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Article

Toward sustainable development: Green economy with economic growth and carbon emission in Vietnam

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Abstract: Transitioning to a green economy is a global concern, considered a pathway to sustainable development. This paper aims to investigate the effect of the transition into a green economy on Vietnam's sustainable development and its two economic and environmental dimensions, with consideration of several essential issues including renewable energy, technological innovation, natural resource rents (oils, forest, and minerals), foreign direct investment, and trade. This paper utilizes data from 1996 to 2020 and then applies the autoregressive distributed lag (ARDL) method for analysis. The results conclude that renewable energy is a driving key to reducing environmental degradation, but it hampers economic growth, while the contrast occurs with technology. Our results emphasize the dependence on non-renewable energy, whereas the innovation of technology does not show a green orientation in Vietnam. Furthermore, there is a lack of sustainability in the effect of natural resource rents, foreign direct investment, and trade. Overall, the transition into a green economy in Vietnam does not illustrate the sustainable orientation. The findings of this research provide empirical evidence to clarify the relationship between this transition and its driving factor, with sustainable development and the two economic environment dimensions. In addition, this study will bring worthwhile implications for the policymakers and scholars on whether the transition to a green economy fulfills the orientation towards sustainability, then enhancing the economy's efficiency to achieve green growth, following the pathway to sustainable development.

Keywords: transitioning; green economy; sustainable development; renewable energy; technological innovation; natural resource rents

1. Introduction

Sustainable development is a critical concern in many nations. In the pathway to reach this target, transition into a green economy is considered an inevitable step (UNEP, 2011, World Bank, 2012, Sharif et al., 2023). The term "green economy" became well-known for the first time at the Rio 20+ Conference, coming with the major concept of achieving "green growth" (Barbier, 2012). More specifically, it is the combination of two core issues: maintaining economic growth and preserving the environment (Bina, 2013, Kshitij et al., 2022). Accordingly, several essential issues have been indicated for the transition into a green economy.

One of the critical issues is reducing carbon emissions, which was recognized by numerous nations in the Rio+20 Conference (Barbier, 2012), becoming the main concept of the Paris Agreement (Li et al., 2022d). Although there are multitudinous factors around this target, technological innovation and renewable energy take crucial roles (Mathews and Tan, 2011, Loiseau et al., 2016, UNEP, 2016). Indeed, renewable energy consumption has a significant meaning in reducing the dependence on fossil energy to protect the environment (Dogan and Seker, 2016, Dong et al., 2018, Dawid et al., 2021). Besides, technological innovations is one of the driving factors in controlling emission, and achieving green growth (Rahman et al., 2022, Habiba et al., 2022, Metawa et al., 2022, Sarwar et al., 2022, Su et al., 2023). Moreover, technological innovation is one of the indispensable focuses for moving toward a green economy, following sustainable development (Lorek and Spangenberg, 2014, Song et al., 2019).

Another crucial issue is resource efficiency, which takes an important role in the transition into a green economy (UNEP, 2011, Xuan et al., 2023). It not only has a strong relationship with controlling environmental degradation but also affects the improvement of economic performance and growth (Reilly, 2012). Indeed, natural resources can be seen as a blessing for a nation (Naseer et al., 2020, Fu and Liu, 2023). However, if it is used inefficiently, and the rich resource could become a "cruse" (Jiang et al., 2021, Li et al., 2022a), affecting environmental sustainability (Li et al., 2022e) and economic growth. It could raise the dependence on natural resources, which reduces economic productivity (Shahbaz et al., 2019, Fu and Liu, 2023). Thus, using natural resources efficiently takes a critical role in the transition into a green economy. In this paper, we concentrate on three kinds of natural resources, which are oil, forest, and minerals.

Furthermore, economic integration has a significant effect on transitioning into a green economy. The effect of economic openness spreads to multiple dimensions in a nation, especially the economic, social, and environmental (Barros and Martínez-Zarzoso, 2022). Indeed, trade openness and foreign direct investment (FDI) are the driving keys to economic growth (Kong et al., 2021, Keho, 2017, Opoku et al., 2019), contributing to the green economy's transition through investment, technological transfer (Zheng et al., 2022, Ofori et al., 2023). As mentioned, there are several fundamental issues around this transition: renewable energy, technological innovation, natural resource rents (oils, forests, and minerals), foreign direct investment, and trade openness.

Transitioning into a green economy has a tight connection with sustainable development. The green economy is a pathway toward sustainable development. (UNEP, 2011, World Bank, 2012). The concept of "sustainable development" became well-known from "The Brandtland Report" (WCED, 1987). It is a development that "meets the needs of the present without compromising the ability of future generations to meet their own needs". The green economy with the critical task of achieving green growth is also similar to the aims of two dimensions of sustainable development, which are economic development and environmental sustainability (Lélé, 1991). However, the negative effect of the transition process is indicated in several nations, followed by challenges in combining the two dimensions to maintain economic growth while still conserving the environment (Zakari et al., 2022, Khan and Hou, 2021). The main force of economic growth is still technology aligning with non-renewable energy (Xuan et al., 2023), whereas renewable energy consumption does not reach the level of reducing carbon emission target to follow sustainable development (Sharif et al., 2023). Besides, technological innovation could promote environmental pollution, while it raises the energy demand with the new technology (Su et al., 2023). Moreover, using natural resources could bring back economic benefits, but it also affects environmental sustainability (Saud et al., 2020, Nathaniel, 2021). Economic integration and openness are the driving forces of the economy, especially emerging economies. However, the results of several studies investigating the environmental Kuznets curve (EKC), ecological footprint, or pollution heaven hypothesis, indicated the negative relation between this issue and sustainability, mostly in developing countries (Nassani et al., 2021, Destek and Sinha, 2020, Appiah et al., 2022). To sum up, the above issues are critical factors in achieving green growth and transitioning to a green economy. Even existing study mostly claim that green economy is the pathway to achieving sustainable development. (UNEP, 2011, World Bank, 2012, Sharif et al., 2023). However, this transition has not always achieved the necessary conditions for sustainability (Lorek and Spangenberg, 2014). Indeed, the relationship between this transition and sustainable development is unclear, while the driving factors around this transition could have different effects on sustainable development depending on the level of development, level of income, and socio-economic characteristics, according to previous empirical research.

In Vietnam, the early perspective of "sustainable development" emerged in the Document of Vietnam 8th Party Congress in 1996, which also emphasized the point of "aligning the economic growth with environmental conservation". To realise the Millennium Development Goals (MDGs) and then Sustainable Development Goals (SDGs), the orientation toward sustainable development is included in political documents such as the growth strategy approved by the Prime Minister, the legal framework, government program (Nishitani et al., 2021). Besides, the government also established the Sustainable Development Support Fund to help communities and organizations achieve SDGs. According to World Bank data from 1996–2020, the economic growth in Vietnam increased rapidly by approximately 5.2 percent per year, followed by the growth of carbon emissions of 10 percent annually. It cannot be denied that technological innovation has a great role in promoting economic growth in Vietnam. Besides, renewable energy is still a driving key to ensuring energy security, achieving green growth and moving towards sustainable development. Thus, renewable energy is still subject to a lot of potential exploitation. However, the participation of this energy in the energy sector of Vietnam's economy is quite low (Nguyen et al., 2021). In addition, Vietnam is one of the top countries that have a high environmental footprint, considering the environmental degradation issues and exploiting natural resources (Cai and Le, 2023). Therefore, regarding sustainable development, a concern is raised about whether the transition into a green economy in Vietnam shows sustainability.

As a developing country, Vietnam also participates in the race of transitioning to a green economy toward sustainable development. In this process, the transition has a specific effect due to the difference in the social-economic condition, compared with other countries. Vietnam's economy is worth investigating due to its rapid growth and the major energy consumption with the high increasing speed of carbon emission (Hung, 2023). Thus, this paper investigates the impacts of this transition on sustainable development and its two dimensions: economic growth and environmental sustainability in Vietnam. Applying the autoregressive distributed lag method on data from 1996 to 2020, the objective of this paper is to contribute to the knowledge of the relationship between transitioning into a green economy and sustainable development. The result shows that technological innovation promotes economic growth but reduces environmental sustainability. The contrast occurs with renewable energy. Meanwhile, there is a lack of sustainability in the impact of natural resource rents, foreign direct investment, and trade on sustainable development. This study reveals that the transition into a green economy in Vietnam does not illustrate a sustainable orientation. Therefore, the nexus between this transition with sustainable development and its two dimensions is still unclear. Our results demonstrate that the transition with its driving factor could have a negative effect, which doesn't appropriate sustainability. As a typical developing country, this study also contributes valuable evidence to clarify the relationship between this transition and its driving factor, with the sustainable development and the two economic environment dimensions. In addition, this study will bring worthwhile implications for the policymakers and scholars on whether the transition to a green economy fulfills the orientation towards sustainability, then enhancing the economy's efficiency to achieve green growth, following the pathway to sustainable development.

2. Literature review

The well-known term of the green economy is given by UNEP. It is an economy with low carbon emissions, resource-efficient, and socially inclusive, emphasizing the role of renewable energy and innovative technology to achieve the green target (UNEP, 2011, UNEP, 2016). In general, a green economy needs to maintain and balance both two dimensions: economic growth coming with the conservating environment (OECD, 2011, Loiseau et al., 2016). These two dimensions are the core target of developing a green economy (Jacobs, 2012; Reilly, 2012). Besides, green economy and sustainable development have a tight relationship, while the two concepts also focus on economic and environmental dimensions. However, the green economy is not the alternative concept of sustainable development, but it is the inevitable pathway to follow sustainability (UNEP, 2011; Sharif et al., 2023).

Indeed, the transition to a green economy needs to enhance economic growth aligning with environmental sustainability. In this process, there are several fundamental issues, which are mentioned in section one that should be considered: renewable energy, technological innovation, natural resource rents (oils, forests, and minerals), foreign direct investment, and trade openness. However, these issues have a critical role in the way toward sustainability.

Technological innovation is a driven key to moving toward a green economy, following sustainable development. Indeed, Lorek and Spangenberg, 2014 emphasized that the economy needs to focus on sustainability rather than just "greening" to achieve the necessary conditions for sustainable development. They also indicate a critical condition, which is sustainable production and consumption. In other words, it is balancing the above two issues, and achieving high efficiency in using resources to fulfill the needs. Thus, they emphasize technological innovation as the key to achieving this condition, especially when the efficiency of patterns such as sourcing, and production are based on technology. Sharma et al. (2021) also indicate that technological innovation has important effects on promoting the manufacturing sector, raising the performance of operations, and further enhancing economic growth. Indeed, technological innovation is the driving key to promoting economic growth (Chaudhry et al., 2021). Although its role in economic growth is widely supported, its effect on sustainable development is unclear, and there are different opinions about its impact on the environmental dimension (Ahmad et al., 2023b). Many scholars support the perspective that technological innovation is a critical strategy for reducing negative environmental impacts through controlling resource efficiency and reducing emissions in production and consumption processes (Jun et al., 2022; Chien et al., 2021; Khan et al., 2020; Shahbaz et al., 2020; Yikun et al., 2023). On the other hand, the contradictory opinions support the adverse effect of technology on environmental sustainability. Thus, technological innovation could lead to the raising of energy demand, which will cause more pollution (Jin et al., 2018, Gu and Wang, 2018). Dauda et al. (2019), considering the different income level between countries, indicate that technological innovation tends to reduce emissions in high-income countries, while the adverse situation happens the low-middle-income countries. In addition, Chen and Lee (2020) emphasize that the technological innovation in low-income countries could not reach to the green-orient condition with the priority for economic dimension.

Renewable energy is an essential strategy for the transition to a green economy (Gasparatos et al., 2017). Furthermore, it can be seen as the essential solution to sustainable development (Ibrahim et al., 2022). Meanwhile, fossil energy is one of the main factors for environmental degradation (Mensah et al., 2019), through growing greenhouse gas (Hanif et al., 2019), increasing the dependence on limited resources (Khan et al., 2023b), renewable energy is expected to improve environmental sustainability (Jiang et al., 2022). Despite the irreplaceable role of renewable energy in the environmental dimension (Inglesi-Lotz and Dogan, 2018, Kuo et al., 2022), the contribution of this energy to economic growth is still debated. The first perspective shows that renewable energy promotes economic growth (Dogan and Ozturk, 2017, Rahman and Velayutham, 2020, Khan, 2020), while another idea supports that the contribution of renewable energy does not show significant impact (Destek and Sinha, 2020, Nathaniel et al., 2021, Chen et al., 2020). Meanwhile, the other perspective indicates that renewable energy could slow down economic growth. This adverse effect could be due to the high cost of infrastructure for investment in this sector (Bhattacharya et al., 2016), the higher price of this energy compared to traditional energy (Khan et al., 2023a), or the over-dependence on non-renewable energy source in the economy (Li et al., 2022f). Furthermore, Dogan et al. (2020) indicated that the income level of the country could be involved in the effect of renewable energy for this dimension, with a negative effect in high-income countries and the positive effect on low- and middle-income countries.

According to previous empirical studies, the effect of the above two factors on sustainable development and the two dimensions could be different depending on countries and areas, during the transition to a green economy. Multiple research studies indicated that renewable energy and technological innovation have significant meaning to the environment, the critical pillar of development. However, the contrasting opinion can be found in other researchs. Wang et al. (2023) indicated that renewable energy and technological innovation promote environmental sustainability in 14 developing countries in Europe, which also neutralizes environmental degradation in the long term. Renewable energy has a positive impact on sustainable development in Canada (Adebayo, 2022). The same result is shown in the United States (Pata, 2021), but renewable energy does not contribute significantly in Korea (Pata and Kartal, 2023). Nathaniel et al. (2021) indicated that the impact of renewable energy on environmental sustainability is shown insignificantly in MENA countries, especially the negative effect found in Iran. Besides, although the driven contribution of this energy on economic growth has been found in the research in China (Lin and Moubarak, 2014), in the OECD and non-OECD countries in the 1990-2015 period (Ivanovski et al., 2021), Bhattacharya et al. (2016) indicated the negative effect in India, Ukraine, Isreal. Dogan et al. (2020) also finds the negative effect of renewable energy consumption on economic growth in high-income OECD countries from 1990 to 2010. Su et al. (2023) claimed that technological innovation has a meaningful role in reducing carbon emissions in the US. However, on the other hand, it also can raise the demand for energy with the new technology, which will cause more pollution. The research of Zhao et al. (2023) supported that innovation in technology does not bring back a significant effect on sustainable development in several BRICS nations. Meanwhile, technological innovation is an important driving factor in reaching sustainable development in China (Li et al., 2022a; Ahmad et al., 2023b).

The control of resource efficiency to fulfill the present need is an essential key to following sustainable development (UN, 2015). Indeed, if the natural resource is overused, it could lead to environmental degradation, depleting the forest or mineral resources, and reducing the biodiversity (Ahmad et al., 2023a). Resource abundance could bring back economic benefits, but it also could affect environmental sustainability, thereby affecting the goal of sustainable development. (Saud et al., 2023; Nathaniel et al., 2021). This is also linked with the resource curse hypothesis, emphasizing the adverse effect between natural resources and economic growth, further revealing unsustainability (Li et al., 2022c). In clarification, Guo et al. (2023) claim that natural resource abundance could affect the performance of the manufacturing sector, or private savings. Moreover, they emphasize that the lack of the right institutional management could lead to producers utilizing this condition to follow rent-seeking activities, targeting the productive outcome, however slowing the growth.

Research by Hossain et al. (2023) indicates that resource use affects increasing environmental degradation in India. Similar conclusions were also found in a study by Adebayo et al. (2022) in 10 NIC countries. Fu and Liu (2023 based on world data show that resource use, going into three aspects of forest resources, minerals, and gas all have an impact on sustainable development. However, Ibrahim and Ajide (2021) show that resource use has opposite effects on environmental degradation in some BRICS countries. Xiaoman et al. (2021) shows that resource use decreases environmental pollution in the case of MENA countries. Shahabadi and Feyzi, (2016) argue that resource wealth will create an incentive to improve the environment through foreign investment. Balsalobre-Lorente et al. (2018) show the positive impact of natural resources on the reduction of environmental pollution in EU-5 countries. Besides, natural resources also influence economic development, an important pillar of sustainable development, as supported by several research studies. For example, Huang et al. (2020) show that forest and mineral resources have a positive impact on economic growth in some Asian countries. Hordofa et al. (2022) also show a positive effect of natural resources on economic performance in some G7 countries. Mohamed (2020), on the other hand, shows a positive impact of natural resources on economic growth in the short term, but in the long term, it will have a negative effect in the case of Sudan.

In addition, integration issues also have an impact on sustainable development. However, the nexus between trade openness and FDI with sustainable development is still unclear. FDI can be seen as a crucial driving force promoting sustainable economic development (Xuan et al., 2023). There is a close relationship between economic openness and economic growth, followed by the major support of the idea that economic openness promotes economic growth (Yu, 2018). Indeed, it could enhance economic growth by promoting more efficient resource allocation (Helpman and Krugman, 1987; Rodrik, 1988), raising the dynamic in the economy due to competition in the integration context (Paus and Robinson, 1997), or the higher efficiency of foreign capital stimulating the growth (Borensztein et al., 1998). However, there are also opposite opinions, arguing that openness is not always the driving force for economic development. Moreover, it could have a negative effect on economic growth. Aitken and Harrison (1999) with their theory, argue that due to competition the FDI firms with higher advantages could raise the pressure, leading to the reduction of production activities in the domestic firms. More specifically, they indicate that importing materials from international sources instead of the domestic sector could be the reason for this situation. Besides, the high investment in the fields that utilize low-skilled workers could lead to this negative effect. Ali and Abdullah (2015) emphasize that the export of raw materials is mainly instead of final products, followed by this negative effect on economic growth. The impact of economic openness on the environmental dimensions is not unanimous, with both positive and negative impacts appearing, depending on different countries or periods (Yamarik and Ghosh, 2011; Jabeen et al., 2023). In addition, the relationship between economic openness and with environmental dimension could be linked with the pollution heaven hypothesis, especially in developing countries. This idea is given by Pethig (1976) and Walter and Ugelow (1979), and then affirmed by Baumol and Oates (1988). Thereby, Grossman and Krueger (1991), Grossman and Krueger (1995), and Tobey (2001) enhance this hypothesis, indicating that economic openness with benefits from international trade and foreign capital could promote the economy, whereas less concern about environmental sustainability, followed by the negative effect on the environmental degradation. Contrast with this hypothesis is the pollution halo hypothesis, which suggests that foreign investment, along with trade openness, has a positive effect on promoting environmental quality (Balsalobre-Lorente et al., 2019).

Opoku et al. (2019) shows that FDI is an important factor for economic development in 38 African countries. Herzer et al. (2008) examines the data in 28 developing countries, claiming that it exits the negative effect of FDI on economic growth in several countries. Sunde (2017) support the FDI-led growth hypothesis with the research in South Africa. Wang et al. (2023) however, shows that FDI has a negative impact on sustainable development in terms of the environmental dimension in their study in 14 European countries (Nassani et al., 2021) FDI has a positive impact on environmental pollution, while the effect of trade openness is not clear from the study in 24 LICs. (Destek and Sinha, 2020) shows that trade openness promotes ecological sustainability in 24 OECD countries, while the results of Appiah et al. (2022) show a negative effect on environmental pollution in some emerging economies within the period 1971-2013. Tamazian et al. (2009) indicate the positive effect of FDI on environmental quality in BRIC countries. Saqib et al. (2023) revealed that FDI has a negative impact on environmental degradation. Besides, Shahbaz et al. (2012) show that trade openness decreases environmental pollution in the long term in Pakistan within the period 1971–2009. Koc and Bulus (2020) also have a similar result to the results in Korea in the period 1971–2017. However, Gorus and Aslan (2019) support the pollution heaven hypothesis in MENA countries, showing the negative effect of openness on environmental quality.

Therefore, transitioning to a green economy could drift off the sustainable pathway, while its essential driver issues could have different impacts on sustainable development and the two main dimensions. Besides, the effect of several drivers is still unclear. Therefore, the research focuses on clarifying the impact of the transition to a green economy on sustainable development and at the same time deepening the influence on the two economic and environmental dimensions of sustainable development in Vietnam, a developing country, with data collected from 1996–2020, thereby further clarifying the relationship between these issues.

3. Data and methodology

3.1. Data description

The data used in this paper is the secondary data, which is taken from the World Development Indicators Database Online supplied by the World Bank, about Vietnam data in the period 1996 to 2020. The detailed, adjusted net savings (as a percentage of gross national income (GNI) is the extension of traditional net savings with the addition of human capital accumulation, deducting natural resource depletion, and is used as a representation of sustainable development. This indicator is promoted by World Bank (Bolt et al., 2002), and is commonly used in research on sustainable development (Azam et al., 2022), (Güney, 2019). GDP per capita is used to measure economic growth, representing the economic dimension of sustainable development. The CO_2 emission (kt) index is used to measure carbon emissions, illustrating the environmental degradation in the dimension of the environment. Trade openness is calculated by the percentage of GDP. FDI (calculated by the percentage of GDP) is used to measure foreign direct investment. Technological innovation is measured by the proportion of medium and high-tech industry value added to the total value added of manufacturing. Renewable energy use is measured by the proportion of the total final energy consumption. Nature resources are measured by the nature resources rents with three categories: oil rents, forest rents, and mineral rents. The detail of the variable description is shown in **Table 1**.

Table 1. Variable description and sources.

Ord. No.	Variable	Name	Index	Source
1	SD	Sustainable development	Adjusted net savings, excluding particulate emission damage (% of GNI)	World Development Indicators
2	CO_2	Carbon emission	CO_2 emissions (kt)	World Development Indicators
3	GDP	Economic growth	GDP per capita	World Development Indicators
4	FDI	Foreign direct investment	FDI (%GDP)	World Development Indicators
5	TRO	Trade openness	Trade (%GDP)	World Development Indicators
6	TEC	Technological innovation	The proportion of medium and high-tech industry value added in total value added of manufacturing	World Development Indicators
7	REC	Renewable energy consumption	Renewable energy consumption (% of total final energy consumption)	World Development Indicators
8	OILR	Oil rents	Oil rents (% of GDP)	World Development Indicators
9	FORR	Forest rents	Forest rents (% of GDP)	World Development Indicators
10	MINR	Mineral rents	Coal rents (% of GDP)	World Development Indicators

3.2. Research model

This paper investigates the impacts of this transition on sustainable development and its two dimensions: economic growth and environmental sustainability, through several fundamental issues, which are: renewable energy, technological innovation, natural resource rents (oils, forest, and minerals), foreign direct investment, and trade openness. With these issues and our research target, three models are constructed, referencing some recent research (Fu and Liu, 2023; Ahmad et al., 2023b; Nassani et al., 2021; Li et al., 2022e).

The first model examines the effect of the green economy transition on sustainable development:

$$SD_{it} = f(FDI_{it}, REC_{it}, TEC_{it}, TRO_{it}, OILR_{it}, FORR_{it}, MINR_{it}) \quad (1)$$

Accordingly, SD represents sustainable development, FDI is foreign direct investment, REC is renewable energy consumption, TRO is trade openness, OILR is oil rents, FORR is forest rents, and MINR is mineral rents.

The second model examines the effect of the green economy transition on economic growth, representing the economic dimension:

$$GDP_{it} = f(FDI_{it}, REC_{it}, TEC_{it}, TRO_{it}, OILR_{it}, FORR_{it}, MINR_{it}) \quad (2)$$

In detail, GDP is economic growth representing the economic dimension, FDI is foreign direct investment, REC is renewable energy consumption, TRO is trade openness, OILR is oil rents, FORR is forest rents, and MINR is mineral rents.

The third model examines the effect of the green economy transition on environmental sustainability, representing the environmental dimension:

$$CO_{2it} = f(FDI_{it}, REC_{it}, TEC_{it}, TRO_{it}, OILR_{it}, FORR_{it}, MINR_{it}) \quad (3)$$

Meanwhile, CO_2 is carbon emission representing the environmental dimension, FDI is foreign direct investment, REC is renewable energy consumption, TRO is trade openness, OILR is oil rents, FORR is forest rents, and MINR is mineral rents.

3.3. Research methodology

This paper uses the quantitative research method to investigate the impacts of this transition on sustainable development and its two dimensions: economic growth and environmental sustainability in the period from 1996 to 2020. The ARDL model is applied due to the following reasons. According to Pesaran et al. (2001), applying the ARDL method has some advantages, especially in analyzing the time series data rather than other time series methods. The cointegration method requires a large sample and all variables have to be in the order I(1) (Johansen, 1988). However, The ARDL method is efficient and consistent even with the small datasets. Moreover, the ARDL method does not require the condition that variables have the same order so that it can apply to the variables in the order I(0) or I(1) (Ullah et al., 2021). The ARDL method can estimate both long-run and short-run terms. Besides, the ARDL method can manage the situation of serial correlation and endogeneity issues (Ahmad and Du, 2017).

Thus, according to Pesaran et al. (2001), the general ARDL model for the study is built in log form as follows:

$$\Delta LSD_t = \chi_0 + \sum_{i=1}^{\chi 1} \chi_{1i}\Delta LSD_{t-i} + \sum_{i=0}^{\chi 2} \chi_{2i}\Delta LFDI_{t-i} + \sum_{i=0}^{\chi 3} \chi_{3i}\Delta LREC_{t-i} + \sum_{i=0}^{\chi 4} \chi_{4i}\Delta LTEC_{t-i} + \sum_{i=0}^{\chi 5} \chi_{5i}\Delta LTRO_{t-i} + \sum_{i=0}^{\chi 6} \chi_{6i}\Delta LOILR_{t-i} + \sum_{i=0}^{\chi 7} \chi_{7i}\Delta LFORR_{t-i} + \sum_{i=0}^{\chi 8} \chi_{8i}\Delta LMINR_{t-i} + \kappa_1 LSD_{t-1} + \kappa_2 LFDI_{t-1} + \kappa_3 LREC_{t-1} + \kappa_4 LTEC_{t-1} + \kappa_5 LTRO_{t-1} + \kappa_6 LOILR_{t-1} + \kappa_7 LFORR_{t-1} + \kappa_8 LMINR_{t-1} + \varepsilon_t \quad (4)$$

$$\Delta LGDP_t = \sigma_0 + \sum_{i=0}^{\sigma 1} \sigma_{1i}\Delta LGDP_{t-i} + \sum_{i=0}^{\sigma 2} \sigma_{2i}\Delta LFDI_{t-i} + \sum_{i=0}^{\sigma 3} \sigma_{3i}\Delta LREC_{t-i} + \sum_{i=0}^{\sigma 4} \sigma_{4i}\Delta LTEC_{t-i} + \sum_{i=0}^{\sigma 5} \sigma_{5i}\Delta LTRO_{t-i} + \sum_{i=0}^{\sigma 6} \sigma_{6i}\Delta LOILR_{t-i} + \sum_{i=0}^{\sigma 7} \sigma_{7i}\Delta LFORR_{t-i} + \sum_{i=0}^{\sigma 8} \sigma_{8i}\Delta LMINR_{t-i} + \lambda_1 LGDP_{t-1} + \lambda_2 LFDI_{t-1} + \lambda_3 LREC_{t-1} + \lambda_4 LTEC_{t-1} + \lambda_5 LTRO_{t-1} + \lambda_6 LOILR_{t-1} + \lambda_7 LFORR_{t-1} + \lambda_8 LMINR_{t-1} + \varepsilon_t \quad (5)$$

$$\Delta LCO2_t = \alpha_0 + \sum_{i=0}^{\alpha 1} \alpha_{1i}\Delta LCO2_{t-i} + \sum_{i=0}^{\alpha 2} \alpha_{2i}\Delta LFDI_{t-i} + \sum_{i=0}^{\alpha 3} \alpha_{3i}\Delta LREC_{t-i} + \sum_{i=0}^{\alpha 4} \alpha_{4i}\Delta LTEC_{t-i} + \sum_{i=0}^{\alpha 5} \alpha_{5i}\Delta LTRO_{t-i} + \sum_{i=0}^{\alpha 6} \alpha_{6i}\Delta LOILR_{t-i} + \sum_{i=0}^{\alpha 7} \alpha_{7i}\Delta LFORR_{t-i} + \sum_{i=0}^{\alpha 8} \alpha_{8i}\Delta LMINR_{t-i} + \beta_1 LCO2_{t-1} + \beta_2 LFDI_{t-1} + \beta_3 LREC_{t-1} + \beta_4 LTEC_{t-1} + \beta_5 LTRO_{t-1} + \beta_6 LOILR_{t-1} + \beta_7 LFORR_{t-1} + \beta_8 LMINR_{t-1} + \varepsilon_t \quad (6)$$

The ARDL method is implemented with the following steps, according to Pesaran et al. (2001). At first, the Bound test is used to find the cointegration relationship between the variables, thereby determining the long-run relationship between the variables. The lag length is determined by running the VAR (vector autoregression) model and the AIC (Akaike Information Criterion) criterion. After that, the ARDL model is estimated with the optimal lag, which has been found, to test the long-term relationship between the variables in the model, followed by evaluating the short-term effects of the variables with the error correction model (ECM). We also apply the FMOLS method (fully modified ordinary least squares) to confirm long-run findings. Finally, after having the results from the ARDL model, diagnostic tests are conducted to exemplify the model's reliability. The normality test for testing the normal distribution, followed by the Bruce- Godfrey Serial Correlation Lagrange multiplier (LM) Test, and the Heteroskedasticity Test: Breusch-Pagan-Godfrey to make sure not existing the serial correlation or Heteroskedasticity issues in the three models. Besides, the Ramsey Reset Test is used to check the appropriate functional form. The cumulative sum (CUSUM) and CUSUM square tests are used to check the stability of each model.

4. Discussion

4.1. Result findings

We apply the ARDL model with the mentioned steps in Section 3.3. The results are presented according to the order of implemented steps, respectively as follows: the unit root test result, the bound test result, the long-run, and short-run estimated results, the robust check with the FMOLS method, and the diagnostic test result. In detail, the result is illustrated below:

4.1.1. Unit root test

Before applying the ARDL model, it is necessary to ensure the stationarity of the variables in the model. The Dickey-Fuller (ADF) test (Dickey and Fuller, 1979), is used to check the stationarity of the variables and obtain the results as in **Table 2**.

Table 2. The Unit root test result.

	Agumented Dickey-Fuller		
Variables	**Level Stationary**	**1st difference**	**Order**
LSD	−2.467668	−4.632817***	I(1)
LGDP	−0.441386	−2.961041*	I(1)
LCO2	−2.354363	−4.362082**	I(1)
LFDI	−3.512045*	−3.258111	I(0)
LREC	−3.658446**	−3.895772	I(0)
LTEC	−2.340061	−3.795777**	I(1)
LTRO	−2.415197	−3.812009**	I(1)
LOILR	−1.219744	−4.582836***	I(1)
LFORR	−2.866431	−3.932144**	I(1)
LMINR	−0.656527	−6.323732***	I(1)

Note: *** indicates 1%, ** indicates 5% and * indicates a 10% level of significance. Source: Calculation based on Eviews software.

As can be seen in the test results, the variables of LFDI, and LREC are integrated into order 0, and the variables LSD, LGDP, LCO2, LTEC, LTRO, LOILR, LFORR, and LMINR are integrated into order 1. In case the variables do not have the same cointegration order of I(1) or I(0), the ARDL model is the most suitable model for experimental research (Pesaran and Shin, 1995, Pesaran et al., 2001).

4.1.2. The Bound test

Before implementing the Bound test, we determined the optimal lag length by running the VAR (vector autoregression) model. The results are shown in **Table 3**. Based on the criterion, the optimal lag length is 1, which will be applied for the next estimation steps.

Table 3. Lag length criteria.

Model	Lag	LogL	LR	FPE	AIC	SC	HQ
F_{SD}(SD/ FDI, REC, TEC, TRO, OILR, FORR, MINR)	1	168.5068	176.4452*	6.04e−14*	−8.042237*	−4.508076*	−7.104623*
F_{GDP}(GDP/FDI, REC, TEC,TRO, OILR, FORR, MINR)	1	228.2130	227.6336*	4.17e−16*	−13.01775*	−9.483590*	−12.08014*
F_{CO2}(CO2/FDI, REC, TEC, TRO, OILR, FORR, MINR)	1	195.3136	194.1712*	6.47e−15*	−10.27613*	−6.741971*	−9.338519*

Note: * indicates lag order selected by the criterion; LR: sequential modified LR test statistic (each test at 5% level); FPE: Final prediction error; AIC: Akaike information criterion; SC: Schwarz information criterion; HQ: Hannan-Quinn information criterion.

The Bound test is used to examine the cointegration relationship between variables with the following hypothesis:

- H0: $\kappa_1 = \kappa_2 = \kappa_3 = \kappa_4 = \kappa_5 = \kappa_6 = \kappa_7 = \kappa_8 = 0$. No cointegration among the variables.
- H1: $\kappa_1 \neq \kappa_2 \neq \kappa_3 \neq \kappa_4 \neq \kappa_5 \neq \kappa_6 \neq \kappa_7 \neq \kappa_8 = 0$. Existing the cointegration among the variables.

Constructing the same hypothesis with the other two models, we get the results in **Table 4**:

Table 4. The Bound test.

Model	F-statistic	Bounds critical values					
		1%		5%		10%	
		I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
F_{SD}	6.984800	1.92	2.89	2.17	3.21	2.73	3.9
F_{GDP}	46.289893	1.92	2.89	2.17	3.21	2.73	3.9
F_{CO2}	5.664052	1.92	2.89	2.17	3.21	2.73	3.9

Source: Calculation based on Eviews software.

According to the result in **Table 4**, the F-statistic value is higher than the upper and the lower bound values at the level of 5 percent significance, so the alternative hypothesis that the existence of cointegration is accepted, claiming the long-run relationship among the variables.

4.1.3. Estimating the long-run and short-run coefficients of the ARDL model

We estimated the coefficients of the variables in the long run, then continued to use the ECM model to estimate the coefficients in the short run in each model. The results of the three models are shown in **Table 5**, **Table 6**, and **Table 7** respectively. After that, these results are used to investigate the impacts of this transition on sustainable development and its two dimensions: economic growth and environmental sustainability.

Model 1: Sustainable development is the dependent variable

In the first model whose dependent variable is sustainable development, the results are shown in **Table 5**. Firstly, the foreign direct investment coefficient illustrates a negative impact on sustainable development in the long-run term, whereas it shows no significant impact in the short-run term. In detail, if FDI grows by 1 percent in the long term, sustainable development will decrease by 0.38 percent. Besides, trade openness shows a negative effect in both terms. These two results indicate the detrimental impact of integration on sustainable development in the long term. One percent rise in renewable energy will pull down sustainable development by 0.883 percent in short-run. Thus, renewable energy has a negative impact on sustainable development in the short-run term, but in the long-run term, the coefficient is not significant, revealing the ineffective of this energy. Technological innovation plays a positive role in the short-run term, however, the contrast situation happens in the long-run term. One percent growth of technological innovation promotes sustainable development by 0.52 percent in the short-run but reduces it by 0.7 percent in the long-run term. With natural resource rents, mineral rents have a negative effect while the opposite situation happens with forest rent. However, their coefficient is not significant in the long term. The error correction term is −0.869, which is significant at 1 percent, indicating the 86.9 percent speed of adjustment.

Table 5. The long-run and short-run coefficient of model 1—SD is the dependent variable.

	The Short-run results	**The long-run results**
Variables	**Coefficient**	**Coefficient**
FDI	−0.093 (0.065)	−0.388* (0.236)
REC	−0.883*** (0.185)	−0.01 (0.385)
TEC	0.522***(0.118)	−0.702** (0.345)
TRO	−1.005*** (0.191)	−1.24** (0.594)
OILR	0.036 (0.038)	−0.148 (0.176)
FORR	0.317 *** (0.079)	−0.138 (0.322)
MINR	−0.034***(0.012)	−0.035 (0.049)
COINTEQ(−1)	−0.869 (0.077)	
CE = LSD(−1) − (−0.388317*LFDI(−1) − 0.010083*LREC(−1) − 0.702334 *LTEC(−1) − 1.240300*LTRO(−1) − 0.148182*LOILR(−1) − 0.138336 *LFORR(−1) − 0.034925*LMINR(−1) + 11.700165)		

Note: ***, ** and * indicates the 1%, 5% and 10% level of significance, respectively. Standard errors in parentheses. Source: Calculation based on Eviews software.

Model 2: Economic dimension – while GDP is depentdent variable

The results of the second model are shown in **Table 6**. According to the result, FDI has a slightly negative effect on economic growth in the long term, while its rising by 1 percent will pull down economic growth by 0.15 percent. In the short term, its impact is statistically insignificant in the short-run term. The same situation happens with trade openness in both terms, showing the increasing extent of the integration does not come with long-term benefits. Renewable energy has a negative impact on economic growth in both the short and long-run term, revealing that this energy does not contribute significantly to economic growth. Thus, if this energy consumption grows by one percent, the economic growth will decrease by 0.43 percent in the short-run and a higher rate of 0.83 percent in the long-run term. Technological innovation promotes economic growth, while a one percent increase in this sector will pull up economic growth by 0.3 percent and 0.28 percent in the short and long-run term, respectively. Natural resources such as oil rents, and forest rents have a positive impact on economic growth, especially the effect of forest rent appearing in both terms. The error correction term is negative and significant.

Table 6. The long-run and short-run coefficient of model 2—GDP is the dependent variable.

	The Short-run results	The long-run results
Variables	**Coefficient**	**Coefficient**
FDI	0.0045 (0.019)	−0.150** (0.060)
REC	−0.430*** (0.074)	−0.838*** (0.166)
TEC	0.306***(0.0641)	0.282* (0.140)
TRO	0.029 (0.051)	0.236 (0.191)
OILR	0.032* (0.017)	0.017 (0.072)
FORR	0.17 *** (0.041)	0.314 ***(0.087)
MINR	0.002(0.005)	0.025 (0.021)
COINTEQ(−1)	−0.668 (0.113)	

CE = LGDP(−1) − (−0.150065*LFDI − 0.838378*LREC(−1) + 0.282255*LTEC(−1) + 0.236656*LTRO + 0.017016*LOILR(−1) + 0.314567*LFORR(−1) + 0.025439*LMINR(−1) + 8.593003)

Note: ***, ** and * indicates the 1%, 5% and 10% level of significance, respectively. Standard errors in parentheses. Source: Calculation based on Eviews software.

Model 3: Enviromental dimensions—while CO_2 is the dependent variable

The effect of variables on environmental dimension is shown in **Table 7**. Renewable energy contributes significantly to environmental sustainability, while it reduces carbon emissions in both the short and long term. One percent rise in renewable energy will decrease environmental degradation by 0.86 percent and 1.62 percent in the short and long-run term respectively. Technological innovation increases carbon emissions while a raising of 1 percent will put up 0.28 percent of carbon emission. Nature resources rent has a significant impact on environmental sustainability. In detail, the growth of oil rent and forest rent will raise carbon emissions, especially forest rent show its effect in both terms. The error correction term is negative and significant.

Table 7. The long-run and short-run coefficient of model 3—CO_2 is the dependent variable.

	The Short-run results	The long-run results
Variables	**Coefficient**	**Coefficient**
FDI	−0.137 (0.107)	−0.245* (0.132)
REC	−0.865*** (0.091)	−1.627*** (0.334)
TEC	0.287***(0.0693)	0.337 (0.303)
TRO	0.021 (0.104)	0.340 (0.462)
OILR	0.060** (0.022)	0.045 (0.139)
FORR	0.246*** (0.045)	0.498** (0.199)
MINR	0.009 (0.007)	0.038 (0.043)
COINTEQ (−1)	−0.561 (0.057)	

CE = LCO2(−1) − (−0.245298*LFDI + 0.340442*LTRO(–1) − 1.626944*LREC(–1) + 0.337518*LTEC(–1) + 0.045110*LOILR(–1) + 0.498608*LFORR(–1) + 0.038786*LMINR(–1) + 15.026848)

Note: ***, ** and * indicates the 1%, 5% and 10% level of significance, respectively. Standard errors in parentheses. Source: Calculation based on Eviews software

To sum up, in three models, renewable energy shows a negative impact on sustainable development in the short run, while its effect is not significant in the long term. It contributes significantly to environmental sustainability, however, it also has a negative effect on economic growth. Technological innovation promotes sustainable development in the short run but the adverse effect happens in the long-run term. This variable is a driving key to economic growth in both terms, however, it raises environmental degradation. Nature resource has a significant impact on sustainable development. Growing in minerals rent and forest rent will reduce sustainability in both terms, whereas oil rent and forest rent will help to promote economics but also increase carbon emissions.

4.1.4. Robustness check with FMOLS

Table 8. The FMOLS results.

	F_{SD}	F_{GDP}	F_{CO2}
Variable	**Coefficient**	**Coefficient**	**Coefficient**
FDI	−0.429*** (0.119)	−0.184*** (0.058)	−0.314*** (0.070)
REC	0.356 (0.246)	−0.818*** (0.121)	−1.669 ***(0.145)
TEC	−0.009 (0.205)	0.285** (0.101)	0.275** (0.121)
TRO	−0.423 (0.356)	0.193 (0.176)	0.221 (0.210)
OILR	0.032 (0.093)	0.011 (0.046)	0.038 (0.055)
FORR	0.145 (0.159)	0.339*** (0.079)	0.480*** (0.094)
MINR	−0.062** (0.028)	0.028* (0.014)	0.048** (0.016)
R-squared	0.866	0.98	0.989
Adj. R-squared	0.807	0.972	0.984

Note: ***, ** and * indicates the 1%, 5% and 10% level of significance, respectively. Standard errors in parentheses. Source: Calculation based on Eviews software

We also apply FMOLS method to robust check, according to the advantages of this estimation for the long-run term rather than the ARDL method. The results are shown in **Table 8**. Overall, the effect of variables is quite similar to the long-run results of ARDL. Renewable energy has an insignificant effect on sustainable development, whereas it has a positive effect on reducing carbon emissions and an adverse effect on economic growth. A 1 percent of raising in energy consumption will reduce carbon emissions and economic growth by 1.66 and 0.81 percent, respectively. The contrasting situation happens with technological innovation, while it raises economic growth but also carbon emissions. FDI has a negative effect on sustainable development, while its 1 percent rise will come with a 0.42 percent reduction in sustainability. This variable also negatively affects economic growth in the long run, followed by the adverse effect on the environmental dimension. Nature resource rents contribute significantly to promoting economic growth but the increase in this sector also comes with environmental degradation. A 1 percent growth in forest rent will put up economic growth by 0.33 percent, followed by an increase in carbon emission by 0.48 percent. Besides, a 1 percent growth in mineral rent will decrease sustainable development by 0.06 percent, connected with a boost of economic growth and carbon emission by 0.028 percent and 0.048 percent, respectively.

4.1.5. Diagnostic tests

Several diagnostic tests are used to ensure the reliability of the model. More specifically, we use 4 tests: The normality Test, the Ramsey Reset Test, the Breuch-Godfrey Serial Correlation LM Test, and the Heteroskedasticity Test: Breusch-Pagan-Godfrey. The obtained results are presented in **Table 9**. Accordingly, the model has a normal distribution, and serial correlation or Heteroskedasticity issues do not exist in this model. The functional form is appropriate. Overall, the models are well fit.

Table 9. Results of several diagnostic tests.

Diagnostic Tests	F_{SD}	F_{GDP}	F_{CO2}
Normality Test	1.479 (0.477)	1.022 (0.599)	1.527 (0.465)
Ramsey Reset Test	0.839 (0.429)	0.042(0.967)	0.143 (0.889)
Breusch-Godfrey Serial Correlation LM Test	2.017 (0.214)	1.304 (0.3181)	0.941 (0.434)
Heteroskedasticity Test	0.521 (0.868)	1.878 (0.152)	1.309 (0.349)

Note: the *p*-value is in parentheses.

To check the stability of the model, we use the CUSUM and CUSUM square tests. The result of CUSUM (**Figure 1**) and CUSUM square test (**Figure 2**) is shown for model 1, followed by CUSUM (**Figure 3**) and CUSUM square test (**Figure 4**) for model 2, and CUSUM (**Figure 5**) and CUSUM square test (**Figure 6**) for model 3. At the 5 percent significance, these graphs show that variables are stable in three models over time.

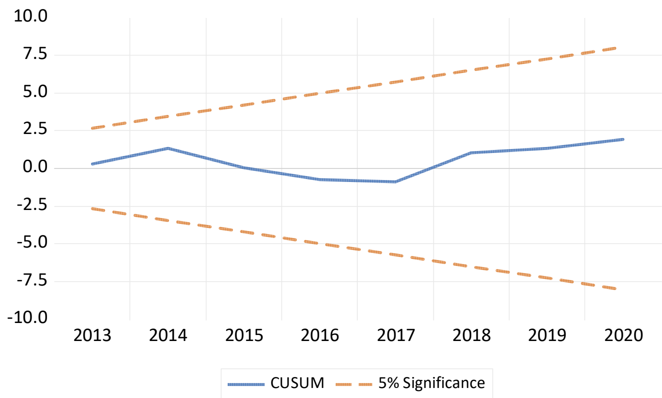

Figure 1. The result of CUSUM test—model F_{SD}.

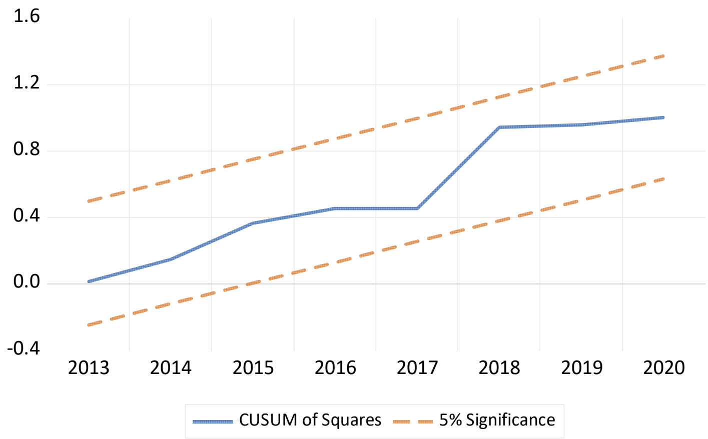

Figure 2. The result of CUSUM square test—model F_{SD}.

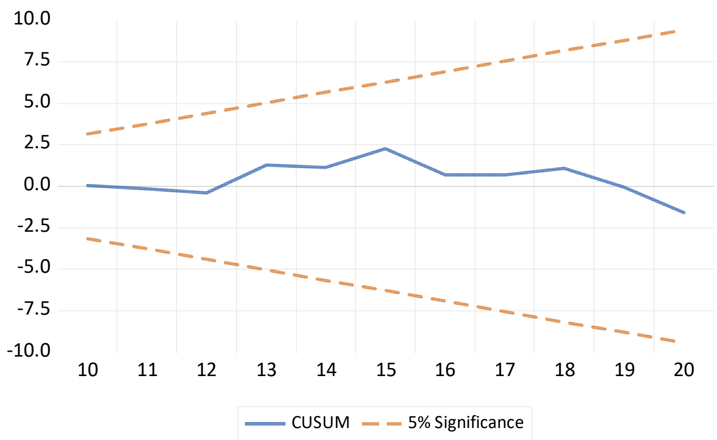

Figure 3. The result of CUSUM test—model F_{GDP}.

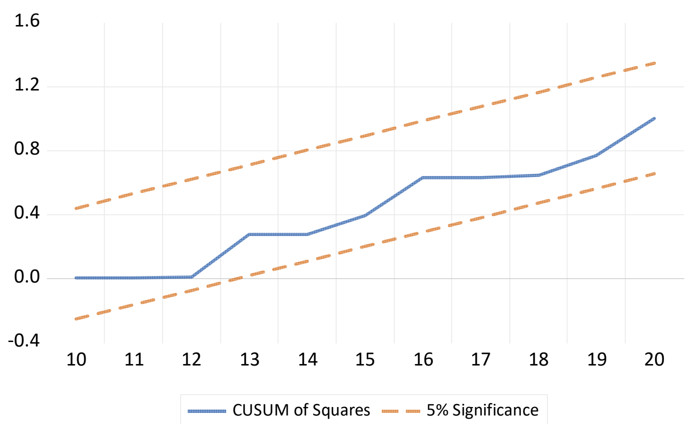

Figure 4. The result of CUSUM square test—model F_{GDP}.

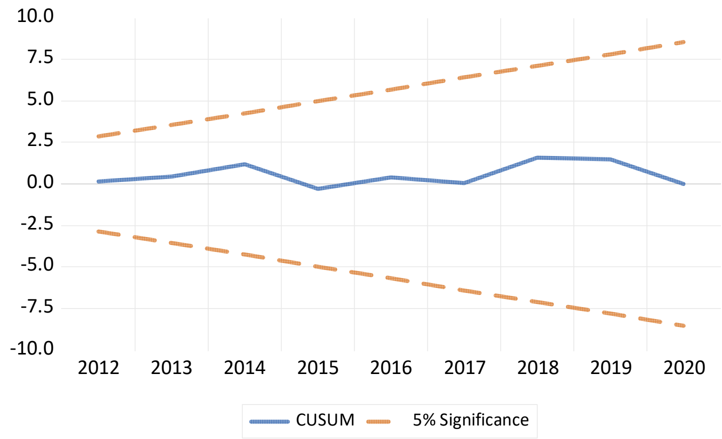

Figure 5. The result of CUSUM test—model F_{CO2}.

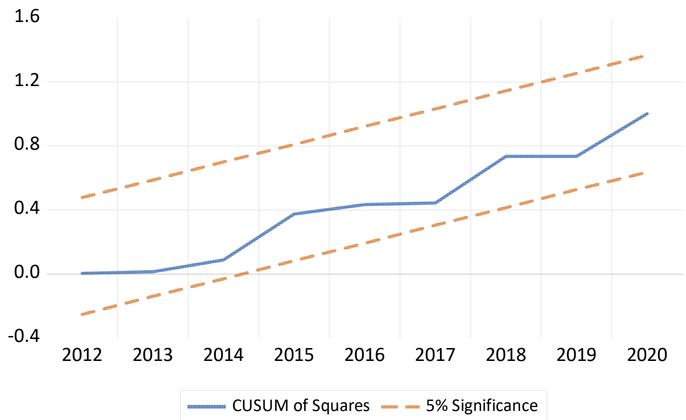

Figure 6. The result of CUSUM square test—model F_{CO2}.

4.2. Discussion

The aim of this paper is to investigate the impact of the transition into a green economy on Vietnam's sustainable development and its two dimensions: economic and environmental, through several fundamental issues: renewable energy, technological innovation, natural resource rents (oils, forest, and minerals), foreign direct investment, and trade. According to the results of the ARDL and FMOLS model, the summary of the results of the study is shown in **Table 10**. Through the results, the transition into a green economy in Vietnam has not yet achieved the right conditions for sustainable development, while the effect of the driven factor shows a lack of sustainability.

Table 10. The summarizing of the results.

Variables	**Short run results**			**Long run results**		
	SD	***EG***	***ED***	***SD***	***EG***	***ED***
FDI				–	–	–
REC	–	–	–		–	–
TEC	+	+	+	–	+	+
TRO	–			–		
OILR		+	+			

Table 11. (*Continued*).

Variables	Short run results			Long run results		
	SD	***EG***	***ED***	***SD***	***EG***	***ED***
FORR	+	+	+		+	+
MINR	−			−	+	+

Note: '+' is the positive effect; '−' is the negative effect, the rest shows the insignificant effect.

As can be seen in the results, the role of renewable energy in achieving sustainable development has not yet been demonstrated. Moreover, it shows a negative effect in the short term, while an insignificant contribution is shown in the long term. In detail, this energy contributes to reducing carbon emissions in the short and long-run term, but it also slows down economic growth. Although renewable energy could help promote environmental sustainability, the raising of this energy consumption will hinder the growth in the economic dimension. Thus, these results reveal the economic growth in Vietnam still depends a lot on non-renewable energy, which is not compatible with sustainable orientation. Our findings align with the opinion of (Nguyen et al., 2021), who show in their study that only a small portion of energy is derived from renewable sources in Vietnam. Our results contribute the evidence to support the negative relationship between renewable energy and economic growth. While the relationship between renewable energy and economic growth remains unclear, our findings will contribute significantly to exemplify this nexus. Moreover, these results will enhance the perspective of Li et al. (2022f), indicating that the dependence on non-renewable energy could impact the nexus between renewable energy and economic growth. Thus, our findings emphasize that renewable energy should be considered with both economic and environmental dimensions, instead of focusing only on environmental sustainability, to reach a green economy following sustainable development.

Technological innovation demonstrates its role as the driving key to Vietnam's economy, which promotes economic growth in the short and long term. Despite its economic contribution, it also causes environmental degradation in both terms. Furthermore, in spite of promoting sustainable development in the short term, it shows a negative effect in the long term. Thus, our results conclude that technological innovation is also not compatible with sustainable orientation. Indeed, these findings reveal that technological innovation boosts the economic dimension, however, the environmental dimension seems to be ignored with the negative effect. Our results support the perspective of Chaudhry et al. (2021) and Li et al. (2022b) that innovation in technology is the driving key to economic growth. Especially, while the nexus between technological innovation and environmental dimension, further sustainable development, still has different views, our findings could contribute empirical evidence for investigating this nexus. Indeed, these findings promote the opinion of Chen and Lee (2020), which shows the innovation of technology in low-income countries could not reach the green-oriented with the priority for economic dimension. As a developing economy and a low-middle-income country, technological innovation tends to put more effort into the economic dimension rather than the environmental dimension. Our findings align with the results of Dauda et al. (2019), indicating that the negative effect of technological innovation on the environmental dimension tends to occur in low-middle-income countries. Besides, our study supports Ahmad et al. (2023b) that it needs to mix with the green-oriented to follow sustainable development. Further, if the new technology does not follow green-oriented, it will just promote fossil energy consumption, followed by the exacẻrbation of environmental degradation (Ganda, 2019). Our results emphasize the positive relationship between technological innovation and sustainable development if it follows the green-oriented.

Using natural resources efficiently has a strong relationship with sustainable development. According to the results, utilizing the natural resources in Vietnam is not yet linked to sustainability. Indeed, three resources contribute significantly to economic growth but it also raises environmental degradation. In detail, growth in mineral rent has a negative effect on sustainable development, followed by the contribution to economic growth, but impacts negatively on the environmental dimension. Even forest rent boosts sustainable development in the short term, but in the long term, it does not have a significant impact. This situation could come from the forest rent's high impact on economic growth but also show the huge negative effect on environmental sustainability. Indeed, it has the greatest influence on the economic dimension among the factors, coming with the highest adverse effect on the environmental dimension. Although the resource curse hypothesis does not happen in Vietnam while the natural resources such as forests and minerals still promote economic growth in the long term, our findings reveal that the utilization of natural resources in Vietnam is not appropriate with a sustainable orientation. Besides, through this research in Vietnam, our findings contribute empirical evidence for Ahmad et al. (2023a), enhancing their perspective that the natural resource was overused, which could lead to environmental degradation, depleting the forest or mineral resource, and reducing biodiversity. We also support the negative effect on sustainable development, especially the environmental degradation that could happen if natural resource is used inefficiently (Xiaoman et al., 2021, Adebayo et al., 2022, Hossain et al., 2023). Through these findings, reducing the dependence on natural sources should be the critical way to transition into a green economy toward sustainability.

Integration has a meaningful role in sustainable development. Our results show that the impact of trade openness on sustainable development is negative in the short and long term, whereas foreign direct investment shows a negative effect in the long term. Our findings are also similar to the results of Sheikh et al. (2020, Belloumi and Alshehry (2020), who indicate a negative correlation between trade openness and sustainable development in India and Saudi Arabia, respectively. When the nexus between integration and sustainable development is still a puzzle, our empirical findings could contribute to exemplifying this relationship. Interestingly, we find that foreign direct investment has a negative relation with economic growth in the long term. This empirical finding is quite rare, while the majority of study claims that FDI promote economic growth, with only a little research showing the adverse effect such as (Herzer et al., 2008, Agbloyor et al., 2014, Sunde, 2017). The theory about the negative effect of FDI on economic growth has been indicated by Aitken and Harrison (1999). According to their theory, the negative effect can come from the influence of FDI firms reducing domestic productivity with the high competition, and the prioritization of material selection from other countries rather than domestic suppliers. Moreover, the high investment in the fields which utilize low-skilled workers could lead to the result. These issues could be suitable for Vietnam, so they should be paid attention. According to the General Statistic Office, the major contribution of import and export comes from FDI firms. Nevertheless, the domestic firms that could fulfill the requirements to join the global supply chain are minor. Besides, for a long time, FDI has focused on cheap labor in Vietnam (Tien et al., 2021). Therefore, our empirical findings will enhance the theory of Aitken and Harrison (1999), further contributing to the nexus between integration and economic growth. The FDI reduces carbon emissions in the long term, which is similar to the results of Tamazian et al. (2009, Lv and Li (2021), and Al-mulali et al. (2015) in other countries, whereas trade openness doesn't have a significant impact on environmental dimension. Through, this result does not support the pollution heaven hypothesis. However, the FDI hinders economic growth and trade openness cannot show their role in promoting economic dimension. Thus, overall, our findings conclude that the integration in Vietnam does not show the appropriate sustainability.

5. Conclusion and policy recommendation

Transitioning to a green economy is the aim in many countries including Vietnam, and it is considered a pathway to sustainable development. However, this transition has diverse effects on sustainable development, according to the different social-economic. This paper focuses on investigating the impact of the transition into a green economy on Vietnam's sustainable development and its two economic and environmental dimensions: through several fundamental issues: renewable energy, technological innovation, natural resource rents (oils, forest, and minerals), foreign direct investment, and trade. The results conclude that renewable energy is a critical key to reducing environmental degradation, but it hampers economic growth. Technological innovation contributes significantly to promoting economic growth, but it has a negative effect on the environmental dimension. Our results emphasize the dependence on non-renewable energy, whereas the innovation of technology does not show a green orientation in Vietnam. Furthermore, there is a lack of sustainability in the effect of natural resource rents, foreign direct investment, and trade. Overall, the transition into a green economy in Vietnam does not illustrate the sustainable orientation.

From the point of theoretical view, our findings indicate several implications. Transitioning into a green economy has a tight connection with sustainable development. Thus, a green economy seems to be a pathway leading to sustainable development. However, the effect of this transition on sustainable development and its two dimensions is still unclear. Our results demonstrate that the transition with its driving factor could have a negative effect, which doesn't show appropriate sustainability. Furthermore, our results enhance several perspectives in previous research around this context. Firstly, our findings support the idea (Li et al., 2022f) that the over-dependence on non-renewable energy sources could hinder the contribution of renewable energy to sustainable development. Secondly, our results contribute the empirical evidence to conclude that technological innovation could have a negative effect on environmental sustainability. This finding emphasizes the opinion of Ahmad et al. (2023b) that it needs to mix with the green-oriented to follow sustainable development. Thirdly, our findings conclude that the inefficient use of natural resources could lead to environmental degradation, further reducing sustainability, even when its rent could help to promote economic growth. Fourthly, our findings indicate the negative effect of integration on sustainable development. While the nexus between integration and sustainable development is still unclear, these empirical results could contribute significantly. Finally, our empirical findings will enhance the theory of Aitken and Harrison (1999), further contributing to the nexus between integration and economic growth. While only a few studies have shown the contradictory result that FDI has a negative effect on economic growth, this empirical evidence will contribute significantly.

Besides, some practical implications could be retrieved from the study outcome. Our study emphasizes the critical factors that should be considered in the green transition with sustainable orientation, which are renewable energy, technological innovation, natural resource rents (oils, forests, and minerals), foreign direct investment, and trade. Indeed, the results reveal the effect of this driving factor of the lack of sustainability in Vietnam. Thus, balancing the benefits in both economic and environmental dimensions could be the key to achieving sustainable development in each economy. Based on this, we propose several policy recommendations to improve this transition with a sustainable orientation. Firstly, innovation in technology should focus on green-clean-oriented, reducing the backward technology with the aim of total replacement in the future. Thus, the policies to restrict the production of technology, which is not environmental-friendly, such as adding environmental regulation in manufacturing or the taxation of conservating environment are necessary. Besides, an incentive policy to attract capital investment in the R&D of green-clean technology should be implemented. Secondly, decreasing the high cost of renewable energy is a critical task to develop a green economy. Government and policymakers should focus on controlling the price of infrastructure in this sector to cut down the investment cost. Furthermore, using energy efficiently should be paid attention. Thirdly, reducing the dependence on natural resources such as forests, and minerals should be considered. In order to do that, the regulations about using these rent must be strengthened, especially the approval process for projects involving these resources should be elaborately examined. Finally, promoting green products in trade should be focused on because they will bring back the benefits in both dimensions. Especially, connecting the FDI firms and domestic firms should be considered a priority task, which will help domestic firms develop, meeting the requirements to join the global supply chain.

Although the study contributes significant implications for the transition into a green economy and following sustainable development, it also has some limitations that should be improved. The first limitation is the study focuses only on Vietnam, using the macro-data time series in a country. Thus, it could affect the effectiveness of implications for the nexus between a driven key factor of the transition with sustainable development and its two dimensions. To exemplify the generality of this nexus, further research should be investigated at the level of multiple countries, such as the developing countries, and developed countries, or based on the country-income level. Besides, the study only focuses on sustainable development with the economic and environmental dimensions. Therefore, future research should aim to investigate the effect on this dimension, to clarify thoroughly the nexus. In general, hopefully, this study could support the transition into the green economy with the sustainability orientation, as it roles—a pathway to sustainable development.

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References

Adebayo, T. S. (2022). Renewable Energy Consumption and Environmental Sustainability in Canada: Does Political Stability Make a Difference? Environmental Science and Pollution Research, 29(40), 61307–61322. https://doi.org/10.1007/s11356-022-20008-4

Adebayo, T. S., Akadiri, S. S., Adedapo, A. T., & Usman, N. (2021). Does interaction between technological innovation and natural resource rent impact environmental degradation in newly industrialized countries? New evidence from method of moments quantile regression. Environmental Science and Pollution Research, 29(2), 3162–3169. https://doi.org/10.1007/s11356-021-17631-y

Agbloyor, E. K., Abor, J. Y., Adjasi, C. K. D., & Yawson, A. (2014). Private capital flows and economic growth in Africa: The role of domestic financial markets. Journal of International Financial Markets, Institutions and Money, 30, 137–152. https://doi.org/10.1016/j.intfin.2014.02.003

Ahmad, M., Peng, T., Awan, A., & Ahmed, Z. (2023). Policy framework considering resource curse, renewable energy transition, and institutional issues: Fostering sustainable development and sustainable natural resource consumption practices. Resources Policy, 86, 104173. https://doi.org/10.1016/j.resourpol.2023.104173

Ahmad, N., & Du, L. (2017). Effects of energy production and CO 2 emissions on economic growth in Iran: ARDL approach. Energy, 123, 521–537. https://doi.org/10.1016/j.energy.2017.01.144

Ahmad, N., Youjin, L., Žiković, S., & Belyaeva, Z. (2023). The effects of technological innovation on sustainable development and environmental degradation: Evidence from China. Technology in Society, 72, 102184. https://doi.org/10.1016/j.techsoc.2022.102184

Aitken, B. J., & Harrison, A. E. (1999). Do Domestic Firms Benefit from Direct Foreign Investment? Evidence from Venezuela. American Economic Review, 89(3), 605–618. https://doi.org/10.1257/aer.89.3.605

Ali, W. & Abdullah, A. (2015). The impact of trade openness on the economic growth of Pakistan: 1980-2010. Global Business and Management Research, 7, 120.

Al-mulali, U., Tang, C. F., & Ozturk, I. (2015). Does financial development reduce environmental degradation? Evidence from a panel study of 129 countries. Environmental Science and Pollution Research, 22(19), 14891–14900. https://doi.org/10.1007/s11356-015-4726-x

Appiah, K., Worae, T. A., Yeboah, B., & Yeboah, M. (2022). The causal nexus between trade openness and environmental pollution in selected emerging economies. Ecological Indicators, 138, 108872. https://doi.org/10.1016/j.ecolind.2022.108872

Azam, M., Ftiti, Z., Hunjra, A. I., et al. (2022). Do market-supporting institutions promote sustainable development? Evidence from developing economies. Economic Modelling, 116, 106023. https://doi.org/10.1016/j.econmod.2022.106023

Balsalobre-Lorente, D., Gokmenoglu, K. K., Taspinar, N., & Cantos-Cantos, J. M. (2019). An approach to the pollution haven and pollution halo hypotheses in MINT countries. Environmental Science and Pollution Research, 26(22), 23010–23026. https://doi.org/10.1007/s11356-019-05446-x

Balsalobre-Lorente, D., Shahbaz, M., Roubaud, D., & Farhani, S. (2018). How economic growth, renewable electricity and natural resources contribute to CO2 emissions? Energy Policy, 113, 356–367. https://doi.org/10.1016/j.enpol.2017.10.050

Barbier, E. B. (2012). The Green Economy Post Rio+20. Science, 338(6109), 887–888. https://doi.org/10.1126/science.1227360

Barros, L., & Martínez-Zarzoso, I. (2022). Systematic literature review on trade liberalization and sustainable development. Sustainable Production and Consumption, 33, 921–931. https://doi.org/10.1016/j.spc.2022.08.012

Baumol, W. J., & Oates, W. E. (1988). The theory of environmental policy. Cambridge university press.

Belloumi, M., & Alshehry, A. (2020). The Impact of International Trade on Sustainable Development in Saudi Arabia. Sustainability, 12(13), 5421. https://doi.org/10.3390/su12135421

Bhattacharya, M., Paramati, S. R., Ozturk, I., & Bhattacharya, S. (2016). The effect of renewable energy consumption on economic growth: Evidence from top 38 countries. Applied Energy, 162, 733–741. https://doi.org/10.1016/j.apenergy.2015.10.104

Bina, O. (2013). The Green Economy and Sustainable Development: An Uneasy Balance? Environment and Planning C: Government and Policy, 31(6), 1023–1047. https://doi.org/10.1068/c1310j

Bolt, K., Matete, M. & Clemens, M. (2002). Manual for calculating adjusted net savings. Environment Department, World Bank, 1, 1-23.

Borensztein, E., De Gregorio, J., & Lee, J.-W. (1998). How does foreign direct investment affect economic growth? Journal of International Economics, 45(1), 115–135. https://doi.org/10.1016/s0022-1996(97)00033-0

Cai, L., & Le, T. T. (2023). Natural resources and financial development: Role of corporate social responsibility on green economic growth in Vietnam. Resources Policy, 81, 103279. https://doi.org/10.1016/j.resourpol.2022.103279

Chaudhry, I. S., Ali, S., Bhatti, S. H., et al. (2021). Dynamic common correlated effects of technological innovations and institutional performance on environmental quality: Evidence from East-Asia and Pacific countries. Environmental Science & Policy, 124, 313–323. https://doi.org/10.1016/j.envsci.2021.07.007

Chen, C., Pinar, M., & Stengos, T. (2020). Renewable energy consumption and economic growth nexus: Evidence from a threshold model. Energy Policy, 139, 111295. https://doi.org/10.1016/j.enpol.2020.111295

Chen, Y., & Lee, C.-C. (2020). Does technological innovation reduce CO2 emissions? Cross-country evidence. Journal of Cleaner Production, 263, 121550. https://doi.org/10.1016/j.jclepro.2020.121550

Chien, F., Ananzeh, M., Mirza, F., et al. (2021). The effects of green growth, environmental-related tax, and eco-innovation towards carbon neutrality target in the US economy. Journal of Environmental Management, 299, 113633. https://doi.org/10.1016/j.jenvman.2021.113633

Dauda, L., Long, X., Mensah, C. N., & Salman, M. (2019). The effects of economic growth and innovation on CO2 emissions in different regions. Environmental Science and Pollution Research, 26(15), 15028–15038. https://doi.org/10.1007/s11356-019-04891-y

Dawid, H., Kort, P. M., & Vergalli, S. (2021). Investments, Energy, and Green Economy. Journal of Economic Dynamics and Control, 126, 104126. https://doi.org/10.1016/j.jedc.2021.104126

Destek, M. A., & Sinha, A. (2020). Renewable, non-renewable energy consumption, economic growth, trade openness and ecological footprint: Evidence from organisation for economic Co-operation and development countries. Journal of Cleaner Production, 242, 118537. https://doi.org/10.1016/j.jclepro.2019.118537

Dickey, D. A., & Fuller, W. A. (1979). Distribution of the Estimators for Autoregressive Time Series with a Unit Root. Journal of the American Statistical Association, 74(366a), 427–431. https://doi.org/10.1080/01621459.1979.10482531

Dogan, E., & Ozturk, I. (2017). The influence of renewable and non-renewable energy consumption and real income on CO2 emissions in the USA: evidence from structural break tests. Environmental Science and Pollution Research, 24(11), 10846–10854. https://doi.org/10.1007/s11356-017-8786-y

Dogan, E., & Seker, F. (2016). Determinants of CO2 emissions in the European Union: The role of renewable and non-renewable energy. Renewable Energy, 94, 429–439. https://doi.org/10.1016/j.renene.2016.03.078

Dogan, E., Altinoz, B., Madaleno, M., & Taskin, D. (2020). The impact of renewable energy consumption to economic growth: A replication and extension of. Energy Economics, 90, 104866. https://doi.org/10.1016/j.eneco.2020.104866

Dong, K., Hochman, G., Zhang, Y., et al. (2018). CO2 emissions, economic and population growth, and renewable energy: Empirical evidence across regions. Energy Economics, 75, 180–192. https://doi.org/10.1016/j.eneco.2018.08.017

Fu, R., & Liu, J. (2023). Revenue sources of natural resources rents and its impact on sustainable development: Evidence from global data. Resources Policy, 80, 103226. https://doi.org/10.1016/j.resourpol.2022.103226

Ganda, F. (2019). The impact of innovation and technology investments on carbon emissions in selected organisation for economic Co-operation and development countries. Journal of Cleaner Production, 217, 469–483. https://doi.org/10.1016/j.jclepro.2019.01.235

Gasparatos, A., Doll, C. N. H., Esteban, M., et al. (2017). Renewable energy and biodiversity: Implications for transitioning to a Green Economy. Renewable and Sustainable Energy Reviews, 70, 161–184. https://doi.org/10.1016/j.rser.2016.08.030

Gorus, M. S., & Aslan, M. (2019). Impacts of economic indicators on environmental degradation: Evidence from MENA countries. Renewable and Sustainable Energy Reviews, 103, 259–268. https://doi.org/10.1016/j.rser.2018.12.042

Grossman, G. M., & Krueger, A. B. (1995). Economic Growth and the Environment. The Quarterly Journal of Economics, 110(2), 353–377. https://doi.org/10.2307/2118443

Grossman, G., & Krueger, A. (1991). Environmental impacts of a North American free trade agreement. National Bureau of economic research Cambridge, Mass., USA.

Gu, G., & Wang, Z. (2018). Research on global carbon abatement driven by R&D investment in the context of INDCs. Energy, 148, 662–675. https://doi.org/10.1016/j.energy.2018.01.142

Güney, T. (2019). Renewable energy, non-renewable energy and sustainable development. International Journal of Sustainable Development & World Ecology, 26(5), 389–397. https://doi.org/10.1080/13504509.2019.1595214

Guo, Y., Wong, W. K., Su, N., et al. (2023). Resource curse hypothesis and economic growth: A global analysis using bootstrapped panel quantile regression analysis. Resources Policy, 85, 103790. https://doi.org/10.1016/j.resourpol.2023.103790

Habiba, U., Xinbang, C., & Anwar, A. (2022). Do green technology innovations, financial development, and renewable energy use help to curb carbon emissions? Renewable Energy, 193, 1082–1093. https://doi.org/10.1016/j.renene.2022.05.084

Hanif, I., Faraz Raza, S. M., Gago-de-Santos, P., & Abbas, Q. (2019). Fossil fuels, foreign direct investment, and economic growth have triggered CO2 emissions in emerging Asian economies: Some empirical evidence. Energy, 171, 493–501. https://doi.org/10.1016/j.energy.2019.01.011

Helpman, E. & Krugman, P. (1987). Market structure and foreign trade: Increasing returns, imperfect competition, and the international economy. MIT press.

Herzer, D., Klasen, S., & Nowak-Lehmann D., F. (2008). In search of FDI-led growth in developing countries: The way forward. Economic Modelling, 25(5), 793–810. https://doi.org/10.1016/j.econmod.2007.11.005

Hordofa, T. T., Liying, S., Mughal, N., et al. (2022). Natural resources rents and economic performance: Post-COVID-19 era for G7 countries. Resources Policy, 75, 102441. https://doi.org/10.1016/j.resourpol.2021.102441

Hossain, M. R., Rej, S., Awan, A., et al. (2023). Natural resource dependency and environmental sustainability under N-shaped EKC: The curious case of India. Resources Policy, 80, 103150. https://doi.org/10.1016/j.resourpol.2022.103150

Huang, Y., Raza, S. M. F., Hanif, I., et al. (2020). The role of forest resources, mineral resources, and oil extraction in economic progress of developing Asian economies. Resources Policy, 69, 101878. https://doi.org/10.1016/j.resourpol.2020.101878

Hung, N. T. (2023). Green investment, financial development, digitalization and economic sustainability in Vietnam: Evidence from a quantile-on-quantile regression and wavelet coherence. Technological Forecasting and Social Change, 186, 122185. https://doi.org/10.1016/j.techfore.2022.122185

Ibrahim, R. L., & Ajide, K. B. (2021). The dynamic heterogeneous impacts of nonrenewable energy, trade openness, total natural resource rents, financial development and regulatory quality on environmental quality: Evidence from BRICS economies. Resources Policy, 74, 102251. https://doi.org/10.1016/j.resourpol.2021.102251

Ibrahim, R. L., Al-mulali, U., Ozturk, I., et al. (2022). On the criticality of renewable energy to sustainable development: Do green financial development, technological innovation, and economic complexity matter for China? Renewable Energy, 199, 262–277. https://doi.org/10.1016/j.renene.2022.08.101

Inglesi-Lotz, R., & Dogan, E. (2018). The role of renewable versus non-renewable energy to the level of CO2 emissions a panel analysis of sub- Saharan Africa's Big 10 electricity generators. Renewable Energy, 123, 36–43. https://doi.org/10.1016/j.renene.2018.02.041

Ivanovski, K., Hailemariam, A., & Smyth, R. (2021). The effect of renewable and non-renewable energy consumption on economic growth: Non-parametric evidence. Journal of Cleaner Production, 286, 124956. https://doi.org/10.1016/j.jclepro.2020.124956

Jabeen, G., Ahmad, M., & Zhang, Q. (2023). Combined role of economic openness, financial deepening, biological capacity, and human capital in achieving ecological sustainability. Ecological Informatics, 73, 101932. https://doi.org/10.1016/j.ecoinf.2022.101932

Jacobs, M. (2012). Green growth: Economic theory and political discourse. Grantham Research Institute on Climate Change and the Environment London.

Jiang, C., Zhang, Y., Kamran, H. W., & Afshan, S. (2021). Understanding the dynamics of the resource curse and financial development in China? A novel evidence based on QARDL model. Resources Policy, 72, 102091. https://doi.org/10.1016/j.resourpol.2021.102091

Jiang, Z., Rahman Mahmud, A., Maneengam, A., Nassani, et al. (2022). Non linear effect of Biomass, fossil fuels and renewable energy usage on the economic Growth: Managing sustainable development through energy sector. Fuel, 326, 124943. https://doi.org/10.1016/j.fuel.2022.124943

Jin, L., Duan, K., & Tang, X. (2018). What Is the Relationship between Technological Innovation and Energy Consumption? Empirical Analysis Based on Provincial Panel Data from China. Sustainability, 10(2), 145. https://doi.org/10.3390/su10010145

Johansen, S. (1988). Statistical analysis of cointegration vectors. Journal of Economic Dynamics and Control, 12(2–3), 231–254. https://doi.org/10.1016/0165-1889(88)90041-3

Jun, W., Mughal, N., Kaur, P., et al. (2022). Achieving green environment targets in the world’s top 10 emitter countries: the role of green innovations and renewable electricity production. Economic Research-Ekonomska Istraživanja, 35(1), 5310–5335. https://doi.org/10.1080/1331677x.2022.2026240

Keho, Y. (2017). The impact of trade openness on economic growth: The case of Cote d’Ivoire. Cogent Economics & Finance, 5(1), 1332820. https://doi.org/10.1080/23322039.2017.1332820

Khan, I., & Hou, F. (2020). The dynamic links among energy consumption, tourism growth, and the ecological footprint: the role of environmental quality in 38 IEA countries. Environmental Science and Pollution Research, 28(5), 5049–5062. https://doi.org/10.1007/s11356-020-10861-6

Khan, S. A. (2020). Metal nanoparticles toxicity: role of physicochemical aspects. In: Shah, M. R., Imran, M. & Ullah, S. (editors). Metal Nanoparticles for Drug Delivery and Diagnostic Applications. Elsevier.

Khan, S. A. R., Yu, Z., & Farooq, K. (2022). Green capabilities, green purchasing, and triple bottom line performance: Leading toward environmental sustainability. Business Strategy and the Environment, 32(4), 2022–2034. Portico. https://doi.org/10.1002/bse.3234

Khan, S. A. R., Zia-Ul-Haq, H. M., Ponce, P., & Janjua, L. (2023). Re-investigating the impact of non-renewable and renewable energy on environmental quality: A roadmap towards sustainable development. Resources Policy, 81, 103411. https://doi.org/10.1016/j.resourpol.2023.103411

Khan, Z., Ali, S., Umar, M., Kirikkaleli, D., & Jiao, Z. (2020). Consumption-based carbon emissions and International trade in G7 countries: The role of Environmental innovation and Renewable energy. Science of The Total Environment, 730, 138945. https://doi.org/10.1016/j.scitotenv.2020.138945

Koc, S., & Bulus, G. C. (2020). Testing validity of the EKC hypothesis in South Korea: role of renewable energy and trade openness. Environmental Science and Pollution Research, 27(23), 29043–29054. https://doi.org/10.1007/s11356-020-09172-7

Kong, Q., Peng, D., Ni, Y., Jiang, X., & Wang, Z. (2021). Trade openness and economic growth quality of China: Empirical analysis using ARDL model. Finance Research Letters, 38, 101488. https://doi.org/10.1016/j.frl.2020.101488

Kshitij, G., Khanna, N., Yıldırım, Ç. V., et al. (2022). Resource conservation and sustainable development in the metal cutting industry within the framework of the green economy concept: An overview and case study. Sustainable Materials and Technologies, 34, e00507. https://doi.org/10.1016/j.susmat.2022.e00507

Kuo, Y., Maneengam, A., Phan The, C., et al. (2022). Fresh evidence on environmental quality measures using natural resources, renewable energy, non-renewable energy and economic growth for 10 Asian nations from CS-ARDL technique. Fuel, 320, 123914. https://doi.org/10.1016/j.fuel.2022.123914

Lélé, S. M. (1991). Sustainable development: A critical review. World Development, 19(6), 607–621. https://doi.org/10.1016/0305-750x(91)90197-p

Li, H., Usman, N., Coulibay, M. H., et al. (2022). Does the resources curse hypothesis exist in China? What is the dynamic role of fiscal decentralization, economic policy uncertainty, and technology innovation for sustainable financial development? Resources Policy, 79, 103002. https://doi.org/10.1016/j.resourpol.2022.103002

Li, J., Dong, K., & Dong, X. (2022). Green energy as a new determinant of green growth in China: The role of green technological innovation. Energy Economics, 114, 106260. https://doi.org/10.1016/j.eneco.2022.106260

Li, S., Long, F., & Long, L. (2022). Resources curse and sustainable development revisited: Evaluating the role of remittances for China. Resources Policy, 79, 103110. https://doi.org/10.1016/j.resourpol.2022.103110

Li, X., Ozturk, I., Ullah, S., et al. (2022). Can top-pollutant economies shift some burden through insurance sector development for sustainable development? Economic Analysis and Policy, 74, 326–336. https://doi.org/10.1016/j.eap.2022.02.006

Li, X., Zhu, S., Li, Y., & Chang, R. (2022). What is the asymmetric influence of natural resource rent and green innovation on the ecological sustainability of the ARCTIC region. Resources Policy, 79, 103051. https://doi.org/10.1016/j.resourpol.2022.103051

Li, Y., Alharthi, M., Ahmad, I., et al. (2022). Nexus between renewable energy, natural resources and carbon emissions under the shadow of transboundary trade relationship from South East Asian economies. Energy Strategy Reviews, 41, 100855. https://doi.org/10.1016/j.esr.2022.100855

Lin, B., & Moubarak, M. (2014). Renewable energy consumption – Economic growth nexus for China. Renewable and Sustainable Energy Reviews, 40, 111–117. https://doi.org/10.1016/j.rser.2014.07.128

Loiseau, E., Saikku, L., Antikainen, R., et al. (2016). Green economy and related concepts: An overview. Journal of Cleaner Production, 139, 361–371. https://doi.org/10.1016/j.jclepro.2016.08.024

Lorek, S., & Spangenberg, J. H. (2014). Sustainable consumption within a sustainable economy – beyond green growth and green economies. Journal of Cleaner Production, 63, 33–44. https://doi.org/10.1016/j.jclepro.2013.08.045

Lv, Z., & Li, S. (2021). How financial development affects CO2 emissions: A spatial econometric analysis. Journal of Environmental Management, 277, 111397. https://doi.org/10.1016/j.jenvman.2020.111397

Mathews, J. A., & Tan, H. (2011). Progress Toward a Circular Economy in China. Journal of Industrial Ecology, 15(3), 435–457. https://doi.org/10.1111/j.1530-9290.2011.00332.x

Mensah, I. A., Sun, M., Gao, C., et al. (2019). Analysis on the nexus of economic growth, fossil fuel energy consumption, CO2 emissions and oil price in Africa based on a PMG panel ARDL approach. Journal of Cleaner Production, 228, 161–174. https://doi.org/10.1016/j.jclepro.2019.04.281

Metawa, N., Dogan, E., & Taskin, D. (2022). Analyzing the nexus of green economy, clean and financial technology. Economic Analysis and Policy, 76, 385–396. https://doi.org/10.1016/j.eap.2022.08.023

Mohamed, E. S. E. (2020). Resource Rents, Human Development and Economic Growth in Sudan. Economies, 8(4), 99. https://doi.org/10.3390/economies8040099

Naseer, A., Su, C.-W., Mirza, N., & Li, J.-P. (2020). Double jeopardy of resources and investment curse in South Asia: Is technology the only way out? Resources Policy, 68, 101702. https://doi.org/10.1016/j.resourpol.2020.101702

Nassani, A. A., Abro, M. M. Q., Batool, R., et al. (2020). Go‐for‐green policies: The role of finance and trade for sustainable development. International Journal of Finance & Economics, 26(1), 1409‐1423. Portico. https://doi.org/10.1002/ijfe.1855

Nathaniel, S. P. (2021). Economic complexity versus ecological footprint in the era of globalization: evidence from ASEAN countries. Environmental Science and Pollution Research, 28(45), 64871–64881. https://doi.org/10.1007/s11356-021-15360-w

Nathaniel, S. P., Adeleye, N., & Adedoyin, F. F. (2021). Natural Resource Abundance, Renewable Energy, and Ecological Footprint Linkage in MENA Countries. Studies of Applied Economics, 39(3). https://doi.org/10.25115/eea.v39i2.3927

Nguyen, X. P., Le, N. D., Pham, V. V., et al. (2021). Mission, challenges, and prospects of renewable energy development in Vietnam. Energy Sources, Part A: Recovery, Utilization, and Environmental Effects, 1–13. https://doi.org/10.1080/15567036.2021.1965264

Nishitani, K., Nguyen, T. B. H., Trinh, T. Q., et al. (2021). Are corporate environmental activities to meet sustainable development goals (SDGs) simply greenwashing? An empirical study of environmental management control systems in Vietnamese companies from the stakeholder management perspective. Journal of Environmental Management, 296, 113364. https://doi.org/10.1016/j.jenvman.2021.113364

OECD 2011. Towards Green Growth: Monitoring Progress. OECD.

Ofori, I. K., Gbolonyo, E. Y., & Ojong, N. (2023). Foreign direct investment and inclusive green growth in Africa: Energy efficiency contingencies and thresholds. Energy Economics, 117, 106414. https://doi.org/10.1016/j.eneco.2022.106414

Opoku, E. E. O., Ibrahim, M., & Sare, Y. A. (2019). Foreign Direct Investment, Sectoral Effects and Economic Growth in Africa. International Economic Journal, 33(3), 473–492. https://doi.org/10.1080/10168737.2019.1613440

Pata, U. K. (2020). Renewable and non-renewable energy consumption, economic complexity, CO2 emissions, and ecological footprint in the USA: testing the EKC hypothesis with a structural break. Environmental Science and Pollution Research, 28(1), 846–861. https://doi.org/10.1007/s11356-020-10446-3

Pata, U. K., & Kartal, M. T. (2023). Impact of nuclear and renewable energy sources on environment quality: Testing the EKC and LCC hypotheses for South Korea. Nuclear Engineering and Technology, 55(2), 587–594. https://doi.org/10.1016/j.net.2022.10.027

Paus, E. A., & Robinson, M. D. (1997). The implications of increasing economic openness for real wages in developing countries, 1973–1990. World Development, 25(4), 537–547. https://doi.org/10.1016/s0305-750x(96)00127-1

Pesaran, M. H. & SHIN, Y. (1995). An autoregressive distributed lag modelling approach to cointegration analysis. University of Cambridge.

Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. Journal of Applied Econometrics, 16(3), 289–326. Portico. https://doi.org/10.1002/jae.616

Pethig, R. (1976). Pollution, welfare, and environmental policy in the theory of Comparative Advantage. Journal of Environmental Economics and Management, 2(3), 160–169. https://doi.org/10.1016/0095-0696(76)90031-0

Rahman, M. M., & Velayutham, E. (2020). Renewable and non-renewable energy consumption-economic growth nexus: New evidence from South Asia. Renewable Energy, 147, 399–408. https://doi.org/10.1016/j.renene.2019.09.007

Rahman, M. M., Alam, K., & Velayutham, E. (2022). Reduction of CO2 emissions: The role of renewable energy, technological innovation and export quality. Energy Reports, 8, 2793–2805. https://doi.org/10.1016/j.egyr.2022.01.200

Reilly, J. M. (2012). Green growth and the efficient use of natural resources. Energy Economics, 34, S85–S93. https://doi.org/10.1016/j.eneco.2012.08.033

Rodrik, D. (1988). Imperfect competition, scale economies, and trade policy in developing countries. Trade policy issues and empirical analysis. University of Chicago Press.

Saqib, N., Ozturk, I., Usman, M., et al. (2023). Pollution Haven or Halo? How European countries leverage FDI, energy, and human capital to alleviate their ecological footprint. Gondwana Research, 116, 136–148. https://doi.org/10.1016/j.gr.2022.12.018

Sarwar, S., Waheed, R., Aziz, G., & Apostu, S. A. (2022). The Nexus of Energy, Green Economy, Blue Economy, and Carbon Neutrality Targets. Energies, 15(18), 6767. https://doi.org/10.3390/en15186767

Saud, S., Chen, S., Haseeb, A., & Sumayya. (2020). The role of financial development and globalization in the environment: Accounting ecological footprint indicators for selected one-belt-one-road initiative countries. Journal of Cleaner Production, 250, 119518. https://doi.org/10.1016/j.jclepro.2019.119518

Saud, S., Haseeb, A., Zafar, M. W., & Li, H. (2023). Articulating natural resource abundance, economic complexity, education and environmental sustainability in MENA countries: Evidence from advanced panel estimation. Resources Policy, 80, 103261. https://doi.org/10.1016/j.resourpol.2022.103261

Shahabadi, A. & Feyzi, S. (2016). The relationship between natural resources abundance, foreign direct investment and environmental performance in selected oil and developed countries during 1996–2013. International Journal of Resistive Economics, 4, 101–116.

Shahbaz, M., Destek, M. A., Okumus, I., & Sinha, A. (2019). An empirical note on comparison between resource abundance and resource dependence in resource abundant countries. Resources Policy, 60, 47–55. https://doi.org/10.1016/j.resourpol.2018.12.002

Shahbaz, M., Lean, H. H., & Shabbir, M. S. (2012). Environmental Kuznets Curve hypothesis in Pakistan: Cointegration and Granger causality. Renewable and Sustainable Energy Reviews, 16(5), 2947–2953. https://doi.org/10.1016/j.rser.2012.02.015

Shahbaz, M., Raghutla, C., Song, M., et al. (2020). Public-private partnerships investment in energy as new determinant of CO2 emissions: The role of technological innovations in China. Energy Economics, 86, 104664. https://doi.org/10.1016/j.eneco.2020.104664

Sharif, A., Brahim, M., Dogan, E., & Tzeremes, P. (2023). Analysis of the spillover effects between green economy, clean and dirty cryptocurrencies. Energy Economics, 120, 106594. https://doi.org/10.1016/j.eneco.2023.106594

Sharma, R., Jabbour, C. J. C., & Lopes de Sousa Jabbour, A. B. (2020). Sustainable manufacturing and industry 4.0: what we know and what we don't. Journal of Enterprise Information Management, 34(1), 230–266. https://doi.org/10.1108/jeim-01-2020-0024

Sheikh, M. A., Malik, M. A., & Masood, R. Z. (2020). Assessing the effects of trade openness on sustainable development: evidence from India. Asian Journal of Sustainability and Social Responsibility, 5(1). https://doi.org/10.1186/s41180-019-0030-x

Song, X., Zhou, Y., & Jia, W. (2019). How do Economic Openness and R&D Investment Affect Green Economic Growth?—Evidence from China. Resources, Conservation and Recycling, 146, 405–415. https://doi.org/10.1016/j.resconrec.2019.03.050

Su, C. W., Liu, F., Stefea, P., & Umar, M. (2023). Does technology innovation help to achieve carbon neutrality? Economic Analysis and Policy, 78, 1–14. https://doi.org/10.1016/j.eap.2023.01.010

Sunde, T. (2017). Foreign direct investment, exports and economic growth: ADRL and causality analysis for South Africa. Research in International Business and Finance, 41, 434–444. https://doi.org/10.1016/j.ribaf.2017.04.035

Tamazian, A., Chousa, J. P., & Vadlamannati, K. C. (2009). Does higher economic and financial development lead to environmental degradation: Evidence from BRIC countries. Energy Policy, 37(1), 246–253. https://doi.org/10.1016/j.enpol.2008.08.025

Tien, N. H., Ngoc, N. M. & Anh, D. B. H. (2021). Current situation of high-quality human resources in FDI enterprises in Vietnam-solutions to attract and maintain. International Journal of Multidisciplinary Research and Growth Evaluation, 2, 31–38.

Tobey, J. (2001). The Effects of Domestic Environmental Policies on Patterns of World Trade. The Economics of International Trade and the Environment, 205–216. https://doi.org/10.1201/9781420032628.ch13

Ullah, A., Zhao, X., Kamal, M. A., et al. (2020). Exploring asymmetric relationship between Islamic banking development and economic growth in Pakistan: Fresh evidence from a non-linear ARDL approach. International Journal of Finance & Economics, 26(4), 6168–6187. Portico. https://doi.org/10.1002/ijfe.2115

UN (2015). Sustainable development goals. United nations department of economic and social affairs, New York, United States.

UNEP (2011). Towards a green economy: Pathways to Sustainable Developement and Poverty Eradication—A Synthesis for Policy Makers.

UNEP (2016). Sustainable Consumption & Production Branch: Resource Efficient and Cleaner Production.

Walter, I. & Ugelow, J. L. (1979). Environmental policies in developing countries. Ambio, 102–109.

Wang, R., Usman, M., Radulescu, M., et al. (2023). Achieving ecological sustainability through technological innovations, financial development, foreign direct investment, and energy consumption in developing European countries. Gondwana Research, 119, 138–152. https://doi.org/10.1016/j.gr.2023.02.023

WCED (1987). Report of the World Commission on Environment and Development: Our Common Future, United Nations General Assembly document A/42/427.

World Bank (2012). Inclusive green growth: The pathway to sustainable development, The World Bank.

Xiaoman, W., Majeed, A., Vasbieva, D. G., et al. (2021). Natural resources abundance, economic globalization, and carbon emissions: Advancing sustainable development agenda. Sustainable Development, 29(5), 1037–1048. Portico. https://doi.org/10.1002/sd.2192

Xuan, D., Jiang, X., & Fang, Y. (2023). Can globalization and the green economy hedge natural resources? Functions of population growth and financial development in BRICS countries. Resources Policy, 82, 103414. https://doi.org/10.1016/j.resourpol.2023.103414

Yamarik, S., & Ghosh, S. (2011). Is natural openness or trade policy good for the environment? Environment and Development Economics, 16(6), 657–684. https://doi.org/10.1017/s1355770x11000271

Yikun, Z., Woon Leong, L., Cong, P. T., et al. (2022). Green growth, governance, and green technology innovation. How effective towards SDGs in G7 countries? Economic Research-Ekonomska Istraživanja, 36(2). https://doi.org/10.1080/1331677x.2022.2145984

Yu, M. (2018). China's international trade development and opening-up policy design over the past four decades. China Economic Journal, 11(3), 301–318. https://doi.org/10.1080/17538963.2018.1516275

Zakari, A., Li, G., Khan, I., et al. (2022). Are abundant energy resources and Chinese business a solution to environmental prosperity in Africa? Energy Policy, 163, 112829. https://doi.org/10.1016/j.enpol.2022.112829

Zhao, W.-X., Samour, A., Yi, K., & Al-Faryan, M. A. S. (2023). Do technological innovation, natural resources and stock market development promote environmental sustainability? Novel evidence based on the load capacity factor. Resources Policy, 82, 103397. https://doi.org/10.1016/j.resourpol.2023.103397

Zheng, H., Zhang, L., & Zhao, X. (2022). How does environmental regulation moderate the relationship between foreign direct investment and marine green economy efficiency: An empirical evidence from China's coastal areas. Ocean & Coastal Management, 219, 106077. https://doi.org/10.1016/j.ocecoaman.2022.106077