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Natural Resource Dependency, Political Stability, and Environmental Sustainability in the G7: Role of Operational Behaviors of Multinational Firms Using Quantile Regression

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Abstract

This study examines the impact of natural resource dependence, political stability, and the operational behaviors of multinational corporations (MNCs) on CO_2 emissions in the G7 region from 1996 to 2021. Due to the non-normal distribution of the data, a quantile regression approach is employed to assess how these factors influence CO_2 emissions across different emission levels. The results indicate that economic growth, natural resource reliance, and political stability contribute to higher CO_2 emissions, whereas MNCs' operational

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behaviors and renewable energy use significantly reduce emissions. Robustness checks using Driscoll-Kraay Standard Errors, Generalized Least Squares (GLS), and Panel Corrected Standard Errors (PCSE) validate these findings. The causality test further reveals unidirectional causality from GDP, operational behaviors of MNCs, and natural resource rents to CO_2 emissions, while renewable energy use exhibits a bidirectional causal relationship with emissions.

Keywords: Natural resources, operation behavior, political stability, renewable energy, quantile regression

JEL Classification: B23, C23, Q54

1. Introduction

The Group of Seven (G7) countries – Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States – represent some of the world's most advanced economies and wield significant influence over global economic and environmental policies (Onwe *et al.*, 2023). These nations face the pressing challenge of balancing economic prosperity with environmental sustainability, a task complicated by their varying degrees of natural resource dependency, levels of political stability, and the extensive operations of multinational companies (MNCs) within their borders. Understanding how these factors interact with the environment is critical for the G7, as they are expected to lead by example in addressing global issues such as climate change, resource depletion, and biodiversity loss. This research investigates the interplay between natural resource dependency, political stability, and the operational behaviors of multinational firms in shaping environmental sustainability across the G7, using quantile regression to provide nuanced insights into these relationships.

Multinational firms, as key players in the global economy, further complicate the dynamic of environmental issues. Operating across borders, these firms drive innovation and economic growth but can also exacerbate environmental challenges through resource exploitation and inconsistent adherence to regulatory standards (Dyreng and Hanlon, 2021). Their operational behaviors – encompassing supply chain management, investment, and corporate social responsibility – can either hinder or advance environmental sustainability, depending on how they align with national policies and resource contexts (Bouguerra *et al.*, 2023). In the G7, where these firms have a significant presence, their actions are particularly consequential given the bloc's commitments to international agreements like the Paris Agreement and its role in setting global sustainability benchmarks.

Several MNCs from developed and emerging economies operate subsidiaries in less industrialized nations. For this reason, MNCs are becoming more widely recognized as the key driver behind the economic expansion and the transfer of technologies from outside to the home nation. However, there are certain unfavorable externalities in the host nation because of MNC operational practices including foreign direct investment (FDI). The harm to the ecosystem spurred by FDI attractiveness is the direct cause of these negative externalities (Marco *et al*., 2019; Zhang, 2008). The consequences of FDI on the ecosystem are conceptually explained by two main theories: the "pollution haven theory" comes first. This hypothesis states that, in contrast to robust rules and regulations in their home countries, MNCs' operational practices are driven by flexible environmental laws and regulations in their host countries (Dogan and Turkekul, 2016; Rafindadi *et al*., 2018; Shahbaz *et al*., 2013). According to the "pollution-halo hypothesis," strict environmental laws encourage innovation in evolving new eco-friendly technologies rather than preventing them from creating environmental pollution in their host nations (Khalil and Inam, 2006; Halicioglu and Ketenci, 2018; Copeland and Taylor, 2001).

Natural resource rents (*NRR*) are crucial for the growth of a country, especially for developing nations aiming to transition to a developed status (Hossain *et al*., 2022). Similarly, wealthy countries such as the G-7 also depend on *NRR* to maintain their economic growth. Natural resources, in their natural state, do not inherently pose a threat to the environment. Instead, environmental degradation often results from the ways these resources are extracted, managed, and utilized by human activities (Aladejare, 2022). Unsustainable practices can lead to habitat destruction, biodiversity loss, and climate change. However, when managed responsibly through sustainable policies, conservation efforts, and technological advancements, natural resources can support ecological balance and long-term environmental health (Hossain *et al*., 2023). The G-7 nations exploit a diverse array of natural resources, encompassing fossil fuels (such as oil, natural gas, and coal), minerals, and forestry. Thus, natural resource dependency varies across the G7: countries like Canada and the United States possess abundant resources such as oil, gas, and minerals, while others, such as Japan and Germany, rely heavily on imports. This dependency can drive economic benefits but also risks environmental degradation and economic volatility if not managed sustainably. Therefore, it is crucial to examine the impact of natural resources in the nexus between the operational behavior of MNCs and CO_2 emissions within the G-7 economies.

The British Petroleum (2021) report states that a negligible 11% of the globe's primary power originates from renewable sources. Even while a few industrialized nations are making efforts to raise the proportion of clean power in their overall energy usage, the achievement of an oil-free economy is still a long way off, particularly for nations with less development. Among the G-7 countries – the USA is the top carbon dioxide generator in the world and the second largest renewable power generator. Furthermore, Canada's advanced oil industries – particularly the shale oil mines in Calgary – pose a serious threat to both the Alaskan territory and the North American ecosystem. Moreover, one of the two biggest energy consumers in the world are Germany and Japan. Therefore, the G-7 nations have expanded their energy sector to greener sources while implementing cautious efforts to reduce oil imports (IEA, 2021). Thus, the present study utilized an econometric method to illustrate how the utilization of *REN* can mitigate the emissions of G-7 countries.

Furthermore, the body of literature has been growing regarding the influence of political stability on the environment. While the number of research on political stability is inadequate, they have been experiencing significant growth in recent years (Kartal *et al*., 2022; Adebayo *et al*., 2022; Özkan *et al*., 2024; Depren *et al*., 2024; Chen and Liu, 2025). These studies demonstrate that the level of political stability significantly influences the amount of CO_2 emissions. Meanwhile, political stability – a hallmark of most G7 nations – plays a crucial role in the effective implementation of environmental policies. Stable political environments facilitate long-term sustainability initiatives, whereas disruptions can lead to short-term, exploitative practices that undermine ecological goals. While there are a few studies in the existing literature that examine the influence of political stability on carbon emissions, the research is still limited and needs further development to explore the connection between political stability and CO_2 emissions in politically stable countries such as the G-7. This represents a gap in the current body of knowledge. Hence, this study aims to address the research motives and gaps described above by answering the following questions:

(i) What is the environmental impact of the operational behavior of MNCs and political stability in the G-7 countries?

(ii) How do natural resource dependency and renewable energy usage impact the G-7 countries' environment?

To achieve these research questions, we depart from previous research by analyzing the impact of MNCs' operational behaviors through FDI, endowments in natural resources, and green energy consumption on the G-7 countries' carbon neutrality. This research makes several significant contributions to the current body of literature. Firstly, this study is crucial because the G-7 nations are among those on the continent that approved the "Paris Agreement at the UN Climate Change Conference (COP21)". Much of the existing literature on natural resource dependency and environmental sustainability centers on developing or resource-rich economies, where resource exploitation often drives economic growth at the expense of environmental degradation. This study shifts the lens to the G7 – advanced economies with diverse resource profiles and substantial global influence. Secondly, while prior research has extensively explored the roles of governments and international agreements in promoting sustainability, the specific influence of multinational firms' operational behaviors through FDI remains underexplored. This study addresses this gap by investigating how MNCs' operating procedures affect environmental outcomes in G7.

Thirdly, this study employs quantile regression to explore these relationships, offering a sophisticated approach that examines how natural resource dependency, political stability, and multinational firms' behaviors affect environmental sustainability across different levels of performance within the G7. Unlike traditional methods that focus on average effects, quantile regression reveals variations across the sustainability spectrum, providing a deeper understanding of the factors that matter most for countries with high versus low environmental outcomes. Finally, the study integrates natural resource dependency (an economic factor), political stability (a political factor), and multinational firms' behaviors (a corporate governance factor) into a unified framework. This interdisciplinary approach illustrates the complex interactions between these dimensions in shaping environmental sustainability for G7 nations, offering valuable insights for policymakers. By showcasing how the G7 can serve as a model for balancing economy with environmental preservation, this research provides practical lessons applicable to both developed and developing economies, contributing to the broader discourse on global sustainability leadership.

2. Previous Literature

2.1 Operation practices of MNCs in the form of FDI and the environment

The study on the relationship between FDI inflows and the pollution of ecosystems presents contradictory findings that demand critical consideration from the standpoint of policy. There are at least a few ways in which the operating practices of MNCs brought in by FDI might deteriorate the environmental conditions of the host nations, even if this is acknowledged in the body of current literature. Environmental rules and regulations are being eased in developing countries to attract FDI through MNC subsidiaries. Strict environmental regulations and cutting-edge technology in developed nations serve as the second channel, preventing MNCs from contaminating their surroundings and promoting ecologically friendly production methods. The ultimate process involves the operations of MNCs within their home nations, which eventually end up in the depletion of natural and forest resources, including conventional energy supplies, lumber, and fossil fuels (Zheng and Shi, 2017; Nadeem *et al*., 2020).

The conflict in the economy between authorities and multinational companies, the rising need for power in emerging nations, and G20 political measures to protect the ecosystem have all contributed to the notable expansion of the renewable energy industry. This is particularly pertinent to the solar, wind, and bioenergy sectors (Agbonaye *et al*., 2020). Nonetheless, the possible harm to environmental quality is one of the main concerns with FDI investments (Khan and Ozturk, 2020). Conversely, MNCs' operating methods in environmentally favorable host countries can spur environmental development through sustainable technologies and best management practices (Dincer and Rosen, 2002; Pao and Tsai, 2011; Ren *et al*., 2014).

Research shows FDI typically damages environmental quality according to the pollution haven hypothesis yet recent studies demonstrate FDI can boost sustainability through technology transfers and knowledge spillovers and host economies adopting stricter environmental standards. The research by Farooq *et al*. (2024), Kor and Qamruzzaman (2024), and Famanta *et al*. (2024) demonstrates how FDI promotes the adoption of cleaner technologies which decreases emissions and enhances environmental efficiency. The authors of Farooq *et al*. (2024) demonstrate that foreign direct investment in renewable energy systems drives decarbonization through increased availability of solar power, wind power, and hydroelectric power. Kor and Qamruzzaman (2024) demonstrate that multinational corporations follow strict environmental regulations in regulated economies to promote sustainable practices together with corporate social responsibility (CSR). The pollution haven hypothesis faces challenges because countries with strict regulations draw FDI that supports environmental sustainability. The research by Famanta *et al*. (2024) shows FDI activates eco-innovation which leads local companies to implement environmental management systems and carbon reduction strategies.

2.2 Natural resources and the environment

The research on energy economic growth, which began with the study by Kraft and Kraft (1978), assessed the link between total energy consumption and GDP expansion in the US between 1947 and 1974 using the Granger causality test. This analysis was based on four hypotheses: growth, conservation, feedback, and neutrality. Rich natural resources slow down the rate of economic expansion, according to Auty (2001). Conversely, natural resources boost income but have a detrimental impact on the rate of national growth, as noted by Bravo-Ortega and de Gregorio (2007). The distinction between abundance and dependency on natural resources was explained by Brunnschweiler and Bulte (2008). According to Balsalobre-Lorente *et al*. (2018), Europe's natural resource wealth lowers CO_2 emissions. They maintained that nations possessing an abundance of natural resources use them in place of fossil fuels to sustain economic expansion.

According to Muhammad *et al*. (2021), the combined effects of renewable energy and total *NRR* have a detrimental impact on environmental deterioration across all nations, including the developed, developing, and emerging BRICS nations. The study of Gyamfi *et al*. (2022) illustrates that natural resources typically start to function as a tool for advancing environmental improvement after a particular threshold is crossed. Moreover, there are opposing viewpoints that contend that endowments with natural resources contribute to environmental sustainability. Balsalobre-Lorente *et al*. (2018), for example, demonstrated how natural resources improve environmental quality by avoiding fossil fuel usage that is rich in pollutants.

2.3 Political stability and the environment

Despite recent growth, the existing literature on the relationship between political stability and CO_2 emissions remains sparse. Some recent studies focus exclusively on a specific country. For example, Su *et al*. (2021) examined this correlation in Brazil and found that a more favorable political environment, characterized by political stability, leads to a reduction in environmental degradation. Adebayo's (2022) study demonstrated that political stability had a mitigating effect on CO_2 emissions in Canada from 1990 to 2018. Kirikkaleli *et al*. (2022) determined that political stability significantly influences CO_2 emissions in China. In their study, Sohail *et al*. (2022) posited that prolonged political instability has a detrimental effect on environmental quality over time. Conversely, they found that political stability had a positive impact on environmental quality in the short term, specifically in the context of Pakistan.

Conversely, certain studies concentrate on a specific set of countries. Rizk and Slimane (2018) conducted a study on 146 nations from 1996 to 2004. They found that higher institutional quality is associated with more protection of the environment. This is because political stability can reduce environmental degradation. In Purcel's (2019) study, a total of 47 poor and lower-middle-income nations were examined for the period of 1990-2015. The findings of the study suggested that political stability has a mitigating effect on CO_2 emissions. In their study, Mrabet *et al*. (2021) examined 16 nations in the MENA region from 1990 to 2016. They found that political stability had a mitigating effect on the ecological footprint. Adebayo *et al*. (2022) conducted a study on BRICS countries spanning from 1990 to 2018.

Their findings indicated that there is a growing correlation between political risk and CO_2 emissions. Jiang *et al*. (2022) examined the G-7 countries from 1990 to 2020 and found that the political risk index has a considerable negative impact on environmental quality.

2.4 Literature gap

While prior research has explored natural resources, political stability, and CO_2 emissions in the larger context, much of it is limited to developing economies and no prior research has addressed this issue in the G7, home to the world's largest industrialized economies, extensive environmental and social policies, and global influence. There are limited studies examining MNCs' operational behavior as a determinant of CO_2 emissions within the G7. The G7's robust regulatory environments, significant industrial activity, and leadership in setting global environmental policy make this a relevant area of research to grasp how economic structure, company behavior, and environmental outcomes coalesce in a socio-spatial context. Moreover, although the results of the study are especially applicable to the G7, they could inform other developed economies that have similar industrial and regulatory contexts (OECD and EU countries). Through its focus on these relatively neglected domains, this research enriches our understanding of the determinants of CO_2 emissions in advanced economies, growing the evidence base available to both academics and policy-makers.

3. Methodology

3.1 Data and variables

This current work is intended to investigate the consequence of the operational behavior of MNCs, *NRR*, political stability, and clean power on environmental sustainability controlling for economic growth. This investigation utilizes a comprehensive, balanced panel dataset for the G7 nations, spanning from 1996 to 2021. The selection of data is dependent upon its accessibility. The sustainability of the ecosystem, measured by CO_2 emissions per capita, is an example of a dependent variable. In line with Balcilar *et al*. (2023), the operational behaviors of MNCs (*OBM*) in this study are measured via the G7 economies' FDI inflow per capita. FDI is often used to reflect MNCs' engagement with their host country, as MNCs shape economic and environmental dynamics in host countries. However, this measure fails to distinguish between sustainable (*e.g.*, renewable energy investments) and unsustainable (*e.g.*, resource-intensive industries) business activities, implying a reductive view of the nuanced environmental impact of multinational operations.

Political stability (PLS) is also calculated based on the World Bank's Worldwide Governance Indicators (WGI): Political Stability and Absence of Violence/Terrorism Index. This index reflects the prospects for government instability, policy consistency, as well as risks for violence or terrorism that impact MNCs' investment decisions and the enforcement of regulations. The index ranges from −2.5 (indicating low stability) to +2.5 (indicating high stability) and serves as a macro-level measure of governance stability. Nonetheless, the index is not a direct measure of the enforcement of environmental policy, so although political stability promotes a market-aligned regulatory environment, it does not mean that environmental governance or policy enforcement is strong. Moreover, GDP per capita (constant 2015 US dollars), and total *NRR* as a percentage of GDP are additional factors. Table 1 offers comprehensive explanations of the data and their origins. Data was mostly gathered from the World Development Indicators (WDI, 2021), except *OBM*, which was retrieved from IMF (2021).

Table 1: Description of variables and sources

Variable	Short form	Measurement	Source
Carbon dioxide emissions	CO_2	CO_2 emissions (metric tons per capita)	The World Bank
Operational behaviors of MNCs	*OBM*	Direct investment equity flows into G-7 economies measured in current US dollars per-capita	International Monetary Fund
Renewable energy consumption	*REN*	Renewable energy consumption (% of total final energy consumption)	The World Bank
Natural resource rents	*NRR*	Total natural resources rents (% of GDP)	The World Bank
Economic growth	*GDP*	GDP per capita growth (annual %)	The World Bank
Political stability	*PLS*	Political Stability and Absence of Violence/Terrorism: Estimate	The World Bank
Numbers of Countries (*N* = 7)	Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States		

While secondary data sources like the IMF and World Bank offer internationally recognized economic and governance indicators, they also have limitations. Variations in data reporting standards, collection methods, and time lags across countries can introduce biases. Additionally, relying on FDI statistics as a proxy for the environmental impact of MNCs and using generalized political stability indicators may overlook micro-level factors, such as firm-specific sustainability initiatives and local government regulations, that significantly influence corporate sustainability. Despite these limitations, the analysis maintains robustness through the use of internationally comparable, high-quality datasets. The application of a quantile regression approach further strengthens the study by capturing heterogeneous effects across varying levels of CO_2 emissions.

3.2 Model specification

This investigation explores the implications of *OBM*, REC, *NRR*, *GDP*, and PLS on CO_2 for G-7 countries for the period from 1996–2021. To account for other established factors affecting ecology, the study constructs baseline empirical models as follows:

$$CO_{2it} = f(GDP_{it}, OBM_{it}, NRR_{it}, PLS_{it}, REN_{it}), \tag{1}$$

where CO_2 represents the environmental consequence assessed by carbon emissions, while *OBM* signifies the operational behaviors of MNCs through FDI inflows. *NRR* represents natural resource rents, and *GDP* denotes the gross domestic product per capita. *REN* stands for renewable energy transition and indicates the proportion of *REN* usage associated with total energy consumption.

Furthermore, the effect of political organizations is characterized by political stability and the absence of violence/terrorism. Here, i designates the cross-sections, and t is the time span (1996 to 2021). The term ε_{it} denotes disturbance, which may include unattainable individual-specific influences. We apply natural logarithms to the factors in Equations (1), to potentially address heteroscedasticity and eliminate the nonlinear functional form. Therefore, we obtain:

$$LCO_{2it} = \Pi_0 + \Pi_1 GDP_{it} + \Pi_2 LOBM_{it} + \Pi_3 NRR_{it} + \Pi_4 LPLS_{it} + \Pi_5 REN_{it} + \varepsilon_{it}, \tag{2}$$

where L signifies the transformation of variables into their natural logarithms, and Π_0 represents constant. The term $€_{it}$ denotes the unobservable individual country effect, while ε_{it} represents residual disturbances, assumed to be serially uncorrelated with zero mean and constant variance. Since the GDP growth rate, natural resource rents, and renewable energy consumption are already expressed as percentages, we did not convert them into their logarithmic forms.

3.3 Econometric framework

This study used quantile regression to achieve the objectives of this study. Before that, we tested the cross-sectional dependence (CSD) test by Pesaran's (2004) scaled LM approach. Then, Pesaran and Yamagata's (2008) technique is adopted to analyze initial slope heterogeneity. After this, the Im–Pesaran–Shin and Levin–Lin–Chu two-panel first-generation unit root assessments were selected for this investigation (IPS, 2003; LLC, 2002). Due to the possibility of CSD, both approaches assume that the panel's units are independent, which may be inaccurate. In addition to the widely employed preliminary panel cointegration checks of Kao (1999) and Pedroni (2004), this study also used the Westerlund (2008) method of testing panel cointegration to avoid this problem.

The research explained the research questions mentioned above using Quantile Regression (QR), which was first presented by Koenker and Bassett (1978). To find the quantiles of the explanatory variable, the QR model uses a median-based strategy, which is a substitute for OLS estimations. The asymmetric characteristics of the distributions of the resultant parameters can be better understood with this approach. When compared to the OLS approach, which is highly reactive to outliers, the quantile regression method allows the framework to consider outliers and explore the elements that influence CO_2 emissions in G-7 regions along the conditional distribution. The findings also describe the average impact of each of the determinants of environmental sustainability because OLS regression values the mean effect. According to Koenker (2005), the expected coefficients from models with varied responses cannot be well explained by the mean effect that emerges from ordinary least squares regression. Not to mention that heteroscedasticity, min-variance, and unbiased estimation are all unrealistic OLS assumptions (Lin and Xu, 2018). In light of this, the panel QR methodology stands as the best method because it can account for distributional differences (Salman *et al.*, 2019).

Quantile regression (QR) for the evaluation of regression models for all quantiles. Furthermore, the QR method can accurately represent the extreme values of a variable's distribution. This method is particularly useful in situations where the variable distribution exhibits a bias towards either the left or the right. It allows for a more comprehensive characterization of the distribution. Furthermore, the coefficient derived from such regression is more resistant to outliers and influential observations compared to that of the OLS method (SU, 2015). Due to the previously stated benefits of QR, many scholars are utilizing it in various disciplines like environmental studies (Carfora *et al.*, 2017), economics (Shahzad *et al.*, 2017), medical science (Olsen *et al.*, 2017), and plant and animal disciplines (Zeuss *et al.*, 2017).

The quantile regression approaches can be expressed mathematically in the following form:

$$Y_i = \acute{x}_i \alpha_{\emptyset} + \pi_{\emptyset i}, \tag{3}$$

$$Quan_{\theta}(Y_i/x_i) = x_i \beta_{\theta}, \tag{4}$$

where x characterizes the regressors, and y signifies the regressand; μ is a random disturbance term, and its conditional quantile distribution is equal to 0. $Quan_{\theta}(Y_i/x_i)$ expresses the θ-th quantile of the dependent variable (y). The value of β_{θ} represents the explanatory component's calculated coefficient on the θ-th quantile of the explicated factor. We use the following model to examine how independent factors affect the dependent variable.

$$Q_{\tau}\left(lnCO_{2_{it}}\right) = \beta_{0\tau} + \beta_{1\tau}\mathrm{L}OBM_{it} + \beta_{2\tau}NRR_{it} + \beta_{3\tau}GDP_{it} + \beta_{4\tau}REN_{it} + \beta_{5\tau}LPLS_{it} + \mu_{it} \tag{3}$$

Further, three distinct tests, *i.e.*, "Generalized Least Square (GLS) Method, Driscoll and Kraay Standard Error (DKSE), and Panel-Corrected Standard Error (PCSE) estimator" are further executed to check the robustness of the QR outcomes.

Causality tests are vital to ascertain particular policy consequences to address emissions of carbon. Granger (1969) created an assessment to evaluate the causal links between the factors; however, it has drawbacks and is inapplicable in situations when panel data has a CSD issue. We use the D–H panel causality examination, an advanced measure of causality that was first created by Dumitrescu and Hurlin (2012) in the present study. Additionally, to address potential endogeneity concerns that may arise from reverse causality or omitted variable bias, this study employs advanced econometric techniques, including the Instrumental Variable-Two Stage Least Squares (IV-2SLS) and Instrumental Variable-Generalized Method of Moments (IV-GMM). The IV-2SLS method helps mitigate endogeneity by using instruments that are correlated with the endogenous explanatory variables but uncorrelated with the error term, ensuring more accurate and unbiased parameter estimates. Meanwhile, the IV-GMM approach accounts for potential heteroskedasticity and autocorrelation in the error structure, further enhancing the reliability and efficiency of the estimated results. These methods strengthen the study's robustness and provide a more precise understanding of the causal relationships examined.

4. Empirical findings

4.1 Cross-sectional dependence test

Any econometric study of panel data must begin with CSD verification. Results of a CSD analysis for moderate cross-sectional connection developed by Pesaran (2004) are presented in Table 2. It appears that the factors are significantly dependent on each other over time periods, according to Pesaran (2004). Due to the very low *p*-values, the CD statistics for all variables are considered statistically significant at conventional levels. With *p*-values of 0.000 for every variable, we can sum up that there is ample proof of cross-sectional correspondence at the 1% level. Consistent with Pesaran's paradigm for evaluating CSD in panel data, this suggests that the variables in question are not autonomous but rather affected by shared causes or linked in some way.

Table 2: Results of the CSD test

Variables	CD statistics	*p*-value
LCO_2	17.99***	0.000
GDP	20.42***	0.000
LOBM	6.34***	0.000
NRR	7.34***	0.000
LPLS	10.41***	0.000
REN	17.31***	0.000

Note: *** denotes statistical significance at the 1% level.
Source: Authors' own calculations

4.2 Slope homogeneity test

To determine if the independent variable coefficients are consistent across several cross-sectional units (here, countries), panel data analysts frequently employ the slope homogeneity (SH) inspection. Panel data models rely on this test to verify their assumptions are correct and to decide whether data pooling is a good idea. Pesaran and Yamagata (2008) state that there is strong evidence contradicting the null hypothesis of SH based on the findings of the SH test, particularly $\breve{\Delta}$ test, and the $\breve{\Delta}$_adj test. There appears to be a significant amount of variation in the slopes across the variables, as indicated by the $\breve{\Delta}$ statistic of 9.539, and the $\breve{\Delta}$_adj test statistic of 10.942, both of which have *p*-values of 0.000 (Table 3). The existence of distinct impacts or coefficients for the explicating variables in the model is suggested by the fact that the connections across the factors in the model vary throughout the units of cross-section.

Table 3: SH test

Slope homogeneity tests	Δ statistic	*p*-value
$\breve{\Delta}$ **test**	9.539***	0.000
$\breve{\Delta}$_***adj*** **test**	10.942***	0.000

Note: *** denotes statistical significance at the 1% level.
Source: Authors' own calculations

4.3 Panel unit root test

The conclusions of Levin *et al.* (2002) unit root examination are presented in Table 4. With the exception of LCO_2 and *REN*, the data indicate that all of these variables are level stationary. At the 1% level of significance, nevertheless, they are all stationary at I(1). The IPS test further provides evidence that stationarity holds at the first difference (I(1)). When dealing with panel data that might display cross-sectional interconnection, second-generation experiments like CIPS and CADF improve upon the first-generation tests by including cross-sectional means of lagged degrees and first differences, leading to more trustworthy results. Table 4 shows that all of the factors being considered here are stationary: LCO_2, *GDP*, *LOBM*, *NRR*, and *LPLS*. This is because their test statistics show that they all possess integration of order 1 (I(1)). However, at I(0), only *LOBM* and *LPLS* are integrated. All of the components are either integrated at level (I(0)) or first difference (I(1)), according to the findings. Therefore, there is no unit root problem, and elements are cointegrated across extended time periods.

Table 4: Panel unit root test

Var.	Levin–Lin–Chu		IPS		CIPS		CADF	
	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
LCO_2	0.7515	−7.5449***	2.861	−8.047***	−2.206	−4.736***	−1.144	−6.071***
GDP	−2.9358***	−7.722***	−0.902	−7.334***	−2.183	−4.197***	−1.213	−4.314***
LOBM	−5.127***	−12.922***	−4.389***	−12.644***	−3.302***	−5.581***	−2.212**	−5.625***
NRR	−1.424*	−9.955***	−0.044	−9.099***	−1.630	−5.576***	2.353	−5.894***
LPLS	−2.394*	−11.330***	−1.712	−10.800***	−2.489**	−5.631***	0.558	−6.395***
REN	−0.786	−8.491***	1.566	−8.087***	−1.679	−4.849***	1.040	−4.057***

Note: ***, **, * denote statistical significance at 1%, 5%, and 10% levels, respectively.
Source: Authors' own calculations

4.4 Panel cointegration Test

Three separate panel cointegration tests i.e., Kao (1999), Pedroni (2004), and Westerlund (2008), are shown in Table 5. The results of Pedroni corroborate those of Kao (1999), who conducted the first residual cointegration test, saying that the test statistics are significant at both the 1% and 5% levels of significance. Both tests provide substantial evidence of interdependence between the regressor and regressand variables over the long term, rejecting the null hypothesis that the elements are not cointegrating. The Westerlund test further confirms the factors' long-term relationship. The estimation's conclusions align with what is discovered in the two earlier experiments. In general, elements such as the operational behavior of multinational corporations (*LOBM*) and the transition to renewable energy (*REN*), as well as other control variables (*GDP*, *NRR*, and *LPLS*), are connected over the long-term with environmental (LCO_2) quality in G-7 region.

Table 5: Panel cointegration test

Kao cointegration		**Pedroni cointegration**	
Estimator	**Statistics**	**Estimator**	**Statistic**
Modified Dickey–Fuller	–3.2974***	Modified Variance Ratio	0.5432
Dickey–Fuller	–2.4302***	Philips Perron	–3.273***
ADF	0.3437*	ADF	–3.0421***
Westerlund cointegration			
Estimator	**Statistics**		
Variance Ratio	2.3241***		

Note: ***, * denote statistical significance at 1%, and 10% levels, respectively.
Source: Authors' own calculations

4.5 Quantile regression findings

Table 6 displays a comprehensive summary of the outcomes from different quantiles, showing the implications of independent factors on the LCO_2 at the chosen points of the distribution of carbon dioxide emissions. Regarding growth in the economy, the calculated coefficient shows the desired positive sign and is statistically significant at the 1% level across all quantiles. Specifically, a 1% increase in *GDP* leads to a rise in carbon emissions ranging from 1.245% to 1.782% across the lower quantile (0.05) to higher quantile (0.95). At higher quantiles, where emissions are already elevated, *GDP* growth likely relies on carbon-intensive industries or less efficient technologies, resulting in a larger emissions increase. In contrast, at lower quantiles, where emissions are less severe, growth may be supported by cleaner technologies, stricter environmental policies, or less carbon-dependent sectors, moderating the rise in emissions. This heterogeneity reflects differences in economic structure, energy efficiency, and policy frameworks across the G7, amplifying the emissions effect in higher-emission scenarios. Alotaibi and Alajlan (2021), Syed *et al*. (2022), and Zheng *et al*. (2019) are only a few examples of the many studies that have used QR to prove a positive correlation between *GDP* and environmental impact. However, this result goes against what has been seen in West Africa (Halliru *et al*., 2020).

After that, the data shows that across all quantiles, the operational behavior of MNCs (L*OBM*) has a detrimental impact on CO_2 pollution. While not statistically significant at the first quantile, this effect is considerable at the other quantiles. The varying impact of MNCs' operational behaviors on CO_2 emissions across different quantiles stems from the differing responsiveness of emission levels to corporate environmental practices. At the second (0.0611%) and fifth (0.0658%) quantiles, where emissions are moderate to high, MNCs can significantly reduce CO_2 emissions through actions like adopting cleaner technologies, improving supply chain efficiency, or investing in renewable energy, likely because these contexts feature less stringent regulations or heavier reliance on carbon-intensive practices. In contrast, the minimal impact at the fourth quantile (0.0379%) suggests that emissions are already somewhat controlled – possibly due to stricter regulations or more efficient existing technologies, leaving less room for substantial further reductions through corporate efforts. Thus, the effectiveness of MNCs' operational conduct is highly context-dependent, with greater potential for impact in higher-emission scenarios in G7 countries. Previous research by Balcilar *et al*. (2023) indicated a negative relationship between *OBM* and the environment in Africa, lending credence to this finding. Furthermore, Zhu *et al*. (2016) and Yan *et al*. (2022) reported on an encouraging association involving foreign investment and environmental conditions for ASEAN-5 and BRI nations, respectively. In contrast, Chowdhury *et al*. (2021) found the opposite for 92 regions of the world.

In the G7 countries, the positive and statistically significant coefficient for *NRR* (natural resource rents or revenue) across all quantiles in Table 6 shows that greater dependency on natural resources consistently increases CO_2 emissions, with the effect strengthening at higher quantiles (*e.g.*, rising from 0.0983 at the 0.05 quantile to 0.182 at the 0.95 quantile). This trend occurs because G7 nations with higher emission levels, such as resource-rich Canada and the United States, rely heavily on carbon-intensive activities like oil, gas, and mining, which amplify emissions as resource dependency grows. In contrast, resource-importing countries like Japan and Germany, with more diversified or cleaner energy systems, experience a lesser impact, highlighting how the environmental cost of resource reliance is most pronounced in economies already emitting at elevated levels. Previous work by Gyamfi *et al*. (2022), which also applied to the G7 countries, lends credence to the idea that *NRR* and CO_2 emissions are positively correlated.

In the G7 countries, the impact of renewable energy (*REN*) on reducing CO_2 emissions increases across quantiles – from −0.113 to −0.226 – because nations with higher emissions, like the U.S. and Canada, rely heavily on fossil fuels, making the shift to renewables more effective at cutting carbon output. In contrast, countries like Germany or France, with more established renewable or nuclear energy systems, see smaller marginal gains. However, this transition involves trade-offs, such as the environmental costs of renewable infrastructure (*e.g.*, land used for wind farms or mining for battery materials), which can strain ecosystems. Regional disparities also complicate the shift, as areas dependent on fossil fuels, like coal regions in the U.S., face economic challenges, while nations like Canada leverage vast hydroelectric potential differently. However, the coefficient values of *REN* show that the clean energy shift is more successful in reducing atmospheric CO_2 concentrations than foreign investment (*LOBM*). The results obtained align with those found in Danish *et al*. (2019), Saqib *et al*. (2023), and Gyamfi *et al*. (2022) when applied to the economies of the OECD, G-7, and BRICS, respectively.

Also, the outcome of Table 6 showed that political stability is also responsible for environmental deterioration. The variable *LPLS* exhibits a positive coefficient across all quantiles at a 1% significance level. The outcomes also demonstrate that the surge in CO_2 emissions due to *LPLS* is substantial; however, the magnitude of the effect declines from 0.521 to 0.134 as the quantile increases. In lower-emission nations like Germany and Japan, stability significantly boosts carbon-intensive activities, leading to a larger impact on emissions (coefficient of 0.521 at the 0.05 quantile). However, in high-emission countries such as the US and Canada, the effect is smaller (coefficient of 0.134 at the 0.95 quantile) due to factors like regulatory pressures and saturation in already emission-heavy economies. Furthermore, political stability fosters economic confidence, leading to increased investments and industrial growth. In G7 countries, stable political conditions create favorable business environments that support industrial expansion and drive-up energy consumption. The prevalence of carbon-intensive industries, along with extensive manufacturing and transportation sectors, enables these nations to leverage stable governance for economic growth. However, this economic growth often comes at the cost of higher CO_2 emissions. Therefore, G7 countries should strive to maintain political stability while implementing strict environmental regulations and adhering to good manufacturing practices to balance economic growth with environmental sustainability. Several studies such as Fatah and Altaee (2024), and Purcel (2029) also found that political stability has a role in increasing CO_2 emission.

Table 6: Quantile regression findings

Variables	(1)	(2)	(3)	(4)	(5)
	$Q_{0.05}$	$Q_{0.25}$	$Q_{0.50}$	$Q_{0.75}$	$Q_{0.95}$
GDP	1.245*** (0.181)	1.507*** (0.392)	1.600*** (0.194)	1.725*** (0.234)	1.782*** (0.237)
LOBM	−0.0407 (0.0421)	−0.0611** (0.0252)	−0.0531** (0.0254)	−0.0379* (0.0194)	−0.0658*** (0.0208)
NRR	0.0983*** (0.0308)	0.115*** (0.0184)	0.128*** (0.0186)	0.171*** (0.0142)	0.182*** (0.0152)
REN	−0.113* (0.0646)	−0.123*** (0.0386)	−0.20*** (0.0390)	−0.242*** (0.0298)	−0.226*** (0.0319)
LPLS	0.521*** (0.0651)	0.441*** (0.0389)	0.252*** (0.0393)	0.161*** (0.0300)	0.134*** (0.0321)
Constant	−12.52*** (3.746)	−14.13*** (2.238)	−14.66*** (2.261)	−9.061*** (1.726)	−12.02*** (1.848)
Observations	175	175	175	175	175

Notes: Robust standard errors in parentheses; ***, **, * denote statistical significance at 1%, 5%, and 10% levels, respectively.

Source: Authors' own calculations

4.6 Robustness check

To further examine the credibility of quantile regression, we used a number of estimating methods, including GLS, DKSE, and PCSE. Table 7 records the findings of GLS, DKSE, and PCSE. According to the GLS estimator, the estimated coefficient value of *LOBM* is −0.0443, which is significant at the 1% level. The sign is also negative for all other estimators. This description is similar to the findings of QR and suggests that increasing *LOBM* will considerably decrease CO_2 emissions. Similarly, GDP's coefficient is positive and statistically significant at the "1% level of significance under the GLS, DKSE, and PCSE estimation". These outcomes are consistent with the main estimating method's findings and suggest that an upsurge in *GDP* also generates CO_2 emissions.

Finally, verification by GLS, DKSE, and PCSE confirms that renewable energy significantly reduces CO_2 generation, saving the biodiversity of the G-7 economies. For this, the three tests of robustness have confirmed once again that drivers such as economic growth, natural resources, and political stability are deteriorating the environment in the G-7 region, even though the operational behavior of MNCs and the transition to renewable energy can reduce it to some extent.

Table 7: Results of robustness check

Variables	(1)	(2)	(3)
	GLS	DKSE	PCSE
GDP	1.684*** (0.158)	1.713*** (0.168)	1.865*** (0.200)
LOBM	−0.0443*** (0.0170)	−0.0456** (0.0173)	−0.0476*** (0.0158)
NRR	0.132*** (0.0124)	0.145*** (0.0109)	0.165*** (0.00961)
LPLS	0.231*** (0.0263)	0.243*** (0.0537)	0.241*** (0.0336)
REN	−0.161*** (0.0261)	−0.176*** (0.0334)	−0.177*** (0.0219)
Constant	−13.941*** (1.512)	−13.098*** (1.639)	−13.798*** (1.968)
Observations	175	175	175

Notes: Robust standard errors in parentheses; ***, **, * denote statistical significance at 1%, 5%, and 10% levels, respectively.

Source: Authors' own calculations

4.7 D–H causality test

A panel causality assessment is feasible to draw statistical conclusions about the calculated coefficients and the different types of possible connections – linear or nonlinear – based on the test discoveries. To this end, the Dumitrescu and Hurlin (2012) examination has been utilized, and Table 8 summarizes its findings. The five explanatory factors were suitably selected as exogenous variables, as can be indicated there is no causal direction from the LCO_2 towards them and no endogenous interactions except for *REN*. However, as it only considers linear causality, it is unable to uncover any potential nonlinear interactions among the factors at hand. Therefore, changing the variables only based on the experiment's conclusions could weaken the structure of the model and its economic implications. Research has revealed a one-way causal relationship from *GDP* to LCO_2, L*OBM* to LCO_2, and from *NRR* to LCO_2, with a two-way causation relationship between *REN* and LCO_2.

Table 8: Results of the D–H causality test

Null Hypothesis	*W*-Stat.	*Z*-bar Stat.	Prob.
$GDP \neq LCO_2$	5.1394	2.99642	0.0027
$LCO_2 \neq GDP$	2.0049	−0.25418	0.7994
$LOBM \neq LCO_2$	5.59244	2.35512	0.0225
$LCO_2 \neq LOBM$	2.12654	−0.12803	0.8981
$NRR \neq LCO_2$	4.36042	2.18858	0.0286
$LCO_2 \neq NRR$	3.50113	1.29747	0.1945
$LPLS \neq LCO_2$	2.52748	0.28776	0.7735
$LCO_2 \neq LPLS$	1.52787	−0.74887	0.4539
$REN \neq LCO_2$	3.87206	1.68213	0.0925
$LCO_2 \neq REN$	5.43577	3.30376	0.001

Source: Authors' own calculations

4.8 Two-Stage Least Squares and Generalized Method of Moments Estimation

To address potential endogeneity issues, this study applies the Instrumental Variable-Two Stage Least Squares (IV-2SLS) and Instrumental Variable-Generalized Method of Moments (IV-GMM) methodologies, as detailed in Table 9. *GDP* is treated as a potentially endogenous variable, given its potential correlation with the error term due to reverse causality or omitted variables. To mitigate this issue, we use several instrumental variables, including the one-year lagged value of *GDP*, the operational behavior of multinational firms, natural resource rents, political stability, and renewable energy. These instruments are chosen for their theoretical relevance and validity in capturing exogenous variation in *GDP*. The results in Table 9 reveal that after addressing endogeneity, the IV-2SLS and IV-GMM estimates are consistent with our benchmark quantile regression findings, reinforcing the robustness of the analysis. The similarity between the adjusted and initial results suggests that endogeneity does not significantly bias the primary estimates, strengthening the credibility of our conclusions regarding the relationship between *GDP*, industrial activity, and CO_2 emissions. This comprehensive approach ensures a more reliable interpretation of the causal linkages explored in the study.

Table 9: Addressing endogeneity issues: IV-2SLS, IV-GMM

	(1)	(2)
Variables	GMM	2SLS
GDP	1.211*** (0.290)	1.241*** (0.235)
LOBM	−0.0661*** (0.0243)	−0.0661*** (0.0180)
NRR	0.161*** (0.0108)	0.162*** (0.0119)
LPLS	0.165*** (0.0337)	0.165*** (0.0269)
REN	−0.165*** (0.0311)	−0.165*** (0.0303)
Constant	−8.319*** (2.556)	−8.319*** (2.142)
Observations	175	175
R^2	0.622	0.622

Notes: Robust standard errors in parentheses; ***, **, *
denote statistical significance at 1%, 5%, and 10% levels, respectively.

Source: Authors' own calculations

5. Policy recommendation

The results of the study reveal that in the G7 region, *GDP* growth, the exploitation of natural resources, and political stability are key drivers of elevated CO_2 emissions while MNCs' behavior measured through FDI, and renewable energy usage do otherwise. This underscores the necessity for targeted policy interventions that account for each country's distinct economic and environmental circumstances. For instance, the United States and Canada, home to some of the world's largest fossil fuel reserves, should focus on phasing out fossil fuel subsidies gradually while bolstering incentives for renewable energy investment. Additionally, carbon pricing mechanisms – such as cap-and-trade systems or carbon taxes – can push industries toward adopting cleaner energy alternatives. In Europe, where Germany and France are pioneers in renewable energy expansion, the broader European Union should prioritize grid integration technologies to better align national energy systems, reducing renewable energy costs not only domestically but also for all participants in a shared grid. Furthermore, to harmonize economic growth with environmental goals, policies like tax breaks or stricter environmental reporting requirements can encourage multinational corporations to invest in green technologies.

Given Japan's high urbanization and reliance on imported energy, its mid- to long-term decarbonization strategy should prioritize smart cities, emphasizing battery-free technologies like rail systems and hydrogen fuel innovations. Meanwhile, the UK and Italy should bolster circular economy policies to curb industrial waste and promote low-carbon manufacturing through sustainable supply chains, leveraging public-private partnerships to drive investments in energy-efficient green technologies for lasting emissions reductions. As the study highlights that MNCs and renewable energy use help lower CO_2 emissions, policymakers should enact legislation – such as tax incentives, mandatory ESG (Environmental, Social, and Governance) disclosures, and emissions targets – to spur MNCs toward eco-friendly practices while enhancing civil society and regulatory oversight for transparent environmental reporting and accountability.

However, these findings also reveal trade-offs and regional disparities within the G7 that warrant attention. The expansion of renewable energy infrastructure demands significant resource extraction – such as rare earth metals and lithium – which can lead to environmental degradation, habitat disruption, and waste management challenges. Similarly, while MNCs can advance green investments and knowledge transfer, their impact varies by sector; some continue to fuel resource-intensive manufacturing and emissions despite sustainability commitments. Energy strategies further diverge across the G7: Germany and France excel in renewables, the US and Canada remain tethered to fossil fuels, and Japan grapples with import dependency, suggesting that a one-size-fits-all policy is impractical. Tailored solutions, aligned with each nation's economic framework and environmental goals, are essential to ensure equitable and effective green transitions.

6. Limitations and future research directions

This study on natural resource dependency, political stability, MNCs' behavior, and environmental sustainability provides valuable insights but is constrained by several limitations that pave the way for future research. One key limitation is its reliance on FDI inflows to measure MNC behavior, which fails to capture nuanced environmental efforts like carbon footprint reduction, eco-friendly technology adoption, or green certification of MNCs. Additionally, the research focuses solely on G7 countries (Canada, France, Germany, Italy, Japan, the UK, and the US), limiting its applicability to diverse economic and political contexts, such as emerging markets or developing nations. While the findings of this study offer valuable insights that can be applied to similar economies and serve as a blueprint for other countries, they cannot be universally generalized to all economies worldwide. Economic structures, industrial compositions, regulatory frameworks, and environmental policies vary significantly across nations, influencing the dynamics of carbon emissions in different ways. Data inconsistencies across countries – stemming from variations in reporting standards, collection methods, and time lags – further introduce potential biases, a common challenge in cross-country analyses.

To address these gaps, future research could expand its scope and refine its approach. Incorporating variables like corporate sustainability reports or green certifications (*e.g.*, ISO 14001) would offer a fuller picture of MNCs' environmental impact beyond FDI statistics. Extending the study to include diverse economies, such as BRICS or ASEAN nations, could test the findings' global relevance. Finally, integrating micro-level factors – such as firm-specific sustainability practices (*e.g.*, renewable energy use) or local regulations (*e.g.*, emissions standards) – would enhance the analysis, providing a more detailed understanding of how MNCs influence environmental sustainability across different contexts.

7. Conclusion

This research evaluates the influence of clean power consumption, natural resources, political stability, and the operational conduct of multinational firms on CO_2 emissions in the G-7 area from 1996 to 2021. To account for the non-normal distribution of variables, a QR method was used to assess the consequence of different variables on CO_2 pollution at various quantiles within the G-7 countries. The outcomes reveal that there exists a strong positive link between economic development, natural resources, political stability, and CO_2 emissions. Conversely, the actions of multinational firms and the adoption of renewable energy sources have a large destructive consequence on CO_2 pollution. To enhance the strength and accuracy of the analysis, we used supplementary estimate techniques such as DKSE, GLS, and PCSE methods. The credibility of the quantile regression findings was validated by all three methodologies. Moreover, the D–H causality test was used to investigate the causal connections within the factors. The findings demonstrated a one-way causal connection between *GDP* to CO_2 emissions, the operational behavior of MNCs to CO_2, and natural resources to CO_2 emissions. A reciprocal causal link was identified between the adoption of green power and the release of CO_2. Lastly, this study employed IV-2SLS and IV-GMM techniques to address potential endogeneity concerns and conducted robustness checks, confirming that the primary quantile regression findings are reliable, free from endogeneity biases, and unaffected by measurement errors.

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