of the environment in Indonesia.

Figure 3e presents the influence of financial globalization on CO_2 in Mexico. In the lower and upper quantiles (0.1-0.40 and 0.85-0.95) of CO_2 and all tails (0.1-0.95) of financial globalization, the influence of financial globalization on CO_2 is weak and negative suggesting that financial globalization improve quality of the environment. However, in the middle tail (0.45-0.75) of CO_2 and middle and upper tails (0.50-0.95) of financial globalization, the effect of financial globalization on CO_2 is positive. In summary, negative influence of financial globalization on CO_2 is dominant. Fig. 3f depicts the effect of financial globalization on CO_2 in Russia. In the lower tail (0.1-0.35) of CO_2 and all quantiles (0.1-0.95) 0f financial globalization, the effect of financial globalization on CO_2 is weak and positive; however, we observed negative effect of financial globalization on CO_2 in the middle and higher tails (0.40-0.80) of CO_2 and across all tails (0.1-0.95) of financial globalization. In summary, the negative effect of financial globalization on CO_2 is more pronounced; though heterogeneous effect is also visible.

Lastly, Figure 3g presents the effect of financial globalization on CO_2 in Turkey. In the lower and middle tails (0.1-0.50) of financial globalization and lower tail (0.1-0.40) of CO_2, the effect of financial globalization on CO_2 is weak and negative; however, positive effect is observed in the upper tail (0.70-0.95) of both financial globalization and CO_2. Moreover, positive effect of financial globalization on CO_2 is observed in the middle and upper tails (0.50-0.85) of CO_2 and upper tail (0.60-0.95) of financial globalization. In summary, the effect of financial globalization on CO_2 is positive. Thus, financial globalization degrade the quality of the environment in Turkey.

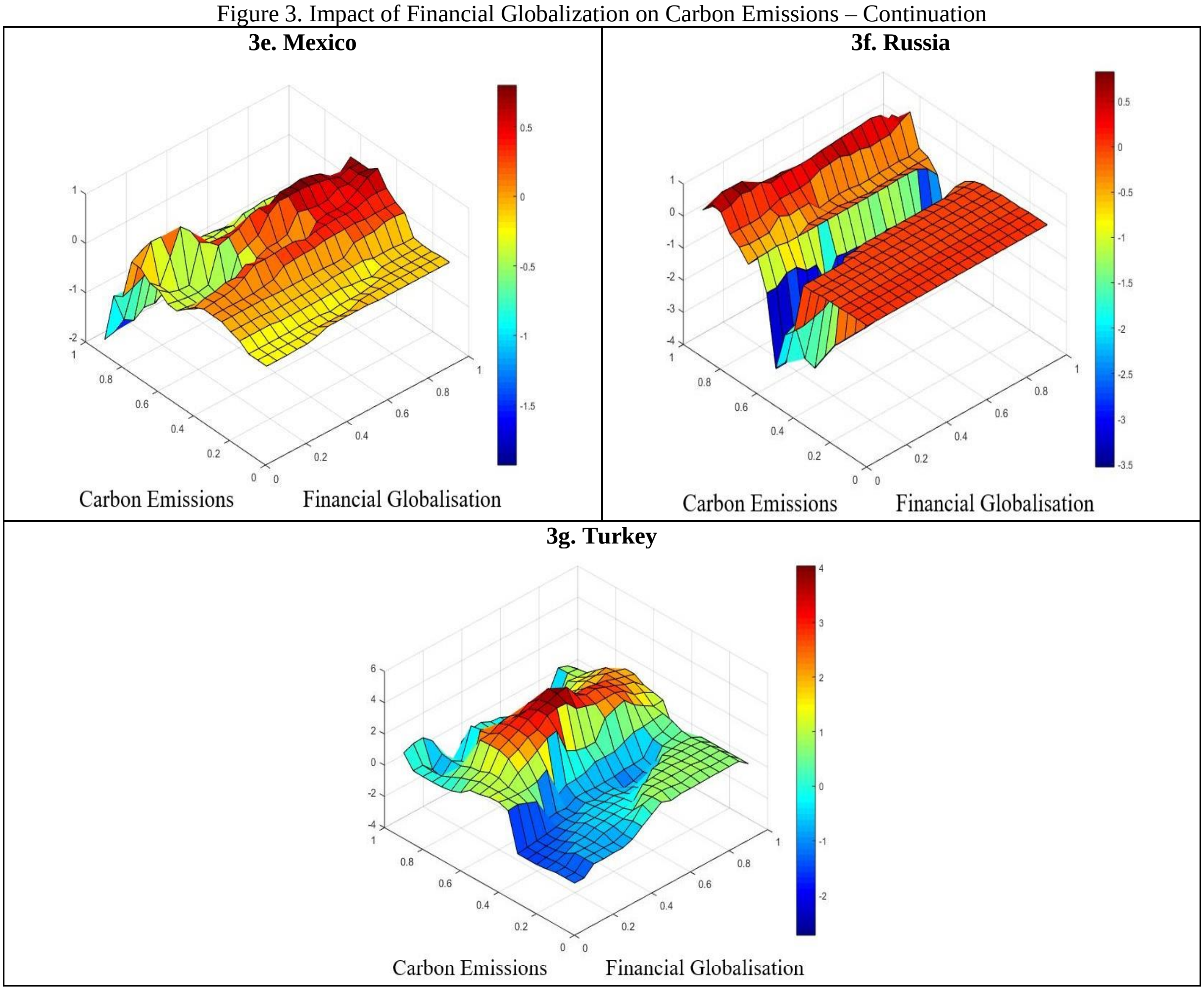
Figure 3. Impact of Financial Globalization on Carbon Emissions



4.4. Nonparametric Causality Outcomes

This research also utilizes the causality in mean and variance suggested by Balciliar et al. (2018) to capture the causality in mean and variance between financial globalization and CO_2 in the E7 economies. The causality-in-quantile approach has the following novelties: first, it is resistant to misspecification issues since it recognizes the

Figure 3. Impact of Financial Globalization on Carbon Emissions – Continuation



inherent dependency structure between the time series in question; this could be especially useful because high-frequency data is known to have nonlinear dynamics. Second, we can use this approach to test for causality not just in the mean (1st instant), but also in the tails of the joint distribution of the variables, which is extremely noteworthy if the dependent variable has a fat tail.

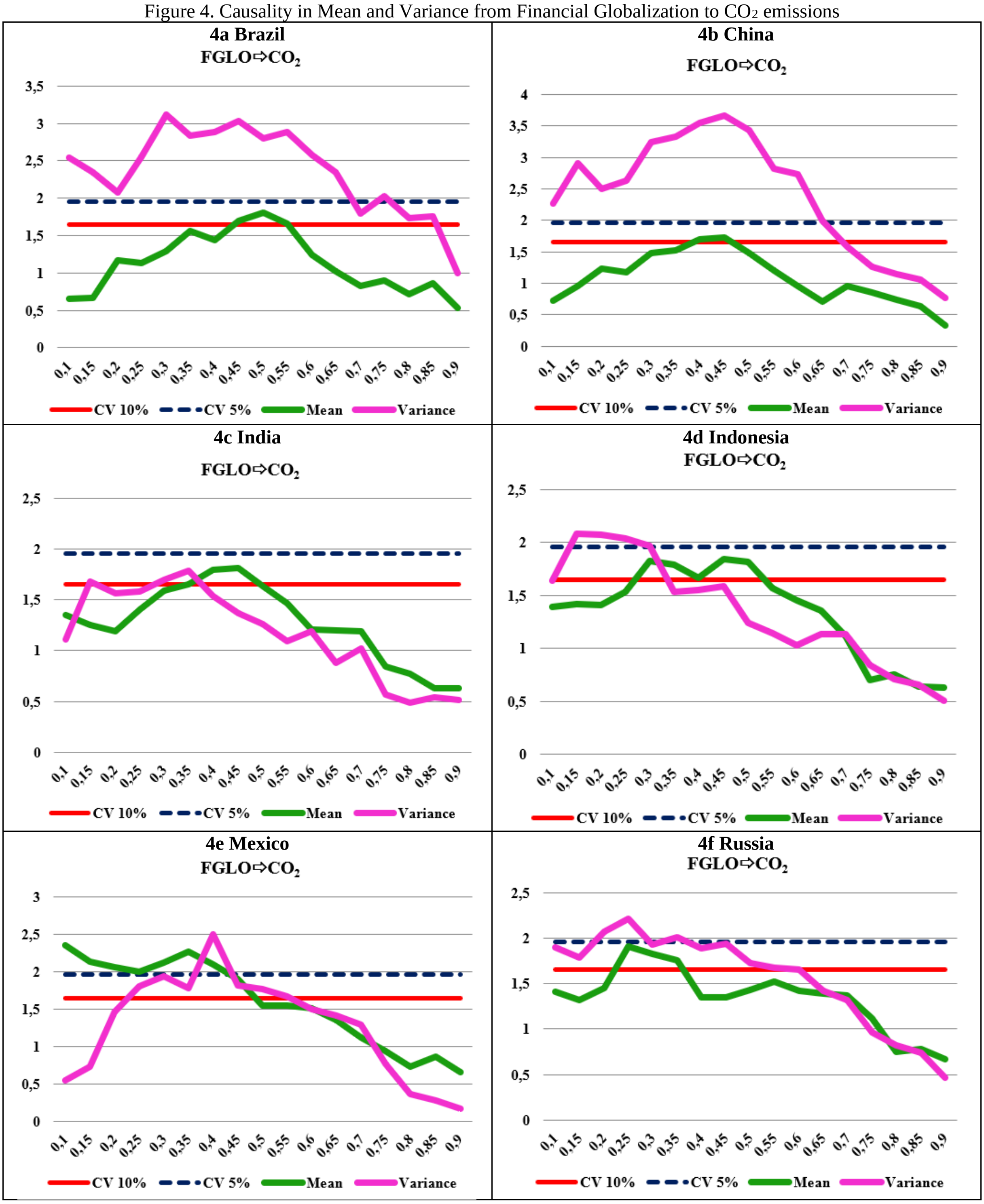
The outcomes of the causality-in-quantile are illustrated by Figure 4. Figure 4a presents the effect of financial globalization on CO_2 for Brazil. The influence of financial globalization is significant in the middle quantile (0.40-0.60) of the provisional distribution of CO_2. A t-statistic of 1.80 reveals that the impact grows bigger and more significant in the middle quantiles. The effect of volatility is significant across all quantiles (0.1-0.85) at the 5% and 10% level of significance. For China, The influence of financial globalization is significant in the middle quantile (0.35-0.50) of the provisional distribution of CO_2 (see Figure 4b). A t-statistic of 1.72 reveals that the impact grows bigger and more significant in the middle quantiles. Furthermore, the effect of volatility is significant across all quantiles (0.1-0.85) at the 5% and 10% level of significance. Figure 4c discloses the effect of financial globalization on CO_2 for India. The influence of financial globalization is significant in the lower and middle quantiles (0.30-0.60) of the provisional distribution of CO_2 at 10% level of significance. A t-statistic of 1.81 reveals that the impact grows bigger and more significant in the middle quantiles. The effect of volatility is significant in the lower quantile (0.1-0.55) at 10% level of significance.

Moreover, Figure 4d presents the effect of financial globalization on CO_2 for Indonesia. The influence of financial globalization is significant in the lower and middle quantiles (0.25-0.55) of the provisional distribution of CO_2 emissions. A t-statistic of 1.84 reveals that the impact grows bigger and more significant in the middle quantiles. The volatility effect is significant lower and middle quantiles (0.1-0.45) at the 5% and 10% level of significance. For Mexico, The influence of financial globalization is significant in the lower and middle quantiles (0.10-0.55) of the provisional distribution of CO_2 at the 5% and 10% level of significance (see Figure 4e). A t-statistic of 2.21 reveals that the impact grows bigger and more significant in the lower quantiles. Furthermore, the effect of volatility is significant in the lower and middle quantiles (0.20-0.60) at the 5% and 10% level of significance. Figure 4f discloses the effect of financial globalization on CO_2 for Russia. The influence of financial globalization is significant in the lower quantiles (0.20-0.40) of the provisional distribution of CO_2 at 10% level of significance.

A t-statistic of 1.82 reveals that the impact grows bigger and more significant in the lower quantiles. The effect of volatility is significant in the lower quantile (0.1-0.65) at the 5% and 10% level of significance.

Lastly, Figure 4g discloses the effect of financial globalization on CO_2 for Turkey. The influence of financial globalization is significant in the lower and middle quantiles (0.20-0.35 and 0.55) of the provisional distribution of CO_2 at 10% level of significance. A t-statistic of 1.73 reveals that the impact grows bigger and more significant in the lower quantiles. The effect of volatility is significant in the lower quantile (0.1-0.70) at the 5% and 10% level of significance.

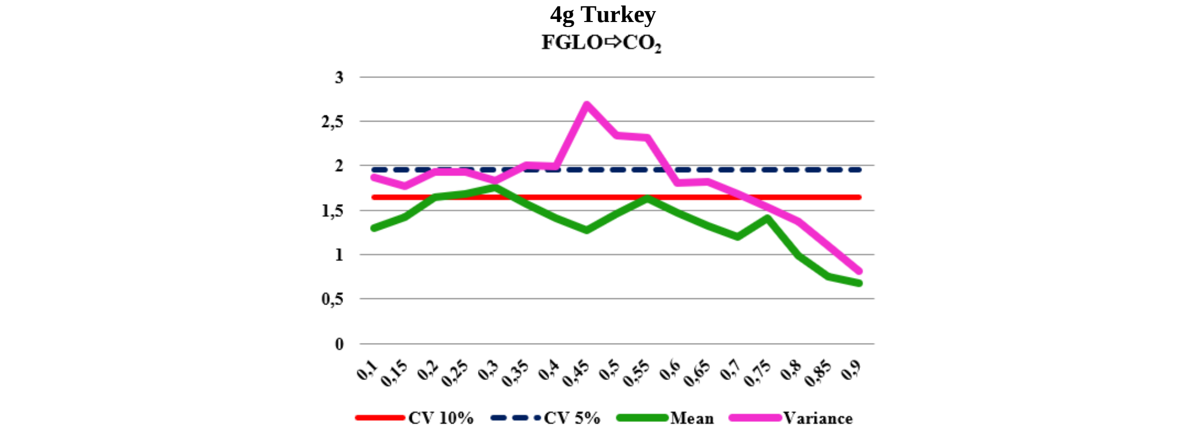
Figure 4. Causality in Mean and Variance from Financial Globalization to CO_2 emissions



4.4. Discussion of Findings

This portion of the empirical analysis presents a precise discussion based on the outcomes gathered from QQR. In the majority of the quantiles, the effect of financial globalization on CO_2 is positive for Brazil, China, India and

Figure 4. Causality in Mean and Variance from Financial Globalization to CO_2 emissions – Continuation



Turkey, thus validating the pollution-haven-hypothesis. This implies that the rapid increase in economic globalization in Brazil, China, India and Turkey contributes substantially to CO_2 emissions. This outcome is supported by the studies of Shahbaz et al. (2015) for Australia, Acheampong & Adebayo (2021) for Australia, Leal et al. (2020) for developing and developed countries and Solarin et al. (2017) for Malaysia, who reported a positive interconnectedness between globalization and CO_2 emissions. According to Adebayo et al. (2021), trade openness has a wide-ranging impact on ecological deterioration because fast improvements in the degree of openness lead to pollution. Furthermore, as a result of globalization, nations demand more resources, which has a huge impact on the environment. Rapid economic growth also causes increased energy demand, resulting in environmental deterioration over time.

Moreover, for Indonesia, Russia and Mexico, in the majority of the quantiles, the effect of financial globalization on CO_2 is negative, therefore validating the pollution-halo-hypothesis. The studies of Koengkan et al., (2020) for 18 Latin American and Caribbean nations, Yuping et al. (2021) for Argentina, Rahman, (2020) for the top 10 electricity consuming countries reported similar findings. The beneficial ecological effects of financial globalization could be due to the fact that it aids in the transition to renewable energy sources by incorporating sustainable and environmentally-friendly energy sources into the national energy mix (Ahmed et al., 2021). Likewise, a number of previous studies have shown the negative ecological consequences of various kinds of financial globalization (Murshed et al., 2021). Furthermore, financial globalization can have a green technology spillover effect, which can help to mitigate damage to the environment. As a result, the fact that financial globalization reduces CO_2 emissions in the E7 nations suggests that financial globalization is a critical mechanism for achieving the technique and composition impacts required to phase out the economic growth-ecological damage trade-off. Furthermore, this conclusion shows that financial globalization promotes the quality of the environment in the E7 nations, which could be attributable to technological diffusion resulting from sustainable FDI inflows.

Moreover, we applied the novel causality in quantiles approach and the outcomes disclosed that financial globalization can predict CO_2 emissions for the E7 nations. Therefore, any policy channeled towards financial globalization will have a significant influence on CO_2 emissions in the E7 economies.

5. Conclusion

At COP 21 in Paris, the Members of the United Nations Framework Convention on Climate Change (UNFCCC) struck a significant agreement to combat climate change and to hasten and reinforce the investments and actions required to secure a viable low-carbon future. The Paris Accord expanded on this by bringing all countries together for the first time to establish coordinated measures to combat and adapt to climate change, including increased support for impoverished nations. This also sets a new course for the international climate strategy. The E7 nations face the same problem of reducing CO_2 emissions, and as a result, are staunchly dedicated to a climate of sustainable growth. Thus, this research assesses the interrelationship between financial globalization and the CO_2 emissions of E7 countries between 1990Q1 and 2018Q4 by utilizing the BDS test, quantile cointegration, quantile-on-quantile regression and quantile regression (QR) as a robustness check.

The outcomes of the BDS nonlinear test affirmed utilization of nonlinear approaches. Furthermore, the quantile cointegration outcomes revealed cointegration between financial globalization and CO_2 in each of the E7 nations. Furthermore, the QQR outcomes disclosed that in the majority of the quantiles, the effect of financial globalization on CO_2 is positive for Brazil, China, India and Turkey, thus validating the pollution-haven-hypothesis. Moreover, for Indonesia, Russia and Mexico, in the majority of the quantiles, the effect of financial globalization on CO_2 is negative, therefore validating the pollution-halo-hypothesis. The financial globalization–environment nexus's heterogeneity between nations can be attributed to a number of factors. It is dependent on the degree to which financial globalization is viewed as a critical component of economic growth, as well as the operational efficiency and

technical level. In addition, we applied the novel causality in quantiles approach and the outcomes disclosed that financial globalization can predict CO_2 emissions for the E7 nations. Therefore, any policy channeled towards financial globalization will have a significant influence on CO_2 emissions in the E7 economies.
This research offers the following policy recommendations predicated on the results obtained. Firstly, Indonesia, Mexico, and Russia should become more financially integrated into the global economy, as financial globalization has been shown to reduce the deterioration of the environment. In addition, the authorities in Indonesia, Mexico, and Russia should encourage financial liberalization, which means that their political structures should welcome more international capital inflows. However, this foreign cash should be deployed in eco-friendly processes of production. On the other hand, financial globalization contributes to the deterioration of the environment for Brazil, China, India and Turkey. Therefore, policymakers in Brazil, China, India and Turkey should re-strategize their policies on financial globalization, since it deteriorates the quality of the environment.

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