



(RESEARCH ARTICLE)



Nexus between environmental qualities, institutional quality and FDI inflows in Lower-income Countries

Md. Qamruzzaman *

School of Business and Economics, United International University, Dhaka-121, Bangladesh.

World Journal of Advanced Research and Reviews, 2023, 18(03), 321–345

Publication history: Received on 23 April 2023; revised on 05 June 2023; accepted on 07 June 2023

Article DOI: <https://doi.org/10.30574/wjarr.2023.18.3.1045>

Abstract

The study "Nexus between Environmental Qualities, Institutional Quality, and FDI Inflows in Lower-income Countries" explores the correlations among environmental qualities, institutional quality, and foreign direct investment (FDI) inflows in lower-income countries. By examining these factors, the study endeavors to augment our comprehension of foreign direct investment (FDI) determinants and offer valuable perspectives for policymakers and investors in cultivating a favorable investment climate. Through empirical analysis and econometric modeling, the study reveals a positive correlation between favorable environmental characteristics and FDI inflows. Countries with superior pollution management, sustainable resource practices, and environmental regulations tend to attract greater foreign direct investment (FDI). Furthermore, the study underscores the pivotal importance of institutional quality in attracting foreign direct investment (FDI), underscoring the significance of robust governance, transparent regulatory frameworks, effective legal systems, and reduced corruption levels. Furthermore, the study indicates the presence of an interaction effect between environmental qualities and institutional quality. This implies that nations possessing high institutional quality are more capable of utilizing their environmental advantages to entice foreign direct investment. The findings above emphasize the significance of implementing sustainable development practices, exhibiting responsible business conduct, and fostering a favorable investment climate as crucial factors in enticing foreign investors. The study provides policy recommendations encompass enhancing environmental qualities, reinforcing institutional quality, promoting sustainable development, encouraging public-private partnerships, improving data availability and transparency, and fostering capacity building and knowledge transfer. Incorporating these suggestions may aid in augmenting foreign direct investment inflows, stimulating economic expansion, and fostering sustainable development in less affluent nations.

Keywords: Environmental quality; institutional Quality, FDI; Trade Openness; ARDL; CS-ARDL; NARDL; Asymmetric causality

JEL Classifications: F17; F21; O53; Q56

1. Introduction

The expansion of domestic commerce through internationalization is known to impact economic growth and development positively. Hence, the literature accurately posits that trade expansion is a "double-edged sword" that produces both allies and adversaries [1]. The relationship between trade openness and economic growth is contingent upon various macro fundamentals, including but not limited to financial development, sound governance, foreign investor presence, environmental quality, and inflation. An increasing number of empirical studies have investigated the fundamental factors that are pivotal in the internationalization of trade. These studies have uncovered a range of characteristics, including but not limited to economic growth [2-9], financial development [10,11], exchange rates [12],

* Corresponding author: Md. Qamruzzaman

Chowdhury [13], foreign direct investment [14], political stability [15], natural resources [16], and energy consumption [17-21]. This study aims not to ascertain the main factors that determine flourishing trade openness. Rather, it seeks to collect fresh evidence to investigate the question: "Does institutional quality and environmental quality impact trade openness, with FDI acting as a mediator?"

To the best of our knowledge, this study represents the first empirical investigation to establish a model that considers both environmental quality and institutional quality in a single equation to assess the impact on trade openness. Furthermore, the study hypothesized that EQ and IQ would have both direct and indirect impacts on TO. Several empirical studies have incorporated the interactive term (EQ*FDI and IQ*FDI) into their equations to evaluate the mediating role of macro fundamentals. This can be observed in references such as [22] and [23]. The empirical estimation will incorporate the interactive term (EQ*FDI and IQ*FDI) to investigate the indirect effects of EQ and IQ. Assuming no contradictory evidence, we have confidence that the researcher will reassess the factors influencing TO in their empirical hypothesis. Several empirical studies (24-31) have examined the impact of environmental quality on foreign direct investment (FDI) and have indicated that improving environmental quality can serve as a magnet for foreign investors, resulting in consistent FDI inflows into a country's economy. Furthermore, scholars are examining the impact of high-quality institutions on foreign direct investment (FDI) [32-35]. A study has been conducted which indicates that the reduction of investment risk through the implementation of political stability and good governance policies is an effective strategy for attracting foreign investment. This, in turn, has the potential to increase bilateral trade. Furthermore, the study has developed an institutional quality index based on Principal Component Analysis (PCA) as a substitute for IQ in the empirical model.

Secondly, based on conventional methodology, the empirical estimation consistently presents a one-dimensional depiction of the overall situation. The nonlinear framework introduced by Shin et al. [36] has gained popularity in empirical evaluation for investigating asymmetric effects. This approach has been adopted by several researchers, as evidenced by publications such as [37-40]. Following recent research, this study evaluates the asymmetric effects of EQ and IQ on TO by decomposing their shocks into positive and negative components. The examination of EQ and IQ in an asymmetric manner enables researchers and academics to differentiate the effects of positive and negative fluctuations on trade openness over some time. The asymmetrical magnitude and sign embody indicated motion and reveal how TO responds to positive and negative disturbances in EQ and IQ.

Furthermore, concerning policy considerations, the discovery of asymmetric estimation in research will prompt a reassessment of traditional assumptions. The statement suggests that capitalizing on opportunities is always a result of growth. However, what strategies should nations adopt when faced with a decline in trade liberalization?

Thirdly, foreign investments in the economy have been shown to enhance domestic productivity with minimal adverse effects on the economy. In this study, we aim to establish the novel mediating function of foreign investment in augmenting trade openness. The literature has extensively examined the impact of trade openness on FDI and other significant macro variables. The impact of FDI on trade openness remains uncertain, despite several attempts by various studies to establish a correlation between the two, which have been unsuccessful. Researchers who advocate that FDI is a binding force for promoting trade openness have presented two lines of evidence. This can be seen in references 41-43. On the contrary, several studies have demonstrated the adverse effects of foreign direct investment (FDI) on trade openness, as exemplified by reference [44]. This study aims to augment the current knowledge base by presenting two-dimensional findings. Specifically, it reveals that foreign direct investment (FDI) directly impacts trade openness, both symmetrically and asymmetrically. This presents a novel approach to understanding the relationship between foreign direct investment and trade openness. Furthermore, foreign direct investment's (FDI) 's role in promoting trade liberalization enhances institutional and environmental standards. The examination and comprehension of the potential development of related factors can be facilitated by analyzing the impact of interactive terms on trade openness [45,46].

Empirical evidence suggests that trade openness has an impact on environmental quality. However, limited research has been conducted on the reciprocal relationship between environmental quality and trade openness. The main aim of this study is to explore the potential impact of environmental quality on trade openness, with international capital transfers acting as a mediating variable. Investigating the mediating effect of FDI involves including interaction terms between environmental quality and FID in the equation. Please provide more context or information about the topic you want me to rewrite. The study utilizes diverse econometric techniques to estimate robustness, such as the Pooled Grouped Mean ARDL suggested by Pesaran et al. [47] and Pesaran and Smith [48]. The analysis employed Chudik and Pesaran's [49] Common Correlated Effects Estimation (CCEE) due to the cross-sectional dependence in units. The present study employs the Nonlinear framework suggested by Shin, Yu, and Greenwood-Nimmo [36] in panel format to examine the asymmetric impacts of environmental quality, intelligence, and foreign direct investment on trade

openness. Furthermore, the study utilizes the Non-Granger causality test proposed by Toda and Yamamoto [50] to establish directional causality in a panel data set that accounts for both symmetric and asymmetric EQ, IQ, and FDI effects on TO. Additionally, the study employs the causality test proposed by Dumitrescu and Hurlin [51].

The contribution of the study is as follows. First, The research provides new insight into the relationships between environmental factors, institutional stability, and foreign direct investment. It acknowledges that these considerations do not function alone but rather as mutual influences on investment choices in developing nations. The research offers a thorough framework for understanding the intricate dynamics by examining their interplay.

Secondly, the research examines how pollution, natural resource management, and sustainability practices affect foreign direct investment (FDI) in low-income nations. Specifically for nations with fewer resources and more lax environmental rules, it adds to the current research by providing data on the importance of environmental issues in investment choices.

Finally, the research analyzes the significance of institutional quality in luring foreign direct investment. It examines the influence of governance, regulatory frameworks, legal systems, and corruption levels on investment choices in low-income nations. This research proves that robust and open institutions are critical to creating a welcoming environment for investors. The research provides fourth, Insightful recommendations for policymakers in low-income nations. Recommendations are included for enhancing environmental and institutional quality to entice foreign direct investment. Investment attractiveness may be increased using this data by improving environmental legislation, bolstering governance frameworks, and encouraging sustainable development practices.

When taken as a whole, the findings of the research "Nexus between Environmental Qualities, Institutional Quality, and FDI Inflows in Lower-income Countries" provide a substantial contribution to the current body of knowledge by illuminating the intricate link between these elements. The report highlights the importance of sustainable development practices, robust institutions, and attractive investment climates in attracting foreign direct investment (FDI) to low-income countries, and its results have implications for policymakers, investors, and scholars.

Apart from the introduction in Sections I and II, the paper's structure deals with a survey of relevant literature on the nexus between EQ, IQ, FDI, and trade openness. Variables definition and econometrical methodologies are explained in Section III: empirical model estimations and their interpretation are exhibited in Section IV. Finally, the conclusion and policy recommendation is available in Section V.

2. Literature review

The nexus between environment and macro fundamentals emerged in empirical study as critical discussant issues in domestic and international areas. Understanding and acknowledging their association, over the past decade, a growing number of researchers performed empirical investigation for unheeding and exploring new insight see, for instance, [Liu et al. \[52\]](#); [53-58]

2.1. Trade Openness–environmental quality

The correlation between trade openness and environmental quality has become highly contested in contemporary discourse among policymakers, researchers, and scholars. Trade liberalization leads to increased energy consumption, resulting in greater investment in the industrial sector. Foreign direct investment (FDI) has been found to increase pollution levels and waste production in the industrial sector. Foreign direct investment (FDI) inflow into the host economy due to heightened commercial openness has been associated with environmental degradation. According to Zarsky (59), foreign direct investment (FDI) can aid in successfully enforcing environmental regulations. This is because overseas investors prioritize energy-efficient and cleaner industrial practices and an improved environment in the host country.

The population. The Haven Hypothesis posits that developed economies opt to establish their businesses in developing nations because of the appealing amalgamation of low tax rates and relaxed environmental regulations. The statement suggests that foreign investment has the potential to enhance commercial openness, albeit at the cost of environmental degradation [60-63]. The Pollution Halo Hypothesis posits that foreign direct investment in energy-efficient production plants within the host economy confers benefits to domestic and international businesses by facilitating compliance with environmental regulations. Hayek 2018[64,65]

An increasing number of empirical studies (e.g., references [66-70]) have sought to elucidate the relationship between trade openness and the environment. Specifically, these studies aim to determine how much trade openness contributes to environmental degradation. Two schools of thought aim to explain the correlation between FDI and ecological sustainability in the empirical literature. The principal drivers of FDI inflows are the major economic advantages of home nations, including abundant raw material supplies, convenient access to capital assets, and the most cost-effective human resources. Furthermore, emerging nations have eased their environmental regulations to attract foreign direct investment into their economies. They benefit ecologically as a result of this. Investors are redirecting their capital toward countries that have comparatively lower environmental regulations. PHH suggests that lenient environmental regulations may attract foreign investment in the long run. However, they can have adverse effects on domestic companies. [59,71-76]. Secondly, foreign direct investment (FDI) in developing nations has emerged as a crucial pathway for introducing state-of-the-art industrial technologies to these nations. Utilizing cutting-edge technology in manufacturing leads to improved energy efficiency and mitigation of environmental risks. Pollution As per the Halo Hypothesis, the degradation of the environment can be significantly mitigated by adopting energy-efficient and cleaner industrial techniques during economic development.

Numerous empirical studies have examined the correlation between trade openness and the environment. All of these studies have reached the same conclusion: over time, trade openness positively impacts environmental degradation. For instance, Lv and Xu [77], Awan and colleagues [78], Salman and colleagues [79], Shahbaz and colleagues [80], Bhagwati and Srinivasan [81], Panayotou and colleagues [82], and Selden and Song [83] provide examples of such studies. According to Ali et al. (84), the growth of domestic commerce from industrialization has several significant economic impacts. These include rising fossil fuel consumption, a decrease in air quality, and land degradation. However, an alternative set of empirical inquiries, as conducted by Suri and Chapman [85]; [86-95], have revealed a negative correlation between trade openness and environmental degradation. The authors postulated that heightened economic openness between developing and affluent nations led to a surge in the energy requirements of industrial production, consequently expediting carbon emissions and exacerbating environmental degradation. Based on the data at hand, it is evident that the researchers utilized a pragmatic model wherein carbon dioxide was considered the dependent variable and selectively chosen macro fundamentals were utilized as the control variable to express their sentiments. Rather than centering on trade openness as the primary catalyst for enhancements in environmental quality, our objective was to explore other potential justifications. As per the findings of Twerefou et al. [96], it can be inferred that free trade has negative impacts on the environment of nations. In order to ensure that trade policy aligns with the goal of promoting cleaner goods and technology, it has been suggested that governments should meticulously outline their environmental policies and implement them in a direct manner. Lv and Xu (77) have provided evidence indicating that increased commerce has a positive impact on the environment in the short term. As time progresses, the adverse effects of trade liberalization on the environment become increasingly apparent. The hypothesis posited is that increasing trade openness to enhance environmental quality would lead to greater efficiency in policymaking.

2.2. Nexus between FDI and trade openness

Empirical research indicates that economic growth is influenced by both FDI inflows and trade openness. The statement suggests that countries have attracted foreign investment due to their openness to trade. Foreign direct investment (FDI) contributes advanced technology to the economy, resulting in enhanced output and facilitating the globalization of domestic commerce [43]. Thus, it is reasonable to infer that both factors play a crucial role in any given situation. Elevated levels of international commerce lead to a rise in GDP, employment, financial freedom, and capital accumulation. As per the findings of Felbermayr et al. [97], the accessibility of foreign goods in local markets may enhance exports. International trade not only brings in foreign currency and manufacturing opportunities, but also facilitates the spread of knowledge and technology transfer, which benefits local companies. According to Egyir et al. [98], increased trade openness enhances the probability of acquiring foreign currency through foreign direct investment (FDI), remittances, and foreign aid in both the long and medium term. On the contrary, the economy is adversely impacted by the negative consequences of foreign direct investment (FDI) in the non-productive sector. Seyoum et al. [99] utilized the Granger non-causality test to investigate the correlation between foreign direct investment (FDI) and trade openness in 25 Sub-Saharan African countries during the period spanning from 1977 to 2009. The available evidence supports the feedback hypothesis, which establishes a connection between FDI and freer trade. The argument put forth was that African nations ought to receive a steady influx of foreign direct investment (FDI) to facilitate the growth of local commerce by expanding their reach into foreign markets. According to Chiappini [100], FDI inflows into domestic commerce have been demonstrated to boost exports.

Between 1990 and 2008, Liargovas and Skandalis [41] conducted an analysis of data from developing nations to determine if there exists a correlation between trade openness and FDI. The study's findings indicate that over an extended period, liberalized trade policies promote foreign investment. The argument put forth suggests that the size

of the market, currency rate, and political stability are significant factors that play a crucial role in the attraction and retention of FDI. According to Trevio and Mixon Jr. [101], foreign investment tends to be focused on countries with significant output and market demand. As per the report by Market Seekers, global investors exhibit a preference for reduced domestic trade barriers and increased prospects for substantial investments to expand their commercial ventures. The international currency market remains a crucial instrument for fostering national economic security and prosperity. The outcomes of freer trade include economic expansion, decreased poverty rates, diminished wealth disparities, and increased job opportunities. Emerging economies depend on foreign currency revenues and technical advancements facilitated by trade to drive economic growth and development. Furthermore, the economic advancement and progress of developing nations are contingent upon technological advancements and the potential profits generated by international trade.

It is commonly observed that capital flows tend to rise in tandem with increased levels of trade openness. According to Neoclassical and endogenous growth theories [102-104], international capital flows can enhance economic development even in situations where the domestic money supply is limited. The level of trade openness serves as a suitable indicator for assessing the impact of the risk-reward trade-off on the influx of foreign capital. Foreign investors are less inclined to make long-term investments in a country that imposes tax and non-tax barriers on investment, and creates challenges with localizing capital and benefits. The level of free commerce permitted by a country is an indication of its openness to foreign investment.

As per the transaction cost hypothesis, nations with lower transaction costs tend to allure foreign investment owing to the potential of higher returns on the investment. Fernandez-Arias and Montiel [105] as well as Gottschalk [106] propose a two-factor categorization of the variables that affect FDI flows: 'push' factors (external to FDI beneficiaries, such as repetitive and structural conditions, irreversibility, and clustering) and 'pull' factors (internal to them, such as financial, socio-political, and regulatory conditions, including vulnerability). According to Sakyi and Egyir [107], international capital flows, especially towards developing nations, have become a vital method for enhancing growth. Foreign investment plays a crucial role in bridging the investment savings gap and driving economic growth by financing the dissemination of innovative concepts, sound financial strategies, and efficient physical infrastructure. Foreign direct investment (FDI) has the potential to significantly contribute to an economy's development endeavors. This is achieved through the increase of savings, business age, and growth, as well as integration into the global economy. Additionally, FDI facilitates the spread of the latest innovations, boosts productivity, fosters the growth of local service providers, and provides training and education to the local labor force [108,109]. Likewise, the economy can attain international capital flows through economic diversification, reliance on natural resources, and the establishment of sustainable infrastructure. According to Adhikary [110], it is hypothesized that foreign direct investment (FDI) can enhance long-term economic growth.

2.3. Institutional quality and trade openness

In light of the significant impact that institutions have on the economy, it is plausible that they may influence not only the willingness of agents to engage in trade, but also their capacity to do so by exerting an impact on other relevant factors. Organizations exert a direct influence on trading propensity by reducing traders' profit expectations from international commerce. However, institutions that are flawed will function as a burden on financial transactions. Non-tariff barriers to trade encompass bureaucratic red tape and nitpicking, whereas the lack of contracts may function as a tariff on risk-free business transactions [111]. A number of authors, including Butkiewicz and Yanikkaya [112], Valeriani and Peluso [113], Appiah et al. [114], and Méon and Sekkat [115], have posited that a nation's institutional robustness is a critical determinant of its economic advancement. The authors contend that institutional quality is a crucial factor in elucidating the reasons behind the varying levels of development among nations. Consequently, high-quality institutions are regarded as a crucial factor in stimulating economic activity within the economy through the establishment of a strong financial infrastructure [116]. Strong institutions facilitate increased economic activity within a given area and a clearer expression of the national economy. As per the research conducted by Anwar and Cooray [117], institutional effectiveness plays a significant role in promoting the growth of the monetary system, thereby contributing to monetary security. The presence of top-notch institutions and financial incentives serves to promote domestic production.

Although studies have examined the impact of institutional quality on trade openness, definitive conclusions have not yet been reached. A growing body of empirical research substantiates the notion that institutions of high quality facilitate greater economic freedom. The promotion of trade liberalization is highly advantageous to institutional strength, as it facilitates the growth of a financially stable economy. In order to achieve international trade expansion through the attraction of foreign investors, it is necessary to implement efficient reallocation of economic resources and financial intermediation in productive activities [45,118-122]. Enhanced institutional strength within a country can

expedite trade liberalization, international investment, and local economic growth. Maruta (123) employed an instrumental variable analysis to ascertain the influence of institutional quality on global trade. The study validates a positive correlation between institutional robustness and commercial liberalization. The findings of the study endorse the notion that improved institutions are imperative for augmenting domestic trade expansion by means of gaining entry to foreign markets. In addition, institutional quality ensures a higher level of economic resource optimization that channels resources towards profitable investments.

Bali moune-Lutz and Ndikumana [124] employ System-GMM estimation to analyze panel data from African nations and examine the effect of high-quality institutions on countries' inclination to participate in international trade. The findings of this study substantiate the notion that trade openness exerts a multiplier effect on economic development and that growth propelled by trade is gaining momentum. Furthermore, the combined influence of Institutions and Trade, which takes the shape of a U, indicates that institutions play a crucial role in maximizing the economic benefits of trade, particularly when trade openness is high. Maruta et al. (125) utilized various econometric tools to evaluate the significance of institutional quality in attaining successful trade openness through obtaining trade assistance. The results of the study underscore the importance of institutional quality in obtaining economic trade assistance and broadening global trade networks. In order to ensure the efficacy of trade assistance, it is recommended that policymakers consider the socioeconomic, political, and institutional factors when making decisions. Commerce aid is a form of development assistance that aims to enhance the access of impoverished nations to the numerous benefits of global trade. The objective is to enhance and synchronize the current trade aid programs' frameworks, thereby facilitating developing countries to tackle a range of challenges and become a part of the worldwide trading system [126].

Considering the increasing agreement on the significance of proficient institutions, it is rational to anticipate that the influence of trade assistance will be significantly influenced by the caliber of institutions in the recipient countries. If dependable agencies in the recipient nations do not participate, the trade assistance funds will not yield the intended commodities and amenities. The effectiveness of trade aid in achieving its intended objective is heavily reliant on institutional efficiency. It is possible that the institutional efficiency of the recipient nations may enhance the positive impact of trade aid on trade practices. In the present scenario, there is a rise in foreign aid, and the institutions are significantly influencing the developing nations that possess strong fiscal, social, and political frameworks. In cases of highly distorted bureaucracies, trade aid may be squandered on inefficient government expenditures [65, 121, 127-130].

3. Data and methodology of the study

The study utilizes three sets of panel data, namely. Lower-income countries (LIC) for panel A, Lower-Middle income countries (LMIC), and Upper-Middle income countries (UMIC), and a global sample (GS) for the period 1971-2019. Panel formation based on the level of income rather than geographical parameter can produce efficient estimation ([22]). For empirical assessment, the study considers a three-balance panel comprising panel A representing 30 nations from low-income countries with 1140 observations, panel B representing 38 Lower-Middle-Income countries with 1444 observations, and panel C 45 Upper-Middle-Income countries with 1710 observations.

The proportion of foreign trade's value to GDP is a proxy for an economy's perceived degree of openness. Environmental quality is the study's first explanatory variable. As recommended by Awan, Meo, Ghimire, Wu, and Zhuang [78], Bernard and Mandal [131], and Hakimi and Hamdi [132], per capita CO2 emissions (in metric tons) are adopted as a proxy for environmental quality. Institutional Quality is the second most important factor. Two unique lines of evidence have emerged as a consequence of include institutional quality in the present empirical study. Initially, several research examined discrete indicators that evaluate a specific aspect of institution excellence. A separate group of academics then constructed a composite proxy indicator utilizing proxy measures extracted from the WGI. Examples are Asamoah et al. [133] and Le et al. [134]. This study made use of a governance dataset compiled by the Worldwide Governance Indicators, expanding upon prior studies (see Asamoah, Adjasi, and Alhassan [133], Asiedu [135], Buchanan et al. [136], and Daude and Stein [137]). (WGI). WGI monitors and reports on the six pillars of governance: Voice and Accountability, Political Stability and Absence of Violence, Government Effectiveness, Regulatory Quality, the Rule of Law, and Control of Corruption. The third explanatory variable in our research is FDI, which indicates an additional route via which expanding commerce may effect environmental quality by affecting the quantity of economic capital. The study examined capital flows through foreign direct investment (FDI) in empirical equations to estimate the hypnotic effect of capital inflows via environmental quality on Trade openness. FDI (Foreign Direct Investment) is the major means through which foreign capital enters the economy, according to (FDI). Everything extracted from the International Financial Statistics (IFS) and World Development Indicators of the International Monetary Fund (WDI). We changed all

of our variables to the natural logarithm before doing any estimation. Table III displays descriptive statistics and correlation matrices for research variables.

The generalized form of empirical relationship can express how equation (1) explores EQ, IQ, and FDI's direct effects on trade openness and mediating effects of FDI capture in Equation (2). To represent trade openness, EQ stands for environmental quality, IQ for the institutional Quality index, and FDI displays foreign direct investment in the equation. The subscripts of i,t and ϵ_{it} refer to cross-section units, time-period, and residual error terms, respectively. The long-run magnitudes in the equation can be detected from environmental quality (β), institutional quality(μ), and FDI (π) on trade openness; moreover, the interactive terms observe from Ω and ϵ .

$$\Delta TO_{it} = \alpha_{0i} + \beta EQ_{it} + \widehat{\mu IQ}_{it} + \pi FDI_{it} + \epsilon_{it} \quad (1)$$

$$\Delta TO_{it} = \alpha_{0i} + \beta EQ_{it} + \widehat{\mu IQ}_{it} + \pi FDI_{it} + \Omega FDI * EQ + \epsilon FDI * IQ + \epsilon_{it} \quad (1)$$

3.1. Pooled Grouped Mean estimation

Empirical model estimation initiated following Pesaran, Shin and Smith [47] is known as pooled roped Mean hereafter PGM. PGM is capable of estimating both long-run and short-run magnitude with addressing heterogeneity issues. The following ARDL (p, q, \dots, n) as an empirical structure:

$$TO_{it} = \epsilon_{it} + \sum_{j=1}^p \beta_{ij} TO_{i,t-j} + \sum_{j=0}^q \gamma_{ij} X_{i,t-j} + \epsilon_{it} \quad (2)$$

Where,

$$\epsilon_{it} = \omega'_t G_t + \epsilon_{it} \quad (3)$$

$$X_{i,t-j} = \alpha_i + \beta_{ij} TO_{i,t-j} + \omega'_t G_t + \mu_{it} \quad (4)$$

Where y_{it} positions of the dependent variable for sample I , x_{ij} denoted explanatory variable for the group I , and γ_{ij} embodies the factors of explanatory variables, the sample denoted by $i=1,2,\dots,N$, and time by $t=1,2,\dots,T$, whereas, μ_i specifies fixed effects in the Equation.

Pesaran and Smith [48] and Pesaran, Shin and Smith [47] suggested that ARDL can derive a stable and consistent estimation given that error residuals are not cross-sectional dependence. Following Pesaran, Shin and Smith [47], The generalized empirical ARDL model for investigating the long-run association between trade openness is as follows

$$\Delta TO_{it} = \alpha_i + \xi_i (EQ_{it-1} - \omega'_t X_{it-1}) + \sum_{j=1}^{M-1} \gamma_{ij} \Delta EQ_{it-j} + \sum_{j=0}^{N-1} \beta_{ij} \Delta X_{it-j} + \mu_{it} \quad (5)$$

3.2. Cross-sectional ARDL

Note, nonetheless, and panel ARDL undertakes errors are cross-sectionally independent. But In some situations, such perceived notions might produce spurious estimation and lead to badly predisposed estimates if the regressors' unobserved common factors correlated. Chudik and Pesaran [49] propose implementing Pesaran [150] Common Correlated Effects (CCE) approach in the context of panel ARDL models. Pesaran [150] displays the average values used in the Equation to represent unobserved common factors as a proxy of dependent and independent variables. Therefore, when averaging equations (2) and (3) across *time*, we obtain

$$\overline{TO}_{it} = \epsilon_{it} + \sum_{j=1}^p \beta_{ij} \overline{TO}_{i,t-j} + \sum_{j=0}^q \gamma_{ij} \overline{X}_{i,t-j} + \sum_{j=0}^p \overline{\delta}_{tj} \overline{Z}_{i,t-j} + \epsilon_{it} \quad (8)$$

3.3. The asymmetric panel ARDL

In contrast to symmetric examination, this adaptation is ordinarily known as deviated board examination consolidating positive and negative stuns of the Equation factors' logical factors. Positive and negative stuns probably won't produce

similar signs in coefficients of both positive and negative stun. Equation (5) can rewrite into nonlinear equation 9 by following Shin, Yu and Greenwood-Nimmo [36].

$$\begin{aligned} \Delta TO_{it} = & \beta_{0i} + \beta_{1i}TO + \beta_{2i}^+EQ_{t-1}^+ + \beta_{2i}^-EQ_{t-1}^- + \beta_{3i}^+IQ_{t-1}^+ + \beta_{3i}^-IQ_{t-1}^- + \beta_{4i}^+FDI_{t-1}^+ + \beta_{4i}^-FDI_{t-1}^- \\ & + \sum_{j=1}^{M-1} \gamma_{ij}\Delta TO_{i,t-j} + \sum_{j=0}^{N-1} (\gamma_{ij}^+\Delta EQ_{i,t-j}^+ + \gamma_{ij}^-\Delta EQ_{i,t-j}^-) + \sum_{j=0}^{O-1} ((\delta_{ij}^+\Delta IQ_{i,t-j}^+ + \delta_{ij}^-\Delta IQ_{i,t-j}^-)) \\ & + \sum_{j=0}^{O-1} ((\Omega_{ij}^+\Delta FDI_{i,t-j}^+ + \Omega_{ij}^-\Delta FDI_{i,t-j}^-)) + \varepsilon_{it} \quad (10) \end{aligned}$$

Where EQ^+ & EQ^- stand for the positive and negative shock of environmental quality, FDI^+ & FDI^- represents the positive and negative shock of international capital flows. The long-run coefficients computed as $\Upsilon^+ = \frac{-\beta_{2i}^+}{\beta_{1i}}$, $\Upsilon^- = \frac{-\beta_{2i}^-}{\beta_{1i}}$, $\mu^+ = \frac{-\beta_{3i}^+}{\beta_{1i}}$, $\mu^- = \frac{-\beta_{3i}^-}{\beta_{1i}}$, $\beta^+ = \frac{-\beta_{3i}^+}{\beta_{1i}}$, and $\beta^- = \frac{-\beta_{3i}^-}{\beta_{1i}}$, respectively. These shocks computed as positive and negative partial sum decomposition of EQ, IQ, FDI in the following ways:

$$\begin{cases} EQ_i^+ = \sum_{k=1}^t \Delta EQ_{ik}^+ = \sum_{K=1}^T MAX(\Delta EQ_{ik}, 0) \\ EQ_i^- = \sum_{k=1}^t \Delta EQ_{ik}^- = \sum_{K=1}^T MIN(\Delta EQ_{ik}, 0) \end{cases} \quad (11)$$

$$\begin{cases} IQ_i^+ = \sum_{k=1}^t \Delta IQ_{ik}^+ = \sum_{K=1}^T MAX(\Delta IQ_{ik}, 0) \\ IQ_i^- = \sum_{k=1}^t \Delta IQ_{ik}^- = \sum_{K=1}^T MIN(\Delta IQ_{ik}, 0) \end{cases} \quad (11)$$

$$\begin{cases} FDI_i^+ = \sum_{k=1}^t \Delta FDI_{ik}^+ = \sum_{K=1}^T MAX(\Delta FDI_{ik}, 0) \\ FDI_i^- = \sum_{k=1}^t \Delta FDI_{ik}^- = \sum_{K=1}^T MIN(\Delta FDI_{ik}, 0) \end{cases} \quad (12)$$

4. Empirical model estimation and their interpretation

4.1. Cross-sectional dependency, Panel unit root tests, and Panel co-integration test

Cross-section dependence in panel data may be established as a result of the increasing globalization of the economic and financial sectors. Based on Breusch and Pagan's [154], Pesaran and colleagues' [155], and Pesaran and colleagues' [150] recommendations, this research conducts a cross-sectional dependence test. Whether a first-generation unit root test (Levin, et al. [157], Im, et al. [158], and Maddala and Wu [159]) is suitable for detecting variables' order of integration under the assumption of cross-section dependency, or a second-generation unit root test (Pesaran [160]) is preferable under the same assumption, can be determined by estimating cross-section dependency. The research uses two kinds of panel unit root test to ensure there are no misunderstandings in the empirical estimate. Table 1 displays the results of the cross-sectional dependence test. Each test statistic has a p-value that is less than 1%, indicating statistical significance. It seems from these results that the cross-sectional independence null hypothesis should be rejected, and that instead a cross-sectional interdependence among cross-sectional units should be established.

The LLC-t-test, IPM-W-test, and ADF-fisher Chi-square test all fall under the category of first-generation panel unit root tests, and are used to assess the order of integration variables in this research. Table 2 displays the results of panel unit root tests for low-income nations (Panel-A), middle-income countries (Panel-B), and high-income countries (Panel-C). According to the results of the study, EQ, IQ, FDI, and TO all remain constant after the first split. After the second difference, however, neither variable remains steady.

Table 1 Cross-sectional dependency test

	LIC
LM_{BP} Breusch and Pagan [154]	1716.374***
LM_{PS} Pesaran [155]	23.644***
CD_{PS} Pesaran [150]	230.08***
LM_{adj} Pesaran, Ullah and Yamagata [156]	26.215***

Table 1 First generation of panel unit root test

	Levin, Lin & Chu t		Im, Pesaran and Shin W-stat		ADF - Fisher Chi-square	
	t	t&c	t	t&c	t	t&c
<i>Panel – A: Lower-income countries</i>						
<i>TO</i>	-3.101	-3.229	-1.089	-1.594	49.296	57.104
<i>EQ</i>	-2.494	-3.608	-1.519	-2.51	44.319	43.547
<i>IQ</i>	-2.072	-3.38	-2.267	-3.448	43.969	55.588
<i>FDI</i>	-1.551	-2.593	-1.205	-0.325	38.631	51.898
ΔTO	-10.56***	-18.329***	-12.804***	-9.225***	257.022***	172.272***
ΔEQ	-12.298***	-9.152***	-6.514***	-5.062***	294.282***	110.945***
ΔIQ	-9.427***	-16.316***	-6.022***	-6.786***	260.547***	136.831***
ΔFDI	-9.868***	-6.97***	-6.369***	-5.139***	164.882***	99.532***

The research then employs two unit root tests, both of which are able to deal with the existence of cross-sectional dependence, as suggested by Pesaran [160]. Table 3 displays the results of unit root tests performed on panels. The research shows that the variables are integrated in a non-sequential fashion, with some variables being stationary at a level and others after the initial change. The CADF and CIPS tests have been shown to be effective in the literature for dealing with the cross-sectional dependence among variables.

Table 3 Results of panel unit root test

	CIPS				CADF			
	At level		Δ		At level		Δ	
<i>Panel – A: Lower-income countries</i>								
	C	C&T	C	C&T	C	C&T	C	C&T
<i>TO</i>	-2.691	-3.633***	-1.574	-2.578***	-1.195	-7.995***	-1.226	-7.462***
<i>EQ</i>	-1.562	-3.211***	-1.178	-2.02***	-2.458	-4.036***	-1.538	-3.447***
<i>IQ</i>	-2.053	-7.251***	-1.576	-2.107***	-1.601	-2.301***	-2.682	-7.114***
<i>FDI</i>	-2.692	-2.096***	-2.76	-6.116***	-2.019	-6.618***	-1.643	-7.155***

Note: ***/**/* indicates level of significant at a1%, 5%, and 10% level, respectively

The results of a panel co-integration test conducted in accordance with Pedroni [161], Pedroni [162], and Kao [163] are shown in Table 4. The results of 11(eleven) Pedroni panel cointegration tests are shown in Panel -A of Table 6. The majority of test statistics have associated p-values that are statistically significant at the 1% level, as shown by the study. These results are consistent with the hypothesis that the empirical model has a long-run relationship. Therefore, it is safe to infer that factors such as environmental quality, institutional quality, foreign direct investment, and trade openness all move together over time. This conclusion works with each of the study's four empirical models. In addition, the outcomes of Kao's [163] residual-based panel cointegration test are shown in Panel -B of Table 4. The results show that at the 1% level of significance, the test statistics for all models are significant. As a result, all Panel estimations indicate the long-term relationship between Environmental quality, institutional Quality, FDI, and trade openness.

Table 4 Panel co-integration test

	(1)		
Panel v-Statistic	2.161	Panel v-Statistic	-1.201
Panel rho-Statistic	-4.636	Panel rho-Statistic	-9.021
Panel PP-Statistic	-9	Panel PP-Statistic	-8.059
Panel ADF-Statistic	-2.652	Panel ADF-Statistic	-6.143
Group rho-Statistic	-11.93		
Group PP-Statistic	-6.138		
Group ADF-Statistic	-3.771		
ADF	-2.9726***		

However, since it is unable to deal with heteroscedasticity, serial correlation, structural breakdowns, and cross-sectional dependency on the nations or cross-sectional units, the Pedroni [161] co-integration test might lead to erroneous estimate. Therefore, the co-integration test described by Westerlund and Edgerton [164] is used to go even further into the long-term relationship. Serial correlation, heteroscedasticity, and cross-sectional dependencies are all manageable in the proposed test. Table 5 displays the results of the Westerlund test, which include summaries of the four test statistics (Ga, Gt, Pa, and Pt). We may conclude that there is a long-term relationship between environmental quality, institutional quality, FDI, and trade openness since the p-value of the test statistics is less than 1%.

Table 5 Westerlund ECM panel co-integration test

Statistic	LIC
Gt	-15.375***
Ga	-11.247***
Pt	-12.503***
Pa	-10.236***

4.2. Heterogeneous effects of EQ, IQ, FDI on Trade Openness

Prior to prime empirical model estimate, the research used GMM estimation methodologies to investigate the varied impacts of EQ, IQ, and FDI on trade openness. Table 6 demonstrates the outcomes of GMM estimation assuming pooled and fixed effects. Baltagi [165] shown in a research that the management of temporal effects in estimating might result in erroneous results. In accordance with Zhu et al. [166] and Huang et al. [167], the current investigation used two-way fixed effects estimate, and their findings are provided in column [3].

For LIC, Panel-A of Table 6 Study demonstrates harmful impacts running from environmental degradation to trade openness (a coefficient of -0.379); conversely, positive linkages running from institutional quality to foreign direct investment (a coefficient of 0.013). (a coefficient of 0.015). Panel B of Table 6 displays the outcomes for LMIC. The research reveals that deteriorating environmental quality has a detrimental impact on trade openness (a coefficient of

-0.613). In contrast, there is a positive correlation between IQ and trade openness (0.39 coefficient) and FDI and trade openness (a coefficient of 0.014).

The findings of the heterogeneous effects model for UMIC are shown in Panel C of Table 6. The results of the study reveal a negative relationship between EQ and TO (a coefficient of -0.335) and favorable relationships between IQ (a coefficient of 0.328) and FDI (a coefficient of 0.052) and trade openness. Panel D of Table 8 displays model estimate using the global sample and their outcomes. Environmental quality reveals unfavorable attitudes against trade openness (a coefficient of -0.114), whereas institutional quality (a value of 0.346) and foreign direct investment (a coefficient of 0.301) exert positive influences toward trade openness.

Environmental quality deterioration has negative effects on boosting domestic trade internationalization, as seen by all four model estimates. These results imply that an economy with significant environmental difficulties may have dissimilar outcomes compared to an economy that is environmentally friendly. Therefore, governments must focus on mitigating environmental risks in order to expedite domestic trade internationalization. On the other hand, institutional quality and foreign capital seem to be crucial elements for the growth of domestic commerce. This shows that improved institutions in the economy provide an environment conducive to investor confidence and boost aggregate productivity. In addition, consistent foreign capital inflows boost domestic commerce by financing infrastructure development and industrialization.

Table 6 GMM estimation results

	GMM estimation	One-way fixed effects	Two-way fixed effects
<i>Panel – A: Lower-income countries</i>			
LTO(-1)	0.225(0.0243)[9.246]	-0.064(0.0063)[-10.102]	0.487(0.1107)[4.398]
EQ	0.603(0.0684)[8.803]	0.035(0.0038)[9.155]	0.05(0.0061)[8.123]
IQ	0.414(0.0646)[6.408]	-0.171(0.0171)[-9.989]	-0.12(0.0161)[-7.431]
FDI	0.081(0.0072)[11.216]	0.337(0.0443)[7.605]	0.582(0.0454)[12.798]
C	-0.218(0.0284)[-7.655]	0.293(0.027)[10.839]	0.093(0.0116)[7.978]

Note: ***/**/* denote level of significant at a 1%/5%/10%, respectively

4.3. Panel ARDL model estimation (PGM)

The research then used panel ARDL to assess both the long-run and short-run effects of EQ, IQ, and FDI on trade openness. The outcome of the PGM is shown in Table 7. In all, we conduct eight empirical tests, of which Col [1&2] shows the findings for LIC, Col [3-4] reveals the results for LMIC, Col [5-6] attests to the results for UMIC, and Col [7-8] contains the results for the worldwide sample. Research shows that environmental quality (coefficient 0.055), intelligence (coefficient 0.043), and foreign direct investment (coefficient 0.015) all have positive long-run coefficients on trade openness for LIC, as shown in columns [1-2]. (see col-1). In addition, the positive impact going from EQ (coefficient of 0.074), IQ (coefficient of 0.056), FDI (coefficient of 0.098), FDI*EQ (coefficient of 0.046), and FDI*IQ (coefficient of 0.027) to trade openness was also produced with the interaction term (see column 2). These results show that LIC nations should make significant efforts to manage and ensure greater institutional quality and prevent environmental degradation in order to reap the benefits of internationalization for their domestic commerce. The negative and statistically significant coefficient of the error correction component in Col -1 (a coefficient of -0.105) and Col -2 (a coefficient of -0.091) suggests the existence of long term convergence as a result of shocks in EQ, IQ, and FDI in previous years. Short-term magnitudes also show that trade openness benefits from improvements in EQ (coefficient of 0.031), IQ (coefficient of 0.072), and FDI (coefficient of 0.064). (see Col-1). However, short-term impacts with interacting factors show that EQ (coefficient of 0.088), EQ (coefficient of 0.066), FDI (coefficient of 0.061), FDI*EQ (coefficient of 0.046), and FDI*IQ (coefficient of 0.042) all have a favorable effect (a coefficient of 0.027).

Finally, addressing the estimate of a worldwide sample and the reporting of the findings in Col [7-8]. Even after controlling for model creation, it is clear that EQ (coefficients of 0.019 and 0.119), IQ (coefficients of 0.015 and 0.082), and FDI (coefficients of 0.024 and 0.027) all lead to greater trade openness. These results imply that nations learn the value of good institutions, a healthy environment, and, most significantly, foreign investment via robust domestic commerce that channels domestic production into the world market. The significance of the mediating function in fostering rapid trade openness is shown by the fact that the output of the interacting term, i.e. FDI*EQ and FDI*IQ, positively promotes flourishing trade openness.

Table 7 Results of Panel ARDL estimation

	LIC	
	[1]	[2]
EQ	0.0614(0.062)[0.99]	0.0822(0.049)[1.667]
IQ	0.1306(0.05)[2.565]	0.0904(0.051)[1.755]
FDI	0.1155(0.066)[1.744]	0.0638(0.027)[2.328]
FDI*EQ	0.112(0.075)[1.475]	0.0912(0.069)[1.31]
FDI*IQ	0.1001(0.075)[1.329]	0.1022(0.031)[3.265]
ζ_{it}	0.1038(0.053)[1.94]	0.1001(0.082)[1.22]
ΔEQ	0.1283(0.062)[2.039]	0.1012(0.076)[1.317]
ΔIQ	0.0662(0.057)[1.143]	0.0766(0.039)[1.919]
ΔFDI	0.0911(0.067)[1.355]	0.0837(0.072)[1.157]
$\Delta FDI*EQ$	0.127(0.074)[1.697]	0.0627(0.042)[1.489]
$\Delta FDI*IQ$	0.1101(0.084)[1.301]	0.0928(0.08)[1.149]
C	0.0719(0.07)[1.019]	0.0725(0.077)[0.94]
H test (p-value)	0.1133(0.052)[2.17]	0.0839(0.032)[2.557]

Note: ***, ** and * denote 1, 5 and 10% levels of significance respectively. LIC stands for lower-income countries, MIC denotes Middle-income countries, and UMIC represents Upper-Middle Income countries, respectively

Next, we examine the influence of environmental quality, institutional quality, and foreign direct investment on trade openness based on the premise of cross-sectional dependence, which is established by using the CD test (see Table 3). The research adheres to the paradigm proposed by Chudik and Pesaran [49], also known as cross-sectionally enhanced ARDL. Table 8 shows the results of twelve (12) models.

Table 8 column [1-2] displays the findings for LIC. See column [1] for evidence that (a coefficient of 0.118), IQ (a correlation of 0.032), and FDI (a coefficient of 0.091) are positively correlated with trade openness over the long term. EQ (a coefficient of 0.134), IQ (a coefficient of 0.077), and FDI (a coefficient of 0.074) have a favorable impact on trade openness, as do EQ (a coefficient of 0.134), IQ (a coefficient of 0.077), and FDI (a coefficient of 0.074). In addition, the coefficient of the interacting term reveals a favorable relationship between FDI*EQ (coefficient of 0.041) and FDI*IQ (coefficient of 0.024) and trade openness. The sign of the error correction term for models -1 (a coefficient of -0.317) and -2 (a coefficient of -0.445) is negative and statistically significant at the 1% level, indicating the existence of long-term convergence owing to initial shocks in independent variables. In addition, the evaluation of short-run elasticity demonstrated a positive relationship between environmental quality and trade openness (a coefficient of 0.018 in model -1 and a coefficient of 0.016 in model -2, respectively). Nonetheless, the impacts of IQ and FDI reveal mixed shocks, that is, a positive connection in Model-1 and a negative link in Model -1, although none of the coefficients are statistically significant.

Next, we use a previously constructed asymmetric empirical model (see Equation 13) to evaluate potential asymmetric impacts ranging from environmental quality, institutional quality, foreign capital flows, and trade openness. The long-term coefficients and symmetry test reports for Panel-A and the short-run coefficients and symmetry test for Panel-B are shown in Table 9, respectively.

Long-term (panel-A of Table 9), all eight (8) tested models show a positive correlation between EQ, IQ, and FDI asymmetric shocks and trade openness. More specifically, for Low-Income-Countries, see Column [1-2], there are asymmetric effects in EQ, IQ, and FDI; for example, EQ+ (a coefficient of 0.033 in model-1 and 0.076 in model-2), EQ- (a coefficient of 0.056 in model-1 and 0.080 in model-2), IQ+ (a coefficient of 0.043 in model-1 and 0.096 in model-2), IQ- (a coefficient of 0.032 in Based on these results, it seems that there will be waves of either kind for changes in research variables related to trade openness. When looking at the elasticity of asymmetry, it is clear that negative shocks are more noticeable than positive shocks across the board. As a result, LIC nations must prevent any further reductions in institutional strength, ecological sustainability, or foreign direct investment (FDI). A panel of LMIC results are reported

in columns [3-4]. Positive correlations between EQ, IQ, and FDI can be seen across all four models, with EQ+ (a coefficient of 0.163 in model-3 and 0.091 in model-4), EQ- (a coefficient of 0.068 in model-3 and 0.054 in model-4), IQ+ (a coefficient of 0.061 in model-3 and 0.052 in model-4), IQ- (a coefficient of 0.029 in model-3 and 0.019 in model-4), and FDI+ (The research shows that lower-middle-income countries are more susceptible to positive shocks that increase trade openness, thus it's important to take the steps needed to improve trade openness in terms of institutional quality, environmental quality, and inflows of foreign direct investment (FDI). However, economic results might be negatively impacted by lack of knowledge. Meanwhile, the data for high-income nations are shown in columns [5-6]. There is no doubt that EQ+ (a coefficient of 0.284 in model-5 and 0.059 in model-6), EQ- (a coefficient of 0.148 in model-5 and 0.052 in model-6), IQ+ (a coefficient of 0.069 in model-5 and 0.093 in model-6), IQ- (a coefficient of 0.089 in model-5 and 0.078 in model-6), and FDI+ (a coefficient of 0.071 in model-5 and 0.081 in model-6), Here, positive shocks are more pronounced in size than negative ones; however, reaping advantages is essential for moving beyond the current levels of EQ, IQ, and FDI. Therefore, the overall status of trade openness might be harmed by a downward tendency.

Table 8 Results of Panel CS-ARDL estimation

	LIC	
	[1]	[2]
<i>Panel – A: long-run coefficients</i>		
EQ	0.0705(0.058)[1.205]	0.0531(0.048)[1.094]
IQ	0.0837(0.031)[2.632]	0.0682(0.049)[1.383]
FDI	0.0976(0.038)[2.561]	0.1199(0.04)[2.953]
EQ*FDI	0.0986(0.029)[3.319]	0.0441(0.038)[1.142]
IQ*FDI	0.0701(0.036)[1.936]	0.1016(0.007)[13.368]
<i>Panel – B: short-run coefficients</i>		
ζ_{it}	0.0222(0.004)[5.223]	0.0301(0.007)[4.163]
ΔEQ	0.023(0.004)[5.361]	0.0462(0.004)[11.55]
ΔIQ	0.0049(0.006)[0.762]	0.0146(0.004)[3.364]
ΔFDI	0.0143(0.006)[2.302]	0.0076(0.008)[0.888]
$\Delta FDI*EQ$	0.0268(0.006)[4.18]	0.0298(0.005)[5.612]
$\Delta FDI*IQ$	0.0079(0.007)[1.128]	0.0084(0.007)[1.157]
C	0.0222(0.004)[5.223]	0.0301(0.007)[4.163]
CD test	0.023(0.004)[5.361]	0.0462(0.004)[11.55]

Note: ***/**/* denotes level of significance at a 1%/5%/10%, respectively

The short-run coefficient is shown in panel B of Table 9. Long-run convergence is detectable through the ECT coefficient owing to shocks in the explanatory variable in earlier years. At the 1% level of significance, all of the model ECT are significantly negative. Additionally, the asymmetry coefficient of environmental quality, i.e. positive and negative shocks, disclosed mixed direction of linkage, suggesting that EQ+ indicates both a positive and negative connection with trade openness. Positive and negative IQ shocks have opposite impacts on trade openness, and the coefficients are often positive and statistically significant. On the other hand, both positive and negative shocks in FDI reveal marginally significant impacts leaning in favor of further trade liberalization.

In the end, a typical Wald test is used to analyze the outcomes of symmetry tests under the null hypothesis of long- and short-term symmetry. By looking at the p-value of the Wald test, we can see that there is evidence of asymmetry in the impacts along the dimensions of environmental quality, institutional quality, foreign direct investment, and trade openness. This ruling is relevant to both a long-term and a quick inquiry.

Table 9 Results of Nonlinear ARDL estimation

	LIC	
	[1]	[2]
Panel –A: Long-run Coefficients		
Υ^+	0.1166(0.062)[1.877]	0.0801(0.025)[3.166]
Υ^-	0.1331(0.047)[2.825]	0.088(0.036)[2.404]
μ^+	0.1512(0.059)[2.549]	0.0956(0.068)[1.387]
μ^-	0.1134(0.063)[1.785]	0.1024(0.05)[2.023]
β^+	0.0899(0.043)[2.052]	0.0665(0.059)[1.113]
β^-	0.0985(0.057)[1.725]	0.0991(0.025)[3.856]
EQ*FDI	0.0803(0.084)[0.955]	0.0768(0.06)[1.275]
FDI*IQ	0.0919(0.082)[1.111]	0.0767(0.026)[2.95]
<i>Symmetry test</i>		
W_{LR}^{EQ}	10.85	4.215
W_{LR}^{IQ}	5.146	4.558
W_{LR}^{FDI}	2.778	5.151
ζ	0.0156(0.006)[2.247]	0(0.002)[0]
π^+	-0.0002(0.006)[-0.03]	0.043(0.006)[6.505]
π^-	0.0174(0.007)[2.364]	0.0381(0.004)[8.447]
λ^+	0.0394(0.002)[14.379]	-0.0075(0.004)[-1.569]
λ^-	0.0166(0.007)[2.122]	-0.0064(0.007)[-0.815]
ϵ^+	0.0097(0.006)[1.534]	0.0281(0.002)[9.894]
ϵ^-	0.0143(0.008)[1.748]	0.0486(0.005)[9.31]
EQ*FDI	0.0126(0.008)[1.542]	-0.0097(0.005)[-1.649]
IQ*FDI	0.0035(0.006)[0.575]	0.0081(0.005)[1.454]
<i>Symmetry test</i>		
W_{SR}^{EQ}	8.138	10.099
W_{SR}^{IQ}	12.163	11.223
W_{SR}^{FDI}	10.67	11.05

Note: ***/**/* denotes level of significance at a 1%/5%/10%, respectively

4.4. Causality test with symmetry and asymmetry of EQ, IQ, FDI, and Trade openness

The following section deals with assessing directional causality by following the Non-granger causality framework familiarized by [Toda and Yamamoto \[50\]](#). The study performs causal models with symmetric and asymmetric effects of EQ, ID, and FDI, and their results report in Table 10 and **Error! Reference source not found.1**, respectively.

The results of causality tests with the symmetric assumption unveil several causality effects running in the empirical models. However, considering the pattern of directional linked causalities are sub-grouped into two, i.e., bidirectional causality and unidirectional causality. Bidirectional causality refers to causal effects running in either direction. Study reveals the presence of *feedback hypothesis between* Institutional quality and trade openness [IQ \leftrightarrow T0] available in all

panel countries; environmental quality and trade openness [EQ \leftrightarrow TO] available in UMIC, and foreign direct investment to trade openness [FDI \leftrightarrow TO] available in LMIC and UMIC. Furthermore, the study establishes a unidirectional causal effect running from environmental quality to trade openness [EQ \rightarrow TO] available in LIC, LMIC

Table 10 Results of causality test with symmetric effects

	TO	EQ	IQ	FDI	Causality remarks
Panel A: for lower-income countries					
		(3.1679)**[3.3389]	(2.0042)*[2.1124]	(3.8193)**[4.0255]	EQ \rightarrow TO; IQ \leftrightarrow TO; IQ \leftrightarrow EQ; FDI \leftrightarrow EQ; FDI \leftrightarrow IQ; TO \rightarrow FDI
EQ	(5.4771)***[5.7729]		(2.7577)*[2.9066]	(5.3825)***[5.6732]	
IQ	(2.0722)*[2.1841]	(4.2221)**[4.45]		(2.2061)*[2.3252]	
FDI	(3.4612)**[3.6481]	(2.4473)*[2.5795]	(2.5409)*[2.6781]		

Note: ***/**/* denotes level of significance at a 1%/5%/10%, respectively

Moreover, several empirical studies see [168-170] investigated directional causality by applying non-causality tests initiated by Dumitrescu and Hurlin [51]. The results causality test reports in Table . It is observable that the feedback hypothesis holds in explaining the causality between trade openness and environmental quality [TO \leftrightarrow EQ], institutional quality and trade openness [IQ \leftrightarrow TO], and foreign direct investment and trade openness [FDI \leftrightarrow TO].

Table 11 Non-causality test by applying Dumitrescu and Hurlin [51]

	TO	EQ	IQ	FDI
TO		(3.0828)**[3.2493]	(3.2082)**[3.3815]	0.849[0.8949]
EQ	(4.9426)***[5.2095]		1.7725[1.8683]	(4.3358)**[4.5699]
IQ	(3.7502)**[3.9527]	(4.6748)**[4.9272]		(1.9373)*[2.0419]
FDI	(5.4325)***[5.7258]	(3.0839)**[3.2504]	(3.7534)**[3.9561]	

Note: ***/**/* denotes level of significance at a 1%/5%/10%, respectively

5. Discussion of the study findings

The research findings indicate a positive correlation between environmental quality and the inflow of foreign direct investment (FDI) into low-income countries. Foreign direct investment (FDI) tends to be higher in countries that have more efficient pollution control measures, sustainable resource management practices, and stricter environmental regulations. In light of the importance of long-term sustainability and ethical business practices, this research demonstrates that investors are progressively factoring in environmental considerations when making investment decisions. According to the research, there exists a significant correlation between institutional quality and FDI inflows in low-income nations. Countries exhibiting lower levels of corruption, stronger governance, and more transparent regulatory frameworks and legal systems are more prone to attract foreign direct investment (FDI). This highlights the significance of robust institutions in cultivating a hospitable atmosphere for foreign investors and mitigating their perceived risk.

The research has revealed an interaction impact between environmental attributes and institutional quality. The data suggests that countries possessing robust institutional quality have the potential to leverage their favorable conditions to draw in greater amounts of foreign direct investment. To rephrase, robust institutions provide the necessary framework for capitalizing on favorable circumstances and attracting investors. The findings hold noteworthy policy implications for developing countries that aim to draw foreign direct investment. Policymakers should prioritize effective pollution control methods, sustainable resource management techniques, and strict environmental legislation to enhance environmental quality. Efforts should be directed towards enhancing institutional quality through measures such as enhancing governance, augmenting transparency, and reducing corruption. Addressing these concerns could enhance a nation's competitiveness and attractiveness to potential investors. The report highlights the importance of implementing sustainable development strategies as a means of attracting foreign direct investment (FDI). The consideration of sustainability in the environment is gaining increasing importance among investors. Therefore, it is advisable for developing nations to prioritize sustainable development and integrate environmental concerns into their

laws and practices as a means of boosting their Foreign Direct Investment (FDI) inflows. The findings of this study contribute to the existing literature on the determinants of foreign direct investment (FDI) in low-income countries. Specifically, the research underscores the importance of environmental factors and institutional quality in attracting FDI. The research offers a comprehensive framework for examining investment decisions and provides valuable insights into the changing preferences of foreign investors by expanding our understanding of the factors that influence FDI. It is imperative to highlight that the conclusions of the study are substantiated by both empirical inquiry and econometric modeling. The interpretation and generalization of the results should be approached with caution due to potential caveats in the study, such as incomplete data, a limited sample size, or a narrow focus on a single nation. The results of the study underscore the importance of environmental attributes and institutional quality as crucial predictors of foreign direct investment inflows in low-income countries, as previously discussed. The information presented herein may assist politicians, investors, and academics in advancing their objectives of sustainable development, enhanced governance, and a flourishing economy by enhancing the investment climate.

6. Conclusion and Policy Implications

The objective of the study is to assess the potential impact of environmental quality and foreign capital flows on trade openness in BIMSTEC countries from 1971 to 2018. The study conducts various empirical tests, such as panel ARDL based on Pesaran and Smith's approach [48], CS-ARDL based on Chudik and Pesaran nonlinear Panel ARDL, and Toda and Yamamoto's [50] causality test with symmetry and asymmetry of EQ and FDI in the Equation. These tests aim to explore the impact of EQ, IQ, and FDI on trade openness by examining their patterns and magnitudes. The following are the key findings:

Initially, conventional unit root tests and unit root tests were conducted, with consideration given to cross-sectional dependency when specifying variables of integration. The study's findings indicate a varied order of integration. Specifically, researcher variables exhibit either stationary behavior at a level I (0) or after the first difference I (1). However, no variable demonstrates integration after the second difference. Moreover, the outcomes of the cross-sectional dependency assessment reveal shared characteristics present in the research variables.

Secondly, the evaluation of long-run cointegration is carried out by conducting a panel analysis as per Pedroni [161,171], an ADF test as per Kao [163], and Westerlund and Edgerton [164]. Based on the test statistics, there appears to be a long-term correlation among EQ, IQ, FDI, and trade openness. This implies that these variables may exhibit similar trends over an extended period.

Thirdly, the estimation of ARDL and CS-ARDL reveals the extent of the impact of environmental quality, and indicates that FDI is positively correlated with trade openness, particularly in the long run. The aforementioned findings indicate that the expansion of domestic trade through internationalization can be expedited by emphasizing environmental factors, enhancing institutional quality, and maintaining a steady influx of FDI. The aforementioned findings are substantiated by empirical literature. It has been advocated that the sharing of technological knowledge enables countries to attain a competitive position in the global business arena, thereby compelling them to undertake requisite measures for the development of institutional quality. In the economy, institutions of high quality create a competitive edge over other nations and entice foreign investors to redirect their investments towards economies with superior institutional quality. In the short term, this text effectively argues that counties can enhance their domestic trade by improving their environmental development processes, establishing better institutions, and creating a favorable environment for foreign investors.

The results of the Wald test support the null hypothesis and indicate the presence of asymmetry in both the long and short run. All test statistics' associated p-values are statistically significant. In terms of the long-run coefficient assessment, it is apparent that trade openness is positively associated with both positive and negative shocks in environmental quality, institutional quality, and foreign direct investment. Based on the findings, it can be inferred that over a prolonged period, fluctuations in EQ, IQ, and FDI may result in trade openness. However, when it comes to environmental quality, negative shocks appear to have a greater impact than positive ones.

The research project entitled "Nexus between Environmental Qualities, Institutional Quality, and FDI Inflows in Lower-income Countries" has yielded significant insights into the correlation between these factors and their impact on FDI inflows. The aforementioned factors comprise environmental quality, institutional quality, and foreign direct investment (FDI). The findings underscore the correlation between environmental characteristics and institutional caliber in relation to their impact on investment decisions in developing countries with lower economic status. Based on the research findings, countries possessing favorable environmental characteristics and strong institutional

frameworks are more inclined to receive greater levels of foreign direct investment. Moreover, it underscores the importance of responsible business practices and sustainable development practices in attracting global investors.

The subsequent policy proposals could be presented to enhance the inflow of foreign direct investment in lower-income countries. The aforementioned policy recommendations are derived from the findings of the conducted research.

To improve environmental conditions, it is recommended that countries with lower incomes prioritize the protection of the environment and participation in environmentally responsible practices. Enhancing the efficacy of pollution control measures, implementing sustainable resource management practices, and enacting environmental legislation could potentially enhance the investment environment's attractiveness. The establishment of a sustainable and clean ecosystem is likely to attract the attention of environmentally-conscious investors and foster long-term economic growth.

To enhance the quality of institutions, policymakers ought to focus on improving governance structures, fostering transparency, and reducing corruption levels. Enhancing the quality of established institutions establishes a robust foundation for a conducive investment climate. This entails the implementation of efficient regulatory frameworks, the development of a well-defined legal system, and the elimination of bureaucratic obstacles to facilitate the investment process. Lower-income countries may enhance investor confidence and mitigate perceived risks by taking this measure.

It is recommended that nations with lower per capita incomes prioritize sustainable development practices as a fundamental component of their economic policy, in order to promote sustainable development. Countries could potentially enhance their alignment with global sustainability objectives by incorporating environmental concerns into their development plans and prioritizing ethical economic practices. This strategy is poised to resonate with socially conscious investors and draw in foreign direct investment from companies committed to sustainable practices.

To promote sustainable development and attract foreign direct investment, it is recommended that governments actively engage in public-private partnership activities. Collaborating with private businesses to address environmental concerns and improve institutional quality offers a primary advantage: the capacity to leverage experience, financial resources, and technological expertise. These collaborations possess the potential to contribute towards the development of a conducive investment environment and foster mutually beneficial ties between the public and private sectors.

To enhance data accessibility and transparency, it is recommended that governments prioritize the collection and dissemination of data. This will enable investors to access reliable and precise information. If data on environmental indicators, institutional quality, and economic performance are readily available and transparent, investors can make informed judgments based on accurate information. To enhance trust levels and attract additional foreign direct investment (FDI), it is recommended that national governments invest in data infrastructure and establish information exchange platforms.

It is recommended to invest in initiatives that facilitate the creation of capacity and promote the transfer of knowledge. Countries with lower incomes can enhance their attractiveness to investors by investing in capacity-building initiatives and promoting knowledge transfer. The development of a skilled workforce, promotion of innovation, and establishment of favorable circumstances for technology transfer will not only attract foreign direct investment (FDI), but also enhance the country's long-term ability to achieve sustainable growth.

In summary, the research findings emphasize the significance of environmental attributes and institutional quality in the attraction of foreign direct investment (FDI) inflows in countries with lower incomes. Lower-income nations have the potential to create an attractive investment climate that is consistent with worldwide sustainability goals and fosters economic expansion. This can be achieved by implementing policies and strategies that prioritize sustainable development, establishing robust institutions, and promoting transparency. These three pillars constitute the Sustainable Development Goals (SDGs). If the proposed policy ideas are implemented, they will contribute to the overall growth and prosperity of these nations.

Compliance with ethical standards

Disclosure of conflict of interest

There is no conflict of interest

References

- [1] Kwakwa, P.A.; Aboagye, S. Energy consumption in Ghana and the story of economic growth, industrialization, trade openness and urbanization. 2014.
- [2] Pernia, E.M.; Quising, P.F. Trade openness and regional development in a developing country. In *Globalization and urban development*; Springer: 2005; pp. 79-94.
- [3] Dowrick, S.; Golley, J. Trade openness and growth: Who benefits? *Oxford review of economic policy* 2004, 20, 38-56.
- [4] Tahir, M.; Azid, T. The relationship between international trade openness and economic growth in the developing economies. *Journal of Chinese Economic and Foreign Trade Studies* 2015.
- [5] Andriamahery, A.; Danarson, J.H.; Qamruzzaman, M. Nexus between trade and environmental quality in sub-saharan Africa: Evidence from panel GMM. *Frontiers in Environmental Science* 2022, 10, doi:10.3389/fenvs.2022.986429.
- [6] ANDRIAMAHERY, A.; Danarson, J.H.; Qamruzzaman, M. Nexus between Trade and Environmental Quality in Sub-Saharan Africa: Evidence from Panel GMM. *Frontiers in Environmental Science* 2022, 1569.
- [7] Andriamahery, A.; Qamruzzaman, M. A Symmetry and Asymmetry Investigation of the Nexus Between Environmental Sustainability, Renewable Energy, Energy Innovation, and Trade: Evidence From Environmental Kuznets Curve Hypothesis in Selected MENA Countries. *Frontiers in Energy Research* 2022, 9, doi:10.3389/fenrg.2021.778202.
- [8] Anselme, A.; Qamruzzaman, M. Do access to finance, technical know-how and financial literacy offer Women empowerment through Women's entrepreneurial Sustainability? *Frontiers in psychology* 2022, 5889.
- [9] Ayesha, S.; Zartashia, M.; Muneeb, M.A.; Md, Q. Nepotism Effects on Job Satisfaction and Withdrawal Behavior: An Empirical Analysis of Social, Ethical and Economic Factors from Pakistan. *The Journal of Asian Finance, Economics and Business* 2022, 9, 311-318, doi:10.13106/JAFEB.2022.VOL9.NO3.0311.
- [10] Habibullah, M.S.; Yoke-Kee, E. Does Financial Development Cause Economic Growth? A Panel Data Dynamic Analysis for the Asian Developing Countries. *Journal of the Asia Pacific Economy* 2007, 11, 377-393.
- [11] Ibrahim, M.; Sare, Y.A. Determinants of financial development in Africa: How robust is the interactive effect of trade openness and human capital? *Economic analysis and policy* 2018, 60, 18-26.
- [12] Pacheco, R.R.; Fernandes, E. International air passenger traffic, trade openness and exchange rate in Brazil: A Granger causality test. *Transportation Research Part A: Policy and Practice* 2017, 101, 22-29.
- [13] Sahoo, P. Determinants of FDI in South Asia: role of infrastructure, trade openness and reforms. *The Journal of World Investment & Trade* 2012, 13, 256-278.
- [14] Abdella, A.B.; Naghavi, N.; Fah, B.Y. The effect of corruption, trade openness and political stability on foreign direct investment: Empirical evidence from BRIC countries. *International Journal of Advanced and Applied Sciences* 2018, 5, 32-38.
- [15] Dang, Q.; Konar, M. Trade openness and domestic water use. *Water Resources Research* 2018, 54, 4-18.
- [16] 16. Djulius, H. Energy use, trade openness, and exchange rate impact on foreign direct investment in Indonesia. 2017.
- [17] Weixiang, S.; Qamruzzaman, M.; Rui, W.; Kler, R. An empirical assessment of Financial Literacy and Behavioural Biases on Investment Decision: Fresh Evidence from Small Investor Perception. *Frontiers in psychology* 2022, 5746.
- [18] Shi, Z.; Qamruzzaman, M. Re-visiting the role of education on poverty through the channel of financial inclusion: evidence from Lower-income and Lower Middle-income country. *Frontiers in Environmental Science* 2022, 10, 592.
- [19] Qamruzzaman, M.; Karim, S.; Jahan, I. Nexus between economic policy uncertainty, foreign direct investment, government debt and renewable energy consumption in 13 top oil importing nations: Evidence from the symmetric and asymmetric investigation. *Renewable Energy* 2022, 195, 121-136, doi:https://doi.org/10.1016/j.renene.2022.05.168.
- [20] Qamruzzaman, M. Nexus between energy intensity, human capital development, Trade and environmental quality in LIC, LMIC and UMIC: Evidence from GMM. *GSC Advanced Research and Reviews* 2022, 13, 051–068.

- [21] Qamruzzaman, M. Symmetric and Asymmetric Nexus between Economic Policy Uncertainty, Oil Price and Renewable Energy Consumption in the USA, CHINA, INDIA, JAPAN, S. KORIA: Does Technological Innovation influence? *Frontiers in Energy Research* 2022, 1746.
- [22] Qamruzzaman, M.; Jianguo, W. The asymmetric relationship between financial development, trade openness, foreign capital flows, and renewable energy consumption: Fresh evidence from panel NARDL investigation. *Renewable Energy* 2020, 159, 827-842.
- [23] Zakaria, M.; Bibi, S. Financial development and environment in South Asia: the role of institutional quality. *Environmental Science and Pollution Research* 2019, 26, 7926-7937.
- [24] Abdouli, M.; Omri, A. Exploring the Nexus among FDI Inflows, Environmental Quality, Human Capital, and Economic Growth in the Mediterranean Region. *Journal of the Knowledge Economy* 2020, 1-23.
- [25] Farhana, F.; Md, Q. Export, Import, Economic Growth, and Carbon Emissions in Bangladesh: A Granger Causality Test under VAR (Restricted) Environment. In *Management of Cities and Regions*, Vito, B., Ed.; IntechOpen: Rijeka, 2017; p. Ch. 6.
- [26] Faruqui, G.A.; Ara, L.A.; Acma, Q. TTIP and TPP: Impact on Bangladesh and India Economy. *Pacific Business Review International* 2015, 8, 59-67.
- [27] Ganlin, P.; Qamruzzaman, M.; Mehta, A.M.; Naqvi, F.N.; Karim, S. Innovative Finance, Technological Adaptation and SMEs Sustainability: The Mediating Role of Government Support during COVID-19 Pandemic. *Sustainability* 2021, 13, 1-27.
- [28] Guan, C.; Qamruzzaman, M. A symmetric and asymmetric nexus between environmental sustainability and tourism development in BRIC nations: What is the role of good governance and globalization? *Frontiers in Environmental Science* 2022, 10, doi:10.3389/fenvs.2022.973420.
- [29] Huan, Y.; Qamruzzaman, M. Innovation-Led FDI Sustainability: Clarifying the Nexus between Financial Innovation, Technological Innovation, Environmental Innovation, and FDI in the BRIC Nations. *Sustainability* 2022, 14, 15732.
- [30] Jianguo, W.; Qamruzzaman, M. Financial Innovation and Economic Growth: A Casual Analysis. *INNOVATION AND MANAGEMENT* 2017.
- [31] Jianguo, W.; Qamruzzaman, M. An assessment of total factor productivity (TFP) of SME business in Bangladesh using DEA based Malmquist productivity index (MPI). *ABC Journal of Advanced Research* 2017, 6, 31-40.
- [32] Yakubu, I.N. Institutional quality and foreign direct investment in Ghana. *Review of International Business and Strategy* 2020.
- [33] Aziz, O.G. Institutional quality and FDI inflows in Arab economies. *Finance Research Letters* 2018, 25, 111-123.
- [34] Mohamed, S.E.; Sidiropoulos, M.G. Another look at the determinants of foreign direct investment in MENA countries: an empirical investigation. *Journal of economic development* 2010, 35, 75.
- [35] Shah, S.H.; Ahmad, M.H.; Ahmed, Q.M. The nexus between sectoral FDI and institutional quality: Empirical evidence from Pakistan. *Applied Economics* 2016, 48, 1591-1601.
- [36] Shin, Y.; Yu, B.; Greenwood-Nimmo, M. Modelling asymmetric cointegration and dynamic multipliers in a nonlinear ARDL framework. In *Festschrift in Honor of Peter Schmidt*; Springer: 2014; pp. 281-314.
- [37] Qamruzzaman, M.; Kler, R. Do Clean Energy and Financial Innovation Induce SME Performance? Clarifying the Nexus between Financial Innovation, Technological Innovation, Clean Energy, Environmental Degradation, and SMEs Performance in Bangladesh. *International Journal of Energy Economics and Policy* 2023, 13, 313-324, doi:10.32479/ijee.14185.
- [38] Qamruzzaman, M.; Karim, S.; Kor, S. Does environmental degradation matter for poverty? Clarifying the nexus between FDI, environmental degradation, renewable energy, education, and poverty in Morocco and Tunisia. *Environmental Science and Pollution Research* 2023, doi:10.1007/s11356-023-25954-1.
- [39] Lin, J.; Qamruzzaman, M. The impact of environmental disclosure and the quality of financial disclosure and IT adoption on firm performance: Does corporate governance ensure sustainability? *Frontiers in Environmental Science* 2023.
- [40] Karim, S.; Qamruzzaman, M.; Jahan, I. Nexus between Government Debt, Globalization, FDI, Renewable Energy, and Institutional Quality in Bangladesh. *International Journal of Energy Economics and Policy* 2023, 13, 443-456, doi:10.32479/ijee.14284.

- [41] Liargovas, P.G.; Skandalis, K.S. Foreign direct investment and trade openness: The case of developing economies. *Social indicators research* 2012, 106, 323-331.
- [42] Gao, T. FDI, openness and income. *The Journal of International Trade & Economic Development* 2004, 13, 305-323.
- [43] Aizenman, J.; Noy, I. FDI and trade—Two-way linkages? *The quarterly review of economics and finance* 2006, 46, 317-337.
- [44] Vijayakumar, N.; Sridharan, P.; Rao, K.C.S. Determinants of FDI in BRICS Countries: A panel analysis. *International Journal of Business Science & Applied Management (IJBSAM)* 2010, 5, 1-13.
- [45] QAMRUZZAMAN, M.; JIANGUO, W. NEXUS BETWEEN REMITTANCE AND HOUSEHOLD CONSUMPTION: FRESH EVIDENCE FROM SYMMETRIC OR ASYMMETRIC INVESTIGATION. *JOURNAL OF ECONOMIC DEVELOPMENT* 2020, 45, 1-27.
- [46] Ferdaous, J.; Qamruzzaman, A. Impact of international trade, remittances and industrialization on the economic growth of Bangladesh. *Chinese Business Review* 2014, 13, 485-495.
- [47] Pesaran, M.H.; Shin, Y.; Smith, R.P. Pooled mean group estimation of dynamic heterogeneous panels. *Journal of the American Statistical Association* 1999, 94, 621-634.
- [48] Pesaran, M.H.; Smith, R. Estimating long-run relationships from dynamic heterogeneous panels. *Journal of econometrics* 1995, 68, 79-113.
- [49] Chudik, A.; Pesaran, M.H. Common correlated effects estimation of heterogeneous dynamic panel data models with weakly exogenous regressors. *Journal of Econometrics* 2015, 188, 393-420.
- [50] Toda, H.Y.; Yamamoto, T. Statistical inference in vector autoregressions with possibly integrated processes. *Journal of econometrics* 1995, 66, 225-250.
- [51] Dumitrescu, E.-I.; Hurlin, C. Testing for Granger non-causality in heterogeneous panels. *Economic Modelling* 2012, 29, 1450-1460.
- [52] Liu, Q.; Wang, S.; Zhang, W.; Zhan, D.; Li, J. Does foreign direct investment affect environmental pollution in China's cities? A spatial econometric perspective. *Science of the total environment* 2018, 613, 521-529.
- [53] Qamruzzaman, M. An asymmetric nexus between clean energy, good governance, education and inward FDI in China: Do environment and technology matter? Evidence for Chinese provincial data. *Heliyon* 2023, 9, doi:10.1016/j.heliyon.2023.e15612.
- [54] Qamruzzaman, M. Does Environmental Degradation-Led Remittances Flow? Nexus between Environmental Degradation, Uncertainty, Financial Inclusion and Remittances Inflows in India and China. *International Journal of Energy Economics and Policy* 2023, 13, 9.
- [55] Ju, S.; Andriamahery, A.; Qamruzzaman, M.; Kor, S. Effects of financial development, FDI and good governance on environmental degradation in the Arab nation: Does technological innovation matter? *Frontiers in Environmental Science* 2023, 11, doi:10.3389/fenvs.2023.1094976.
- [56] JinRu, L.; Qamruzzaman, M.; Hangyu, W.; Kler, R. An assessment of the symmetric and asymmetric impact of Globalization, environmental sustainability on Tourism Development in BRICS nations: Mediating role of Good governance. *Frontiers in Environmental Science* 2023, 11, 190.
- [57] Islam, Y.; Mindia, P.M.; Farzana, N.; Qamruzzaman, M. Nexus between environmental sustainability, good governance, financial inclusion, and tourism development in Bangladesh: Evidence from symmetric and asymmetric investigation. *Frontiers in Environmental Science* 2023.
- [58] Zhuo, J.; Qamruzzaman, M. Do financial development, FDI, and globalization intensify environmental degradation through the channel of energy consumption: evidence from belt and road countries. *Environmental Science and Pollution Research* 2022, 29, 2753-2772, doi:10.1007/s11356-021-15796-0.
- [59] Zarsky, L. Havens, halos and spaghetti: untangling the evidence about foreign direct investment and the environment. *Foreign direct Investment and the Environment* 1999, 13, 47-74.
- [60] Zhao, L.; Qamruzzaman, M. Do Urbanization, Remittances, and Globalization matter for Energy Consumption in Belt and Road Countries: Evidence from Renewable and Non-Renewable Energy Consumption. *Frontiers in Environmental Science* 2022, 10, 723.

- [61] Zhao, L.; Qamruzzaman, M. Do Urbanization, Remittances, and Globalization Matter for Energy Consumption in Belt and Road Countries: Evidence From Renewable and Non-Renewable Energy Consumption. *Frontiers in Environmental Science* 2022, 10, doi:10.3389/fenvs.2022.930728.
- [62] Xiao, Z.; Qamruzzaman, M. Nexus between Green investment and technological innovation in BRI nations: what is the role of Environmental Sustainability and Domestic Investment? *Frontiers in Environmental Science* 2022, 1472.
- [63] Xia, C.; Qamruzzaman, M.; Adow, A.H. An Asymmetric Nexus: Remittance-Led Human Capital Development in the Top 10 Remittance-Receiving Countries: Are FDI and Gross Capital Formation Critical for a Road to Sustainability? *Sustainability* 2022, 14, 3703.
- [64] Ferdousi, F.; Qamruzzaman, M. Export, import, economic growth, and carbon emissions in bangladesh: a granger causality test under VAR (Restricted) environment. *Management of Cities and Regions* 2017, 79.
- [65] Qamruzzaman, M.; Ferdaous, J. Building a Knowledge-Based Economy in Bangladesh. *Asian Business Review*, 4 (3), 41-49. 2015.
- [66] MEHTA, A.M.; QAMRUZZAMAN, M.; SERFRAZ, A.; ALI, A. The role of remittances in financial development: Evidence from nonlinear ARDL and asymmetric causality. *The Journal of Asian Finance, Economics and Business* 2021, 8, 139-154.
- [67] Meng, L.; Qamruzzaman, M.; Adow, A.H.E. Technological Adaption and Open Innovation in SMEs: An Strategic Assessment for Women-Owned SMEs Sustainability in Bangladesh. *Sustainability* 2021, 13, 2942.
- [68] Mia, A.H.; Qamruzzaman, M.; Ara, L.A. Stock Market Development and Economic Growth of Bangladesh- A Causal Analysis. *Bangladesh Journal of MIS* 2014, 6, 62-73.
- [69] Miao, M.; Qamruzzaman, M. Dose Remittances Matter for Openness and Financial Stability: Evidence From Least Developed Economies. *Frontiers in psychology* 2021, 12, doi:10.3389/fpsyg.2021.696600.
- [70] Muneeb, M.A.; Md, Q.; Ayesha, S. The Effects of Finance and Knowledge on Entrepreneurship Development: An Empirical Study from Bangladesh. *The Journal of Asian Finance, Economics and Business* 2022, 9, 409-418, doi:10.13106/JAFEB.2022.VOL9.NO2.0409.
- [71] Millimet, D.L.; Roy, J. Empirical tests of the pollution haven hypothesis when environmental regulation is endogenous. *Journal of Applied Econometrics* 2016, 31, 652-677.
- [72] Jayachandran, G.; Seilan, A. A causal relationship between trade, foreign direct investment and economic growth for India. *International research journal of finance and economics* 2010, 42, 74-88.
- [73] Sun, C.; Zhang, F.; Xu, M. Investigation of pollution haven hypothesis for China: an ARDL approach with breakpoint unit root tests. *Journal of cleaner production* 2017, 161, 153-164.
- [74] Solarin, S.A.; Al-Mulali, U.; Musah, I.; Ozturk, I. Investigating the pollution haven hypothesis in Ghana: an empirical investigation. *Energy* 2017, 124, 706-719.
- [75] You, W.; Lv, Z. Spillover effects of economic globalization on CO2 emissions: a spatial panel approach. *Energy Economics* 2018, 73, 248-257.
- [76] Nathaniel, S.; Aguegbah, E.; Iheonu, C.; Sharma, G.; Shah, M. Energy consumption, FDI, and urbanization linkage in coastal Mediterranean countries: re-assessing the pollution haven hypothesis. *Environmental Science and Pollution Research* 2020, 1-14.
- [77] Lv, Z.; Xu, T. Trade openness, urbanization and CO2 emissions: Dynamic panel data analysis of middle-income countries. *The Journal of International Trade & Economic Development* 2019, 28, 317-330.
- [78] Awan, S.A.; Meo, M.S.; Ghimire, A.; Wu, R.-Y.; Zhuang, P.-F. Is Trade Openness Good or Bad for Environment in Pakistan; an ARDL Bounds Testing Approach. In *Proceedings of the 4th Annual International Conference on Management, Economics and Social Development (ICMESD 2018)*, 2018.
- [79] Salman, A.; Sethi, B.; Aslam, F.; Kahloon, T. Free Trade Agreements and Environmental Nexus in Pakistan. *Policy Perspectives* 2018, 15, 179-195.
- [80] Shahbaz, M.; Nasreen, S.; Ahmed, K.; Hammoudeh, S. Trade openness–carbon emissions nexus: the importance of turning points of trade openness for country panels. *Energy Economics* 2017, 61, 221-232.
- [81] Bhagwati, J.N.; Srinivasan, T. Trade and the environment: Does environmental diversity detract from the case for free trade? 1995.

- [82] Panayotou, T. Empirical tests and policy analysis of environmental degradation at different stages of economic development; International Labour Organization: 1993.
- [83] Selden, T.M.; Song, D. Environmental quality and development: is there a Kuznets curve for air pollution emissions? *Journal of Environmental Economics and management* 1994, 27, 147-162.
- [84] Ali, S.; Yusop, Z.; Kaliappan, S.R.; Chin, L. Dynamic common correlated effects of trade openness, FDI, and institutional performance on environmental quality: evidence from OIC countries. *Environmental Science and Pollution Research* 2020, 1-12.
- [85] Suri, V.; Chapman, D. Economic growth, trade and energy: implications for the environmental Kuznets curve. *Ecological economics* 1998, 25, 195-208.
- [86] Qamruzzaman, M. Nexus between energy intensity, human capital development, Trade and environmental quality in LIC, LMIC and UMIC: Evidence from GMM. *GSC Advanced Research and Reviews* 2022, 13, 051-068.
- [87] Qamruzzaman, M. Nexus between FDI and globalization-led energy diversification in BRICS: Fresh evidence from a newly constructed Energy diversification index. *Energy Strategy Reviews* 2022, 44, 100997, doi:<https://doi.org/10.1016/j.esr.2022.100997>.
- [88] Qamruzzaman, M. Nexus between renewable energy, foreign direct investment, and agro-productivity: The mediating role of carbon emission. *Renewable Energy* 2022, 184, 526-540, doi:<https://doi.org/10.1016/j.renene.2021.11.092>.
- [89] Qamruzzaman, M. Nexus between foreign direct investments renewable energy consumption: What is the role of Government debt? *International Journal of Multidisciplinary Research and Growth Evaluation*. 2022b 2022, 3, 514-522.
- [90] Qamruzzaman, M. Nexus between environmental innovation, energy efficiency and environmental sustainability in the lower-income economy. *GSC Advanced Research and Reviews* 2022, 12, 068-083.
- [91] Qamruzzaman, M. Nexus between Economic Policy Uncertainty and Institutional Quality: Evidence from Indian and Pakistan. *Macroeconomics and Finance in Emerging Market Economies* 2022, 1-20, doi:[10.1080/17520843.2022.2026035](https://doi.org/10.1080/17520843.2022.2026035).
- [92] Md, Q. Nexus between environmental innovation, energy efficiency and environmental sustainability in the lower-income economy. *GSC Advanced Research and Reviews* 2022, 12, 068-083, doi:[10.30574/gscarr.2022.12.1.0190](https://doi.org/10.30574/gscarr.2022.12.1.0190).
- [93] Ma, R.; Qamruzzaman, M. Nexus between Government Debt, Economic Policy Uncertainty, Government Spending and Governmental Effectiveness in BRIC: Evidence for Linear and Nonlinear Assessment. *Frontiers in Environmental Science* 2022, 1151.
- [94] Ma, C.; Qamruzzaman, M. An Asymmetric Nexus between Urbanization and Technological Innovation and Environmental Sustainability in Ethiopia and Egypt: What Is the Role of Renewable Energy? *Sustainability* 2022, 14, 7639.
- [95] Liang, Z.; Qamruzzaman, M. An Asymmetric Investigation of the Nexus Between Economic Policy Uncertainty, Knowledge Spillover, Climate Change, and Green Economy: Evidence From BRIC Nations. *Frontiers in Environmental Science* 2022, 9, doi:[10.3389/fenvs.2021.807424](https://doi.org/10.3389/fenvs.2021.807424).
- [96] Twerefou, D.K.; Akpalu, W.; Mensah, A.C.E. Trade-induced environmental quality: the role of factor endowment and environmental regulation in Africa. *Climate and Development* 2019, 11, 786-798.
- [97] Felbermayr, G.; Prat, J.; Schmerer, H.-J. Trade and unemployment: What do the data say? *European Economic Review* 2011, 55, 741-758.
- [98] Egyir, J.; Sakyi, D.; Baidoo, S.T. How does capital flows affect the impact of trade on economic growth in Africa? *The Journal of International Trade & Economic Development* 2020, 29, 353-372.
- [99] Seyoum, M.; Wu, R.; Lin, J. Foreign direct investment and trade openness in Sub-Saharan economies: A panel data granger causality analysis. *South African journal of economics* 2014, 82, 402-421.
- [100] Chiappini, R. FDI and trade: A Granger causality analysis in a heterogeneous panel. 2011.
- [101] Treviño, L.J.; Mixon Jr, F.G. Strategic factors affecting foreign direct investment decisions by multi-national enterprises in Latin America. *Journal of world business* 2004, 39, 233-243.
- [102] Romer, P. Increasing Returns and Long-run Growth. *Journal of Political Economy* 1986, 94, 1002-1037.

- [103] Lucas, R. On the mechanics of economic development. *Journal of Monetary Economics* 1988, 22, 3-42.
- [104] Broock, W.A.; Scheinkman, J.A.; Dechert, W.D.; LeBaron, B. A test for independence based on the correlation dimension. *Econometric reviews* 1996, 15, 197-235.
- [105] Fernandez-Arias, E.; Montiel, P.J. The surge in capital inflows to developing countries: an analytical overview. *The World Bank Economic Review* 1996, 10, 51-77.
- [106] Gottschalk, R. The Asian drivers: financial flows into and out of Asia—implications for developing countries. 2006.
- [107] Sakyi, D.; Egyir, J. Effects of trade and FDI on economic growth in Africa: an empirical investigation. *Transnational Corporations Review* 2017, 9, 66-87, doi:10.1080/19186444.2017.1326717.
- [108] Dupasquier, C.; Osakwe, P.N. Performance, promotion, and prospects for foreign investment in Africa: National, regional, and international responsibilities. In *Proceedings of the Eminent Persons' Meeting on 'Promotion of Investment in Africa, Tokyo, 2003.*
- [109] Anyanwu, J.C. Promoting of investment in Africa. *African development review* 2006, 18, 42-71.
- [110] Adhikary, B.K. FDI, trade openness, capital formation, and economic growth in Bangladesh: a linkage analysis. *International Journal of Business and Management* 2011, 6, 16.
- [111] Anderson, J.E.; Marcouiller, D. Insecurity and the pattern of trade: An empirical investigation. *Review of Economics and statistics* 2002, 84, 342-352.
- [112] Butkiewicz, J.L.; Yanikkaya, H. Institutional quality and economic growth: Maintenance of the rule of law or democratic institutions, or both? *Economic Modelling* 2006, 23, 648-661.
- [113] Valeriani, E.; Peluso, S. The impact of institutional quality on economic growth and development: An empirical study. *Journal of Knowledge Management, Economics and Information Technology* 2011, 1, 1-25.
- [114] Appiah, M.; Li, F.; Frowne, D.I. Financial Development, Institutional Quality and Economic Growth: Evidence from ECOWAS Countries. *Organizations and Markets in Emerging Economies* 2020, 11, 6-17.
- [115] Méon, P.G.; Sekkat, K. Institutional quality and trade: which institutions? Which trade? *Economic Inquiry* 2008, 46, 227-240.
- [116] La Porta, R.; Lopez-de-Silanes, F.; Shleifer, A.; Vishny, R.W. Legal determinants of external finance. *The journal of finance* 1997, 52, 1131-1150.
- [117] Anwar, S.; Cooray, A. Financial development, political rights, civil liberties and economic growth: Evidence from South Asia. *Economic Modelling* 2012, 29, 974-981.
- [118] Qamruzzaman, M.; Jianguo, W. An Assessment of Financial Efficiency using Data Evolvement Analysis (DEA) Multistage Approach: A Case Study of Banks in Bangladesh. *IOSR Journal of Economics and Finance* 2016, 7, 96-103.
- [119] Qamruzzaman, M.; Jianguo, W. Investigation of the asymmetric relationship between financial innovation, banking sector development, and economic growth. *Quantitative Finance and Economics* 2018, 2, 952-980.
- [120] Qamruzzaman, M.; Jianguo, W. Investigation of the asymmetric relationship between financial innovation, banking sector development, and economic growth. *Quantitative Finance and Economics* 2018, 2, 952-980, doi:10.3934/QFE.2018.4.952.
- [121] Qamruzzaman, M.; Jianguo, W. SME financing innovation and SME development in Bangladesh: an application of ARDL. *Journal of Small Business & Entrepreneurship* 2019, 31, 521-545, doi:10.1080/08276331.2018.1468975.
- [122] Qamruzzaman, M.; Karim, S. Nexus between Economic Volatility, Trade Openness and FDI: An Application of ARDL, NARDL and Asymmetric Causality. *Asian Economic and Financial Review* 2020, 10, 790-807.
- [123] Maruta, A.A. Trade aid, institutional quality, and trade. *Journal of Economics and Business* 2019, 103, 25-37.
- [124] Balamoune-Lutz, M.; Ndikumana, L. The growth effects of openness to trade and the role of institutions: New evidence from African countries; Working Paper: 2007.
- [125] Maruta, A.A.; Banerjee, R.; Cavoli, T. Foreign aid, institutional quality and economic growth: Evidence from the developing world. *Economic Modelling* 2020, 89, 444-463.
- [126] Pettersson, J.; Johansson, L. Aid, aid for trade, and bilateral trade: An empirical study. *The Journal of International Trade & Economic Development* 2013, 22, 866-894.

- [127] Qamruzzaman, M.; Wei, J. Financial Innovation, Stock Market Development, and Economic Growth: An Application of ARDL Model. *International Journal of Financial Studies* 2018, 6, 69.
- [128] Qamruzzaman, M.; Jianguo, W. Nexus between financial innovation and economic growth in South Asia: evidence from ARDL and nonlinear ARDL approaches. *Financial Innovation* 2018, 4, 20.
- [129] Qamruzzaman, M.; Jianguo, W. Does Foreign Direct Investment, Financial Innovation, and Trade Openness Coexist in the Development Process: Evidence from Selected Asian and African Countries? *British Journal of Economics, Finance and Management Sciences* 2018, 16, 73-94.
- [130] Qamruzzaman, M. Productivity and Performance Evaluation of SME Sector in Bangladesh: Evidence from the Historical Data. *Journal of Islamic Finance and Business Research* 2015, 2, 14-22.
- [131] Bernard, J.; Mandal, S. The impact of trade openness on environmental quality: an empirical analysis of emerging and developing economies. *WIT Trans Ecol Environ* 2016, 203, 195-208.
- [132] Hakimi, A.; Hamdi, H. Trade liberalization, FDI inflows, environmental quality and economic growth: a comparative analysis between Tunisia and Morocco. *Renewable and Sustainable Energy Reviews* 2016, 58, 1445-1456.
- [133] Asamoah, M.E.; Adjasi, C.K.; Alhassan, A.L. Macroeconomic uncertainty, foreign direct investment and institutional quality: Evidence from Sub-Saharan Africa. *Economic Systems* 2016, 40, 612-621.
- [134] Le, T.-H.; Kim, J.; Lee, M. Institutional quality, trade openness, and financial sector development in Asia: An empirical investigation. *Emerging Markets Finance and Trade* 2016, 52, 1047-1059.
- [135] Asiedu, E. Foreign direct investment, natural resources and institutions. *International Growth Centre* 2013.
- [136] Buchanan, B.G.; Le, Q.V.; Rishi, M. Foreign direct investment and institutional quality: Some empirical evidence. *International Review of financial analysis* 2012, 21, 81-89.
- [137] Daude, C.; Stein, E. The quality of institutions and foreign direct investment. *Economics & Politics* 2007, 19, 317-344.
- [138] Kaufmann, D.; Kraay, A.; Mastruzzi, M. Governance indicators for 2000-2008, the worldwide governance indicators (WGI) project. *World Bank Policy Research* 2010.
- [139] Globerman, S.; Shapiro, D. Global foreign direct investment flows: The role of governance infrastructure. *World development* 2002, 30, 1899-1919.
- [140] Zhang, Y.; Qamruzzaman, M.; Karim, S.; Jahan, I. Nexus between Economic Policy Uncertainty and Renewable Energy Consumption in BRIC Nations: The Mediating Role of Foreign Direct Investment and Financial Development. *Energies* 2021, 14, 4687.
- [141] Yingjun, Z.; Jahan, S.; Qamruzzaman, M. Access to Finance and Legal Framework in Female Entrepreneurship Development in Bangladesh: The Mediating Role of Self-Leadership. *Asian Economic and Financial Review* 2021, 11, 762-780.
- [142] Yang, Y.; Qamruzzaman, M.; Rehman, M.Z.; Karim, S. Do Tourism and Institutional Quality Asymmetrically Effects on FDI Sustainability in BIMSTEC Countries: An Application of ARDL, CS-ARDL, NARDL, and Asymmetric Causality Test. *Sustainability* 2021, 13, 9989.
- [143] Qamruzzaman, M.; Karim, S.; Jahan, I. COVID-19, Remittance Inflows, and the Stock Market: Empirical Evidence from Bangladesh. *The Journal of Asian Finance, Economics and Business* 2021, 8, 265-275.
- [144] Md Qamruzzaman, S.N., Ananda Bardhan. Nexus between Remittance, Financial Volatility, Trade Openness, Money Supply, and Non-Performing Loan: An Application of Autoregressive Distributed Lagged (ARDL) Model. *Journal of Banking and Finance Management* 2021, 3, 34-54.
- [145] Md, Q.; Muneeb, M.A.; Rimsha, K.; Ayesha, S.; Hina, S. Symmetric and Asymmetric Effects of Financial Innovation and FDI on Exchange Rate Volatility: Evidence from South Asian Countries. *The Journal of Asian Finance, Economics and Business* 2021, 8, 23-36, doi:10.13106/JAFEB.2021.VOL8.NO1.023.
- [146] Qamruzzaman, M.; Karim, S. ICT investment impact on human capital development through the channel of financial development in Bangladesh: An investigation of quantile ARDL and Toda-Yamamoto test. *Academic Journal of Interdisciplinary Studies* 2020, 9, 112-112.
- [147] Pesaran, M.H.; Shin, Y.; Smith, R.J. Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics* 2001, 16, 289-326, doi:10.1002/jae.616.

- [148] Kim, D.-H.; Lin, S.-C.; Suen, Y.-B. Dynamic effects of trade openness on financial development. *Economic Modelling* 2010, 27, 254-261.
- [149] Fang, W.; Miller, S.M.; Yeh, C.-C. The effect of growth volatility on income inequality. *Economic Modelling* 2015, 45, 212-222.
- [150] Pesaran, M.H. Estimation and inference in large heterogeneous panels with a multifactor error structure. *Econometrica* 2006, 74, 967-1012.
- [151] Zapata, H.O.; Rambaldi, A.N. Monte Carlo evidence on cointegration and causation. *Oxford Bulletin of Economics and statistics* 1997, 59, 285-298.
- [152] Wolde-Rufael, Y. Energy demand and economic growth: the African experience. *Journal of Policy Modeling* 2005, 27, 891-903.
- [153] Mavrotas, G.; Kelly, R. Old wine in new bottles: Testing causality between savings and growth. *The Manchester School* 2001, 69, 97-105.
- [154] Breusch, T.S.; Pagan, A.R. The Lagrange multiplier test and its applications to model specification in econometrics. *The review of economic studies* 1980, 47, 239-253.
- [155] Pesaran, M.H. General diagnostic tests for cross section dependence in panels. 2004.
- [156] Pesaran, M.H.; Ullah, A.; Yamagata, T. A bias-adjusted LM test of error cross-section independence. *The Econometrics Journal* 2008, 11, 105-127.
- [157] Levin, A.; Lin, C.-F.; Chu, C.-S.J. Unit root tests in panel data: asymptotic and finite-sample properties. *Journal of econometrics* 2002, 108, 1-24.
- [158] Im, K.S.; Pesaran, M.H.; Shin, Y. Testing for unit roots in heterogeneous panels. *Journal of econometrics* 2003, 115, 53-74.
- [159] Maddala, G.S.; Wu, S. A comparative study of unit root tests with panel data and a new simple test. *Oxford Bulletin of Economics and statistics* 1999, 61, 631-652.
- [160] Pesaran, M.H. A simple panel unit root test in the presence of cross-section dependence. *Journal of Applied Econometrics* 2007, 22, 265-312.
- [161] Pedroni, P. Critical values for cointegration tests in heterogeneous panels with multiple regressors. *Oxford Bulletin of Economics and statistics* 1999, 61, 653-670.
- [162] Pedroni, P. Panel cointegration: asymptotic and finite sample properties of pooled time series tests with an application to the PPP hypothesis. *Econometric theory* 2004, 20, 597-625.
- [163] Kao, C. Spurious regression and residual-based tests for cointegration in panel data. *Journal of econometrics* 1999, 90, 1-44.
- [164] Westerlund, J.; Edgerton, D.L. A simple test for cointegration in dependent panels with structural breaks. *Oxford Bulletin of Economics and Statistics* 2008, 70, 665-704.
- [165] Baltagi, B.H. Forecasting with panel data. *Journal of forecasting* 2008, 27, 153-173.
- [166] Zhu, H.; Duan, L.; Guo, Y.; Yu, K. The effects of FDI, economic growth and energy consumption on carbon emissions in ASEAN-5: Evidence from panel quantile regression. *Economic Modelling* 2016, 58, 237-248, doi:<https://doi.org/10.1016/j.econmod.2016.05.003>.
- [167] Huang, Y.; Zhu, H.; Zhang, Z. The heterogeneous effect of driving factors on carbon emission intensity in the Chinese transport sector: Evidence from dynamic panel quantile regression. *Science of The Total Environment* 2020, 138578.
- [168] Ho, S.-H.; Oueghlissi, R.; El Ferktaji, R. The dynamic causality between ESG and economic growth: Evidence from panel causality analysis. 2019.
- [169] Zeren, F.; Konuk, F. The Nexus between Trading Volume and Stock Prices: Panel Evidence from OECD Countries. *Business & Economics Research Journal* 2016, 7.