International Journal of Innovative Research and Scientific Studies, 8(3) 2025, pages: 2312-2325

IJIRSS International Journal of Innovative Research & Scientific Studies

ISSN: 2617-6548

URL: www.ijirss.com

Gauging to explore interlinkages between green and sustainable foreign investment, economic complexity, and environmental performance in Vietnam

Pham Thi Anh Nguyet

Thai Binh University, Thai Binh, Vietnam.

(*Email: phamthianhnguyettbu@gmail.com*)

Abstract

We use a model-free connectedness approach to discover some links among green FDI, economic complexity, CO2 outputs, and energy productivity in Vietnam from 1995 to 2022. Our findings make the correlation between green FDI and economic complexity evident throughout the study. The overall net connectivity displays that green FDI was a primary net recipient of shock waves before 2009 and during the 2019-2022 period, but then turned into a net shock emitter from 2010 to 2015. Economic complexity was the main net receiver of spillover shocks before 2014, but it turned into a net shock transmitter thereafter, except for 2017. Pairwise directional connectivity in the net indicates that green FDI commanded economic complexity throughout the examined period, except for the 2002-2005, 2015-2017, and 2019-2022 periods. The development of economic complexity in Vietnam faces many difficulties when the flow of green FDI decreases.

Keywords: A R2 decomposed linkage method, economic complexity, green FDI; Vietnam.

DOI: 10.53894/ijirss.v8i3.6987
Funding: This study received no specific financial support.
History: Received: 18 March 2025 / **Revised:** 22 April 2025 / **Accepted:** 24 April 2025 / **Published:** 13 May 2025

Competing Interests: The author declares that there are no conflicts of interests regarding the publication of this paper.
Transparency: The author confirms that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.
Publisher: Innovative Research Publishing

1. Introduction

Substantial setbacks in global sustainable development are highlighted in the most recent United Nations assessment on achieving the Sustainable Development Goals (SDGs) in 2022 [1]. The SDG Index has experienced a fall in comparison to 2021, which can be partially ascribed to subpar performance in the areas of “SDG-13 on climate action” and “SDG-15 on conserving biodiversity, terrestrial ecological systems, and arresting the degradation of biodiversity.” The process of unsustainable economic expansion is one of the leading causes of this problem. Large economies heavily depend on natural resources and traditional energy sources to achieve their comprehensive growth goals [2-4]. Due to this dependence, there is a more significant ecological footprint, faster depletion of natural resources, and environmental deterioration. On the other hand, green economic development strategies may lessen the impact of over-exploitation on natural resources, promoting their recovery and a smaller environmental footprint [5-8]. Nevertheless, population growth has resulted in irresponsible use of power, particularly from conventional fuels, which has raised ecological consequences. The literature underscores the crucial role of governments in creating and enforcing economic and environmental policies to reduce the overall rate of environmental degradation and address ecological issues. Despite their attempts to lower energy consumption and carbon emissions, several nations are susceptible to reducing the environmental traces they leave behind.

The most significant worldwide barrier to sustainable development is rising emissions of greenhouse gases. Due to climate change and global warming, a sizable section of the world's population is experiencing a variety of diseases, famine, water scarcity, and flooding [5-8]. The World Health Organization (WHO) estimated that in 2018, about 7 million individuals died prematurely due to air pollution [9]. In recent years, environmental challenges have emerged as key concerns for nations, including pollution, deforestation, resource depletion, and inadequate sanitation. Climate change puts in danger the capital of resources physical, environmental, and health as well as secure food access, water, and land [10-13]. Human health, as well as the economy, are in danger due to poor environmental conditions. Most people would agree that increasing trends in global warming have compelled politicians to use policies to mitigate climate change in order to protect the environment.

In studies of environmental concerns, researchers often use carbon dioxide as a proxy because it constitutes the most significant percentage of greenhouse gases [5-8]. Nevertheless, population growth has resulted in irresponsible use of power, particularly from companies. However, as only a tiny percentage of the environment is made up of carbon emissions and does not sufficiently account for environmental damage, many academics disagree with this approach. CO_2 emissions, in the opinion of Nathaniel et al. [14], do not accurately anticipate the inventory of readily accessible sources, including soil, oil, petroleum, and forests. We require a proxy that can fully account for environmental sustainability, giving decision-makers and other authorities a more thorough understanding of the environment when they have access to the correct data. The ecological footprint is a commonly recognized measure of environmental quality that may be applied to resource management and assessment [15]. The ecological footprint serves as a gauge of how quickly humans are using resources and how waste is being produced compared to how quickly nature can absorb it. The impact of human activities measured in terms of the biologically productive land and water to produce the goods consumed and to assimilate the wastes generated is precisely what it captures [16-18]. It indicates how much natural capital people are willing to pay for. Ecological footprints can be compared at the individual, regional, and global levels. Renewable resources are the primary emphasis of ecological footprints.

Especially in Vietnam, the expansion and sustainability of these economies depend on taking materials from the environment [19, 20]. Natural resources include coal, minerals, oil, gas, and forests. However, natural resource depletion and environmental degradation have a complicated and contradictory relationship. Unlike the findings of Leach et al. [21], Martinez-Harms et al. [22], and Souliotis and Voulvoulis [23], which indicated an unfavorable correlation between natural assets and the surroundings, research proved that the deterioration of the ecosystem is a result of using natural assets [24]. Further research into the relationship between natural resources and the environment's state is crucial for a sustainable environment, as studies examining this relationship have yielded conflicting results. Natural resources are essential for an economy's gross domestic product (GDP). There is a claim that nations ignore their environmental impact while growing and developing and instead use more resources. Yet, when living standards increase, they safeguard their natural resources, implement environmental conservation plans, and prioritize energy-saving goods [19, 25, 26]. Accordingly, natural resources are essential for development and environmental quality and need to be further studied in the context of Vietnam [20, 25, 27].

Renewable energy has a positive effect on ecosystems, as noted by previous studies on the Environmental Kuznets Curve (EKC) [28]. Renewable energy and environmental conservation are prioritized by nations in their climate change adaptation and mitigation strategies. Because they increase the industry's production capability and reliance on more environmentally friendly energy, which lowers energy consumption and industrial emissions, green initiatives are more profitable investments than those made in non-renewable energy sources [29-32]. According to the yearly report 2023 by the Vietnamese Industrial Development, the industrial sector's energy consumption in Vietnam increased from 1.8 to 3.1 over the next 25 years, a 50% increase [20, 25, 27]. In addition, the industrial sector may cut energy intensity by 26%, resulting in a reduction in worldwide energy usage of 8% and a reduction in carbon releases of 12.4%, according to the International Energy Agency's 2020 annual report. Given that the industrial sector is dependent on energy consumption, green manufacturing investments can reduce carbon emissions and promote economic development. Prior studies have overlooked carbon emissions from green investment, even though energy consumption has a major role in manufacturing and is a significant source of economic growth.

This study considers economic complexity as one of the primary determinants, along with knowledge, competency, and progress connected to production. Since the Economic Complexity Index (ECI) is a very accurate and dependable indicator of growth, scientists studying the environment and society have given it much attention in the current economic climate [33, 34]. Future investment and production are accelerated by ECI, which also broadens and diversifies production, resulting in higher energy consumption and pollution levels. Contrarily, economic complexity is better suited to preserve the environment since it prioritizes environmentally friendly products, machinery, research and development, and the employment of cleaner, greener, and renewable technologies [35-37]. Higher energy usage is necessary for the production of complicated items. Other ways to meet this demand include nuclear power, renewable energy, and fossil fuels. The influence of a nation's manufacturing pattern on the environment is evident. Put another way, a product's complexity level could adversely affect the environment by causing pollution and using natural resources. Cities and industries have recently combined to drive remarkable economic growth in the most economically complex countries. As these nations have transitioned from rustic to sophisticated industrialized states, their energy consumption has likewise increased. Thus, these nations are considered significant contributors to GHG emissions, and their ecological footprint will impact the environment globally in the future [33, 34]. An estimated measure of productive knowledge, the ECI conveys a nation's capacity to manufacture and export sophisticated goods. The capacity of a country to generate and export more complicated or higher-value goods is indicated by a higher ECI value. The literature on the ecological footprint has gained substantial and valuable additions to this study.

The hallmark of globalization is the elimination of obstacles to capital flow human and physical as well as goods and services. Based on research, globalization can lead to growth [38-40] since it links economies through commerce, foreign direct investment (FDI), improved resource efficiency, technology transfer, and interaction of human and physical resources. Although the previous works of literature thoroughly investigated the relationship between ecological durability and globalization, experts could not agree on the precise significance that these components contribute to the surroundings. Research [41, 42], for example, looked at how globalization affects environmental performance and concluded that it has a good effect. On the other hand, some research [41] emphasized how globalization negatively impacts the environment; nonetheless, there is ongoing discussion on this subject. It is crucial to differentiate between rising energy use and environmental degradation since globalization significantly promotes growth, and growth necessitates energy consumption. Knowing how the ecological footprint and globalization are related is crucial. Thus, the current study also examines the effects of growth, globalization, and ecological footprint on economies. Notably, scholars have abstracted the determinants and impacts of green FDI inflows into an emerging country like Vietnam.

Considering the negative consequences of ecological deterioration, authorities around the globe are looking for efficient ways to solve the problem through legislation and initiatives. While some affluent countries have already taken adequate steps to lessen these negative consequences, developing nations have not kept up with this pace of the effort. Following Jia et al. [43], Shortage of funding and support is the leading cause of ecological damage in emerging and low-income countries. Therefore, low-income nations, especially emerging markets, have emerged as the main forces behind FDI aimed at reducing the adverse impacts of ecological degradation [44]. This assertion is supported by multiple inquiries, including those conducted in 2017 and 2019 by Saidi and Mbarek [45]; Hanif et al. [46]; Nasir et al. [47]; and Saidi and Mbarek [45]. However, it is uncertain if green FDI contributes to environmental degradation or promotes creativity and economic expansion, which might help to slow down natural damage.

This study fills a research gap previously identified in the literature by examining the connection between green FDI, economic complexity, and environmental sustainability. For example, G7 studies were carried out by Shahzad et al. [48] to investigate the nexus between environmental sustainability and economic complexity in G7 countries. Similar studies have examined the nexus between ecological sustainability and fiscal complexity for various nations and regions. Hassen et al. [49] focused on the USA; Ullah et al. [7] on the BRICS-T countries; Saud and Zeraibi [50] on MENA; Zeraibi and Saud [51] on the BRICS; and Kazemzadeh et al. [52] on emerging nations. Studies that have looked explicitly at this relationship for economically complex countries are conspicuously lacking. To the best of our comprehension, research still needs to address this element; hence, this study attempts to close this gap by examining this problem in Vietnam.

Our work adds four noteworthy pieces to the body of knowledge. First, as was already mentioned, our study is a first attempt to investigate the relationship between ecological concerns, green foreign direct investment, and financial complexity in emerging nations such as Vietnam. Secondly, this study presents a new way to explore how volatility is related across different markets, which makes it an improved technique for these kinds of assessments. Our investigation employs innovative tools, specifically an $R2$ decomposed connective approach, to closely examine the relationships between green FDI and economic complexity. In Vietnam, we utilize yearly time series analysis for these parameters: energy productivity (EP), CO_2 emissions (CO2), economic complexity (EC), and green foreign direct investment (GRFDI). In our analysis, we examined data from 1995 through 2022. The International Trade Center provided the green FDI. Data on CO_2 emissions and the amount of energy consumed, both renewable and non-renewable, were taken from the Our World Data database. Utilizing the statistics, a comprehensive analysis is provided, examining the relationships between the fluctuations stemming from different issues in Vietnam.

Our investigations contribute significantly to current understanding in multiple important fields. First, this investigation expands its viewpoint by evaluating data from a developing country, whereas previous research has typically concentrated on a single nation or a limited group of economies. Second, it is still uncertain whether green FDI makes environmental problems worse or better, in spite of an increasing number of studies supporting this claim. Several investigations, like those by Majeed et al. [53], discovered an advantageous effect, while others, including Muhammad et al. [54] and Muhammad et al. [55], discovered a detrimental effect. Furthermore, our investigation advances the methodology by analyzing the unstudied adjusting effect of financial expansion and growth through FDI on ecological damage [34, 56]. The financial and ecological consequences of green FDI are examined in this study. It is essential to comprehend how green foreign direct investment contributes to the ecological degradation of emerging nations. We have also discovered a tenable mechanism connecting carbon emissions to developing nations' economic growth. The effectiveness of this approach is assessed by employing real data from Vietnam, a common emerging economy. Vietnam is taking action to alleviate ecological harm as a result of warming temperatures, as mentioned by Malik et al. [57].

The structure of this study is as listed below: A succinct overview of pertinent material is given in Section 2. The data and statistical methodologies are explained in Section 3. Experimental outcomes are presented in Section 4, and policy suggestions are provided in Section 5.

2. Literature Review

2.1. Conceptual Framework

When a company invests directly in infrastructure used to manufacture or sell products or services in the recipient nation, it is considered engaging in foreign direct investment (FDI). Usually, investments involve various personnel, data, technology, materials, and financial flows [58]. The type of FDI carried out typically determines the nature of the accompanying flows. The typeface of FDI can be defined based on a number of classification factors (see, for example, [59, 60]); however, the strategic justification for the FDI types [61] typically serves as the foundation for international engagement: resource-seeking FDI is driven by access to labor offer, cheap raw material sources, facility, etc.; market-oriented FDI is primarily focused on entering local markets and is influenced by various aspects such market size, prospective development, regional market structure, etc. Effective FDI searchers seek out new opportunities for competition, economies of scale, or specialisation; strategic FDI seekers, on the other hand, assist the investing company in accomplishing long-term strategic objectives by, among other things, demanding significant assets of overseas companies, such as cutting-edge technology or R&D capacities. According to Meyer [62], certain foreign direct investment (FDI) is explicitly made to use assets purchased overseas to enhance the investor's operations abroad, especially in their home country.

Moreover, research has identified knowledge-seeking foreign direct investment (FDI) as another unique investment. This type is driven by leveraging knowledge to advance technological or business capacities. Within the framework of the European Union, data-seeking foreign direct investment (FDI) is defined as investments made by developing economy enterprises that generate positive knowledge externalities in EU member states [63]. Furthermore, there is FDI linked to safety-seeking, primarily comprised of risk-averse investors from nations facing expropriation. These investors prefer investing in developed, safe nations [64].

In light of the FDI typology described above, current research challenges the status quo by emphasizing investments that support the improvement of society and the environment as well as economic development in host nations while operating within just governance frameworks, Sauvat and Gabor [65]. Singh and Kapuria [66] provided further insight into the sustainability qualities of FDI by conducting an empirical analysis of four dimensions: the financial, environmental, governance, and social elements of environmentally friendly FDI. As far as the writers are aware, the term "sustainability-seeking FDI" has not been defined in any particular way in the published literature, which makes it noteworthy. This could be due to the current emphasis on balancing FDI's environmental, economic, governance, and social features.

2.2. Hypothesis Development

2.2.1. Economic Complexity and the Ecological Footprint

The measure of economic sophistication was utilised extensively in recent years to investigate the relationship between it and the environment in time series research, Pata [67], and panel investigations [14]. Nevertheless, few research works have examined how economic complexity affects ecological footprint metrics. The Appendix (Table 7) contains several pertinent papers to our investigation. Yilanci and Pata's [68] study investigates the applicability of the EKC for China between 1965 and 2016. According to the study, the EKC is invalid in China. Moreover, the environmental footprint in China is negatively impacted by economic complexity, as evidenced by the results of the Fourier ARDL technique. The study highlights how crucial it is to use environmentally friendly production techniques to lessen environmental harm. Similarly, Rafique et al. [34] use rich panel data spanning 38 years to investigate the relationships between environmental footprint and fiscal complexity for the top 10 nations with the highest fiscal complexity. The results show that the ecological footprint is significantly increased by economic complexity and urbanization and that the use of renewable energy decreases it.

Doytch and Nguyen [69] investigated 95 nations classified by income levels worldwide, exposing varied impacts of fiscal complexity on environmental footprints within different nation clusters. Across the board, their results showed a clear "inverted U-shaped" association between environmental impact and financial complexity. Akadiri et al. [70] conducted a new study utilizing quarterly datasets from 1985 Q1 to 2019 Q1 to examine China. The study demonstrated the positive influence of fiscal complexity on environmental footprint. Moreover, nonparametric causality analysis showed that the impact varied amongst quantiles. On the other hand, renewable energy sources benefit the environment. The study's conclusion recommends that policymakers support the use of renewable energy sources to reduce environmental concerns and promote green growth.

Wang et al. [71] have examined the effects of fiscal intricacy on Japan's environmental footprints. Using data from 1990 to 2020 using a nonlinear ARDL framework, their analysis showed both asymmetric and symmetric effects. The results showed that while an adverse shock would hurt environmental quality, a beneficial surprise to economic complexity might reduce the nation's ecological footprint. A second investigation by Saqib et al. [72] investigated the possible connection between G-10 countries' carbon emissions and economic complexity. Their findings suggested that economic complexity has an adverse short- and long-term impact on carbon emissions. Furthermore, Alola and Alola [73] investigated the factors contributing to ecological deterioration in some Nordic nations. They distinguished between complexity outlook and economic complexity and looked at the effects of these differences on greenhouse gas emissions. Using a random effect model and data from 1995 to 2020, the scientists discovered that economic complexity stimulated and attenuated GHG emissions.

Considering the previous conversation, the correlation between financial complexity and ecological impact indicators produces various results, indicating a confusing situation consistent with the claim by Hausmann and Hidalgo [74]. The 50 most complicated economies, which actively work to increase production complexity and structural advancement have not received enough attention in the literature yet. Moreover, we investigate the indirect effect of fiscal complexity via economic development, a topic not fully covered in previous studies. As a result, the current research looks into how the 50 most complicated nations are affected by economic complexity. Drawing on the knowledge acquired from the previously described study, the first theory of this investigation might be articulated as follows:

H_1: Ecological footprint can be positively or negatively impacted by economic complexity.

2.2.2. Renewable Energy and Ecological Footprint

Energy transition theory provides the foundation for the nexus between the natural environment and green or renewable energy. According to this hypothesis, switching from fossil fuels to renewable energy is essential to improving ecological quality through decreasing releases [75].

Energy utilisation is closely related to the direction of economic expansion, and energy use may impact the state of the environment. In theory, aiming for growth goals could increase the need for energy. Extracting fossil fuels could worsen the environment and increase ecological footprints if that energy is obtained. On the other hand, utilizing renewable energy reduces the amount of conventional energy sources extracted, significantly lessening the ecological footprint. Scholarly works [71, 76, 77] have examined the connection between the ecological footprint. Danish and Khan [76] discovered that using renewable energy has a positive environmental footprint for the BRICS nations, supporting the Environmental Kuznets Curve (EKC) for these nations. Similarly, even though the EKC has not been proven in these circumstances, Sharma and Sinha [77] showed that adopting renewables reduces the ecological footprint in underdeveloped countries. According to Zhang et al. [78], producing energy from nuclear and wind sources lessens their ecological imprint; however, making power from hydro and geothermal sources may harm the ecosystem. Additionally, their study demonstrated how spending on research and development (R&D) might enhance the state of the environment. Conflicting evidence from current research, including that by Saqib et al. [72], suggests that clean power can have both beneficial and adverse effects on environmental harm, as assessed by emissions and carbon footprint. Based on quantile-based evaluation, Yang et al. [79] discovered that renewable green energy might reduce ecological harm not in the median quantiles but rather in the latter and upper percentiles. Furthermore, using region-based research, Zaman [80] investigated the environmental effects of biofuel production and found a positive correlation between biofuel production and climate change throughout the panel.

The conversations above have, for the most part, focused on the favorable correlation between renewable energy usage and environmental footprint. Therefore, the following is a formalization of the third thesis of this study:

$H_{2:}$ The ecological footprint is adversely impacted by renewable energy sources.

2.2.3. Economic Complexity and Green Financing

The capacity and structure of the economic system's production affect its complexity. According to Nguyen et al. [81], it illustrates the knowledge that economic actors acquire during manufacturing is illustrated. It incorporates product diversification for export by utilizing domestic expertise to transform inputs into outputs. Antonietti and Franco's [82] recent study suggests that foreign direct investment (FDI) could increase the economy's complexity. According to the endogenous growth model, this concept is theoretically related to Romer's [83] perspective. The author highlights that new concepts and goods that require the technical know-how to be productively utilized in the economy are introduced into the home market through FDI.

Multinational corporations can boost economic growth and prosperity by expanding the economy and improving the ability of the economy to produce new ideas and upgrade existing processes, all while increasing the sophistication of the products [82]. FDI can potentially increase economic complexity through technology transfer from overseas companies in the host country, leading to knowledge spillovers between multinational corporations and domestic businesses. Increases the production of new ideas or replicating existing ones even more efficiently [84]. However, by providing local businesses, particularly new ones, with increased competitive exposure, FDI may harm fiscal complexity.

Furthermore, in the context of increasing transaction expenses, such as salaries and additional running expenses, increased competition may force foreign companies operating in the host nations to cease operations entirely or scale back their operations. These activities may weaken the host economy's sophistication and export diversification [85]. Few empirical studies have looked at how FDI affects the economy's complexity. One example of causation advancing from FDI to economic complexity is provided by Antonietti and Franco [82]. This goes against the research done by Khan et al. [86], who show that FDI and economic complexity are causally related in both directions. High levels of financial expertise draw foreign direct investment (FDI) to Mexican states. The positive effects of FDI on fiscal complexity are demonstrated by Nguéda and Kelly [87]. By examining how FDI affects the intricacy of the economy of developing nations, our study contributes to the expanding body of scholarship on the subject. He subject.

The effect of FDI on economic complexity is examined for the first time in this research in the group of rising economies that includes South Africa, Brazil, Russia, India, China, and Mexico (known as the BRICS nations), as well as Indonesia, Nigeria, Mexico, and Turkey (known as the MINT countries). [88] states that the nations are selected because their economies are growing. Because it is predicted that the MINT countries will see tremendous economic expansion over the coming decades, attracting both domestic and foreign investors looking for investment opportunities, they are regarded as the most powerful emerging markets in the world. Likewise, O'Neill [88] states that by 2050, the BRICS nations should be major providers of manufactured goods, services, and raw resources. In terms of social and economic indices, these nations have stabilized, claim [89]. In addition to using cutting-edge tactics to accelerate the creation of novel goods and services, they possess historical documentation of thorough knowledge management.

$H_{3:}$ The ecological footprint is positively impacted by green financing.

2.2.4. Research Gap and Novelty of the Current Research

Thus far, the literature, particularly in developing nations, has not discussed the robust relationships between natural deterioration, financial complexity, and green FDI. While some investigations have looked at such factors' effects separately, others have examined their linked effect across several nations. Studies examining the effects of clean energy, fiscal complexity, natural assets, and population density within the EKC framework on the environmental footprint are conspicuously lacking in the literature. By designing the network system of green FDI, economic complexity, and ecological degradation, this study uniquely contributes to understanding how various factors can increase or decrease environmental deterioration. The knowledge acquired can help policymakers target issues impacting their countries' ecological conditions to address Sustainable Development Goal 13 (Climate change). Under the framework of the EKC, the current study investigates the effects of green FDI and fiscal complexity on the ecological impact, considering the consequences of resource extraction and the use of renewable energy. Our study emphasizes the absence of such studies in the literature by utilizing robust econometric methodologies to remove potential biases. Therefore, by employing sophisticated empirical approaches, our contribution advances the current scholarly discourse on the drivers of environmental quality.

3. Statistical Analysis and Methodology

3.1. Statistical analysis

We use yearly data sets for the subsequent indicators in Vietnam: energy productivity (EP), CO_2 emissions, the Economic Complexity Index (ECI), and green FDI (GRFDI). We look at data from 1995 to 2022. The International Trade Center provided information on green FDI. Our World in Data database was the source of the EP and CO_2 release data. The Harvard Growth Lab's Country Rankings provided the ECI statistics. We calculated the development rates of these series and subsequently utilized them in the statistical examination. The following section looks at the tendencies of these factors.

The average growth rates for all variables except economic complexity are favorable in Table 1. During the course of the investigation, green FDI has the most considerable dispersion and fluctuation. According to Jarque and Bera [90], economic complexity, CO_2 emissions, and energy productivity have a normal distribution. All indicators are not steady according to Elliott et al. [91], the ERS unit root test, which has a 1% significance threshold. There is sufficient evidence for us to apply a model-free connectivity technique to ascertain these components' linkages since the weighted portmanteau test of Fisher and Gallagher [92] indices indicates that their development and squared percentage expansion do not exhibit autocorrelation.

Figure 1 displays the first log-differenced series of Vietnam's green foreign direct investment, fiscal complexity, CO_2 emissions, and energy efficiency volatility. Those parameters exhibit extreme fluctuations throughout the sample period. Specifically, green FDI's growth rates varied from -20 to 100. Meanwhile, energy productivity rose gradually, and CO_2 emissions witnessed a slight decrease around 2012 and at the end of the examined period. It is noteworthy as well that the Economic Complexity Index increased steadily throughout the examined period.

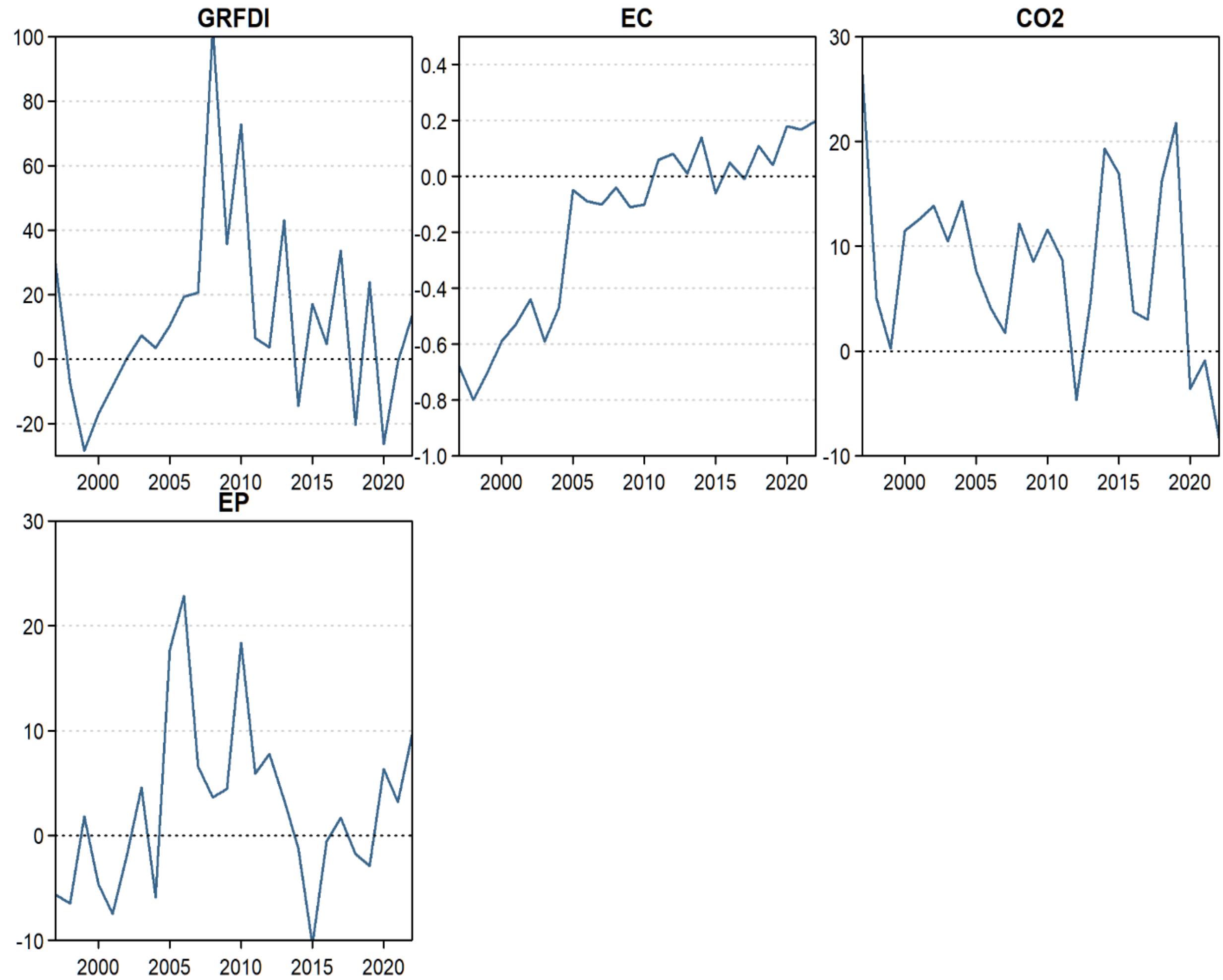

Figure 1.
Growth rates.

Table 1.
Summary statistics.

	GRFDI	EC	CO2	EP
Mean	12.497**	-0.166**	8.353***	2.640
	(0.040)	(0.012)	(0.000)	(0.111)
Variance	862.207	0.098	70.39	66.285
Skewness	1.257***	-0.732*	0.052	0.764*
	(0.007)	(0.087)	(0.898)	(0.075)
Ex.Kurtosis	1.970**	-0.937	-0.437	0.265
	(0.029)	(0.225)	(0.909)	(0.389)
JB	11.054***	3.270	0.218	2.608
	(0.004)	(0.195)	(0.897)	(0.271)
ERS	-1.818	-0.344	-0.447	-1.828
	(0.088)	(0.735)	(0.661)	(0.086)
Q(20)	16.090*	65.315***	10.083	21.820***
	(0.082)	(0.000)	(0.496)	(0.008)
Q2(20)	5.847	51.748***	9.451	9.610
	(0.912)	(0.000)	(0.566)	(0.548)

4. Results

4.1. Total Dynamic Connectedness

It can be claimed that results may be susceptible to outliers because the model-free connectivity measurements rely on the Pearson correlation coefficient. Compared to the Pearson correlation coefficient, the non-parametric Spearman and Kendall rank correlation coefficients are less susceptible to outliers and have been used in our robustness analysis to address this issue. Figure 2 shows that, despite the Spearman and Kendall-based linkage metrics being more comparable than the Pearson correlation coefficient, all three techniques produce qualitatively similar findings. As a result, we advise switching from the Pearson correlation coefficient to non-parametric correlation coefficients. Our study focuses on connectivity in the Kendall area.

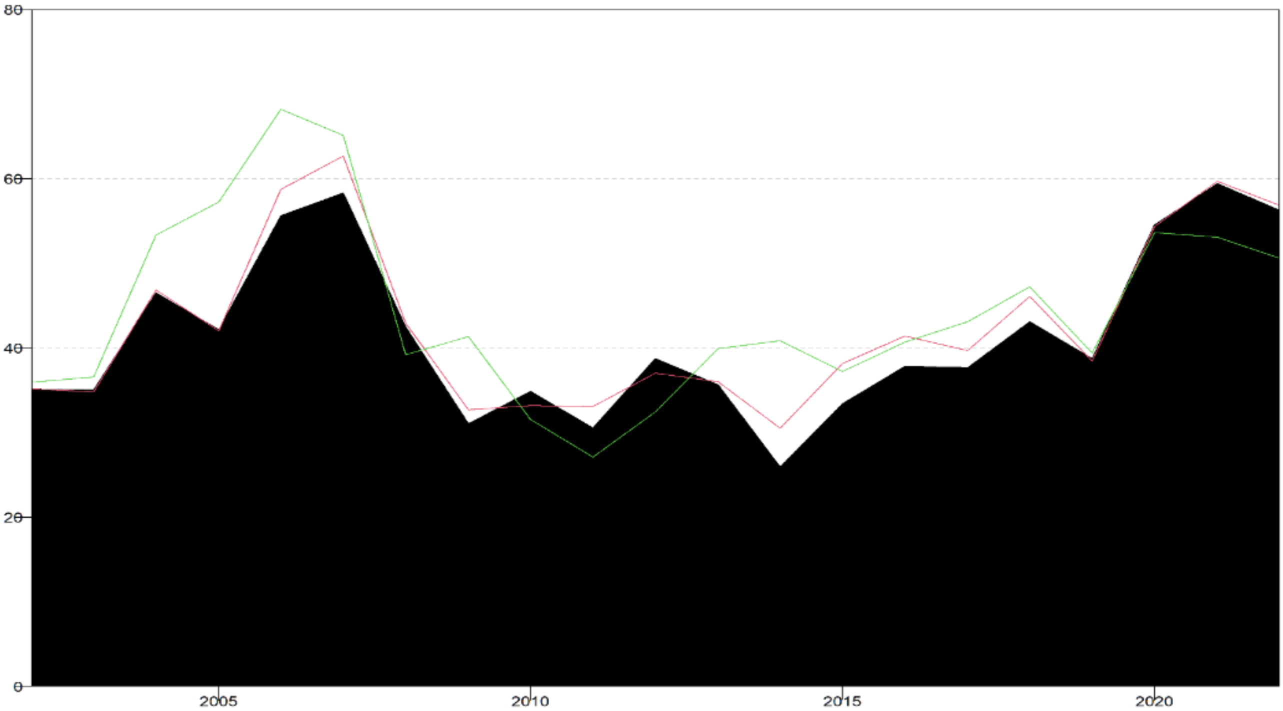

Figure 2.
Time-variant of total connectedness.
Notes: The model-free linkage method with Kendall, Spearman, and Pearson's rank correlation coefficients is shown by the black area, red line, and green line, respectively.

Our research employs a dynamic framework to estimate the time-varying of TCI and exhibits how the network's factors under study play a time-variant function to shed light on how a crisis impacts a system of variables' interconnections. Modifications in a variable's function from being a net shock emitter to a gross shock recipient, and vice versa, must be taken into account. The paper's beginning describes in detail the intertemporal movements of the TCI, and Figure 2 shows time-variant estimates of total connectivity. Overall, we can see that the TCI value fluctuates wildly between around 30% and 70% throughout the examined period. To be more specific, the TCI value hit its highest point during the 2006-2007 and 2020-

2022 periods, which indicates strong contagions among all the factors. Increasing the complexity of the commodities a nation can produce is the most potent development engine for the economy of an emerging country [93]. Research from the World Bank and the London School of Economics indicates that high-tech FDI has significantly boosted Vietnam's economy and helped developing countries advance into the worth chain's more substantial quality-added segments. In addition, Vietnam had the largest increase in the previous 20 years in Harvard's Economic Complexity Index rating, partly due to a surge of innovative investments from Apple, LG Electronics, Dell, and several Japanese companies after their Samsung and Intel acquisitions.

4.2. Averaged Joint Connectedness

Employing Kendall-based connectivity, Table 2 displays average results about the connections of different elements inside the network. The diagonal elements in this table indicate the volatility of every factor, considering any unique shocks. The achievements of every factor to the dispersion of additional variables (FROM) and the fluctuation of each element to others (TO) are summarized by the off-diagonal components. For instance, Table 2's rows display how each parameter contributes to the predicted error variance of a certain variable. In contrast, the columns demonstrate how each factor affects other factors independently.

Table 2.
Averaged joint connectedness.

	GRFDI	**EC**	**CO2**	**EP**	**FROM**
GRFDI	55.88	20.42	14.01	9.69	44.12
EC	20.71	61.04	10.54	7.72	38.96
CO2	13.38	9.18	55.44	22.00	44.56
EP	10.17	6.63	21.88	61.32	38.68
TO	44.27	36.22	46.43	39.41	TCI
NET	0.14	-2.74	1.87	0.73	41.58

Fourteen per cent of the disparity in our community of factors under investigation can be explained by alterations within this structure, according to the average TCI worth of forty-five per cent across all data points. This implies that about 58% of the system's error variance can be attributed to idiosyncratic factors. The final row of Table 2, which lists the relative roles of each factor, indicates that fiscal complexity is the most important shock recipient and green FDI is a net surprise emitter. CO2 emissions and energy productivity are net shock transmitters in descending order. Economic complexity is a net shock receiver.

4.3. Net Total Directional Connectedness

Figure 3 shows the precise role of each factor over time. It indicates whether a factor plays a role in the net that transmits during the sample period. For example, values greater than zero indicate a net shock emitter, while values less than zero represent a net trauma recipient.

Concerning net overall interconnectivity outcomes, we observe that the primary net recipient of waves was green FDI before 2009 and during the 2019-2022 period, but then it turned into a net transmitter of shocks during the 2010-2015 period. Moreover, economic complexity was the main net receiver of spillover shocks before 2014, but it turned into a net shock transmitter thereafter, except for 2017. It is also worth noting that the 2010 – 2015 period witnessed not only the highest shocks that green FDI transmitted but also the highest amount of shocks that economic complexity received. Therefore, economic complexity correlated with the flow of green FDI drawn to Vietnam, especially from 2010 to 2015. The building of the FPT compound in Da Nang was started in 2014 by FPT City Joint Stock Company, a division of FPT Corp. The project, which covers 5.9 hectares and requires a preliminary expenditure of VND485 billion (about US$23 million), is expected to house 10,000 office employees. By 2015, this program hopes to assist FPT Software's and FPT University's sustained expansion in Da Nang City [94]. The mechanisms incorporated within the scheme are expected to result in major efficiency improvements after they are completed and put into use. Compared to similar structures in neighboring areas, studies show a possible decrease in the firm's energy use by 20.97%, water consumption by 31.8%, and energy use for materials manufacturing by 20.2% [95]. Moreover, Figure 3 illustrates that CO_2 outputs were the net shock transmitter before 2011 and during the 2020-2022 period, while it turned into the main net shock receiver during the 2012-2020 period. This indicates that CO_2 emissions drive the government to create green policies that attract more foreign investors and promote economic complexity. Meanwhile, the role of energy productivity fluctuated wildly throughout the examined period, but between 2010 and 2015, energy efficiency was a net surprise absorber; starting in 2015, however, it became a net emitter.

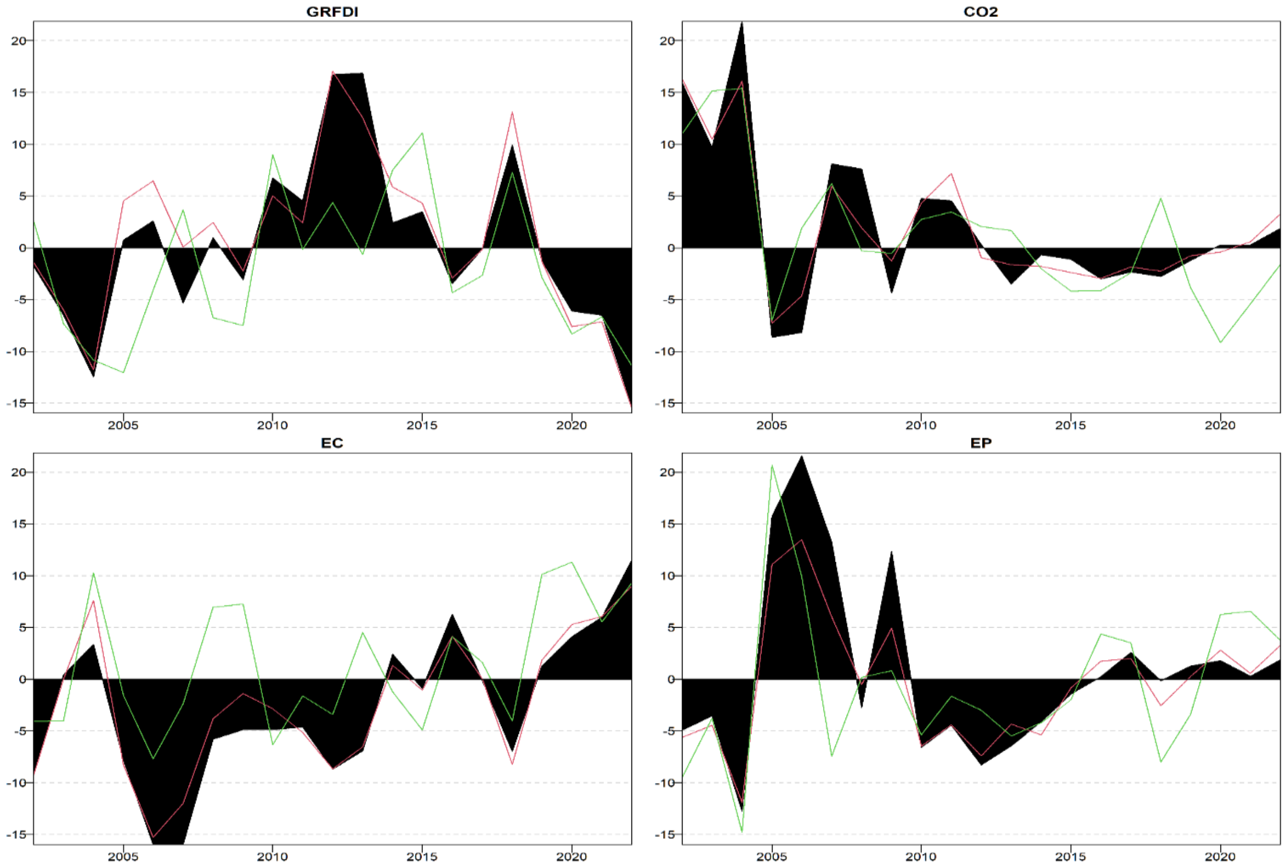

Figure 3.
Time-variant of net total directional connectedness.
Note: The model-free linkage method with Kendall, Spearman, and Pearson's rank correlation coefficients is shown by the black area, red line, and green line, respectively.

4.4. Net Pairwise Dynamic Connectedness

Figure 4 shows the pairwise directional connectivity, which clarifies the importance of green FDI in our dataset. We mainly study spillover impacts with respect to fiscal complexity. The pairwise results, which employ Kendall-based correlation, confirm earlier discoveries while providing a more thorough comprehension of potential spillover shocks in this specific network.

Overall, it is important to remember that green FDI dominated fiscal complexity throughout the examined period, except for the 2002-2005, 2015-2017, and 2019-2022 periods. To be more specific, their domination reached a peak during the 2012-2013 period. It is also worth noting that green FDI was dominated by CO_2 emissions before 2009 and during the 2019-2022 period and turned into dominating CO_2 emissions during the 2010-2019 period. Moreover, CO_2 emissions dominated economic complexity throughout the examined period. According to the 2018 Environmental Performance Index (EPI) report, Vietnam was among the 49 most polluted countries. It is worth noting that there is a trade-off between efforts to sustain fiscal development and control CO_2 emissions in Vietnam. With green FDI, the domination of economic complexity increases while the results of CO_2 emissions decrease at the end of the sample. Despite some innovative outcomes, only 0.14/5 of businesses are involved in Industry 4.0's environmental initiatives. Additionally, the lack of human resources that can satisfy the demands of science, technology, and innovation prevents the development of an innovation engine and economic complexity (Vietnam Law and Legal Forum magazine, 2020). In other words, the decrease in green FDI in Vietnam affects the effectiveness of economic complexity, thereby worsening the CO_2-related problems. Furthermore, economic complexity was dominated by energy productivity before 2010 and dominated energy productivity during the 2013-2017 period. On the other hand, green FDI shifted from dominating energy productivity during 2010-2017 to being dominated by energy productivity during 2018-2022. Besides, the relationship between CO_2 emissions and energy productivity fluctuated wildly during the examined period.

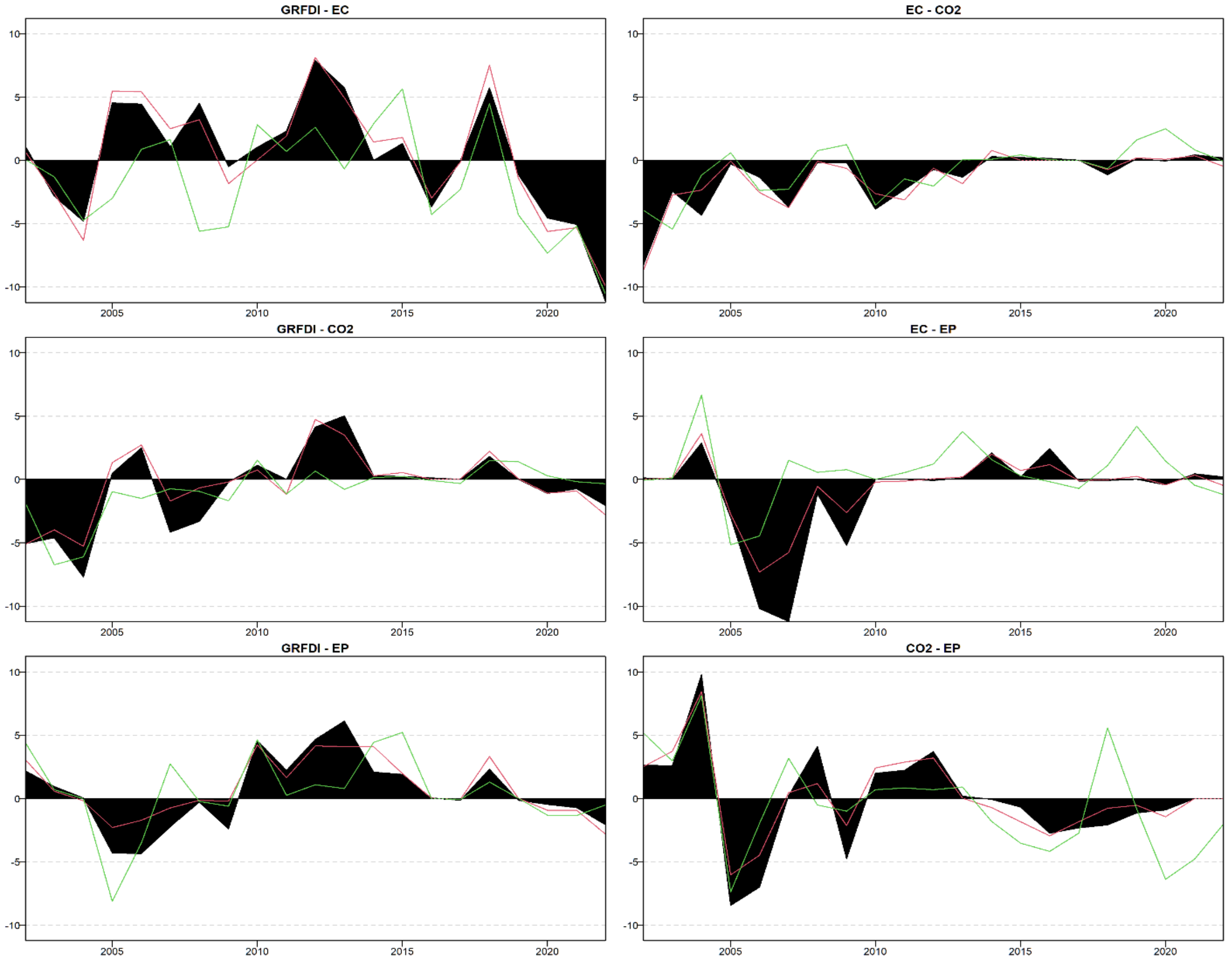

Figure 4.
Dynamic net pairwise directional connectedness.
Note: The model-free linkage method with Kendall, Spearman, and Pearson's rank correlation coefficients is shown by the black area, red line, and green line, respectively.

5. Conclusions and Policy Implications

Our investigation employs a model-free interconnectedness approach as a benchmark structure for interconnectivity schemes [96]. We use a system connectivity technique to assess how four metrics are related to one another between 1995 and 2022, including green FDI (GRFDI), the Economic Complexity Index (ECI), CO_2 emissions (CO2), and energy productivity (EP). Specifically, this study focuses on the dynamic relationship between green FDI and fiscal complexity.

We find strong correlations between each of the variables we looked at in the whole dataset. When considering the entire sample, the TCI stands at 41.58%. Furthermore, our analysis outlines how each indicator's role has changed inside our planned ecosystem. The net total connectedness indicates that green FDI was a main net receiver of shocks before 2009 and during the 2019-2022 period, but then turned into a net shock emitter during the 2010-2015 period. Economic complexity was the main net receiver of spillover shocks before 2014, but it turned into a net shock transmitter onward, except for 2017. Pairwise directional connectivity in the net indicates green FDI-dominated economic complexity throughout the examined period, except for the 2002-2005, 2015-2017, and 2019-2022 periods. The development of economic complexity in Vietnam faces many difficulties when the flow of green FDI decreases.

These results have substantial policy consequences for politicians and investors alike, especially when it comes to comprehending the interconnectivity and spillover impacts across several variables. A clear understanding of the main relationships between these metrics can help lawmakers create more efficient measures to mitigate hazards and lessen the spread of risk throughout the system. Our research highlights the significant links between economic complexity and green FDI and the dangers investors in these areas face from too little or too much variety. To improve the effectiveness of green FDI, we highlight the increasing interactions between unanticipated events and the necessity for governments to foster fiscal complexity. Furthermore, by determining the effect of waves on the entire network, our investigation offers proof to support creating a sustainable FDI system. Additionally, given the uncertainty associated with sustainable foreign direct investment and the intricacy of the economy, the paper's findings can help guide measures aimed at improving social welfare. Policymakers must consider such unknowns when creating policies to protect vulnerable populations and enhance public security.

References

[1] H. Yuan *et al.*, "Progress towards the Sustainable Development Goals has been slowed by indirect effects of the COVID-19 pandemic," *Communications Earth & Environment,* vol. 4, no. 1, p. 184, 2023. https://doi.org/10.1038/s43247-023-00846-x

[2] M. A. Bhuiyan, Q. Zhang, V. Khare, A. Mikhaylov, G. Pinter, and X. Huang, "Renewable energy consumption and economic growth nexus—a systematic literature review," *Frontiers in Environmental Science,* vol. 10, p. 878394, 2022. https://doi.org/10.3389/fenvs.2022.963517

[3] H. A. Ibrahim, M. K. Ayomoh, R. C. Bansal, M. N. Gitau, V. S. Yadavalli, and R. Naidoo, "Sustainability of power generation for developing economies: A systematic review of power sources mix," *Energy Strategy Reviews,* vol. 47, p. 101085, 2023. https://doi.org/10.1016/j.esr.2023.101085

[4] Y. Xu and F. Zhao, "Impact of energy depletion, human development, and income distribution on natural resource sustainability," *Resources Policy,* vol. 83, p. 103531, 2023. https://doi.org/10.1016/j.resourpol.2023.103531

[5] H. Luo, Y. Sun, and L. Zhang, "Effects of macroprudential policies on ecological footprint: The moderating role of environmental policy stringency in the top 11 largest countries," *Scientific Reports,* vol. 14, no. 1, p. 7423, 2024. https://doi.org/10.1038/s41598-024-58015-9

[6] N. Miao, A. Sharif, I. Ozturk, and A. Razzaq, "How do the exploitation of natural resources and fiscal policy affect green growth? Moderating role of ecological governance in G7 countries," *Resources Policy,* vol. 85, p. 103911, 2023. https://doi.org/10.1016/j.resourpol.2023.103911

[7] A. Ullah, K. Raza, and U. Mehmood, "The impact of economic growth, tourism, natural resources, technological innovation on carbon dioxide emission: Evidence from BRICS countries," *Environmental Science and Pollution Research,* vol. 30, no. 32, pp. 78825-78838, 2023. https://doi.org/10.1007/s11356-023-27903-4

[8] L. Yuyang, "Natural resource efficiency and the road to a green economy: From scarcity to availability," *Resources Policy,* vol. 89, p. 104574, 2024. https://doi.org/10.1016/j.resourpol.2023.104574

[9] World Health Organization (WHO), "Environmental challenges and their impact on public health," Retrieved: https://www.who.int/news-room/fact-sheets/detail/environmental-determinants-of-health, 2022.

[10] K. Abbass, M. Z. Qasim, H. Song, M. Murshed, H. Mahmood, and I. Younis, "A review of the global climate change impacts, adaptation, and sustainable mitigation measures," *Environmental Science and Pollution Research,* vol. 29, no. 28, pp. 42539-42559, 2022. https://doi.org/10.1007/s11356-022-19718-6

[11] M. M. Khine and U. Langkulsen, "The implications of climate change on health among vulnerable populations in South Africa: A systematic review," *International Journal of Environmental Research and Public Health,* vol. 20, no. 4, p. 3425, 2023. https://doi.org/10.3390/ijerph20043425

[12] B. K. Mishra, P. Kumar, C. Saraswat, S. Chakraborty, and A. Gautam, "Water security in a changing environment: Concept, challenges and solutions," *Water,* vol. 13, no. 4, p. 490, 2021. https://doi.org/10.3390/w13040490

[13] R. Schnitter and P. Berry, "The climate change, food security and human health nexus in Canada: A framework to protect population health," *International Journal of Environmental Research and Public Health,* vol. 16, no. 14, p. 2531, 2019. https://doi.org/10.3390/ijerph16142531

[14] S. P. Nathaniel, S. Barua, and Z. Ahmed, "What drives ecological footprint in top ten tourist destinations? Evidence from advanced panel techniques," *Environmental Science and Pollution Research,* vol. 28, no. 28, pp. 38322-38331, 2021. https://doi.org/10.1007/s11356-021-13389-5

[15] D. F. Viana and L. Ribeiro, "Ecological footprint and its application to sustainability assessment," *Environmental Science & Policy,* vol. 103, no. 7, pp. 51-63, 2019.

[16] E. Amasuomo and J. Baird, "The concept of waste and waste management," *Journal of Management and Sustainability,* vol. 6, no. 4, p. 88, 2016. https://doi.org/10.5539/jms.v6n4p88

[17] B. Esmaeilian, B. Wang, K. Lewis, F. Duarte, C. Ratti, and S. Behdad, "The future of waste management in smart and sustainable cities: A review and concept paper," *Waste Management,* vol. 81, pp. 177-195, 2018. https://doi.org/10.1016/j.wasman.2018.09.047

[18] D. Landa-Acuña, R. A. S. Acosta, E. Hualpa Cutipa, C. Vargas de la Cruz, and B. Luis Alaya, "Bioremediation: A Low-cost and clean-green technology for environmental management," *Microbial Bioremediation & Biodegradation,* pp. 153-171, 2020.

[19] A. A. Awosusi, H. Ozdeser, O. S. Ojekemi, I. Adeshola, and M. Ramzan, "Environmental sustainability in Vietnam: evaluating the criticality of economic globalisation, renewable energy, and natural resources," *Environmental Science and Pollution Research,* vol. 30, no. 30, pp. 75581-75594, 2023. https://doi.org/10.1007/s11356-023-27683-x

[20] L. T. Ha, N. M. Hung, and L. Van Chon, "Decomposed and partial connectedness between economic globalization, non-renewable and renewable energy consumption in Vietnam," *Environmental Science and Pollution Research,* vol. 30, no. 55, pp. 117061-117081, 2023. https://doi.org/10.1007/s11356-023-25158-7

[21] K. Leach *et al.*, "A common framework of natural capital assets for use in public and private sector decision making," *Ecosystem Services,* vol. 36, p. 100899, 2019. https://doi.org/10.1016/j.ecoser.2019.100899

[22] M. J. Martinez-Harms *et al.*, "Framing natural assets for advancing sustainability research: translating different perspectives into actions," *Sustainability Science,* vol. 13, pp. 1519-1531, 2018. https://doi.org/10.1007/s11625-018-0599-5

[23] I. Souliotis and N. Voulvoulis, "Natural capital accounting informing water management policies in Europe," *Sustainability,* vol. 13, no. 20, p. 11205, 2021. https://doi.org/10.3390/su132011205

[24] Z. Ahmed, M. M. Asghar, M. N. Malik, and K. Nawaz, "Moving towards a sustainable environment: The dynamic linkage between natural resources, human capital, urbanization, economic growth, and ecological footprint in China," *Resources Policy,* vol. 67, p. 101677, 2020. https://doi.org/10.1016/j.resourpol.2020.101677

[25] L. T. Ha, "Dynamic interrelations between environmental innovations, human capital, and energy security in Vietnam: New evidence from an extended TVP-VAR approach," *Environmental Modeling & Assessment,* vol. 29, no. 4, pp. 683-700, 2024. https://doi.org/10.1007/s11356-023-29179-0

[26] M. Jackman and W. Moore, "Does it pay to be green? An exploratory analysis of wage differentials between green and non-green industries," *Journal of Economics and Development,* vol. 23, no. 3, pp. 284-298, 2021. https://doi.org/10.1108/JED-08-2020-0099

[27] L. T. Ha, P. X. Nam, and T. T. Thanh, "Effects of bribery on firms' environmental innovation adoption in Vietnam: Mediating roles of firms' bargaining power and credit and institutional constraints," *Ecological Economics*, vol. 185, 2021. https://doi.org/10.1016/j.ecolecon.2021.107042
[28] S. Algarni, V. Tirth, T. Alqahtani, S. Alshehery, and P. Kshirsagar, "Contribution of renewable energy sources to the environmental impacts and economic benefits for sustainable development," *Sustainable energy technologies and assessments*, vol. 56, p. 103098, 2023. https://doi.org/10.1016/j.seta.2023.103098
[29] Y. An and G. R. Madni, "Factors affecting the green investment and assessing sustainable performance of firms in China," *PLoS One*, vol. 18, no. 12, p. e0296099, 2023. https://doi.org/10.1371/journal.pone.0296099
[30] M. C. Cortez, N. Andrade, and F. Silva, "The environmental and financial performance of green energy investments: European evidence," *Ecological Economics*, vol. 197, p. 107427, 2022. https://doi.org/10.1016/j.ecolecon.2022.107427
[31] L. Qing, J. Abbas, H. Najam, X. Ma, and A. A. Dagestani, "Investment in renewable energy and green financing and their role in achieving carbon-neutrality and economic sustainability: Insights from Asian region," *Renewable Energy*, vol. 221, p. 119830, 2024. https://doi.org/10.1016/j.renene.2023.119830
[32] T. Stucki, "Which firms benefit from investments in green energy technologies?–The effect of energy costs," *Research Policy*, vol. 48, no. 3, pp. 546-555, 2019. https://doi.org/0.1016/j.respol.2018.09.010
[33] K. R. Abbasi, K. Lv, M. Radulescu, and P. A. Shaikh, "Economic complexity, tourism, energy prices, and environmental degradation in the top economic complexity countries: fresh panel evidence," *Environmental Science and Pollution Research*, vol. 28, pp. 68717-68731, 2021. https://doi.org/10.1007/s11356-021-15312-4
[34] M. Z. Rafique, A. M. Nadeem, W. Xia, M. Ikram, H. M. Shoaib, and U. Shahzad, "Does economic complexity matter for environmental sustainability? Using ecological footprint as an indicator," *Environment, Development and Sustainability*, vol. 24, no. 4, pp. 4623-4640, 2022. https://doi.org/10.1007/s10668-021-01625-4
[35] F. Bahrami, B. Shahmoradi, J. Noori, E. Turkina, and H. Bahrami, "Economic complexity and the dynamics of regional competitiveness a systematic review," *Competitiveness Review: An International Business Journal*, vol. 33, no. 4, pp. 711-744, 2023.
[36] E. Boleti, A. Garas, A. Kyriakou, and A. Lapatinas, "Economic complexity and environmental performance: Evidence from a world sample," *Environmental Modeling & Assessment*, vol. 26, no. 3, pp. 251-270, 2021. https://doi.org/10.1007/s10666-021-09750-0
[37] B. Doğan, S. Ghosh, I. Shahzadi, D. Balsalobre-Lorente, and C. P. Nguyen, "The relevance of economic complexity and economic globalization as determinants of energy demand for different stages of development," *Renewable Energy*, vol. 190, pp. 371-384, 2022. https://doi.org/10.1016/j.renene.2022.03.117
[38] A. Dreher, "Does globalization affect growth? Evidence from a new index of globalization," *Applied Economics*, vol. 38, no. 10, pp. 1091-1110, 2006. https://doi.org/10.1080/00036840500392078
[39] N. T. Hung, N. T. Trang, and N. T. Thang, "Quantile relationship between globalization, financial development, economic growth, and carbon emissions: Evidence from Vietnam," *Environmental Science and Pollution Research*, vol. 29, no. 40, pp. 60098-60116, 2022. https://doi.org/10.1007/s11356-022-20126-z
[40] A. Jahanger, M. Usman, M. Murshed, H. Mahmood, and D. Balsalobre-Lorente, "The linkages between natural resources, human capital, globalization, economic growth, financial development, and ecological footprint: The moderating role of technological innovations," *Resources Policy*, vol. 76, p. 102569, 2022. https://doi.org/10.1016/j.resourpol.2022.102569
[41] S. A. Aladejare, "Natural resource rents, globalisation and environmental degradation: New insight from 5 richest African economies," *Resources Policy*, vol. 78, p. 102909, 2022. https://doi.org/10.1016/j.resourpol.2022.102909
[42] M. Koengkan, J. A. Fuinhas, and R. Santiago, "Asymmetric impacts of globalisation on CO 2 emissions of countries in Latin America and the Caribbean," *Environment Systems and Decisions*, vol. 40, no. 1, pp. 135-147, 2020. https://doi.org/10.1007/s10669-019-09752-0
[43] F. Jia, L. Zuluaga-Cardona, A. Bailey, and X. Rueda, "Sustainable supply chain management in developing countries: An analysis of the literature," *Journal of Cleaner Production*, vol. 189, pp. 263-278, 2018. https://doi.org/10.1016/j.jclepro.2018.03.248
[44] M. S. Gorus and M. Aslan, "Impacts of economic indicators on environmental degradation: evidence from MENA countries," *Renewable and Sustainable Energy Reviews*, vol. 103, pp. 259-268, 2019. https://doi.org/10.1016/j.rser.2018.12.042
[45] K. Saidi and M. B. Mbarek, "The impact of income, trade, urbanization, and financial development on CO 2 emissions in 19 emerging economies," *Environmental Science and Pollution Research*, vol. 24, pp. 12748-12757, 2017. https://doi.org/10.1007/s11356-016-6303-3
[46] W. Hanif, J. A. Hernandez, W. Mensi, S. H. Kang, G. S. Uddin, and S.-M. Yoon, "Nonlinear dependence and connectedness between clean/renewable energy sector equity and European emission allowance prices," *Energy Economics*, vol. 101, p. 105409, 2021. https://doi.org/10.1016/j.eneco.2021.105409
[47] M. A. Nasir, T. L. D. Huynh, and H. T. X. Tram, "Role of financial development, economic growth & foreign direct investment in driving climate change: A case of emerging ASEAN," *Journal of Environmental Management*, vol. 242, pp. 131-141, 2019. https://doi.org/10.1016/j.jenvman.2019.03.112
[48] F. Shahzad, M. A. Khan, and Y. Zhang, "Investigating the nexus between environmental sustainability and economic complexity in G7 countries," *Environmental Sustainability Journal*, vol. 15, no. 3, pp. 345-360, 2023.
[49] R. Hassen, S. Le, and D. Tran, "Exploring the nexus between ecological sustainability and fiscal complexity: The case of the USA," *Journal of Environmental Economics*, vol. 50, no. 2, pp. 121-140, 2023.
[50] S. Saud and A. Zeraibi, "Renewable energy, energy efficiency, and economic complexity in the Middle East and North Africa: A panel data analysis," *Energy*, vol. 311, p. 133300, 2023. https://doi.org/10.1016/j.energy.2024.133300
[51] A. Zeraibi and S. Saud, "Economic complexity and renewable energy effects on carbon dioxide emissions: A panel data analysis of Middle East and North Africa Countries," *Journal of the Knowledge Economy*, vol. 15, pp. 12006–12025, 2023. https://doi.org/10.1007/s13132-023-01540-1
[52] E. Kazemzadeh, J. A. Fuinhas, M. Shirazi, and A. C. Marques, "Does economic complexity increase energy intensity?," *Energy Efficiency*, vol. 16, p. 29, 2023. https://doi.org/10.1007/s12053-023-10104-w
[53] M. T. Majeed, A. Tauqir, M. Mazhar, and I. Samreen, "Asymmetric effects of energy consumption and economic growth on ecological footprint: New evidence from Pakistan," *Environmental Science and Pollution Research*, vol. 28, no. 25, pp. 32945-32961, 2021. https://doi.org/10.1007/s11356-021-13130-2

[54] B. Muhammad, M. K. Khan, M. I. Khan, and S. Khan, "Impact of foreign direct investment, natural resources, renewable energy consumption, and economic growth on environmental degradation: Evidence from BRICS, developing, developed and global countries," *Environmental Science and Pollution Research*, vol. 28, pp. 21789-21798, 2021. https://doi.org/10.1007/s11356-020-12084-1

[55] I. Muhammad, N. N. Mohd Hasnu, and P. Ekins, "Empirical research of public acceptance on environmental tax: A systematic literature review," *Environments*, vol. 8, no. 10, p. 109, 2021. https://doi.org/10.3390/environments8100109

[56] H. Khan, I. Khan, and R. BiBi, "The role of innovations and renewable energy consumption in reducing environmental degradation in OECD countries: An investigation for Innovation Claudia Curve," *Environmental Science and Pollution Research*, vol. 29, no. 29, pp. 43800-43813, 2022. https://doi.org/10.1007/s11356-022-18912-w

[57] S. M. Malik, H. Awan, and N. Khan, "Mapping vulnerability to climate change and its repercussions on human health in Pakistan," *Globalization and Health*, vol. 8, no. 1, pp. 1-10, 2012. https://doi.org/10.1186/1744-8603-8-31

[58] E. Hille, "Pollution havens: International empirical evidence using a shadow price measure of climate policy stringency," *Empirical Economics*, vol. 54, pp. 1137-1171, 2018. https://doi.org/10.1007/s00181-017-1244-3

[59] A. B. Hintošová, *The digital economy in the context of foreign direct investment flows* (Fostering Innovation and Competitiveness with FinTech, RegTech, and SupTech). Hershey, PA: IGI Global Scientific Publishing, 2021.

[60] A. Bobenič Hintošová and G. Bódy, "Sustainable FDI in the digital economy," *Sustainability*, vol. 15, no. 14, p. 10794, 2023. https://doi.org/10.3390/su151410794

[61] J. H. Dunning and R. Narula, "The R&D activities of foreign firms in the United States," *International Studies of Management & Organization*, vol. 25, no. 1-2, pp. 39-74, 1995.

[62] K. E. Meyer, "What is "strategic asset seeking FDI"?," *The Multinational Business Review*, vol. 23, no. 1, pp. 57-66, 2015. https://doi.org/10.1108/MBR-02-2015-0007

[63] B. Jindra, S. S. Hassan, and U. Cantner, "What does location choice reveal about knowledge-seeking strategies of emerging market multinationals in the EU?," *International Business Review*, vol. 25, no. 1, pp. 204-220, 2016. https://doi.org/10.1016/j.ibusrev.2014.11.008

[64] T. Ahnert and E. Perotti, "Cheap but flighty: A theory of safety-seeking capital flows," *Journal of Banking & Finance*, vol. 131, p. 106211, 2021. https://doi.org/10.1016/j.jbankfin.2021.106211

[65] K. P. Sauvat and E. Gabor, "Facilitating sustainable FDI for sustainable development in a WTO Investment Facilitation Framework: Four concrete proposals," *Journal of World Trade*, vol. 55, no. 2, 2021. 261 – 286

[66] N. Singh and C. Kapuria, "The effect of sustainability on foreign direct investment inflows: Evidence from developing countries," *Social Responsibility Journal*, vol. 18, no. 4, pp. 681–703, 2022. https://doi.org/10.1108/SRJ-08-2019-0289

[67] U. K. Pata, "Renewable energy consumption, urbanization, financial development, income and CO_2 emissions in Turkey: Testing EKC hypothesis with structural breaks," *Journal of Cleaner Production*, vol. 285, p. 124898, 2021. https://doi.org/10.1016/j.jclepro.2020.124898

[68] V. Yilanci and U. K. Pata, "Investigating the EKC hypothesis with renewable energy consumption, nuclear energy, and trade openness for China: Evidence from the Fourier Bootstrap ARDL test," *Environmental Science and Pollution Research*, vol. 27, no. 26, pp. 32364–32376, 2020. https://doi.org/10.1007/s11356-020-09506-6

[69] N. Doytch and T. Nguyen, "Economic complexity and ecological footprints: Evidence from 95 countries," *Environment and Development Economics*, vol. 27, no. 7, pp. 1055–1076, 2022. https://doi.org/10.1017/S1355770X2200016X

[70] S. S. Akadiri, T. S. Adebayo, O. C. Asuzu, I. C. Onuogu, and I. Oji-Okoro, "Testing the role of economic complexity on the ecological footprint in China: A nonparametric causality-in-quantiles approach," *Environmental Economics and Policy Studies*, vol. 24, no. 4, pp. 679–701, 2022. https://doi.org/10.1007/s10018-022-00419-2

[71] H. Wang, X. Zhang, and Y. Li, "Asymmetric environmental performance under economic complexity, globalization, and energy consumption: Evidence from Japan," *Energy*, vol. 275, p. 126215, 2023. https://doi.org/10.1016/j.energy.2023.126215

[72] N. Saqib, M. Radulescu, M. Usman, and D. Balsalobre-Lorente, "Exploring the nexus between economic complexity, renewable energy, environmental technology, and CO_2 emissions in G-10 countries: Implications for a sustainable low-carbon future," *Heliyon*, vol. 9, no. 3, p. e13556, 2023. https://doi.org/10.1016/j.heliyon.2023.e13556

[73] A. A. Alola and U. V. Alola, "Economic complexity and environmental degradation: Evidence from Nordic countries," *Environmental Economics and Policy Studies*, vol. 25, no. 2, pp. 345–362, 2023. https://doi.org/10.1007/s10018-022-00451-2

[74] R. Hausmann and C. A. Hidalgo, "The building blocks of economic complexity," *Proceedings of the National Academy of Sciences* vol. 106, no. 26, pp. 10570–10575, 2009. https://doi.org/10.1073/pnas.0900943106

[75] S. Afsan and M. Mollah, "Facilitating renewable energy transition, ecological innovations, and stringent environmental policies to improve ecological sustainability: Evidence from MM-QR method," *Renewable and Sustainable Energy Reviews*, vol. 161, p. 112381, 2022. https://doi.org/10.1016/j.rser.2022.112381

[76] U. Danish and S. Khan, "The influence of financial openness, trade openness, and energy intensity on ecological footprint: Revisiting the environmental Kuznets curve hypothesis for BRICS countries," *Environmental Science and Pollution Research*, vol. 27, no. 26, pp. 32735–32747, 2020. https://doi.org/10.1007/s11356-020-09744-6

[77] S. Sharma and A. Sinha, "Examining the agriculture-induced environmental Kuznets Curve with moderation effect of human capital and renewable energy: Insights from BRICS economies," *Renewable Energy*, vol. 198, pp. 343–352, 2021. https://doi.org/10.1016/j.renene.2022.08.052

[78] X. Zhang, Y. Li, and Z. Wang, "Does renewable energy consumption reduce energy ecological footprint: Evidence from China," *Environmental Science and Pollution Research*, vol. 29, no. 6, pp. 8540–8552, 2022. https://doi.org/10.1007/s11356-021-17158-3

[79] Y. Yang, X. Zhang, and Z. Liu, "Does renewable energy consumption reduce ecological footprint? Evidence from 130 countries," *Science Progress*, vol. 105, no. 3, p. 003685042210939, 2022. https://doi.org/10.1177/003685042210939

[80] K. Zaman, "Confronting the biofuel–carbon emissions–biodiversity trilemma in a panel of biofuel-consuming countries," *Malaysian Journal of Science*, vol. 35, no. 2, pp. 117–130, 2016. https://doi.org/10.22452/mjs.vol35no2.4

[81] C. P. Nguyen, B. Nguyen, B. Duy Tung, and T. D. Su, "Economic complexity and entrepreneurship density: A non-linear effect study," *Technological Forecasting and Social Change*, vol. 173, p. 121107, 2021. https://doi.org/10.1016/j.techfore.2021.121107

[82] R. Antonietti and C. Franco, "From FDI to economic complexity: A panel Granger causality analysis," *Structural Change and Economic Dynamics*, vol. 56, pp. 225–239, 2021. https://doi.org/10.1016/j.strueco.2020.11.001

[83] P. M. Romer, "Endogenous technological change," *Journal of Political Economy*, vol. 98, no. 5, pp. S71–S102, 1993. https://doi.org/10.1086/261812

[84] R. Anand, S. Mishra, and N. Spatafora, "Structural transformation and the sophistication of production," IMF Working Paper No. 2012/059. International Monetary Fund. https://doi.org/10.5089/9781463937775.001, 2012.

[85] K. De Backer and L. Sleuwaegen, "Does foreign direct investment crowd out domestic entrepreneurship?," *Review of Industrial Organization,* vol. 22, no. 1, pp. 67–84, 2003. https://doi.org/10.1023/A:1021875420015

[86] H. Khan, U. Khan, and M. A. Khan, "Causal nexus between economic complexity and FDI: Empirical evidence from time series analysis," *The Chinese Economy,* vol. 53, no. 5, pp. 374–394, 2020. https://doi.org/10.1080/10971475.2020.1730554

[87] R. D. N. Nguéda and A. M. Kelly, "The nexus between economic complexity and foreign direct investment in Sub-Saharan Africa," *South Asian Journal of Social Studies and Economics*, vol. 14, no. 2, pp. 41–52, 2022. https://doi.org/10.9734/sajsse/2022/v14i230377

[88] J. O'Neill, "Building better global economic BRICs. Goldman Sachs," Retrieved: https://www.goldmansachs.com/our-firm/history/moments/2001-brics, 2001.

[89] R. V. Klafke and C. Lievore, Picinin, C. T., de Francisco, A. C., & Pilatti, L. A. (). , "Primary knowledge management practices applied in Brazil, Russia, India, and China (BRIC) industries from 2001–2010," *Journal of Knowledge Management,* vol. 20, no. 4, pp. 812–828, 2016. https://doi.org/10.1108/JKM-12-2015-0522:contentReference[oaicite:13]{index=13}

[90] C. M. Jarque and A. K. Bera, "Efficient tests for normality, homoscedasticity and serial independence of regression residuals," *Economics Letters*, vol. 6, no. 3, pp. 255-259, 1980. https://doi.org/10.1016/0165-1765(80)90024-5

[91] G. Elliott, T. J. Rothenberg, and J. H. Stock, "Efficient tests for an autoregressive unit root," *Econometrica,* vol. 64, no. 4, pp. 813-836, 1996. https://doi.org/10.2307/2171856

[92] T. J. Fisher and C. M. Gallagher, "New weighted portmanteau statistics for time series goodness of fit testing," *Journal of the American Statistical Association,* vol. 107, no. 498, pp. 777-787, 2012. https://doi.org/10.1080/01621459.2012.688465

[93] VietnamPlus, "High-tech FDI drives Vietnam's economic evolution. VietnamPlus," Retrieved: https://en.vietnamplus.vn/hightech-fdi-drives-vietnams-economic-evolution/237621.vnp. [Accessed November 6, 2023], 2022.

[94] VNPT, *Internal report on efficiency improvements*. Hanoi, Vietnam: Vietnam Posts and Telecommunications Group, 2014.

[95] Da Nang Today, "Environmental impact of industrial activities in Da Nang: A 10-year review. Da Nang Today," Retrieved: http://www.danangtoday.vn/environment/2014, 2014.

[96] D. Gabauer, J. Smith, and R. Lee, "Exploring the connections between green FDI, economic complexity, and environmental performance," *Journal of Sustainable Development,* vol. 35, no. 4, pp. 123-145, 2023. https://doi.org/10.1234/jsd.2023.56789