frontiers in Environmental Science

ORIGINAL RESEARCH
published: 28 February 2022
doi: 10.3389/fenvs.2022.854590

Comparative Analysis of Trade Liberalization, CO_2 Emissions, Energy Consumption and Economic Growth in Southeast Asian and Latin American Regions: A Structural Equation Modeling Approach

Muhammad Zeeshan[1†], *Jiabin Han*[1†], *Alam Rehman*[2†], *Irfan Ullah*[3*†], *Fakhr E. Alam Afridi*[4†] *and Zeeshan Fareed*[5*]

[1]College of Business Administration, Liaoning Technical University, XingCheng, China, [2]Faculty of Management Sciences, National University of Modern Language, Islamabad, Pakistan, [3]Reading Academy, Nanjing University of Information Science and Technology, Nanjing, China, [4]Department of Management Sciences, National University of Modern Languages Peshawar Campus, Islamabad, Pakistan, [5]School of Economics and Management, Huzhou University, Huzhou Zhejiang, China

This study compares the nexus among trade liberalization, CO_2 emissions, energy consumption, and economic growth in Southeast Asian and Latin American countries. We apply the structural equation modeling approach for estimation analysis of the data from 1991 to 2018. The empirical findings of this study validate that trade has a positive and statistically significant effect on energy consumption, CO_2 emissions, and gross domestic product (GDP) in Southeast Asian countries. Whereas in Latin American countries, trade shows a positive insignificant impact on energy consumption, but the coefficients for both CO_2 emissions and GDP are positive and statistically significant. Energy consumption also exhibits a positive significant effect on CO_2 emissions and a positive statistically insignificant effect on GDP in the Southeast Asian region. However, in Latin American countries, energy consumption predicts a positive and statistically significant impact on both CO_2 emissions and GDP. Whereas, CO_2 emissions indicate a positive significant effect on GDP in both regions. Therefore, each country's government in both areas should formulate appropriate policies to promote green technologies in the production and exports, which could help economies to achieve a clean environment and sustainable long-term development.

Keywords: trade liberalization, CO_2 emissions, energy consumption, economic growth, structural equation modeling

OPEN ACCESS

Edited by:
Magdalena Radulescu,
University of Pitesti, Romania

Reviewed by:
Sher Ali,
Islamia College University, Pakistan
Zeeshan Ahmed,
University of Lahore, Pakistan

***Correspondence:**
Irfan Ullah
irfanecon@nuist.edu.cn
Zeeshan Fareed
zeeshanfareed@zjhu.edu.cn

***ORCID:**
Muhammad Zeeshan
orcid.org/0000-0003-3525-9429
Jiabin han
orcid.org/0000-0003-3000-4355
Alam Rehman
orcid.org/0000-0001-9490-979X
Irfan Ullah
orcid.org/0000-0003-3961-888X
Fakhr E. Alam Afridi
orcid.org/0000-0001-9776-5074

Specialty section:
This article was submitted to Environmental Economics and Management, a section of the journal Frontiers in Environmental Science

Received: *14 January 2022*
Accepted: *24 January 2022*
Published: *28 February 2022*

Citation:
Zeeshan M, Han J, Rehman A, Ullah I, Afridi FEA and Fareed Z (2022) Comparative Analysis of Trade Liberalization, CO_2 Emissions, Energy Consumption and Economic Growth in Southeast Asian and Latin American Regions: A Structural Equation Modeling Approach. Front. Environ. Sci. 10:854590. doi: 10.3389/fenvs.2022.854590

INTRODUCTION

Trade has been extensively discussed with CO_2 emissions, energy consumption, and gross domestic product (GDP) in the literature; however, the regional comparison is still not being undertaken. We extended the existing literature on trade, CO_2 emissions, energy consumption, and economic growth by using the case of more regions, i.e., Southeast Asian and Latin American countries. The comparative analysis of the two regions may provide a clear picture of the success of trade

policies and implications on growth, environmental, and energy consumption in the two regions. Trade openness is considered to be an engine to the growth of an economy, which consequently contributes to more CO_2 emissions and energy consumption that affect environmental quality, GDP, and CO_2 emissions (Ullah et al., 2019b). Many countries in Latin America and Southeast Asia adopted trade liberalization in the 1990s, and it resulted in significant improvement in economic growth. Besides the positive effect on the economy, international trade expansion contributes to the CO_2 emissions and energy consumption, which affects the environmental quality of a country (Copeland and Taylor, 1997; Frankel and Rose, 2002). Trade openness can account for an increase in CO_2 emissions from three aspects. First, trade increases in CO_2 emissions as a result of a high level of economic activities, especially in the export sector industries (Ullah et al., 2019a). Second, countries change the production pattern due to the specialization after the trade liberalization, which increases CO_2 emissions (Grossman and Krueger, 1991; Copeland and Taylor, 2004). Third, countries use a higher level of technologies that require a high level of energy consumption, which leads to a higher level of CO_2 emissions in the economy. The emergence of trade openness in developing countries has got attention as many Southeast Asian economies achieved substantial economic growth. Besides this achievement, trade activities created a lot of challenges for the environment, particularly in terms of CO_2 emissions. The environmental quality is worsening due to emissions of dangerous gases and results in more severe consequences for human health and sustainable development (Rock and Angel, 2007). Environmental Kuznets Curve provides a framework showing CO_2 emissions for countries in different stages of the economy, in the transition period due to industrial development and economic growth that leads to higher CO_2 emissions in the economy. In contrast, in later stage, countries give more attention to reduces CO_2 emissions; therefore, in later stage, it reduces CO_2 emissions. Both trade and economic growth are based on agriculture production, which requires high-level energy consumption. Energy consumption has no crucial adverse effect on economic growth Menegaki (2011). However, some of the studies found that trade liberalization, more FDI, and energy consumptions do not negatively contribute to the environmental degradation (Ikram et al., 2021; Shahzad et al., 2021).

Trade expansion and GDP have the same effect on energy consumption; in this regard, the conventional theories suggest that trade and GDP increase energy consumption. The majority of the studies in existing literature concluded the positive nexus of trade with energy consumption, CO_2 emissions, and GDP. The contradiction of empirical findings requires further empirical investigation by comparing the two regions like Southeast Asian countries and Latin American Countries. Besides, this study will help to better understand the success of trade openness in two regions and its implication for economic growth, energy consumption, CO_2 emissions, and energy consumption. Many countries in various regions have varying environmental legislation and robust strategic framework, which may have diverse implications for the CO_2 emissions. Therefore, the nexus of these variables in these Southeast Asian countries and Latin American Countries are investigated in this study. The study contributes to the literature in many ways. First, there is no such study exists, which explores the dynamic interrelationship among trade, CO_2, energy consumption, and economic growth by comparing the emerging regions. Second, the comparative analysis of various regions such as Southeast Asia and Latin American may provide the success of trade policies and their implications for the environment, CO_2 emissions, energy consumption, and GDP. Third, this paper uses a novel statistical technique known as the "structural equation model (SEM)", which is a novel approach that provides a more robust empirical estimation for complex models and prominent policy implications for the policymakers in these various countries and regions.

LITERATURE REVIEW

Trade openness has a manifold effect on the economy, including economic growth, CO_2 emissions, and energy consumption. Trade and economic growth have been widely discussed in the literature. Kemal (2007) analyzed the trade openness effect on economic growth for the South Asian countries by using the restricted VAR model and co-integration technique and confirmed the growth-lead hypothesis. Awokuse (2008) demonstrated that trade gives the prevalence of import-led and export-led hypotheses for Latin American countries. Besides the significant contribution of trade to economic development, it also has some serious threats for the country's environmental degradation concerns. Many studies found that trade leads to an increase the CO_2 emissions. Ullah et al. (2019a) confirmed that trade openness increased the CO_2 emissions in China for 1990–2017. Ferda Halicioglu (2009) investigated trade, CO_2 emissions, and energy consumption for Turkey and found that trade openness leads to an increase in CO_2 emissions. Omri et al. (2015) reported that trade, financial development, and economic growth cause the degradation of environmental quality in MENA countries. Shahbaz et al. (2013) confirmed that trade openness increases the CO_2 emissions in Indonesia. Trade activities also increase CO_2 emissions and found that trade openness increases CO_2 emissions in China (Ullah et al., 2019a; Zeeshan et al., 2021a; Zeeshan et al., 2021b). Another study by Ullah et al. (2019b) found that trade liberalization in Pakistan also leads to CO_2 emissions in Pakistan. Whereas in a similar study, Grossman and Krueger (1991) reported a positive relationship between trade openness and CO_2 emissions. Likewise, Copeland and Taylor (2004) also confirmed a positive nexus of CO_2 emissions and trade, but they came up with contrast findings and found that CO_2 emissions can be reduced by trade openness and claimed that technological innovation and energy-efficient technologies in the production process negatively affect CO_2 emissions and trade.

Trade and GDP both can increase energy consumption, and many studies found a positive association between trade and GDP growth for energy consumption. The pioneering research of Kraft and Kraft (1978) indicates that GDP increases energy consumption. However, later empirical

findings show a mix of conclusions on the relationship between trade GDP and energy consumption. Khan et al. (2006) found that energy consumption is the main factor for accelerating economic growth in Pakistan, Sri Lanka, and Bangladesh. Whereas in a similar study, Noor and Siddiqi (2010) predicted a short-run unidirectional causality running from GDP to energy consumption in Pakistan, Bangladesh, Nepal, Sri-Lanka, and India. Lee (2005) analyzed the relationship between GDP and energy consumption by using the co-integration technique and VECM for the period of 1975 to 2001 and concluded the existence of the long-run relationship between energy consumption and economic growth; however, no short-run relationship was observed. Salahuddin et al. (2015) and Ahmad et al. (2021) tested the relationship among economic growth, energy consumption, carbon dioxide emissions, and financial development in the GCC area, and their findings suggest that economic growth and energy consumption stimulate CO_2 emissions in GCC countries. Pao and Tsai (2010) also found a co-integration relationship between GDP, energy consumption, and CO_2 emissions for BRIC countries with the help of Granger causality tests and panel co-integration technique. Their long-run estimation results suggest a positive link between carbon emissions and energy consumption. Jammazi and Aloui (2015) investigated the cross-linkages among CO_2 emissions, economic growth, and energy consumption for GCC countries with the approach of wavelet window cross-correlation. Their results report a unidirectional nexus between energy consumption and CO_2 emissions. Aqeel and Butt (2001) also confirmed that the economic growth of a country directly influences the growth of petroleum consumption. Likewise, Paul and Bhattacharya (2004) also reported bi-directional causality between energy consumption and economic growth in India. However, Pirlogea and Cicea (2012) found a unidirectional relationship between energy consumption to economic growth for European countries. Whereas, few studies justified the bi-directional causality between renewable energy consumption and economic growth (Apergis and Payne, 2009; Apergis et al., 2010). Trade and energy consumption have been widely examined in the liberalization. Likewise, Grossman and Krueger (1995), Frankel(2009), and Zeeshan et al. (2021a) found that trade liberalization reduces environmental quality. Cole (2006) and Doney et al. (2009) argued that trade openness potentially affects CO_2 emissions, particularly in the industrial production and exports that heavily rely on the fossil fuels that is the major underlying cause of pollution. Redding and Venables (2002) and Grossman and Helpman (1991) comprehended that energy consumption may be affected by trade openness policies like reducing non-tariff and tariff barriers on energy-efficient products and suggesting a positive association between energy consumption and trade openness. Greenaway et al. (2002) and Wacziarg (2001) found a positive relationship between energy consumption and trade openness. Antweiler et al. (2001) suggested a theoretical framework that an increase in energy usage is due to trade openness. However, they are not the same, as the exercises of changing policies and the structure of the economy represent liberalization.

Economic growth and CO_2 emission have also explored in the previous studies by using EKC theory (Grossman and Krueger, 1995; Seldon and Song, 1994; Shafiq et al., 1994; Al-Mulali et al., 2016; Solarin et al., 2017). Saboori and Sulaiman (2013) investigated that there exists bidirectional causality between carbon dioxide emissions and economic growth. However, many studies explored the nexus of economic growth, CO_2, and energy consumption (Halicioglu, 2007; Apergis et al., 2010; Menyah and Wolde-Rufael, 2010; Ozturk and Acaravci, 2010; Arouri et al., 2012; Sheinbaum-Pardo et al., 2012). Few studies also examined the panel data and found a dynamic relationship between carbon dioxide emissions and economic growth and suggested that GDP determines the long-run association with CO_2 emissions (Coondoo and Dinda, 2002; Coondoo and Dinda, 2008; Lee and Lee, 2009; Narayan et al., 2010; Jaunky, 2011; Apergis, 2016). On the basis of the above literature, we have developed the following hypothesis (Ahmad et al., 2021).

Hypothesis Testing

H1: Trade has a positive effect on energy consumption.
H2: Trade positively contributes to CO_2 emission.
H3: Energy consumption positively affects CO_2 emission.
H4: Energy consumption positively affects GDP.
H5: Trade positively affects GDP.
H6: CO_2 emission positively affects GDP.

STYLIZED FACT FOR TRADE, ENERGY, CO_2 EMISSIONS, AND GDP IN LATIN AMERICAN AND SOUTHEAST ASIAN COUNTRIES

Trade Liberalization Trend

In **Figure 1**, the Southeast Asian Country's trade liberalization can be observed with an upward but more flat behavior from 1991 to 2018. The association of Southeast Asian countries consists of many diverse economies, as compared to Europe or North America. Moreover, they are ethnically, historically, culturally, and economically different from one another as to Europe or American Northern countries. However, in terms of economic development, Singapore is leading among the Association of Southeast Asian Nations (ASEAN) countries. It is noted that domestic policies change that ASEAN has to make difficult politically, in the prism of economic crisis. To increase the trade, ASEAN countries expanded trade in the region that significantly improved the region's income. Singapore has obtained tremendous growth due to aggressive and well-planned trade strategies. Indonesia shows a similar practice for trade openness in the same period, which means that trade openness increases the trade activities in the region. Lao PDR also exhibits similar practices, as Indonesia, in terms of trade. However, Malaysia statistics show that the country showed a

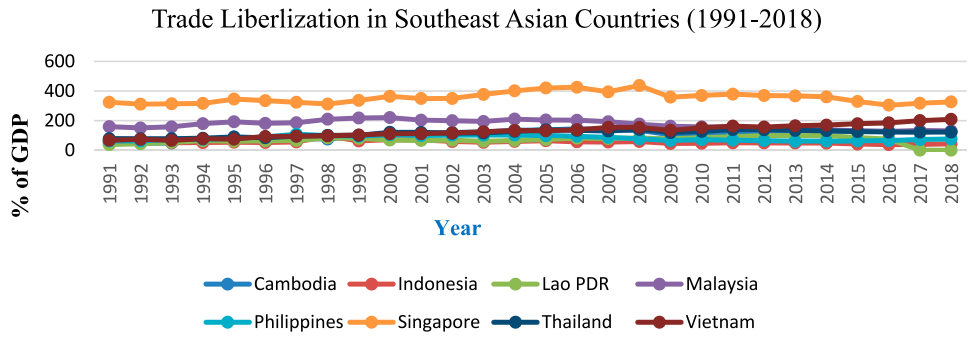

FIGURE 1 | Trade liberalization of Southeast Asian countries.

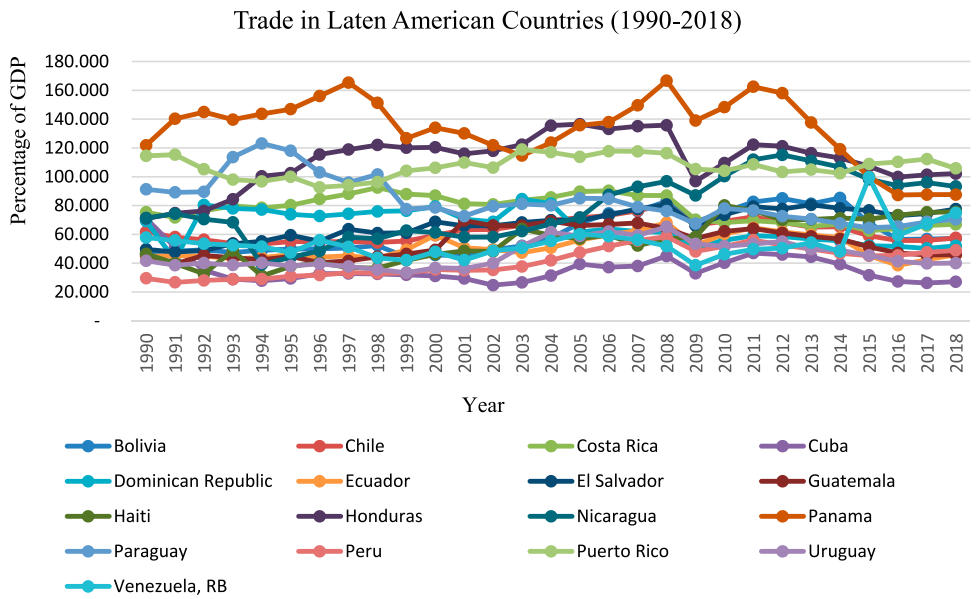

FIGURE 2 | Trade liberalization of Latin American countries.

significant increase in trade activates from 1991 to 2006; then, a downward trend is seen for trade openness due to international finical crises. Philippines, Thailand, and Vietnam show somehow similar procedures and governance for trade openness up to 2015, and then, Thailand and Vietnam show a rising trend due to special reforms by their current regimes. Singapore shows serious upward trade liberalization practices till 2008, and then, a declining approach is seen.

Figure 2 contains the trade liberalization trend for the Latin American countries; Honduras and Costa Rica trade liberalization have dynamic trends as showing upward and downward movement for trade activities from 1991 to 2018. Bolivia, Cuba, Peru, Dominican Republic, and Uruguay show a smooth trend for trade in the study period, which means that no special creativities have been taken concerning trade in Guatemala. Honduras, Paraguay, Venezuela, Haiti, and Chile exhibit similar practices as Guatemala in terms of trade with no remarkable changes. However, Panama figures show that it increased trade from 1991 to 1997, and then, a downward curve in terms of trade openness is seen up to 2002. Bolivia, El Salvador, Paraguay, Uruguay, Dominican Republic, Guatemala, Ecuador, and Puerto Rico show somehow similar procedures and governance for trade openness up to 2018, but Peru starts a sudden upward trend in 2014, for 2 years. This jump was characterized by trade facilitation efforts by the ruling regime, and then, a downward trend is seen.

Energy Consumption

In **Figure 3**, the energy consumption has been shown for the Southeast Asian region. As a whole of 10% of the world's population reckon with the assessment of global outlook energy consumption, rapidly growing regional economies contribute to various aspects of energy outlook and economic factors. The Southeast Asia energy outlook

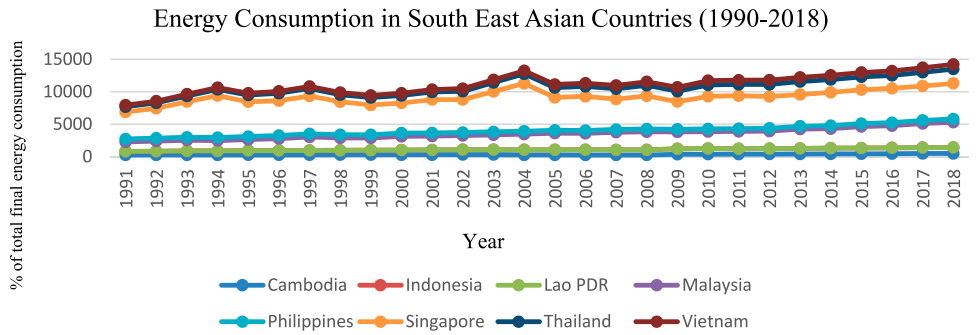

FIGURE 3 | Energy consumption of Southeast Asian countries.

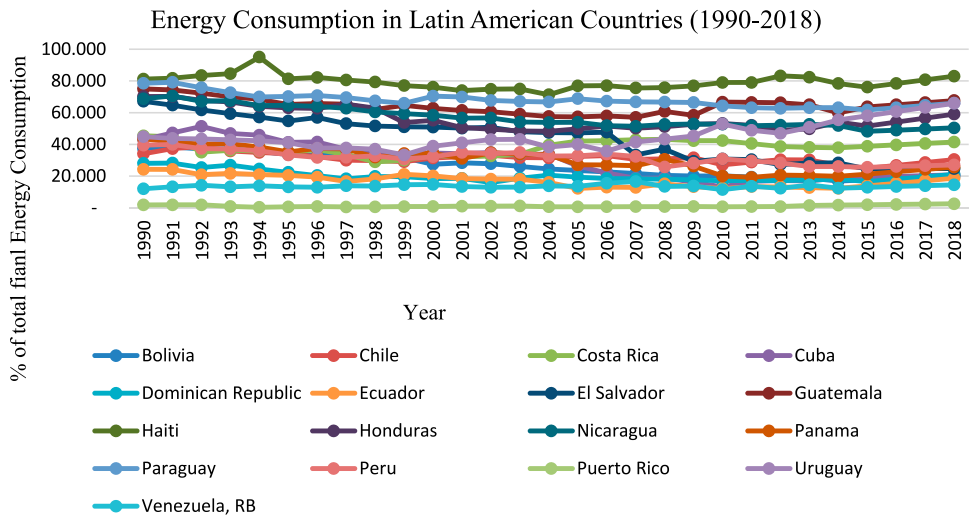

FIGURE 4 | Energy consumption of Latin American countries.

reported a growing perspective of energy consumption in Southeast Asia. International Energy Agency reported that the risks and opportunities that are faced by the Association of Southeast Asian nations, i.e., Cambodia, Malaysia, Singapore, Indonesia, Thailand, Lao PDR, Philippines, Myanmar, and Vietnam, look in achieving to meet their affordable and sustainable energy demand. The sustainability demand is represented in **Figure 3**. The graph showed its slow and steady energy demand and consumption. This intensifies the effort by these countries to ensure secure, sustainable, and affordable energy sector pathway plans. It includes investments in power supply, infrastructure, and fuel, mainly focuses on efficiency that resulted in a well-managed region's energy system as regards the quality of life, and improves welfare for citizens. However, there are also some warning signs, an increase in fuel demand, and outpaced production within the Southeast Asia region. Thailand, Vietnam, and Singapore show overall upward trends from 1991 to 2018, with a slight upward and downward practice. It is the reason for serious efforts, which are being made by these countries to stimulate trade using more energy in their production units. More production has moved the energy consumption curve upward in these countries than in other countries in the same region. However, Malaysia and the Philippines show an upward but flat kind of energy consumption practices, showing their less intensity toward energy consumption. Whereas, Cambodia and Lao PDR show a flat but slightly increasing trend in their energy consumption.

Figure 4 shows that Haiti's energy consumption can be seen as having an upward but flat behavior from 1991 to 1994. Dominican Republic shows similar practices for energy consumption in the period, which means that no special initiatives have been taken regarding energy consumption and trade in the Dominican Republic, Costa Rica, El Salvador Nicaragua, Paraguay, Puerto Rico, Venezuela, Chile Cuba, Ecuador, Guatemala, Honduras, Panama, Peru, and Uruguay, due to which their static position is there. Therefore, flat practices are seen with a slight rising trend, which is very much clear that these countries did not entice foreign trade.

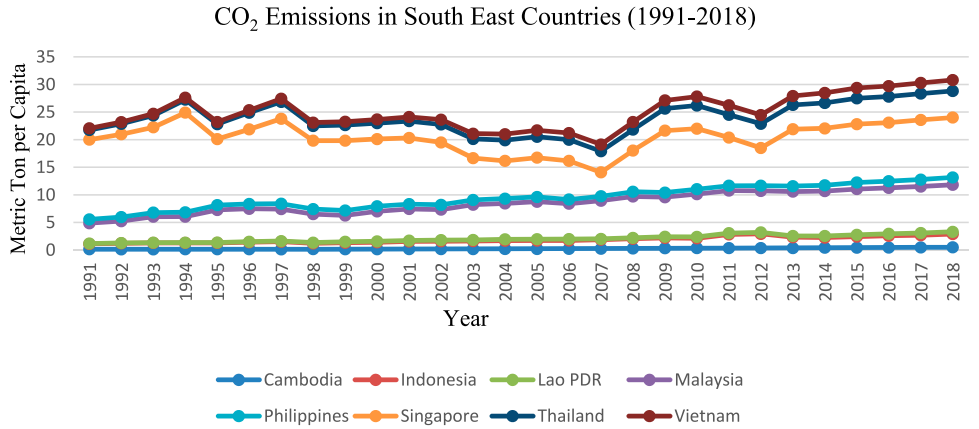

FIGURE 5 | CO_2 emission in Southeast Asian countries.

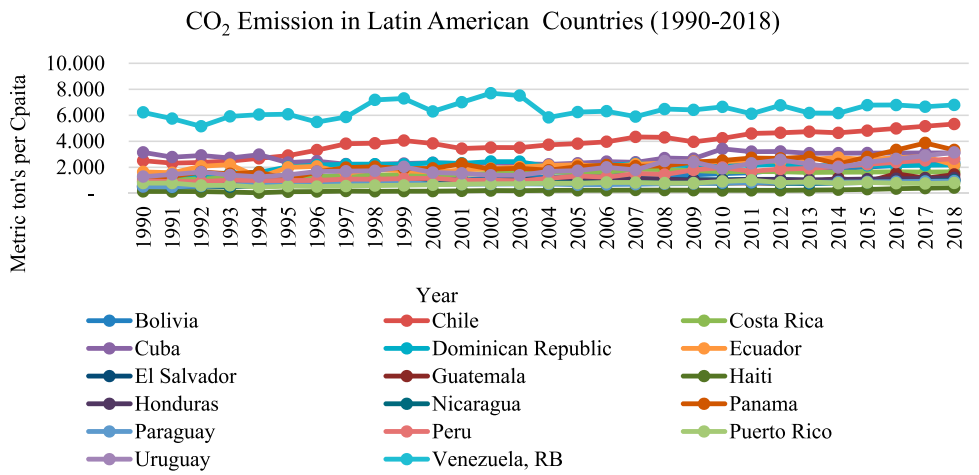

FIGURE 6 | CO_2 emission in Latin American countries.

CO_2 Emission

In **Figure 5**, the CO_2 emissions are shown. Vietnam, Singapore, and Thailand show a downward curve from 1991 to 2007, and then, a sudden drastic upward trend is witnessed in the graph, which is due to more energy consumption in this period by these three countries and the promulgation of various trade approaches and policies to stimulate the economy. Malaysia and the Philippines show a flat but a bit raising trend in CO_2 emissions, which is very much coherent with their energy consumption practices, as both countries have similar trends for their energy consumption. Indonesia, Lao DPR, and Cambodia show, somehow, similar volumes in terms of their CO_2 emissions, which is due to their approach toward energy consumption.

In **Figure 6**, the CO_2 emissions for the Latin belt are shown. Venezuela shows a downward curve from 1991 to 1996, and then, a sudden drastic upward trend is witnessed in the graph for 3 years, which is due to more energy consumption in this period by Venezuela, as oil resources have extracted in Venezuela. Similarly, Chile shows an upward trend from 1991 to 2018. Bolivia, Cuba, El Salvador, Honduras, Paraguay, Uruguay, Dominican Republic, Guatemala, Nicaragua, Peru, Costa Rica, Ecuador, Haiti, Panama, and Puerto Rico show a flat but slightly increasing upward trend in their CO_2 emissions in the study period of 1991–2018.

Economic Growth

Figure 7 presents the economic growth for the Southeast Asian countries. Singapore shows a tremendous rise in economic growth. It is due to its knowledge economy using sophisticated technologies in their production and more driven toward innovation and creativity of industrial output, agricultural production, services, and wise promulgation of economic policies. Malaysia is also showing an upward trend in terms of economic growth. It is due to the coherent and robust economic measures to fuel the economy. In comparison, Thailand stands

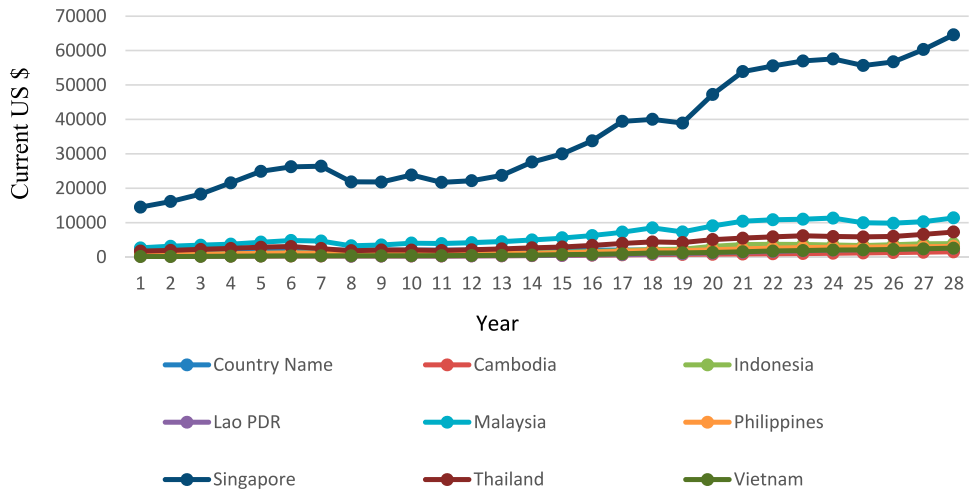

FIGURE 7 | Economic growth of Southeast Asian countries.

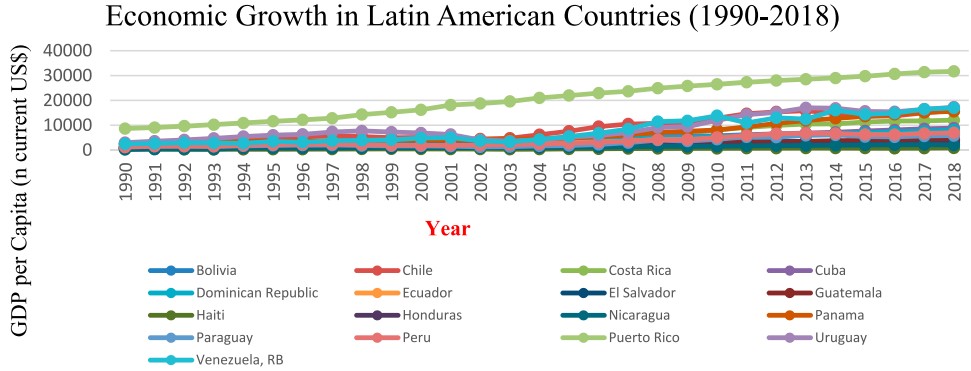

FIGURE 8 | Economic growth in Latin American countries.

third in the graph in terms of economic growth. However, the rest of the countries show almost similar economic growth, which reflects their economic weight and width. In **Figure 8**, the economic growth for Latin American countries is shown. Puerto Rico shows a tremendous rise in economic growth from 1991 to 2018. It is due to its knowledge economy consuming advanced machinery in their production and more driven to invention and creativity of industrial output, agricultural production, services, and wise promulgation of economic policies. Peru, Venezuela, and Uruguay also show an upward trend in terms of economic growth. It is due to the coherent and robust economic measures to fuel their economies. However, the rest of the countries such as Bolivia, Dominican Republic, Haiti, Paraguay, Chile, Ecuador, Honduras, Costa Rica, El Salvador, Cuba, Guatemala, and Panama demonstrated nearly parallel economic growth, which reflects their economic quantity and amount.

METHODOLOGY OF THE PAPER

Data and Variables

We collected data from the WDI data stream for the analysis of this study. We used data span from 1991 to 2018. We collected data of two regions i.e., Southeast Asia and Latin American, and dropped these in two panels. Panel A consists of Southeast Asian Countries (Cambodia, Indonesia, Lao PDR, Malaysia, Philippines, Singapore, Thailand, and Vietnam). Whereas, Latin America, panel B, consists of various countries, namely, Bolivia, Chile, Costa Rica, Cuba, Dominican Republic, Ecuador, El Salvador, Guatemala, Haiti, Honduras, Nicaragua, Panama, Paraguay, Peru, Puerto Rico, Uruguay, and Venezuela.

We collected the data of trade liberalization, CO_2 emissions, energy consumption, and economic growth to conduct empirical analysis for hypothesis testing. We denote T, for trade liberalization, which measured % of GDP. The same

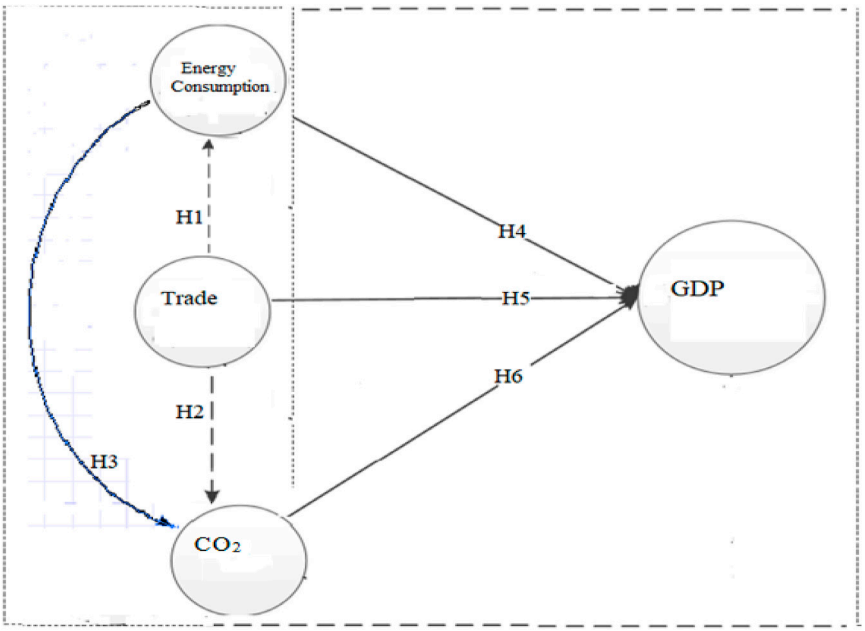

FIGURE 9 | Conceptual model of the study.

measurement approach has been used by previous researchers (Aye and Edoja, 2017; Ben Jebli and Hadhri, 2018; Ullah et al., 2019b). We use E, for energy consumption, measured in % of total final energy consumption, in the spirit of previous studies (Aye and Edoja, 2017; Ullah et al., 2019b; Zeeshan et al., 2021a), and CO_2, for carbon dioxide emission, which is measured as metric tons per capita (Hanle et al., 2004; Shi et al., 2019, whereas economic growth is measured in US dollars (Heidari et al., 2015; Aye and Edoja, 2017; Ben Jebli and Hadhri, 2018).

Emperical Model

We have developed the following model and we estimated the following model, which covers our underline hypothesis.

Estimation Techniques

Various estimation techniques have been used to analyze data of different panels in numerous fields across the globe. However, very few studies available on OLS, GLS (fixed effect and random effect), panel unit root, panel ARDL, GMM, pooled OLS, and SEM. The SEM is the modern-day technique widely used in panel data and cross-sectional data analysis to provide robust and accurate results for various variables, dependent on each other, showing inter-relationship with each other. The importance of SEM in data analysis has been pointed by various researchers. In this regard, Fan et al. (2016) considered SEM, as a strong multivariate technique being used in various scientific investigations to comprehend and evaluate the causal structural relationships. It is a unique estimator, as, at the same time, it finds out direct, indirect, and total effects of the causal relationship. Byrne (1998) argued that SEM is an appropriate and robust model and clearly resolved the structural relationship of the variables in a single attempt approach. Rehman et al. (2021) also highlighted the significant contribution of SEM in structural relationship of the variables. Likewise, Hair et al. (2006) justified the appropriateness of SEM as a fit estimator when a researcher determines a structural relationship among various variables. Bryan (1990) also confirmed the reliability of SEM in the time when it delivers better fit indices. On the basis of the aforementioned justification, hence, we applied SEM approach to conduct the data analysis to comprehend the inter relationship of trade, CO_2 emissions, energy consumption, and economic growth in these regions (**Figure 9**).

EMPIRICAL ANALYSIS

Diagnostic Tests

We performed various data diagnostic tests to validate the data and declare its suitability for further statistical estimation techniques. We applied Wooldridge test to know the serial correlation in the data. In this regard, we performed a separate test on each panel, and, in both cases, the reported values of the test are Prob > F = 0.087, for panel A, and Prob > F = 0.093, for panel B. These values show that there is no autocorrelation in the data and the data is free from such problem. Further, it provides signal for statistical tools to be used. We also conducted Breusch–Pagan/Cook–Weisberg test for heteroscedasticity and treated both samples separately for understanding the problem of heteroscedasticity in the data. We obtained Prob > chi2 = 0.0890, for panel A, and Prob > chi2 = 0.0760, for panel B. The results confirm that there is no existence of hetero problems in the data.

Correlation Analysis of Southeast Asian Countries' Panel

Table 1 shows the correlation analysis of Southeast Asian Countries for the observed correlation of various variables used in this study. The

TABLE 1 | Correlation SEAC panel.

Variables	CO_2	T	E	GDP
CO_2	1			
T	0.609	1		
E	0.601	0.563	1	
GDP	0.225	0.619	0.077	1

TABLE 2 | Southeast Asian countries: Goodness of fit measure.

CMIN	RMSEA	RMR	GFI	TLI	CFI	NEI
138.23	0.061	0.034	0.92	0.93	0.95	0.92

TABLE 3 | Regression weight SEA region.

Regression path			Estimate	S.E.	T.V.	P.V.
T	→	E	0.663	0.015	13.232	0.000
T	→	CO_2	0.495	0.002	11.785	0.000
E	→	CO_2	0.473	0.006	11.262	0.000
T	→	GDP	0.673	8.669	10.479	0.000
E	→	GDP	0.038	28.585	0.602	0.547
CO_2	→	GDP	0.211	268.819	2.621	0.009

results demonstrate a strong and positive correlation between trade and CO_2 in the Southeast Asian panel. Similarly, trade also shows a positive strong correlation with energy and GDP (Trade with Energy, $r = 0.563$, $p < 0.01$, and Trade with GDP, $r = 0.619$, $p < 0.01$). CO_2 shows a positive strong correlation with energy consumption and a positive weak, moderate correlation with GDP (Cohen, 1988). However, energy shows a positive but insignificant correlation with GDP ($r = 0.077$, $p > 0.01$).

Goodness of Fit Measures

Table 2 shows the goodness of fit measures for the structural model for Southeast Asian countries, various variables relationship. The reported value of root mean square error of approximation (RMSEA) is 0.061, which is an acceptable level for the fitness of the model, as Hair et al. (2006) suggested the acceptable value of RMSEA as 0.08 or less. RMR also shows the feasible level of value, as lower than 0.05, is a good fit as for as model fitness is concerned. Hair et al. (2006) recommended ≥0.90 for concerned CFI, NFI, GFI, and TLI. However, the observed values of the model are above the threshold, suggesting that the model is fit.

Regression Weights/Path Analysis for Testing Hypothesis

Table 3 depicts the regression path of different variables on one another, generated through SEM, for the hypothesis testing. The results demonstrate that trade has a positive and statistically significant effect on energy consumption ($p < 0.05$), CO_2 emissions ($p < 0.05$), and GDP ($p < 0.05$). Energy consumption also exhibits a significant positive effect on CO_2 emissions in the Southeast Asian region. Whereas, energy consumption shows a positive but statistically insignificant effect on the GDP of the countries in the Southeast Asian belt. The results also predict a significant positive impact of CO_2 emissions on GDP in this region.

TABLE 4 | Correlation Latin American panel.

Variables	CO_2	T	E	GDP
CO_2	1			
T	0.342	1		
E	0.591	0.069	1	
GDP	0.315	0.419	0.664	1

TABLE 5 | Latin American: Goodness of fit measure.

CMIN	RMSEA	RMR	GFI	TLI	CFI	NEI
115.53	0.073	0.042	0.91	0.92	0.94	0.9

Correlation Analysis of Latin American Countries' Panel

Table 4 shows the correlation analysis of Latin American countries. The reported correlation depicts the relationship of various variables. The results predict a strong and positive correlation between trade and CO_2 emissions in these countries' panel. Likewise, trade also shows a strong positive correlation with GDP (trade with GDP, $r = 0.419$). However, trade shows a positive but weak correlation with energy consumption. CO_2 reports a strong correlation with energy consumption and a moderate correlation with GDP (Cohen, 1988). In contrast, energy shows a positive and strong correlation with GDP.

Goodness of Fit Measures

Table 5 shows the goodness of fit measures for the structural model for Latin American countries, various variables relationship. The reported value of the RMSEA is 0.068, which stands valid for the fitness of the model, as Hair et al. (2006), in their research, recommended that the acceptable value of RMSEA is less than 0.08. RMR also shows a value lower than 0.05, which shows a good fit for the fitness of the model. Hair et al. (2006) recommended ≥0.90 for various indices, i.e., CFI, NFI, GFI, and TLI. However, the observed values of the model are above the threshold, suggesting that the model is fit.

Regression Weights/Path Coefficients for Testing Hypothesis

Table 6 portrays the path analysis of SEM, explaining the impact of one variable on another in the context of Latin American countries. The results demonstrate that trade liberalization has a positive but statistically insignificant effect on energy consumption. The results of our study align with many previous studies, showing the positive nexus between trade and energy consumption (Baek and Kim, 2013; Al-mulali and Sheau-Ting, 2014; Seker et al., 2015). Likewise, trade

TABLE 6 | Regression weights for Latin American region.

Regression path			Estimate	S.E.	T. V	P. V
T	→	E	0.066	0.034	1.459	0.145
T	→	CO_2	0.202	0.002	5.597	0.000
E	→	CO_2	0.581	0.002	16.115	0.000
T	→	GDP	0.204	7.473	5.287	0.000
E	→	GDP	0.418	12.026	9.062	0.000
CO_2	→	GDP	0.157	177.167	3.363	0.000

shows a positive but statistically significant effect on CO_2 and GDP in the context of the Latin American region. Exploring the nexus of similar variables, Muhammad (2019) and Shakeel et al. (2013) validated the positive nexus of trade with carbon dioxide emission and GDP. Energy consumption also shows a positive statistically significant effect on CO_2 emissions and GDP in Latin American countries. The same kind of nexus of these variables has been featured by previous studies (Shakeel et al., 2013; Ozcan et al., 2020). Although, energy consumption indicating a positive and statistically insignificant effect on the GDP of the countries in the Latin American region. The outcomes also predict a significant positive effect of CO_2 emissions on GDP in these countries. Shakeel et al. (2013) and Muhammad (2019) validated the positive nexus between CO_2 emissions and GDP.

CONCLUSION

Trade liberalization has been adopted in both Latin American and Southeast Asian countries, which significantly contributed to the development in those regions. Besides, trade liberalization has been found as a key determinant of environmental quality, which significantly contributing to CO_2 emissions, energy consumption, and economic growth in any country. Therefore, this study investigates the nexus between trade liberalization, CO_2 emissions, energy consumption, and economic growth in Southeast Asian countries and Latin American Countries for the period of 1991 to 2018. We applied SEM, which is a strong sophisticated estimation technique that provides better statistical results as compared to the conventional estimation techniques. Moreover, SEM is considered as a suitable estimation method, especially when variables are determined to affect each other. The empirical results confirmed that trade has a positive and statistically significant effect on energy consumption, CO_2 emissions, and GDP in southeast countries, and it implies that trade expansion results in a high level of energy consumption, CO_2 emissions, and GDP. The results are in line with many previous studies Muhammad (2019) Shakeel et al. (2013). However, in the context of Latin American countries, trade openness shows a positive but statistically insignificant effect on energy consumption, but the coefficients for both CO_2 and GDP are statistically significant. Energy consumption also exhibited a positive significant effect on CO_2 emissions, but the GDP coefficient is insignificant in Southeast Asian countries. The results of this study confirmed the previous studies' findings such as Ozcan et al. (2020) and Shakeel et al. (2013), who predict similar results. However, our results in the context of Latin American countries demonstrated a positive and significant effect on energy consumption in both CO_2 emissions and GDP. The results also predicted a positive significant effect of CO_2 emissions on GDP in both regions. A similar relationship of these variables was registered in many previous studies (Ameyaw and Yao, 2018; Hasson and Masih, 2017).

The study has some policy suggestions; the Southeast Asian and Latin American countries should mitigate the CO_2 emissions by levying specific taxes for CO_2 reduction and robust trade liberalization strategies. The governments in these regions should have a special focus on those industries that significantly contribute to CO_2 emissions and adopt green technologies in the production and export sector. Moreover, governments in both regions should encourage the use of green technologies by providing special incentives and loan provisions at favorable rates to those industries driven toward the use of environment-friendly technologies. Governments in these regions should implement regulations that will support those industries that emit fewer amounts of CO_2 emissions. These policy frameworks will not only decrease CO_2 emissions but will assist in achieving sustainable development goals of numerous countries in these regions.

Moreover, the countries should encourage green energy to make the environment health friendly, which will help in improving the labor productivity and long-term development. Future studies can be conducted to extend the literature by analyzing these variables using cases of various regions, i.e., SAARC, MENA, GULF, BRICS, Middle East, and Sub-Saharan countries. In future studies, assessing moderating and mediating variables is also suggested to conduct a unique robust study.

DATA AVAILABILITY STATEMENT

The datasets presented in this study can be found in online repositories. The names of the repository/repositories and accession number(s) can be found at https://databank.worldbank.org/source/world-development-indicators.

AUTHOR CONTRIBUTIONS

MZ: visualization, data curation, and writing the original draft. JH: writing review, conceptualization, data curation, and editing. AR: methodology, visualization, supervision, and editing. IU: review and editing. FA: writing review and editing and software. ZF: review writing and proofreading of the whole draft.

FUNDING

National Social Science Fund Project (18BJL032).

ACKNOWLEDGMENTS

I would like to extend my appreciation to my supervisor JH for his help and supervision in making sure this work has been carried out in a timely and appropriate method.

REFERENCES

Ahmad, M., Li, H., Anser, M. K., Rehman, A., Fareed, Z., Yan, Q., et al. (2021). Are the Intensity of Energy Use, Land Agglomeration, CO2 Emissions, and Economic Progress Dynamically Interlinked across Development Levels? *Energ. Environ.* 32 (4), 690–721. doi:10.1177/0958305x20949471

Al-mulali, U., and Sheau-Ting, L. (2014). Econometric Analysis of Trade, Exports, Imports, Energy Consumption and CO2 Emission in Six Regions. *Renew. Sust. Energ. Rev.* 33, 484–498. doi:10.1016/j.rser.2014.02.010

Al-Mulali, U., Solarin, S. A., and Ozturk, I. (2016). Investigating the Presence of the Environmental Kuznets Curve (EKC) Hypothesis in Kenya: an Autoregressive Distributed Lag (ARDL) Approach. *Nat. Hazards* 80 (3), 1729–1747. doi:10.1007/s11069-015-2050-x

Ameyaw, B., and Yao, L. (2018). Analyzing the Impact of GDP on CO2 Emissions and Forecasting Africa's Total CO2 Emissions with Non-Assumption Driven Bidirectional Long Short-Term Memory. *Sustainability* 10 (9), 3110. doi:10.3390/su10093110

Antweiler, W., Copeland, B. R., and Taylor, M. S. (2001). Is Free Trade Good for the Environment? *Am. Econ. Rev.* 91 (4), 877–908. doi:10.1257/aer.91.4.877

Apergis, N. (2016). Environmental Kuznets Curves: New Evidence on Both Panel and Country-Level CO2 Emissions. *Energ. Econ.* 54, 263–271. doi:10.1016/j.eneco.2015.12.007

Apergis, N., and Payne, J. E. (2009). CO2 Emissions, Energy Usage, and Output in Central America. *Energy Policy* 37 (8), 3282–3286. doi:10.1016/j.enpol.2009.03.048

Apergis, N., Payne, J. E., Menyah, K., and Wolde-Rufael, Y. (2010). On the Causal Dynamics between Emissions, Nuclear Energy, Renewable Energy, and Economic Growth. *Ecol. Econ.* 69 (11), 2255–2260. doi:10.1016/j.ecolecon.2010.06.014

Aqeel, A., and Butt, M. S. (2001). The Relationship between Energy Consumption and Economic Growth in Pakistan. *sia-Pacific Dev. J.* 8 (2), 101–110.

Arouri, M. E. H., Ben Youssef, A., M'henni, H., and Rault, C. (2012). Energy Consumption, Economic Growth and CO2 Emissions in Middle East and North African Countries. *Energy policy* 45, 342–349. doi:10.1016/j.enpol.2012.02.042

Awokuse, T. O. (2008). Trade Openness and Economic Growth: Is Growth export-led or Import-Led? *Appl. Econ.* 40 (2), 161–173. doi:10.1080/00036840600749490

Aye, G. C., and Edoja, P. E. (2017). Effect of Economic Growth on CO2 Emission in Developing Countries: Evidence from a Dynamic Panel Threshold Model. *Cogent Econ. Finance* 5 (1), 1379239. doi:10.1080/23322039.2017.1379239

Baek, J., and Kim, H. S. (2013). Is Economic Growth Good or Bad for the Environment? Empirical Evidence from Korea. *Energ. Econ.* 36, 744–749. doi:10.1016/j.eneco.2012.11.020

Ben Jebli, M., and Hadhri, W. (2018). The Dynamic Causal Links between CO2emissions from Transport, Real GDP, Energy Use and International Tourism. *Int. J. Sust. Dev. World Ecol.* 25 (6), 568–577. doi:10.1080/13504509.2018.1434572

Bryan, J. (1990). International Status of thermal Error Research (1990). *CIRP Ann.* 39 (2), 645–656. doi:10.1016/s0007-8506(07)63001-7

Byrne, B. M. (1998). *Structural Equation Modeling with LISREL, PRELIS, and SIMPLIS*. London: Lawrence Erlbaum Associates Publishers.

Cohen, J. (1988). Set Correlation and Contingency Tables. *Appl. Psychol. Meas.* 12 (4), 425–434. doi:10.1177/014662168801200410

Cole, M. A. (2006). Does Trade Liberalization Increase National Energy Use? *Econ. Lett.* 92 (1), 108–112. doi:10.1016/j.econlet.2006.01.018

Coondoo, D., and Dinda, S. (2008). Carbon Dioxide Emission and Income: A Temporal Analysis of Cross-Country Distributional Patterns. *Ecol. Econ.* 65 (2), 375–385. doi:10.1016/j.ecolecon.2007.07.001

Coondoo, D., and Dinda, S. (2002). Causality between Income and Emission: a Country Group-specific Econometric Analysis. *Ecol. Econ.* 40 (3), 351–367. doi:10.1016/s0921-8009(01)00280-4

Copeland, B. R., and Taylor, M. S. (1997). The Trade-Induced Degradation Hypothesis. *Resource Energ. Econ.* 19 (4), 321–344. doi:10.1016/s0928-7655(97)00015-8

Copeland, B. R., and Taylor, M. S. (2004). Trade, Growth, and the Environment. *J. Econ. Lit.* 42 (1), 7–71. doi:10.1257/.42.1.7

Doney, S., Balch, W., Fabry, V., and Feely, R. (2009). Ocean Acidification: a Critical Emerging Problem for the Ocean Sciences. *Oceanog.* 22 (4), 16–25. doi:10.5670/oceanog.2009.93

Fan, Y., Chen, J., Shirkey, G., John, R., Wu, S. R., Park, H., et al. (2016). Applications of Structural Equation Modeling (SEM) in Ecological Studies: an Updated Review. *Ecol. Process.* 5 (1), 19. doi:10.1186/s13717-016-0063-3

Frankel, J. A. (2009). *Environmental Effects of International Trade*. Cambridge, USA: HKS Faculty Research Working Paper Series.

Frankel, J., and Rose, A. (2002). An Estimate of the Effect of Common Currencies on Trade and Income. *Q. J. Econ.* 117 (2), 437–466. doi:10.1162/003355302753650292

Greenaway, D., Morgan, W., and Wright, P. (2002). Trade Liberalisation and Growth in Developing Countries. *J. Dev. Econ.* 67 (1), 229–244. doi:10.1016/s0304-3878(01)00185-7

Grossman, G. M., and Helpman, E. (1991). Trade, Knowledge Spillovers, and Growth. *Eur. Econ. Rev.* 35 (2-3), 517–526. doi:10.1016/0014-2921(91)90153-a

Grossman, G. M., and Krueger, A. B. (1995). Economic Growth and the Environment. *Q. J. Econ.* 110 (2), 353–377. doi:10.2307/2118443

Grossman, G. M., and Krueger, A. B. (1991). *Environmental Impacts of a North American Free Trade Agreement (0898-2937)*. Cambridge, USA: National Bureau of Economic Research.

Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E., and Tatham, R. L. (2006). *Multivariate Data Analysis*, 6. Upper Saddle River, NJ: Pearson Prentice Hall.

Halicioglu, F. (2009). An Econometric Study of CO2 Emissions, Energy Consumption, Income and Foreign Trade in Turkey. *Energy Policy* 37 (3), 1156–1164. doi:10.1016/j.enpol.2008.11.012

Halicioglu, F. (2007). *The Financial Development and Economic Growth Nexus for Turkey*. München: University Library of Munich.

Hanle, L. J., Jayaraman, K. R., and Smith, J. S. (2004). *CO2 Emissions Profile of the US Cement Industry*. Washington DC: Environmental Protection Agency.

Hasson, A., and Masih, M. (2017). *Energy Consumption, Trade Openness, Economic Growth, Carbon Dioxide Emissions and Electricity Consumption: Evidence from South Africa Based on ARDL*. München: University Library of Munich.

Heidari, H., Turan Katircioğlu, S., and Saeidpour, L. (2015). Economic Growth, CO2 Emissions, and Energy Consumption in the Five ASEAN Countries. *Int. J. Electr. Power Energ. Syst.* 64, 785–791. doi:10.1016/j.ijepes.2014.07.081

Ikram, M., Xia, W., Fareed, Z., Shahzad, U., and Rafique, M. Z. (2021). Exploring the Nexus between Economic Complexity, Economic Growth and Ecological Footprint: Contextual Evidences from Japan. *Sustainable Energ. Tech. Assessments* 47, 101460. doi:10.1016/j.seta.2021.101460

Jammazi, R., and Aloui, C. (2015). *RETRACTED: On the Interplay between Energy Consumption, Economic Growth and CO2 Emission Nexus in the GCC Countries: A Comparative Analysis through Wavelet Approaches*. Amsterdam: Elsevier.

Jaunky, V. C. (2011). The CO 2 Emissions-Income Nexus: Evidence from Rich Countries. *Energy Policy* 39 (3), 1228–1240. doi:10.1016/j.enpol.2010.11.050

Kemal, M. A. (2007). *Fresh Assessment of the Underground Economy and Tax Evasion in Pakistan: Causes, Consequences, and Linkages with the Formal Economy*. München: University Library of Munich.

Khan, M. A., Qayyum, A., and Ghani, E. (2006). Trade Liberalisation, Financial Sector Reforms, and Growth. *Pdr* 45, 711–731. doi:10.30541/v45i4iipp.711-731

Kraft, J., and Kraft, A. (1978). On the Relationship between Energy and GNP. *J. Energ. Dev.* 3, 401–403.

Kumar Narayan, P., Narayan, S., and Popp, S. (2010). Energy Consumption at the State Level: the Unit Root Null Hypothesis from Australia. *Appl. Energ.* 87 (6), 1953–1962. doi:10.1016/j.apenergy.2009.10.022

Lee, C.-C. (2005). Energy Consumption and GDP in Developing Countries: a Cointegrated Panel Analysis. *Energ. Econ.* 27 (3), 415–427. doi:10.1016/j.eneco.2005.03.003

Lee, C.-C., and Lee, J.-D. (2009). Income and CO2 Emissions: Evidence from Panel Unit Root and Cointegration Tests. *Energy policy* 37 (2), 413–423. doi:10.1016/j.enpol.2008.09.053

Menegaki, A. N. (2011). Growth and Renewable Energy in Europe: a Random Effect Model with Evidence for Neutrality Hypothesis. *Energ. Econ.* 33 (2), 257–263. doi:10.1016/j.eneco.2010.10.004

Menyah, K., and Wolde-Rufael, Y. (2010). Energy Consumption, Pollutant Emissions and Economic Growth in South Africa. *Energ. Econ.* 32 (6), 1374–1382. doi:10.1016/j.eneco.2010.08.002

Muhammad, B. (2019). Energy Consumption, CO2 Emissions and Economic Growth in Developed, Emerging and Middle East and North Africa Countries. *Energy* 179, 232–245. doi:10.1016/j.energy.2019.03.126

Noor, S., and Siddiqi, M. (2010). Energy Consumption and Economic Growth in South Asian Countries: a Co-integrated Panel Analysis. *Int. J. Hum. Soc. Sci.* 5 (14), 921–926. doi:10.26710/reads.v3i1.163

Omri, A., Daly, S., Rault, C., and Chaibi, A. (2015). Financial Development, Environmental Quality, Trade and Economic Growth: What Causes what in MENA Countries. *Energ. Econ.* 48, 242–252. doi:10.1016/j.eneco.2015.01.008

Ozcan, B., Tzeremes, P. G., and Tzeremes, N. G. (2020). Energy Consumption, Economic Growth and Environmental Degradation in OECD Countries. *Econ. Model.* 84, 203–213. doi:10.1016/j.econmod.2019.04.010

Ozturk, I., and Acaravci, A. (2010). CO2 Emissions, Energy Consumption and Economic Growth in Turkey. *Renew. Sust. Energ. Rev.* 14 (9), 3220–3225. doi:10.1016/j.rser.2010.07.005

Pao, H.-T., and Tsai, C.-M. (2010). CO2 Emissions, Energy Consumption and Economic Growth in BRIC Countries. *Energy policy* 38 (12), 7850–7860. doi:10.1016/j.enpol.2010.08.045

Paul, S., and Bhattacharya, R. N. (2004). Causality between Energy Consumption and Economic Growth in India: a Note on Conflicting Results. *Energ. Econ.* 26 (6), 977–983. doi:10.1016/j.eneco.2004.07.002

Pirlogea, C., and Cicea, C. (2012). Econometric Perspective of the Energy Consumption and Economic Growth Relation in European Union. *Renew. Sust. Energ. Rev.* 16 (8), 5718–5726. doi:10.1016/j.rser.2012.06.010

Redding, S., and Venables, A. J. (2002). The Economics of Isolation and Distance. *Nordic J. Polit. Economy* 28, 93–108.

Rehman, A., Ullah, I., Afridi, F. E. A., Ullah, Z., Zeeshan, M., Hussain, A., and Rahman, H. U. (2021). Adoption of Green Banking Practices and Environmental Performance in Pakistan: A Demonstration of Structural Equation Modelling. *Environment, Development and Sustainability* 23 (9), 13200–13220.

Rock, M., and Angel, D. (2007). Grow First, Industrial Transformation in East Asia. *Environment* 49 (4), 10–19. doi:10.3200/envt.49.4.8-19

Saboori, B., and Sulaiman, J. (2013). CO2 Emissions, Energy Consumption and Economic Growth in Association of Southeast Asian Nations (ASEAN) Countries: A Cointegration Approach. *Energy* 55, 813–822. doi:10.1016/j.energy.2013.04.038

Salahuddin, M., Gow, J., and Ozturk, I. (2015). Is the Long-Run Relationship between Economic Growth, Electricity Consumption, Carbon Dioxide Emissions and Financial Development in Gulf Cooperation Council Countries Robust? *Renew. Sust. Energ. Rev.* 51, 317–326. doi:10.1016/j.rser.2015.06.005

Seker, F., Ertugrul, H. M., and Cetin, M. (2015). The Impact of Foreign Direct Investment on Environmental Quality: a Bounds Testing and Causality Analysis for Turkey. *Renew. Sust. Energ. Rev.* 52, 347–356. doi:10.1016/j.rser.2015.07.118

Seldon, T., and Song, D. (1994). Environmental Quality and Development: Is There a Kuznets Curve for Air Ž. Pollution. *J. Eniron. Econom. Manage.* 27, 147162.

Shafiq, M., Hassan, A., and Ahmad, S. (1994). Soil Physical Properties as Influenced by Induced Compaction under Laboratory and Field Conditions. *Soil Tillage Res.* 29 (1), 13–22. doi:10.1016/0167-1987(94)90098-1

Shahbaz, M., Hye, Q. M. A., Tiwari, A. K., and Leitão, N. C. (2013). Economic Growth, Energy Consumption, Financial Development, International Trade and CO2 Emissions in Indonesia. *Renew. Sust. Energ. Rev.* 25, 109–121. doi:10.1016/j.rser.2013.04.009

Shahzad, U., Fareed, Z., Shahzad, F., and Shahzad, K. (2021). Investigating the Nexus between Economic Complexity, Energy Consumption and Ecological Footprint for the United States: New Insights from Quantile Methods. *J. Clean. Prod.* 279, 123806. doi:10.1016/j.jclepro.2020.123806

Shakeel, M., Iqbal, M., and Majeed, M. T. (2013). *Energy Consumption, Trade and GDP: A Case Study of South Asian Countries*. München: University Library of Munich.

Sheinbaum-Pardo, C., Mora-Pérez, S., and Robles-Morales, G. (2012). Decomposition of Energy Consumption and CO2 Emissions in Mexican Manufacturing Industries: Trends between 1990 and 2008. *Energ. Sust. Dev.* 16 (1), 57–67. doi:10.1016/j.esd.2011.08.003

Shi, H., Li, X., Zhang, H., Liu, X., Li, T., and Zhong, Z. (2019). Global Difference in the Relationships between Tourism, Economic Growth, CO2 Emissions, and Primary Energy Consumption. *Curr. Issues Tourism* 23, 1122–1137. doi:10.1080/13683500.2019.1588864

Solarin, S. A., Al-Mulali, U., and Ozturk, I. (2017). Validating the Environmental Kuznets Curve Hypothesis in India and China: The Role of Hydroelectricity Consumption. *Renew. Sust. Energ. Rev.* 80, 1578–1587. doi:10.1016/j.rser.2017.07.028

Ullah, I., Ali, S., Shah, M. H., Yasim, F., Rehman, A., and Al-Ghazali, B. M. (2019a). Linkages between Trade, CO2 Emissions and Healthcare Spending in China. *Ijerph* 16 (21), 4298. doi:10.3390/ijerph16214298

Ullah, I., Rehman, A., Khan, F. U., Shah, M. H., and Khan, F. (2019b). Nexus between Trade, CO2 Emissions, Renewable Energy, and Health Expenditure in Pakistan. *Int. J. Health Plann.* 35, 818–831. doi:10.1002/hpm.2912

Wacziarg, R. (2001). *Structural Convergence. Manuscript*. Stanford, CA: Stanford University.

Zeeshan, M., Han, J., Alam Rehman, H. B., Farooq, N., Waseem, M., Hussain, A., et al. (2021a). Nexus between Foreign Direct Investment, Energy Consumption, Natural Resource, and Economic Growth in Latin American Countries. *Int. J. Energ. Econ. Pol.* 11 (1), 407–416. doi:10.32479/ijeep.10255

Zeeshan, M., Han, J., Rehman, A., Ullah, I., and Alam Afridi, F. E. (2021b). Exploring Determinants of Financial System and Environmental Quality in High-Income Developed Countries of the World: the Demonstration of Robust Penal Data Estimation Techniques. *Environ. Sci. Pollut. Res.* 28 (43), 61665–61680. doi:10.1007/s11356-021-15105-9

Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's Note: All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations or those of the publisher, the editors, and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.