RESEARCH ARTICLE

A study of energy investment and environmental sustainability nexus in China: a bootstrap replications analysis

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Abstract
Environmental sustainability is increasing emphasis on global environmental concerns at the forefront of public policy debate. This paper investigates the relationship between energy investments and environmental sustainability in China from 1980 to 2018 while considering the moderating effect of international trade and economic growth under the environment Kuznets curve (EKC) framework. We apply advanced econometric modeling for empirical analysis. Our findings show that energy investment and economic growth are positive, while international trade is negatively associated with ecological footprints. Moreover, economic growth and energy investment deteriorate, while international trade improves environmental sustainability. This empirical evidence suggests the improvements in cleaner energy infrastructure with the participation of the private sector to promote clean energy investment. We argue that policymakers should ensure environmental provisions in the regional and bilateral trade agreements to harmonize the environmental regulations, and develop crucial trade and ecological policy indicators to monitor policy consistency.

Introduction

Humanity's survival is highly dependent on the health of the physical environment of the planet (Khan et al. 2021b).

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According to World Health Organization (2016), around 24% of global deaths are caused by violations of environmental protocols. People required fresh water to drink, clean air to breathe, and places to live free of toxic substances and hazards through sustainable environmental practices to secure future growth potentials and help build prosperous communities (Goodland and Rockfeller 2019). The ecological footprint is a strategy advanced by the Global Footprint Network (2020) to quantify human requirements on natural capital — the number of natural resources required for an individual or an economy (Khan et al. 2021c). It tracks this requirement through an ecological accounting system. The records contrast the biologically beneficial region individual utilize to the biologically productive area accessible inside a region. Global Footprint Network assessed that, in early 2014, per capita, world footprint was 2.8 gha, while world biocapacity reported was 1.7 gha per capita. The ecological footprint exceeded the earth's biocapacity by 1.1 gha, which means humankind has been using natural capital at a much larger pace than the earth can restore (Lin et al. 2018). Ecological footprint anthropogenic effect (Gyamf et al. 2021) is broadly used to assess environmental sustainability (Khan et al. 2021b). It helps individuals and economies measure and deal with the utilization of natural capital.

Rees (1992) presented the basic ecological footprint concept, which latterly improved (Rees and Wackernagel 1996). According to Global Footprint Network (2016), ecological footprint measures six kinds of productive land, including croplands, forest lands to produce wood products, grazing lands for animal products, build-up lands for infrastructure and housing, marine grounds for fisheries, and forested lands required to absorb harmful emissions resulting from energy consumption (Zaidi et al. 2019b). The ecological footprint is a solitary indicator that estimates the demand and supply of natural resources on the earth (Zaidi et al. 2019a). Thus, the ecological footprint involves the human impact on the environment and is widely used in the literature to support environmental sustainability assessments (Solarin et al. 2021). We use it as the measure for environmental sustainability in this study.

The first question this study addressed is how much energy investment affects environmental sustainability in China. Energy and environmental issues are highly related and have critical ecological concerns (Ahmad et al. 2021a, b, c). The environmental problems are directly linked with energy production, consumption, investment direction, air pollution, water pollution, climate change, solid waste disposal, and thermal pollution. Air pollutant's harmful emissions from non-renewable energy sources ignition are the significant reason for urban air pollution. Consuming non-renewable energy sources is also the main contributor to greenhouse gas emissions (Hathawayu 1994). In 2017, renewable energy investment accounted for US$ 279.8 billion worldwide, with China's share accounted for US$126.6 billion, about 45% of the global energy investment (UNEP 2018). Chinese government planned to spends US$360 billion on the development of renewable in 2020. The Chinese government needs to invest in renewable energy primarily because it empowers the nation to handle air and water contamination issues and moderate economic and environmental insecurity (Irfan et al. 2021a, b). Diminishing air contamination is an immediate motivation for the Chinese government to encourage renewable energy (Chiu 2021).

Another critical question this study addressed is how China's international trade affects environmental sustainability. The sheer volume of China's global trade growth and its ecological deterioration is unprecedented. The current USA and China trade war has stimulated concerns over the trade-oriented environmental impacts (Lu et al. 2020). In 1995, the volume of China's international trade was US$280.9 billion, accounted about 3% of the world trade. However, in 2018, its total global trade in goods and services climbed to US$ 4.6 trillion, accounted for about 12.4% of the world trade (ChinaPowerProject 2018). On the other side, trade openness is central to eliminating global poverty. Nations tend to support trade openness to grow faster, improve productivity, innovations, and provide more income and opportunities to their

citizens. Economic growth as a result of the expansion of international trade may also straightforwardly affect the climate. Moreover, extensive trade liberalization leads to specialization in pollution-intensive exercises in individual states in environmental policy stringency differences (Baloch et al. 2021) across countries called the pollution-heaven hypothesis (OECD 2020). Global trade-related transport freight accounts for about 30% of all transportation-related CO_2 emissions due to fuel combustion and over 7% of global emissions.

The possible contribution of this study to the present literature is reliant on at least the following frontages. This study significantly contributes to the literature by examining the environmental impact of energy investment through the ecological footprint, as very little literature is available on the subject matter. We incorporate international trade into the analytical structure of driving aspects of emissions inequality in China. In China, the emission trading framework is not entirely executed; the degree and direction of international trade have become a significant measure to manage the regional emission transportation and disparities. We analyzed how China's modified global trade structure will mean future environmental sustainability, and whether trade policy arrangements are allied to accomplish environmental mitigation objectives. This study adopts advanced econometric techniques, structural-break unit-root test, bootstrap replication, and robust autoregressive conditional heteroscedasticity (ML-ARCH) regressions.

The remainder of this paper is outlined as follows. The "Literature review" section presents a literature review to help position the paper. The "Data and model descriptions" section provides data and model descriptions. The "Results and discussion" section presents results and discussion. The "Conclusions and policy recommendations" section provides conclusions and policy recommendations.

Literature review

Investment in clean energy can encounter energy demand and moderate climate issues, and thus the nexus between energy investment and climate change is of great significance (Chen et al. 2021). Yang et al. (2020) analyzed how renewable energy investment affects institutional environmental sustainability in China. They expressed that green credit and governmental subsidies after a certain level may create volatility and impact renewable energy investment negatively. Chen et al. (2021) explored the nexus between climate change shocks and clean energy investment for the selected OECD and non-OECD countries. They demonstrated that climate change on clean energy investment varies with different levels of clean energy investment. Abban and Hasan (2021) studied the determinants of renewable energy investment from the government and political ideology

perspectives. They claimed that developed countries do not recognize renewable energy as an alternative to fossil fuels. Moreover, they expressed that developed countries consider investment in renewable energy as essential for environmental sustainability.

Similarly, Agaton et al. (2020) analyzed the waste to energy investment in the Philippines using a real-options approach. They identified that investment in renewable energy is necessary as delaying investment incurs technological opportunity losses. Zhou et al. (2021) studied the risk priorities of investment projects regarding renewable energy using a fuzzy decision-making approach. They demonstrated that the cost efficiency and effectiveness of organizations are notable factors of renewable energy investment. Goes et al. (2020) analyzed the transport energy investment requirement in Brazil. They concluded that the best alternative to fossil fuels non-renewables might be energy infrastructure and electro-mobility investment. In another study, Ahmad et al. (2021) investigated does energy industry investment is a driver for economic performance in China? They claimed that energy industry investment might serve as a crucial economic performance component in China.

Numerous studies have been conducted on the nexus between economic growth and environmental sustainability, and most of the literature demonstrated the classic tradeoff between economic growth and environmental quality. Also, perception prevails that economic growth due to improved technological advancement can enable a higher output level with the least pollution and social security and promote a sustainable environment (Long and Ji 2019). Kurniawan et al. (2021) analyzed economic growth and environment nexus for 140 countries from 1990 to 2014. They demonstrated a favorable composition and technical effects of the economy, which decouples environmental deprivation from economic growth. Mahjabeen et al. (2020) analyzed the nexus of economic growth and environmental sustainability for D-8 countries. They suggested that renewable and non-renewable energy blended with a gradual transition towards renewable energy sources with the broader implementation of technological advancement policies and procedures. Yang et al. (2020) investigated the decoupling analysis between economic growth, environmental resources, and sustainability in the central plains urban agglomeration from 2004 to 2015. They claimed that economic growth is mainly dependent on the consumption of resources and environmental pollution. Zhang et al. (2021) explored how Pakistan's economic growth interacts with the quality environment. They concluded that economic growth has a strong positive relationship with environmental degradation in both the short and long run, like other developing counties. However,

they confirmed the environmental Kuznets curve (EKC) existence in Pakistan among this crucial relationship.

The modifying nature of global trade has initiated the argument that trade opening can adversely affect the environment (Wada et al. 2021). The ongoing research on the links between international trade and environmental quality addresses the blended results. In a preceding study, Grossman and Krueger (1991) investigated the relationship between trade and ecological sustainability and found that expansion in trade and wages decreases contamination concentration (Khan and Hou 2021a). Another study conducted by Gale and Mendez (1998) contended that trade progression contrarily impacts the natural environment. McAusland and Millimet (2013) developed a theoretical model classifying the international trade moves environmental sustainability. They recognized international trade as more environmentally friendly than international trade because of sturdier decoupling interactions. Du et al. (2020) investigated whether trade liberalization encourages environmental unsustainability using CO_2 emissions. They determined that the impact of trade on the environment be consistent with different income levels.

However, Ankerst (2002) expressed that nations gained from trade openness and argued that trade openness and investment might underwrite degraded environments when countries with low environmental standards raise pollution-intensive actions. Thus, this is the pollution heaven hypothesis dubbed with environmental dumping, determined on several interlinked issues. So, trade and environmental nexus are poorly understood and still how different global bodies and governmental strategies affect the environment through trade policies and patterns. In general, the considered literature has different conclusions; however, a large portion of the literature contends that global trade liberalization invigorates environmental deterioration.

Data and model descriptions

The present study's fundamental objective is to test the relationship between energy investment and environmental sustainability in China from 1980 to 2018 while moderating international trade and economic growth.

$$\text{EFPT}_t = \beta_0 + \beta_1 \text{ENI}_t + \beta_2 \text{IT}_t + \beta_3 \text{GDP}_t + \beta_4 \text{GDP}_t{}^2 + \varepsilon_t \qquad (1)$$

where β_0 in an intercept, β_1 to β_4 reflects the coefficients of the independent variables ENI (energy investment), IT (international trade), GDP (economic growth), and GDP^2 (EKC

hypothesis). EFPT (ecological footprint) is the dependent variable, t reflects the sample time series, which is 1980 to 2018, and ε is the error. The data for ecological footprint was collected from Global Footprint Network (GFN). However, energy investment, international trade, and economic growth data were collected from the World Development Indicators (WDI). Raw data for all the variables have been transformed into the logarithm before the empirical analysis for precise estimations. The ecological footprint is measured as the consumption of gha per capita. Energy investment is estimated as an investment in energy with private participation in the current US\$. Economic growth is taken as GDP per capita annual in annual percentage. However, international trade is measured as the percentage of GDP.

In this study, we used both conventional augmented dickey fuller (ADF) Dicky-Fuller (1997) and advanced Zivot-Andrews (1992) structural breakpoints unit-root tests to confirm our data's stationary properties. Khan and Hou (2021) expressed that with 1929's great crash in the global oil prices, the conventional unit root tests produced become useless as they did not consider the structural breaks during their estimations. In their study, Khan and Hou (2021b) used Zivot-Andrew's (1992) unit root tests by explaining that it adheres to the structural breaks within the time series during the estimations. The conventional Dicky-Fuller's (1997) ADF formed as:

$$\Delta y_t = c + a y_{t-1} + \beta_t + \sum_{j=1}^{k} d_j \Delta y_{t-j} + \varepsilon_t. \tag{2}$$

where, Δy_t is an overtime variation, c, a, and b are hypothesized coefficients, and Δy_{t-j} shows the 1st order differencing elements handled through the serial correlations in the random error.

In this study, we employed the co-integration test presented by Johansen (1991, 1995) due to its composite favorable aspects. Notably, it covers variables endogenously, and it consents to yield more than one co-integrating equations Johansen (1991, 1995). Johansen's (1991, 1995) standard equation formed as:

$$y_t = A_1 y_{t-1} + \ldots + A_p y_{t-p} + \beta x_t + \varepsilon_t \tag{3}$$

where, y_t is non-stationary ^{k}-vector, βx_t is the deterministic trend of ^{d}-vector, and ε_t is vector error.

This study employed bootstrap regression Efron (1979) and Engle's (1982) robust ML autoregressive conditional heteroscedasticity (ML ARCH) generalized error distribution (GED) using Marquardt steps. Bootstrap regression involves random sampling with replacement and disperses accuracy measures using bias, variance, prediction error, confidence interval, etc. (Efron 1979). ARCH designates the modification in the current and innovative error terms

variance with the actual size of the preceding period's error term (Engle 1982).

Results and discussion

Table 1 describes the results of descriptive statistics incorporating principal components and pairwise correlations. The first principal component represents 0.4184% of the total variation, and the second presents 0.2961% of the total. Thus first two components represent over 0.7145% of the total variation. The labeled PC1, PC2, PC3, and PC4 represent the coefficients of the linear combination. Result explains that PC1, PC2, and PC4 have negative loading values, while PC3 has positive loading values for all the variables showing the industry-specific component. These results describe and a handful of measures of the individual health status of the studied variables. There is no significant difference between mean and maximum values, so data have a normal distribution; moreover, standard deviation values are pretty low, representing slight fluctuations within the data set. However, the highest level of changes exists in the energy investment data with the standard deviation value of 0.313155 compared with other variables. Lastly, energy investment and international trade are negatively correlated, while economic growth positively correlates with China's ecological footprint. Overall, these descriptive statistics present a rough and raw behavior of data of the included variables; however, we have incorporated a detailed empirical analysis, thorough discussion, and interrelated functional relationships.

Table 2 describes the results of the conventional ADF unit root test. Result explains that ecological footprint, international trade, and economic growth are not significant and are thus non-stationary. These variables are significant at 1% and 10% levels of significance at the first difference, thus becoming stationary at the first difference. However, energy investment is stationary both at the level and first difference. Table 3 presents the outcome of the second-generation advanced Zivot-Andrews structural break unit root test. Here result explains that ecological footprint and economic growth are significant at level, thus stationary at level, while energy investment and international trade are first differenced stationary at 1% and 5%. Additionally, structural breaks exist in 2009, 2000, 2011, 2003, 2012, 1997, and 1999, showing the years of economic and policy changes.

Table 4 describes the co-integration test's detailed results to demonstrate the variables' long-run relationships. Results reject the null hypothesis of no co-integration at 1% and 10% significance levels. This finding claims that the study variables are co-integrated have long-run relationships. It moves together in China during the study period.

Table 5 describes the findings of long-run estimates using bootstrap and robust GED ML-ARCH regression. Overall, the

Table 1 Descriptive statistics

Eigenvalues: (sum=4, average=1)	Value	Difference	Proportion	Cumulative Proportion
1	1.673426	0.488895	0.4184	0.4184
2	1.184531	0.222229	0.2961	0.7145
3	0.962302	0.782561	0.2406	0.9551
4	0.179741	---	0.0449	1.0000
	PC 1	PC 2	PC 3	PC 4
EFPT	0.560579	−0.583012	0.109242	0.577853
ENI	−0.232058	−0.103315	0.965236	−0.061592
IT	0.311080	0.802582	0.190805	0.471895
GDP	0.731525	0.072700	0.141344	−0.663029
	EFPT	ENI	IT	GDP
Mean	0.390070	9.265136	0.494862	1.616197
Median	0.388255	9.341830	0.545678	1.595612
Maximum	0.570579	9.774249	0.791472	1.809418
Minimum	0.184584	8.424081	−0.014884	1.385126
Std. dev	0.138872	0.313155	0.207127	0.111793
Jarque-Bera	3.022222	3.266273	4.378458	0.507196
EFPT	1.000000			
ENI	−0.051270	1.000000		
IT	−0.193368	−0.047017	1.000000	
GDP	0.582022	−0.154345	0.419640	1.000000

results demonstrate that energy investment and economic growth are positively associated, while international trade and the square root of economic growth (EKC) are negatively associated with the ecological footprint of China from 1990 to 2018. The variable energy investment is statistically significant at a 10% significance level, and the coefficient value is positive. The positive coefficient value of energy investment demonstrates that a 1% acceleration in the energy investment increases the ecological footprint (degrade environmental sustainability) of China by 0.18418% (bootstrap) and 0.017622% (ML-ARCH). This finding implies that investment and environment implicate international businesses, their interfaces, and their impact on world nature. External funding sources stimulate the increase of innovative ideas surrounding technological advances while also deteriorating the environment

(Šimelyte and Liučvaitiene 2012). Moreover, these findings imply that increased energy investment stimulates industrial SO_2 levels, thus increasing emissions. Kirkulak et al. (2011) expressed that SO_2 emissions are primary sources of air pollution.

The coefficient value of international trade is negative and statistically significant at a 1% level of significance. The negative dynamics between international trade with ecological footprint explore that a 1% increase in international trade may improve environmental sustainability by 0.49499% (bootstrap) and 0.40227% (ML-ARCH). This finding implies that trade liberalization encourages the world to introduce new products, services and adopt technological advancement to mitigate climate change. The rising income levels resulting from trade liberalization push communities to adopt and demand a sustainable environment while lowering greenhouse gas emissions (WTO 2021). Moreover, this finding supports the comparative advantage theory that international trade encourages countries to conserve resources and avoid waste, thereby becoming more efficient in using resources (Berlin and Lang 1993). Moreover, this finding suggested that international trade exposed the leading importers' environmental requirements and brought changes to meet those requirements, thus stimulating cleaner production and consumption technologies and processes.

Similarly, the coefficient value of economic growth is positive and statistically significant at a 1% significant level. This

Table 2 ADF-unit root test

Variables	Level t Statistic	Prob.	1st difference t Statistic	Prob.
EFPT	−1.438521	0.5486	−6.971608***	0.0000
ENI	−4.715270***	0.0008	−7.820860***	0.0000
IT	−2.569424	0.1110	−3.423598*	0.0189
GDP	−2.172828	0.2199	−3.549721*	0.0142

***and* 1% and10% significance

Table 3 Structural-break unit-root test

Variables	t Statistic Level	Chosen breakpoint	Prob.	t Statistic 1st difference	Chosen breakpoint	Prob.
EFPT	−3.359592**	2009	0.0045	−4.801602**	2003	0.0093
ENI	−4.397201	2000	0.1011	−5.187588*	2012	0.0232
IT	−3.521294	2011	0.7269	−6.574179*	1997	0.0647
GDP	−4.506144**	2003	0.0039	−4.614416*	1999	0.0969

**and* 5% and 10% significance

positive association of economic growth and ecological footprint explains that a 1% increase in economic growth may increase the ecological footprint (promotes environmental unsustainability) in China by 17.3829% (bootstrap) and 16.79089% (ML-ARCH). This judgment advocates that economic growth causing in the exhaustion of natural resources and biodiversity damages and carrying capacity of ecological settings. Also, this outcome denotes that deforestation at the expense of growth and development distresses soil and creation land prone to natural disasters. Thus, increased economic growth increases energy and material uses, promoting an unsustainable environment (Khan et al. 2021a, 2021d).

However, the square root of economic growth (EKC) coefficient value demonstrates a negative relationship at a 1% significance level. This negative association validates the existence of the EKC hypothesis for china during the study period. It explains that a 1% further increase in economic growth decreases China's ecological footprint by 5.00926% (bootstrap) and 4.85806% (ML-ARCH). This result suggests that the enlarged discharge of pollutants and intensive and extensive natural resource exploitation in the first phases of economic growth creates environmental pressure while adopting specific production techniques and technologies for the growing economic activities. However, after achieving a certain economic growth level, communities with higher income levels become environmentally concerned and aware of environmental degradation (Tawiah et al. 2021). Research and

development arrangements are directed more toward the green economy (Maneejuk et al. 2020). Moreover, the EKC hypothesis's findings demonstrate that aggregated or sustainable economic growth considers the country's overall economic climate, irrespective of the industrialization role and economic structural changes.

Table 6 describes the findings of pairwise Granger causality tests for ecological footprint, energy investment, international trade, and China's economic growth. The result explains the pairwise unidirectional Granger causality between energy investment and ecological footprint. The unidirectional causality relationship also exists between the ecological footprint and international trade. However, bidirectional pairwise granger causality happens between ecological footprint and energy investment.

Conclusions and policy recommendations

Environmental sustainability is of considerable concern throughout the world. This study examined the relationship between energy investment and environmental sustainability in China from 1980 to 2018 while moderating international trade and economic growth. In this study, we employed ecological footprint as a measure of environmental sustainability. The data for ecological footprint was collected from GFN; however, energy investment, international trade, and

Table 4 Co-integration test results

Hypothesized no. of CE(s)	Eigenvalue	Trace statistic	0.05 critical value	Prob.
None***	0.777649	64.32879	47.85613	0.0007
At most 1*	0.409216	23.73431	29.79707	0.0211
At most 2	0.257505	9.524084	15.49471	0.3191
At most 3	0.053520	1.485142	3.841466	0.2230
	Eigenvalue	Max-Eigen statistic	0.05 critical value	Prob.
None***	0.777649	40.59448	27.58434	0.0006
At most 1*	0.409216	14.21023	21.13162	0.0348
At most 2	0.257505	8.038942	14.26460	0.3748
At most 3	0.053520	1.485142	3.841466	0.2230

*** and * 1% and 10% significance

Table 5 Long-run results

Variable	Bootstrap regression				Generalized error distribution (GED) ROBUST ML ARCH regression			
	Coefficients	Std. errors	z statistics	Prob.	Coefficients	Std. errors	z Statistics	Prob.
ENI	0.18418*	0.07088	0.26	0.079	0.017622***	0.003394	5.191	0.0000
IT	−0.49499***	0.063819	−7.76	0.000	−0.40227***	0.032588	−12.34	0.0000
GDP	17.3829***	3.158731	5.50	0.000	16.79089***	0.058525	286.90	0.0000
GDP^2	−5.00926***	0.970988	−5.16	0.000	−4.85806***	0.023275	−208.72	0.0000
Constant	−14.4605***	2.460164	−5.88	0.000	−13.9378***	0.096702	−144.13	0.0000

***and* 1% and 10% significance

economic growth data were collected from the WDI. Raw data for all the variables have been transformed into the logarithm before the empirical analysis to ensure precise estimations. This study adopts the most robust advanced econometric techniques, used structural-break unit-root test, bootstrap, and ML-ARCH regressions for long-run estimates. Overall, the results demonstrate that energy investment and economic growth are positively associated, while international trade and the square root of economic growth (EKC) are negatively associated with the ecological footprint of China. Moreover, international trade improves, while energy investment and economic growth deteriorate environmental sustainability in the long run.

Policy recommendations

The long-run estimates suggest that energy investment deteriorates environmental sustainability. Based on the findings, this study recommends escalating access to clean energy, ornamental investment in clean energy infrastructure, shifting from conventional energy sources to clean energy to achieve clean and green growth and development thresholds. This study recommends clean energy and infrastructure improvement by considering the private business sector participation in the clean energy infrastructure. This study suggests developing a level playing field between private and public investors in the clean energy infrastructure to avoid imperfect competition. Moreover, policymakers are encouraged to price carbon, eliminate fossil fuel subsidies, promote clean energy investment by setting long-term goals, incorporate policy incentives for investment in clean energy infrastructure, license

renewable energy plans, and improve clean energy policy coordination and coherence monitoring (Nathaniel et al. 2021).

The long-run estimates of this study confirm that international trade improves environmental sustainability. Based on the finding, this study suggests implementing rigorous environmental strategies compatible with open trade regimes to create a market for environmental goods, successively being exported to nations that follow environmental standards. The policymakers are encouraged to ensure environmental provisions in the regional and bilateral international trade agreements to harmonize the environmental regulations. Practical institutional framework and environmental policies are needed at the global level to address emerging trade and environment issues, like environment and regional trade agreements (RTAs), the drivers of environmental provisions in RATs, environmental policies stringency as a driver for international trade in goods in environmental goods and services. Moreover, this study recommends developing various trade and environmental policy indicators to monitor progress for more policy consistency and identify policy primacies at the international trade and environment nexus.

The long-run estimates confirm that economic growth deteriorates environmental sustainability and that the EKC hypothesis validates this crucial relationship. Based on the findings, this study supports the strategies approaching the decoupling relationship between economic growth and environmental sustainability. Policymakers are suggested to believe in the green growth plans, integrate economic choices with ecological bindings, and price environmental spillovers. Moreover, this study indicates that economists and environmentalists cut ties between economic goods and environmental evils by uncoupling

Table 6 Pairwise Granger causality tests

	EFPT	ENI	IT	GDP
EFPT	——————	0.02871 (0.8668)	8.83991** (0.0064)	2.99813* (0.0957)
ENI	4.41219* (0.0459)	——————	0.03246 (0.8585)	0.48032 (0.4947)
IT	2.22313 (0.1485)	0.23043 (0.6354)	——————	0.15122 (0.7007)
GDP	25.7864*** (0.0000)	0.33784 (0.5663)	1.60754 (0.2165)	——————

***and* 1% and 10% significance

environmental stresses from economic growth that economies should propagate but not at the expense of environmental destructions (Khan and Hou 2021c).

This research concentrated on the linear environmental impact of energy investment; future research may consider this relationship's non-linear EKC framework. Future studies may also combine education, energy trilemma, and institutions as determinants of environmental sustainability, which is relatively little explored in the present literature. This study is limited in that we only check the environmental sustainability aspect. Future researchers may also incorporate economic growth as a dependent variable and ecological footprint to analyze the dilemma's growth and environment.

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