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A look into sustainable development goal amidst technological innovation, financial development and natural resources: a symmetry and asymmetry analyses

Nazakat-Ullah Khan[1] · Edmund Ntom Udemba[2,3] · Firat Emir[4] · Sadam Hussain[5]

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Abstract
Algeria is one of the North African countries endowed with abundant natural resource mostly on oil and gas. Because of its richness in natural resource, most of its economic activities and development (including economic and environment) are dependent and determined by its natural resources. Due to Algeria's rising dependence on natural resource rents, the country's long-term development and environmental policy toward its sustainable development goals (SDGs) have been seriously questioned. For this reason, the objective of this study is to examine the Algeria's sustainable development goals amidst its heavy dependence on natural resources. We applied Algeria's data of 1980 to 2019 with a dual and novel scientific approaches (linear/dynamic ordinary least square—DOLS, and nonlinear autoregressive distributed lag—NARDL) for insightful analysis of this subject. A trio indicator of natural resources, technological innovation and financial development is utilized in this study for a direct overview of their impact on Algeria inclusive sustainable development goals. Findings from the two approaches showed that technological innovation, financial development and natural resources reduce carbon emission and increase economic growth, respectively. Hence, sustainable development goals are achievable for the case of Algeria if policy is framed around innovation, financial development and natural resource. With this, policy framing toward sustainable development goals should focus on increasing technological innovation through financial development which will transcend to improvement on both environment and economic situation of Algeria. Some financial policies such as subsidy from government in financing research projects, and lifting embargo on loan through reduction in interest rate and increase on financial literacy through sensitization on how to go about securing loans are to be considered when framing lasting policies targeting the Algeria's SDGs.

Keywords Economic growth · Natural resources · Technological innovation · Financial development · Algeria sustainable development goals · NARDL

Extended author information available on the last page of the article

1 Introduction

The pursuit of sustainable development goals (SDGs) of 2030 has gained momentum in the research community, as they are seen as a solution to both economic and environmental problems resulting from the global threat of climate change. These goals, adopted by the United Nations, aim to eradicate poverty while also protecting the planet for present and future generations (United Nations, 2015)[1] Unfortunately, environmental degradation is mainly attributed to industrialization and economic expansion, resulting in the increasing amount of carbon dioxide emissions and ecological footprint (Khan et al., 2022a, 2022b, 2022c). The relationship between economic activity and environmental quality or sustainability has been a hotly debated topic for more than two decades. Socioeconomic activities often involve over-utilization of high fossil fuel energy sources, leading to environmental damage. However, economic activities also rely heavily on the environment and can negatively impact its quality (Bogoviz et al., 2022; Khan et al., 2022a, 2022b, 2022c; Yaqoob et al., 2022).

The goal of these discussions is to achieve a balance between economic activities and environmental concerns. Economic growth can only be achieved if the environmental quality is not deteriorated; otherwise, the economic growth objective would be scuppered. Several studies have examined the relationship between economic growth and carbon dioxide (CO_2) emissions in the real world, attempting to determine the unidirectional causality or feedback causality between them, or if there is no causal relationship at all. However, the results of these studies have been mixed, leaving ample room for further research (Ang, 2007; Stern, 2004). Therefore, pursuing the SDGs of 2030 is critical to achieving economic growth while protecting the environment for future generations. Achieving this balance requires continued research and a willingness to implement changes that prioritize environmental concerns alongside economic development.

Furthermore, it has also become more important for researchers and policymakers to debate over the existence of causality between economic growth and the environment because of the Sustainable Development Goals (SDGs) 2030 that world leaders agreed to. As mentioned before, among the goals of the SDGs is to eradicate poverty while also protecting the planet for present and future generations. Environmental degradation is primarily attributed to industrialization and economic expansion. The industrialized countries of the globe are attempting to reduce environmental deterioration by adopting green energy through technological innovation thereby shifting from carbon-intensive industry to green and energy efficient industries. According to Hassan et al. (2019), industrialized countries around the world have reduced carbon dioxide emissions by enacting stringent environmental legislation, effective governance and innovation. Sarkodie (2018) has documented that the world's developing economies are still having problems with the environment due to a lack of sophisticated technology innovation. Hassan et al. (2020) indicated that the implementation of technology breakthroughs and regulations in emerging economies with long-term economic growth, legal framework could help to improve environmental quality. Also, research by Mensah et al. (2019) has shown that climate-related technical innovation aids in pollution reduction and is considered a vital component of green growth. According to Sandberg et al. (2019), green economic growth is anticipated to have a positive impact on the environment. The only way to save energy and lessen environmental damage is to

[1] United Nations. (2015). Sustainable Development Goals. Retrieved from https://sdgs.un.org/

research on the efficient and effective strategies to implement toward assuring sustainable development goals.

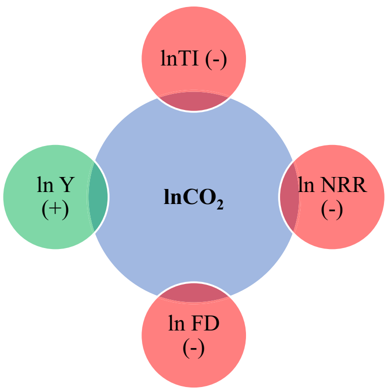
Further, there have been a mixed findings that trailed the argument on the impact of financial development on environment. While some papers are suggesting negative effect, other studies have also proved that financial development contributes a lot in achieving climate and environmental goals. Carbon emissions in Pakistan were studied by Khan et al. (2020); they looked at how financial development and economic indicators affected CO_2 emissions. The findings of the study show that Pakistan's economic growth has a negative effect on the environment, while the financial development is alleviating the environmental degradation. Salahuddin et al. (2018) applied a time series data to examine the effect of financial development and foreign direct investment on Kuwait environment. According to the findings, FDI and financial development contribute in environmental damage in Kuwait. Using panel data, Saud et al. (2019) examined the influence of financial development and income level on carbon dioxide emissions. According to the research, financial advancement is found negatively impacting the environment.

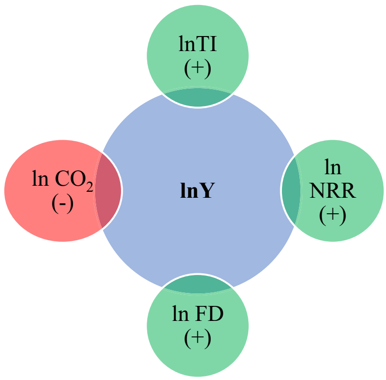
Countries that are natural resource endowed are often rely heavily on the availability of resources for economic development and sustainability. Sequel to this, many developing countries have depleted their natural resources in order to achieve rapid economic expansion. This has caused a lot of damage to the environment (Danish et al., 2020). According to Nathaniel et al. (2021), natural resources also contribute to greenhouse gas emissions. Zhang et al. (2021) studied Pakistan's carbon dioxide emissions and ecological footprint as a result of natural resource depletion; according to the study's findings, depletion of natural resources causes environmental degradation in Pakistan. BRICS (Brazil, Russia, India, China, and South Africa) were studied by Muhammad & Khan (2021) for the impact of natural resource depletion and economic expansion on carbon dioxide emissions. Environmental degradation is caused by depletion of natural resources and the rise of the economy.

Against this background, the present study seeks to examine the environmental cum economic implication of the trio (technological innovation, financial development and natural resources) indicators on Algeria's sustainable development goals. Algeria is one of the Northeast African countries endowed with abundant natural resource mostly on oil and gas. This has placed the country in the class of upper middle-income nation whose major revenue generation via export is oil and gas resources. Due to Algeria's rising dependence on natural resource rents, the country's long-term development and environmental policy have been seriously questioned. Although many studies have been done on implication of natural resources on Algeria's economic perspective, little studies have been done on the environmental perspective of the natural resources impact. The present study will add to the research community by incorporating both linear and nonlinear scientific approaches in examining the dual (economic and environment) impact of natural resources on Algeria's sustainable development. This is an inclusive perspective of natural resources impact that considers both environmental and economic development in the sustainable development goal. Also, adopting technological innovation and financial development in this study will expose the impact of the two indicators in shaping and achieving the country's sustainable development goal. The variables are selected on the economic ground of the country's interest; hence, complementing the quest for economic advancement of Algeria amidst its natural resources with the available technological innovation through its financial development will give insight on the impact of the selected variables on its SDGs.

The immediate and comprehensive objective of this study is to examine the Algeria's ability to achieve its sustainable (economic and environmental) development goals amidst economic activities that are centered on fossil fuels and natural resource rent. The summary of the objective is put as follows: a. Is the Algeria's economic growth impacting its environmental development? b. What is the direction of its economic impact on its environment, negative or positive? c. What is the impact of natural resource on both economic and environment development of Algeria? d. Is the technological innovation of the country felt in both economic and environment? e. Is financial development in Algeria having any effect on both economic and environment development? The answer to the listed objectives in the form of question will justify the motivation of our study, hence environmental cum economic implication of the trio (technological innovation, financial development and natural resources) indicators on sustainable development goals of Algeria. Theoretical contributions of these questions include exploring the relationship between Algeria's economic growth and its environmental development, determining the direction of the economic impact on the environment (positive or negative) and assessing the influence of natural resources on both economic and environmental development. Additionally, investigating the extent to which technological innovation and financial development in Algeria affect both the economy and the environment can provide valuable insights. On the other hand, these questions hold also practical value in guiding economic, environmental and policy decisions in Algeria. Understanding the interplay between Algeria's economic growth and environmental development can aid in forming sustainable growth strategies, determining the consequences of economic activity on the environment and understanding the role of natural resources. Additionally, exploring the effects of technological innovation and financial development on the country's economy and environment can provide insights for policy formulation, technology deployment, and financial practices, all aimed at achieving balanced economic growth and environmental preservation.

The findings and conclusion of our study will have implication and relevance to other emerging countries (especially natural resource based economies in Africa and other emerging countries) in the category of Algeria and also open room for more discussion on this topic. The findings of this study will benefit the policy framing arm of the concerned countries in shaping the strategies of achieving their sustainable development goals.





The structure of this paper comprises several distinct sections. In Sect. 2, a comprehensive review of the existing literature is presented. Section 3 focuses on data analysis, while Sect. 4 presents the estimation procedures, analysis results, outcomes and related discussions. Finally, Sect. 5 provides policy implications based on the findings of the study.

2 Literature review

In the context of the objective of this study, we have alienated preceding literature into three different segments. First strand will encapsulate *CO2 nexus with technological innovation*; second strand will discuss *CO2 nexus with financial development*, whereas the last strand of the literature review will shed light on *CO2 nexus with natural resources*.

2.1 CO2 nexus with technological innovation

The domain of sustainability-oriented innovation has gained recognition as a priority area for empirical research (Schiederig et al., 2012). Many current scholars view technological innovation as a crucial avenue for achieving sustainable products and services. The notion that technological innovation plays a pivotal role in driving societal and economic transformations is not a novel concept in economics. The significance of technological innovation in mitigating environmental problems, particularly air pollution and climate change, has been widely recognized in the literature. Weitzman (1997) posits that technological change is of crucial importance in addressing environmental challenges. Researchers have shown that reducing greenhouse gas (GHG) emissions would require a portfolio of technologies beyond what is currently available, which includes using more energy-efficient production technologies, changes in fuel mix and the installation of end-of-pipe technology.

As environmental and resource challenges become more pressing, recent studies have shifted focus toward how technological innovation must consider the coordination of the economy, environment, and resources. For instance, Jones (2002) verified that investments in R&D and technological change are viable solutions to mitigate CO2 emissions. Using a STIRPAT model, Fan et al. investigate the factors influencing CO2 emissions in various countries at different stages of economic development from 1975 to 2000. Their findings reveal that the impact of technological innovation on CO2 emissions varies across stages of economic development. Additionally, Kumar and Managi (2010) examine the relationship between technological innovation and environmental degradation in 80 developed and developing countries, and find that technological innovation reduces environmental degradation in developed economies but increases it in most developing ones.

Empirical study of Bekhet and Latif (2018) also investigated the effects of institutions quality and technological innovation on sustainable growth in Malaysia over the period 1995–2015. Their results indicate that the interaction between governance and technological innovation positively contributes to Malaysia's sustainable growth. Chen and Lee have raised questions about the homogenous contribution of technological innovation to reduce emissions globally. The authors concluded that while technological innovation has minimal inhibiting effects on CO2 emissions at a global level, the impacts are heterogeneous when smaller samples of countries are considered as case studies. Specifically, they found that countries with high levels of national income, technological endowment and CO2 emissions benefit from an improvement in technological innovation to curb CO2 emissions, while countries without these characteristics may experience a CO2 emission-boosting effect.

Similarly, Shahbaz et al. (2020) studied China and found that the environmental impacts of technological innovation are intertemporal, with short-term increases in CO2 emissions and long-term reductions. Zafar et al. (2021) explored the effects of technological innovation on CO2 emissions in selected APEC countries by estimating a technological innovation index using different indicators, including patent and trademark applications and technical cooperation grants data. Their results showed that technological innovation is a key driver of higher CO_2 emissions in these countries. Sinha et al. (2020) used a technological innovation index and found that technological progress is associated with emission reduction in less-polluted Next Eleven nations, but not for the highly polluted Next Eleven nations. While most studies in the literature focus on the direct impacts of technological innovation on CO_2 emissions, Cheng et al. (2021) claimed that technological innovation indirectly mitigates CO_2 emissions in OECD nations by reducing emissions jointly with higher renewable energy consumption. Zhao et al. also found that technological innovation indirectly inhibits CO_2 emissions by mediating the relationship between financial risk and CO_2 emissions.

2.2 CO2 nexus with financial development

The financial sector has a crucial role to play in reducing energy pollution by facilitating technical advancements in energy supply to reduce emissions. This highlights the importance of financial development, which represents the actual availability of financial assets from banks and stock markets for productive activities and financing networks for projects. It can have a positive and critical impact on curbing environmental degradation, especially by decreasing CO_2 emissions. As such, research has found that financial development has the potential to decrease environmental degradation (Charfeddine et al., 2018; Frankel & Romer, 1999). For instance, Shetty conducted a study on the factors affecting the progress of low-income countries toward achieving Sustainable Development Goals (SDGs). The study pointed out that the existing literature mainly focuses on the mobilization of additional financial sources for funding SDGs in these countries, while not paying enough attention to the institutional environment and domestic policy reforms. The factors that affect low-income countries (LICs) include low global economic growth, limited fiscal space, potential worsening of external debt, difficulties in generating domestic revenue, a low likelihood of economic reforms in such an economic environment and low inflows of private finance.

In this context, Khan and Ozturk (2021) conducted a study on selected developing countries and concluded that the development of the financial sector is a prerequisite for addressing environmental concerns. They found that financial development independently reduces CO_2 emissions and also indirectly contributes to CO_2 emission reduction by mitigating the negative environmental effects associated with economic growth, international trade and foreign direct investment inflows. Habiba and Xinbang (2022) stated that financial development is effective in curbing CO_2 emissions, especially in developed nations such as Australia. However, their study also revealed that financial development could result in increased CO_2 emissions in emerging nations, whereas Adebayo et al. (2021) conducted a study on selected Latin American countries and found that the development of the financial sector has a limited influence on environmental indicators.

An overwhelming part of the literature also indicates that financial development can have negative effects on the environment, particularly on CO_2 emissions. In this vein, the study of Shahbaz et al. (2020) for United Arab Emirates and Ibrahim et al. for BRICS revealed that financial development leads to increase environmental degradation. Abbasi et al. (2022) also discovered that the financial sector in Pakistan is responsible for the nation's environmental hardships, as financial development leads to higher emissions of both consumption and territory-based CO_2 emissions. Similarly, Jiang et al. and Weili et al. (2022) verified that financial development in 57 countries under China's Belt and Road Initiative also led to higher per capita CO2 emissions, whereas Zhu et al. found that higher energy consumption, which is linked to financial development, degrades the environment by stimulating higher CO2 emissions across all quintiles of per capita CO2 emissions. Overall, empirical studies have produced mixed findings on the impact of the financial sector on the environment.

2.3 CO2 nexus with natural resources

Natural resources have a significant role in production, and a balanced supply can help to reduce price increases and slow down oil consumption, as stated by Balsalobre-Lorente et al. (2018). Understanding the relationship between GDP, technological innovation, natural resources and environmental pollution is not only relevant for policy analysis but also for improving renewable energy production industries. While past research has established the association of natural resources with GDP growth, there is little literature available that has examined the relationship between natural resources and the "energy–growth–environment" link, particularly in terms of CO2 emissions. Some studies, such as those conducted by Balsalobre-Lorente et al. (2018), Danish et al. (2019), and Hassan et al. (2019b), have explored this relationship, but their results have varied and have been based on single equation models. Therefore, further empirical analysis on this topic is needed.

Various studies have explored the relationship between natural resources and CO2 emissions using different econometric methods for panel and time-series data. However, the findings of these studies have been mixed. For instance, Balsalobre-Lorente et al. (2018) used the panel least squares (PLS) model to examine the impact of economic growth, electricity and natural resources on CO2 emissions for five European Union (EU) economies from 1985 to 2016. The results showed that natural resources and renewable electricity decreased CO2 emissions. Bekun et al. (2019) used Panel Mean Group (PMG) techniques to evaluate the effect of economic growth, energy consumption and natural resource rentals on CO2 emissions for 16 EU economies over the 1996–2014 period. They found that economic growth, energy consumption and natural resource rentals negatively affected the long-term environmental quality of the EU countries. Danish et al. (2018) employed autoregressive distributive lag (ARDL) techniques to examine the impact of energy use, economic growth and natural resources on Pakistan's CO2 emissions between 1990 and 2013. They found that trade and natural resources contributed to environmental degradation. Using the autoregressive integrated moving average approach, Aeknarajindawat et al. observed that natural resources increased CO2 emissions in Malaysia from 2008 to 2017.

Kwakwa et al. (2020) investigated the impact of extracting natural resources on Ghana's CO2 emissions from 1971 to 2013 using the Stochastic Impacts by Regression on Population, Affluence and Technology (STIRPAT) framework. The results of the Fully Modified Ordinary Least Squares (FMOLS) and Cross-Sectionally Augmented Error Correction Model (CS-ARDL) estimation techniques showed that natural resource extraction increased CO2 emissions and energy consumption, leading to environmental degradation. Shen et al. studied the link between investments, natural resources and CO2 emissions for China from 1995 to 2017. They used cross-sectional augmented autoregressive distributed lags (CS-ARDL) techniques and found that natural resources increased CO2 emissions while green investment contributed to improved environmental quality. However, Khan et al. (2020) used data from Belt & Road Initiative (BRI) countries over the period of

1990–2016 and applied the Generalized Method of Moments (GMM) method to find positive linkages between natural resources and CO2 emissions.

Wang et al. (2020) assessed the effect of economic globalization on CO2 emissions in the 1996–2017 period for the G-7 economies. The empirical findings from CS-ARLD revealed that economic globalization, natural resources and financial development lead to rising CO2 emissions. Finally, Umar et al. (2020) examined the linkage among CO2 emissions determinants in China during the period from 1980 to 2017. The results estimated by FMOLS and DOLS demonstrated that natural resources and economic growth positively affect China's CO2 emissions, while globalization tends to boost environmental sustainability. The causality results show that natural resources, globalization and economic growth contribute to CO2 emissions.

The above-mentioned investigation's results are not consistent, owing to the use of multiple geographical datasets. Although there is sufficient information in the existing literature on environmental indicators such as economic growth, foreign direct investment, technological development and natural resource use, the authors consider that there is still a need for research that employ econometric approaches to assess the effects of economic growth, foreign direct investment, technological development and natural resource use and CO_2 emissions for Algerian economy.

2.4 Theoretical background

Grossman and Krueger (1991) and Panayotou (1997), as environmental economists, were initially investigating the trade-off between economic growth and environmental deterioration. In their studies, they suggested that three separate phases are required for economic growth, namely scale effect, composite effect and technological effect. The scale effect was associated with emerging economies and stated that environment endures with the massive dependence on traditional energy sources. However, other two stages are linked with developed countries, where it is dominated by tertiary sector and technological innovations. Technological innovation is necessary to reduce the greenhouse gases and promoting energy preservation. Moreover, it also helps to improve the efficiency and economic performance in line with environmental sustainability. This can also help Algeria to reach its sustainable development goals.

3 Data, methodology and theoretical background

Algeria is the largest country in Africa. Having the abundance of natural resources, oil and gas, makes it the 4th most influential economy in Africa (see Fig. 1). This has placed the country in the class of upper middle-income nation whose major revenue generation via export is oil and gas resources.

Algeria's natural resource basins are located in 7 different areas: the Reggane and Tindouf basins in the southwest; the Timimoun, Ahnet and Mouydir basins in the central region; the Ghedames and Illizi basins in the east, as presented in Fig. 2.

Besides, in the last four decades, the global economy has grown tremendously including a considerable increase in energy consumption. Regrettably, this causes a rapid increase in deterioration level of environment. Sarkodie and Strezov (2019) highlighted this in their

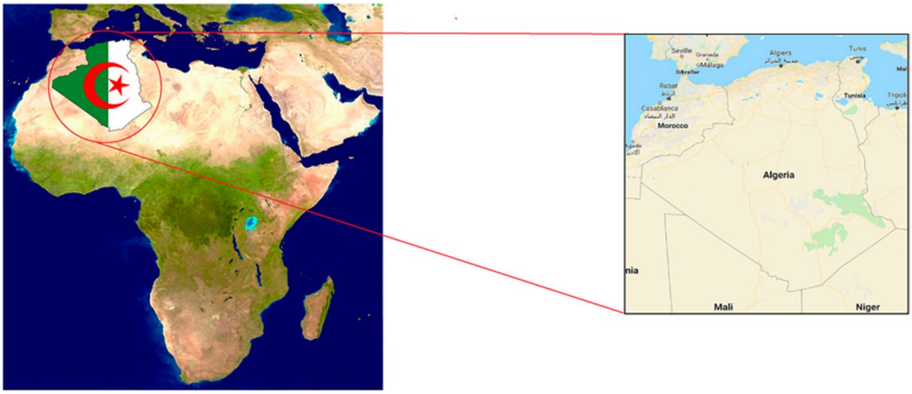


Fig. 1 Map of Algeria. *Source* Zahraoui et al. (2021)

Fig. 2 Location of natural resource basins in Algeria. *Source* Zahraoui et al. (2021)

study and indicated that sustainable growth may not be achieved if there is an increase in environmental degradation level, including climate change and global warming.

To this end, in this study, we attempt to investigate the level of Algerian sustainable development given the moderate development of its economy. This study seeks to examine

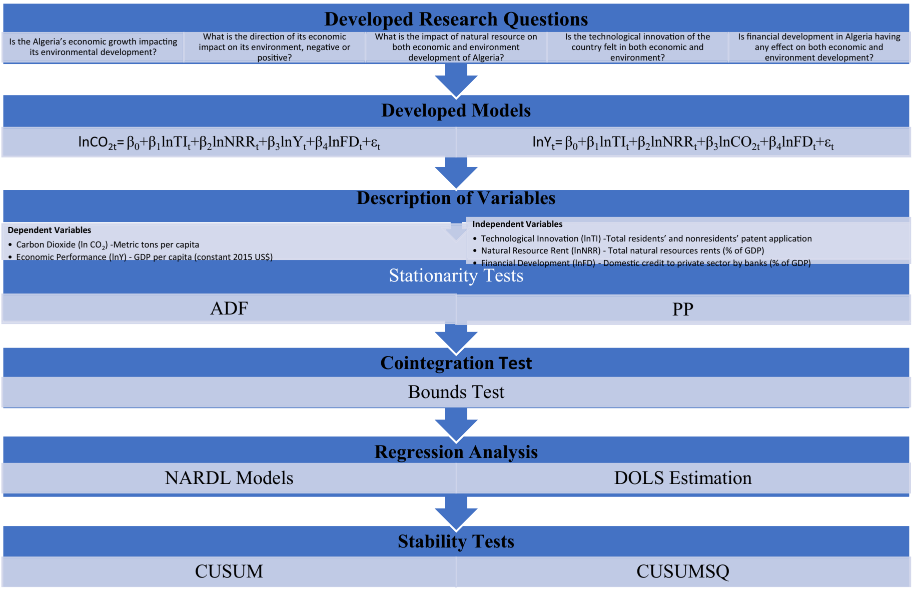


Fig. 3 Research framework diagram

Table 1 Variables and their measurements. *Source* Authors' compilation

Variable name	Measurement
Carbon Dioxide (ln CO_2)	Metric tons per capita(used as an indicator for environmental quality)
Economic Performance (lnY)	GDP per capita (constant 2015 US$)
Technological Innovation (lnTI)	Total residents' and nonresidents' patent application
Natural Resource Rent (lnNRR)	Total natural resources rents (% of GDP)
Financial Development (lnFD)	Domestic credit to private sector by banks (% of GDP)

the inclusive sustainable development of Algeria. This involves studying both the improvement and sustaining the economic and environment development of the country. The process is summarized in Fig. 3.

3.1 Data sources

The symmetric and asymmetric association among environmental degradation, economic performance, technological innovation, financial development and natural resource rent was examined for Algerian economy. For this purpose, the annual data were obtained from World Bank, and time-period is constrained to 1980 to 2019. All investigated variables are used in their logarithmic form in order to obtain the consistent outcome by minimizing the possible effect of heteroscedasticity and multicollinearity problems of time series data. The details about variables are given in Table 1.

Moreover, an expansion in economic performance is directly associated with environmental deterioration. For Algeria, below are two models which are constructed to examine the total symmetric and asymmetric effects of regressors on the economic performance and environmental degradation.

$$\ln\ CO_2 = \beta_0 + \beta_1 \ln\ TI_t + \beta_2 \ln NRR_t + \beta_3 \ln\ Y_t + \beta_4 \ln FD_t + \varepsilon_t \tag{1}$$

$$\ln\ Y_2 = \alpha_0 + \alpha_1 \ln\ TI_t + \alpha_2 \ln\ NRR_t + \alpha_3 \ln CO_{2t} + \alpha_4 \ln FD_t + v_t \tag{2}$$

where intercepts for the models are symbolized with β_0 and α_0 and $\beta_1 \ldots \beta_4$ and $\alpha_1 \ldots \alpha_4$ are the coefficients of the regressors. The t depicts for sample size, and ε and ν indicate the error terms in the models.

3.2 Methodology (nonlinear ARDL method)

In the literature, previous studies investigated the short-term and long-term steady-state associations among variables by utilizing symmetric and ordinary time series methods. However, current studies began to accentuate on asymmetric associations among variables to get sufficient results. This drives researchers to accomplish possible asymmetries in their studies. For this purpose, in this study, we employed nonlinear autoregressive distributed lag model (NARDL) to investigate the short-run and long-run asymmetric effects of independent variables on dependent variables in both models. This model is constructed and can be regressed by using least square technique (Qamruzzaman & Jianguo, 2020). Moreover, it helps us to have strong outcome by adjusting heteroscedasticity and autocorrelation effect of the results (Qamruzzaman & Jianguo, 2020). This model was anticipated by Shin et al. (2014) and detailed by Wang et al. (2020). This model helps us to explore the possible long-run steady-state association among investigated variables which may be at mixed order of integration (I(0) and I(1)) (Erdem and Tugcu, 2012). Part of the benefits of NARDL is the comprehensive nature of the nonlinear analysis with dual analysis which will provide insight on the subject matter with two perspectives of interactions between the explained and explanatory variables. That is it helps in justifying the result found in two ways (positive and negative interactions). In this study, the NARDL model has been constructed to assess the asymmetric effect of independent variables on environmental degradation and economic growth can be presented as follows.

$$\ln\ CO_2 = \beta_0 + \beta_1 \ln\ TI_t + \beta_2 \ln\ NRR_t + \beta_3 \ln\ Y_t + \beta_4 \ln\ FD_t + \varepsilon_t \tag{3}$$

$$\ln\ Y_2 = \alpha_0 + \alpha_1 \ln\ TI_t + \alpha_2 \ln\ NRR_t + \alpha_3 \ln\ CO_{2t} + \alpha_4 \ln\ FD_t + v_t \tag{4}$$

The + and—signs depict for the partial sum of positive and negative changes, respectively. The β's and α's are the unknown long-run coefficients for regressors. The partial sum of these variables can be expressed as follows.

$$X_t^+ = \sum_{i=1}^{t} \Delta X_i^+ = \sum_{i=1}^{t} \Delta \max\left(\Delta X_t^+,\ 0\right) \tag{5}$$

$$X_t^- = \sum_{i=1}^{t} \Delta X_i^- = \sum_{i=1}^{t} \Delta \max\left(\Delta X_t^-,\ 0\right) \tag{6}$$

Also, the short-run and long-run specification of the NARDL model can be presented as below.

$$\begin{aligned}\Delta \ln CO_{2t} &= \delta_0 + \textstyle\sum_{k=0}^{\rho} \delta_1 \Delta \ln CO_{2t-k} + \displaystyle\sum_{k=0}^{\rho} \delta_2 \Delta \ln TI^{+}_{t-k} \\ &+ \sum_{k=0}^{\rho} \delta_3 \Delta \ln TI^{-}_{t-k} + \sum_{k=0}^{\rho} \delta_4 \Delta \ln NRR^{+}_{t-k} + \sum_{k=0}^{\rho} \delta_5 \Delta \ln NRR^{-}_{t-k} \\ &+ \sum_{k=0}^{\rho} \delta_6 \Delta \ln Y^{+}_{t-k} + \sum_{k=0}^{\rho} \delta_7 \Delta \ln Y^{-}_{t-k} + \sum_{k=0}^{\rho} \delta_8 \Delta \ln FD^{-}_{t-k} \\ &+ \sum_{k=0}^{\rho} \delta_9 \Delta \ln FD^{+}_{t-k} + \Phi_1 \ln CO_{2t} + \Phi_2 \ln TI^{+}_{t} + \Phi_3 \ln TI^{-}_{t} \\ &+ \Phi_4 \ln NRR^{+}_{t} + \Phi_5 \ln NRR^{-}_{t} + \Phi_6 \ln Y^{+}_{t} + \Phi_7 \ln Y^{-}_{t} + \Phi_8 \ln FD^{+}_{t} + \Phi_9 \ln FD^{-}_{t}\end{aligned} \tag{7}$$

$$\begin{aligned}\Delta \ln Y_{2t} &= \chi_0 + \sum_{k=0}^{\rho} \chi_1 \Delta \ln\ Y_{t-k} + \sum_{k=0}^{\rho} \chi_2 \Delta \ln\ TI^{+}_{t-k} \\ &+ \sum_{k=0}^{\rho} \chi_3 \Delta \ln\ TI^{-}_{t-k} + \sum_{k=0}^{\rho} \chi_4 \Delta \ln\ NRR^{+}_{t-k} + \sum_{k=0}^{\rho} \chi_5 \Delta \ln NRR^{-}_{t-k} \\ &+ \sum_{k=0}^{\rho} \chi_6 \Delta \ln\ CO^{+}_{2t-k} + \sum_{k=0}^{\rho} \chi_7 \Delta \ln\ CO^{-}_{2t-k} + \sum_{k=0}^{\rho} \chi_8 \Delta \ln\ FD^{+}_{t-k} \\ &+ \sum_{k=0}^{\rho} \chi_9 \Delta \ln\ FD^{-}_{t-k} + \phi_1 \ln Y_t + \phi_2 \ln TI^{+}_{t} + \phi_3 \ln TI^{-}_{t} + \phi_4 \ln NRR^{+}_{t} \\ &+ \phi_5 \ln NRR^{-}_{t} + \phi_6 \ln CO^{+}_{2t} + \phi_7 \ln CO^{-}_{2t} + \phi_8 \ln FD^{+}_{t} + \phi_9 \ln FD^{-}_{t} + v_t\end{aligned} \tag{8}$$

$$\begin{aligned}\Delta \ln CO_{2t} &= \delta_0 + \sum_{k=0}^{\rho} \delta_1 \Delta \ln CO_{2t-k} + \sum_{k=0}^{\rho} \delta_2 \Delta \ln TI^{+}_{t-k} + \sum_{k=0}^{\rho} \delta_3 \Delta \ln TI^{-}_{t-k} \\ &+ \sum_{k=0}^{\rho} \delta_4 \Delta \ln NRR^{+}_{t-k} + \sum_{k=0}^{\rho} \delta_5 \Delta \ln NRR^{-}_{t-k} + \sum_{k=0}^{\rho} \delta_6 \Delta \ln Y^{+}_{t-k} + \sum_{k=0}^{\rho} \delta_7 \Delta \ln Y^{-}_{t-k} \\ &+ \sum_{k=0}^{\rho} \delta_8 \Delta \ln FD^{+}_{t-k} + \sum_{k=0}^{\rho} \delta_9 \Delta \ln FD^{-}_{t-k} + \gamma_0 ECT_{t-1} + \varepsilon_t\end{aligned} \tag{9}$$

$$\begin{aligned}\Delta \ln Y_{2t} &= \chi_0 + \sum_{k=0}^{\rho} \chi_1 \Delta \ln Y_{t-k} + \sum_{k=0}^{\rho} \chi_2 \Delta \ln TI^{+}_{t-k} + \sum_{k=0}^{\rho} \chi_3 \Delta \ln TI^{-}_{t-k} \\ &+ \sum_{k=0}^{\rho} \chi_4 \Delta \ln NRR^{+}_{t-k} + \sum_{k=0}^{\rho} \chi_5 \Delta \ln NRR^{-}_{t-k} + \sum_{k=0}^{\rho} \chi_6 \Delta \ln CO^{+}_{2t-k} + \sum_{k=0}^{\rho} \chi_7 \Delta \ln CO^{-}_{2t-k} \\ &+ \sum_{k=0}^{\rho} \chi_8 \Delta \ln FD^{+}_{t-k} + \sum_{k=0}^{\rho} \chi_9 \Delta \ln FD^{-}_{t-k} + \eta_0 ECT_{t-1} + v_t\end{aligned} \tag{10}$$

Table 2 Unit root test

Variables	ADF		PP	
	Level	Δ	Level	Δ
CO_2	−1.909	−5.844***	−2.178	−5.889***
Y	−1.191	−3.266**	−0.477	−3.327**
FD	−1.330	−5.055***	−1.521	−5.107***
TI	−1.058	−5.621***	−1.123	−5.621***
NRR	−2.249	−4.932***	−2.353	−5.765***

*** and ** stand for the significance level at 1% and 5%, respectively

Table 3 Bound test results. *Source* Authors' calculation

			1%		5%		10%	
	K	Calculated F-stat	B_L	B_U	B_L	B_U	B_L	B_U
ln CO_2	8	11.452***	2.62	3.77	2.11	3.15	1.85	2.85
Ln Y	8	5.665***	2.79	4.10	2.22	3.39	1.95	3.06

where k indicates the number of lags and Δ symbolizes the difference operator. Moreover, long-term coefficients of explanatory variables are signified by $\Phi_1 - \Phi_9$ and $\phi_1 - \phi_9$. The $\delta_0 - \delta_9$ and $\chi_1 - \chi_9$ denote the short-term elasticities in the models. The coefficients of error correction terms are indicated with γ_0 and η_0 in the models.

4 Findings

4.1 Preliminary findings

Before NARDL model is employed, it is crucial to inspect the stationarity of every single time series to assess the applicability of the test. For this purpose, Augmented Dickey–Fuller (1979) and Philips Perron unit root tests were utilized to check the integration order of each series. Table 2 depicts the findings of these tests. Both tests reflect that all investigated variables integrated at order I(1) at 1% significance level, except economic growth. It is at integration order one at 5% significance level. All variables were assessed with only intercept. These results satisfy the prior condition of both NARDL model and Bounds test for cointegration.

After the unit root tests, NARDL models are estimated and cointegration associations among investigated variables are tested by utilizing Bounds tests. The null hypothesis for Bounds test is no cointegration relationship among investigated variables, whereas the alternative hypothesis confirms the cointegration relationship. The details of the tests are shown in Table 3 and confirms the long period connection among the investigated variables at 1% significance level for both models. In detail, since the calculated F statistics are greater than the upper critical bounds, the null hypothesis is rejected for both models and long-run steady-state association among investigated variables is confirmed.

Table 4 Estimation output of dependent variable: environmental quality (Ln CO_2). *Source* Authors calculation

Variable	Coefficient	Std. Error	*t*-Statistic	Prob.
Short-run coefficients				
D(LN CO_2 (-1))	0.207***	0.049	4.176	0.0007
D(LNFD+)	−0.235***	0.069	−3.418	0.0035
D(LNFD-)	0.011**	0.014	0.784	0.0441
D(LNTI+)	−0.056**	0.038	−1.484	0.0152
D(LNTI-)	0.317***	0.042	7.528	0.0000
D(LNNRR+)	−0.182***	0.045	−4.021	0.0010
D(LNNRR-)	0.042**	0.029	1.463	0.0162
D(LNY+)	0.548**	0.355	1.543	0.0142
D(LNY-)	−2.729***	0.541	−5.041	0.0001
ECT(-1)	−0.567***	0.035	−16.015	0.0000
Long-run coefficients				
LNFD+	−0.053***	0.320	−3.284	0.0047
LNFD-	0.028*	0.046	0.616	0.0545
LNTI+	−0.165**	0.138	−1.191	0.0256
LNTI-	0.548***	0.350	4.414	0.0004
LNNRR+	−0.614**	0.269	−2.278	0.0368
LNNRR-	0.172**	0.141	1.214	0.0241
LNY+	0.825**	0.166	2.707	0.0483
LNY-	−3.268***	0.660	−3.173	0.0059
C	1.213	0.109	11.087	0.0000

The significance levels are denoted with *(1%), **(5%), *** (10%), respectively

4.2 Asymmetric and symmetric estimations

On the other hand, NARDL and dynamic OLS techniques were employed to test the symmetric and asymmetric impact of the investigated variables on endogenous variable for both models. Tables 4 and 5 give short-run and long-run estimation details for both models estimated by using NARDL approach.

4.2.1 For model 1

The short-run coefficients indicate the environmental degradation is a cumulative issue, and it is affected from its lag variable. In other words, the current level of environmental degradation is affected by 0.207% from the previous term. Moreover, a percent surge in financial increase will lead to 0.235% reduction in CO_2 emission in Algeria and improve environmental quality. However, a 1% increase in negative shocks on financial development will deteriorate the environment by 0.011%, on average.

Furthermore, one percent increase in technological innovation, patent application by residents and non-residents, will improve environmental quality by 0.056%, on average. However, any adverse shocks on TI will lead to deteriorate the atmosphere quality by 0.317%.

Table 5 Result of dependent variable: economic performance (lnY). *Source* Authors calculation

Variable	Coefficient	Std. Error	*t*-Statistic	Prob.
Short-run coefficients				
D(LN CO_2+)	0.014*	0.033	1.426	0.0674
D(LN CO_2-)	0.104**	0.044	2.337	0.0285
D(LNFD+)	0.090***	0.023	3.767	0.0010
D(LNFD-)	−0.014**	0.006	−2.060	0.0508
D(LNTI+)	0.009*	0.014	1.619	0.0514
D(LNTI-)	0.026***	0.013	1.951	0.0632
D(LNNRR+)	0.074***	0.018	4.067	0.0005
D(LNNRR-)	−0.001*	0.014	−1.078	0.0938
C	5.372	0.669	8.019	0.0000
ECT(-1)	−0.654	0.081	−8.024	0.0000
Long-run coefficients				
LNCO2+	0.012***	0.048	0.253	0.0018
LNCO2-	0.192*	0.108	1.772	0.0896
LNFD+	0.219***	0.040	5.409	0.0000
LNFD-	−0.002*	0.010	−0.261	0.0959
LNTI+	0.027**	0.021	1.242	0.0266
LNTI-	−0.042*	0.029	−1.453	0.0597
LNNRR+	0.033**	0.043	0.783	0.0414
LNNRR-	−0.083***	0.029	−2.823	0.0096

The significance levels are denoted with *(1%), **(5%), *** (10%), respectively

Regarding natural resource rent, it has negative association with CO_2 emission. This means that a 1% increase in natural resource rent will deduct the level of CO_2 emission by 0.182% and improve environmental quality; however, a 1% rise in the adverse shocks on natural resource rent will add to worsening level of environment by 0.042%.

Economic growth is another determinant of environmental degradation. A 1% improvement in economic performance causes 0.548% increase in environmental degradation, while a 1% reduction in economic performance will lead to mitigate the environmental degradation level by 2.729%, on average.

On the other hand, long-run coefficients for model 1 show that a positive shock in financial development leads to 0.053% reduction in carbon dioxide level in Algeria, on average, while this level is measured as 0.028% contribution for every 1% increase in negative shocks on financial development.

Moreover, a 1% increase in positive (negative) variation in technological innovation mitigates (increase) the environmental degradation by 0.155% (0.548%), on average.

Furthermore, a 1% rise in positive (adverse) shocks on natural resource rent will add to mitigate (increase) atmosphere degradation by 0.614% (0.172%) on average. Additionally, one percent rise in economic growth in long run will lead to increase the worsening level of atmosphere by 0.825, while a 1% reduction in economic performance in Algeria will significantly contribute to environmental quality by 3.268%, on average.

Table 6 DOLS Estimation output. *Source*: Authors Calculation

Dependent Variable CO_2	Coefficient	Std. Error	t-Statistic	Prob
LNFD	−0.021**	0.021	−1.908	0.0320
LNTI	−0.066**	0.078	−0.847	0.0427
LNNRR	−0.162***	0.057	−2.844	0.0074
LNY	0.700*	0.358	1.951	0.0591
C	−4.614*	2.508	−1.839	0.0744
R-squared	0.604	Adjusted R-squared		0.559
Dependent Variable Y	Coefficient	Std. Error	t-Statistic	Prob
LNFD	0.059***	0.015	3.993	0.0003
LNTI	0.088***	0.021	4.031	0.0003
LNNRR	0.032*	0.017	1.789	0.0825
LNCO2	−0.072***	0.032	−1.223	0.0000
C	7.226***	0.062	1.329	0.0000
R-squared	0.963	Adjusted R-squared		0.957

The Significance levels are denoted with *(1%), **(5%), *** (10%), respectively.

4.2.2 For model 2

In model 2, the estimated coefficients of technological innovation increase pertaining to economic performance are 0.009 (0.026) in short run and 0.027 (−0.042) in the long run. This leads to understand that a 1% increase in technological innovation contributes to economic performance by 0.009% in short run and 0.027% in the long run in terms of benefits from patents, and quality and quantity of production. However, a 1% reduction in technological innovation will lead to contribute to economic performance by 0.026% in the short run due to the opportunity cost of reducing a spending on innovative activities, although it causes 0.042% reduction in economic performance in the long run.

Furthermore, in the short run a 1% increase (decrease) in financial development and natural resource rent will lead to increase (decrease) economic performance by 0.090% (0.014%) and 0.074% (0.001%), on average, respectively. For the long run, these coefficients are estimated as 0.219% (0.002%) and 0.033% (0.083%), on average, respectively. Lastly, a 1% increase in CO_2 emission will lead to upsurge economic performance of Algeria by 0.014% in the short run and 0.012% in the long run.

Moreover, a 1% reduction in CO_2 will contribute to economic performance by 0.104%, on average in the short run, while this level is measured as 0.192%, in the long run. This helps us to understand that the CO_2 is emitted due to economic activities; thus, the more economic activity leads to have the more CO_2 emission and the greater economic performance in both long run and short run.

The coefficients of error correction terms for both models are estimated as negative and statistically significant at one percent significance level. This elaborates the speed of convergence of the variables to steady-state level in the long run. In other words, for model one, 56.7% of deviation from short-run equilibrium is corrected gradually through a series of partial long-run adjustments and this is calculated as 65.4% for model 2.

Table 6 demonstrates the result of the DOLS estimation which is used to affirm the validity of the coefficients acquired from NARDL estimation. The results show that a percent rise in financial progress will mitigate the environmental dilapidation by 0.021%, on average. Thus, as it is also confirmed with the second model, one percent rise in financial progress will lead to advance economic performance by 0.059%, on average in long run.

Moreover, one percent increase in patent applications by residents and non-residents will lead to improve environmental quality in the long run by 0.066%, on average. Also, this will lead to improve economic performance by 0.088%, in the long run.

Furthermore, imposition of natural resource rent in the economy will lead to mitigate the level of environmental degradation by 0.162% for every 1% increase and this will also contribute to economic performance by 0.032% in the long run, on average.

Also, when the dual effect of environmental degradation and economic performance is evaluated, a one percent increase in economic growth will contribute to atmosphere degradation level by 0.70%, and a 1% increase in CO_2 emission will lead to reduce the economic performance by 0.072%, on average.

Finally, CUSUM and CUSUMsq tests were employed to test the stability of the coefficients estimated in NARDL model. Both tests affirms that all estimated coefficients for regressors are stable for both models since the test lines (blue lines) fall within the 5% significance level. The result from CUSUM and CUSUMsq estimate is displayed in Figs. 4 and 5

5 Discussions

The outcomes of both techniques confirm each other and prove that all selected regressors are the main determinants of the dependent variables in both models at different significance levels.

5.1 From model 1

The result revealed financial development as a capable mitigating force against environmental degradation. Financial development helps borrowers to easily have access to credits. Easy access to money in the developing economics, especially financial supports with policies to spent on environmentally friendly goods and technologies, will lead people to consume more environmentally friendly goods and invest more on new green capital to increase the capacity of production. This in turn helps country to reduce CO_2 emission and grow sustainably**.** This finding supports the findings from Petrović and Lobanov, (2022) and contradicts the findings from Anwar et al. (2022).

On the other hand, long-run coefficients for model 1 show that a positive shock in financial development leads to 0.053% reduction in carbon dioxide level in Algeria, on average. The probable reason for this result is that financial development leads to improve economic performance which also increases energy consumption. Since Algeria is energy-dependent country and uses traditional energy sources (e.g., coal, crude oil) and at the same time could not achieve to increase the share of renewable energy sources in its energy mix, the efforts to mitigate the environmental degradation are ineffective.

Regarding natural resource rent, it has negative association with CO_2 emission. This means that resource policy of the country is responding to the betterment of the environmental development. Revenue generation from the production of the oil and gas, and judicious spending of the revenue through capital and development purposes are capable of

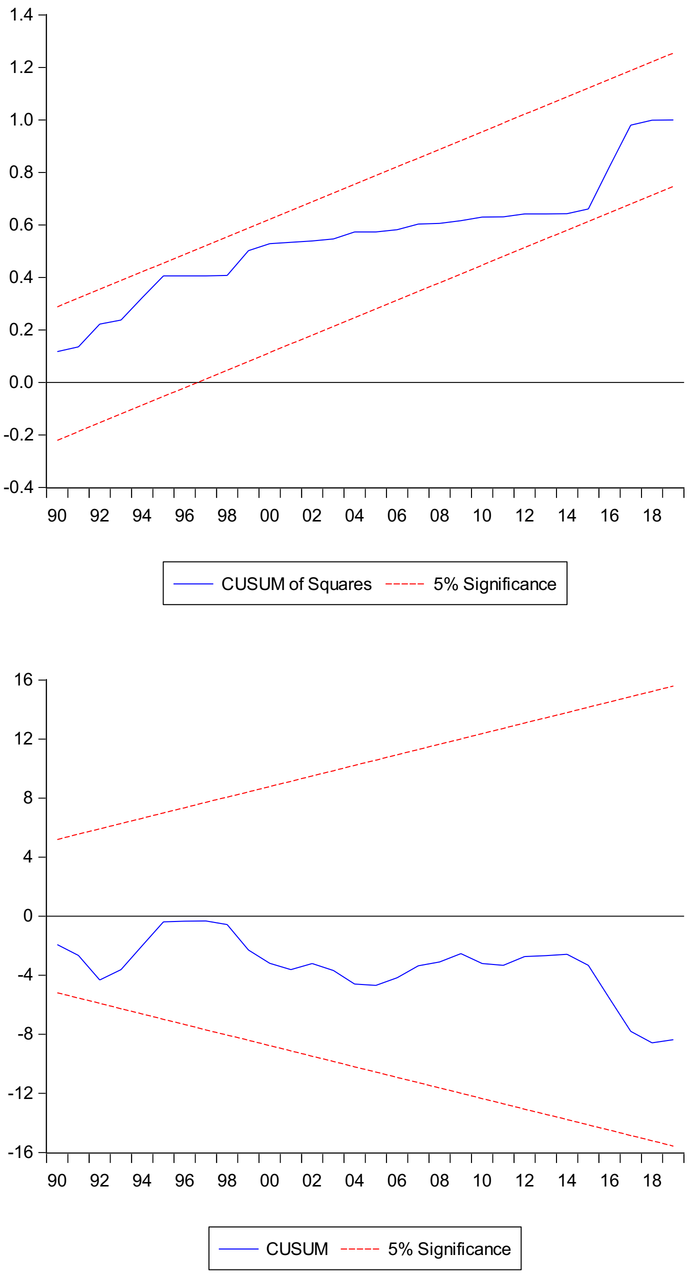


Fig. 4 Cusum and CusumSq for model 1. *Source* Authors' computation

curtailing excessive carbon emissions, and hence improve and sustain environmental development. Most of the resource-based economies including Algeria are leveraging on the revenue generation through the exploration and production of the resource to sustain the development (economic and environment). This could be done by reinvesting the revenue

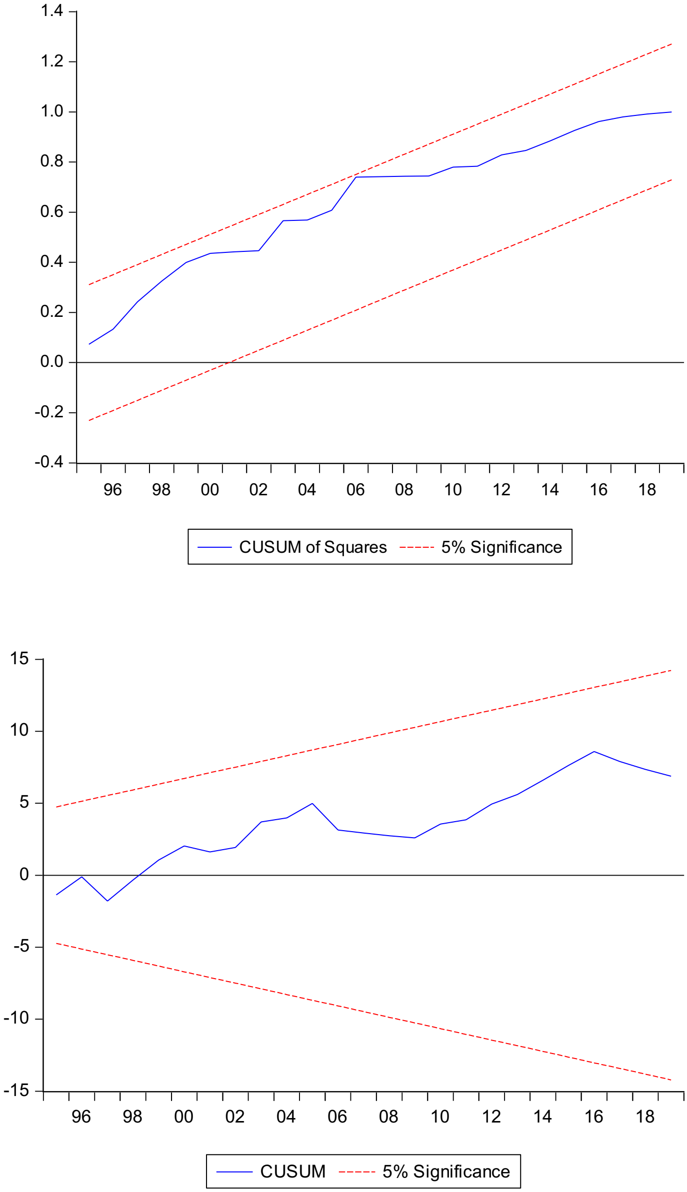


Fig. 5 Cusum and CusumSq for model 2. *Source* Authors' computation

generated from resource production into development projects which includes expanding renewables energy development projects such as installing big green power plants, e.g., massive photovoltaics, hydropower stations, etc. This also helps in diversification of the economy for a sustainable economic development instead of depending on one source for foreign exchange attraction. This finding confirms to the findings from Udemba and Yalçıntaş, (2021), Ling et al. (2022) and Usman and Balsalobre-Lorente, (2022).

Economic growth increase in environmental degradation. This helps us to understand that Algeria, as developing country, faces with the scale effect, stated by Grossman and Krueger (1991) and Panayotou (1997) and a positive shock on economic performance contributes to environmental degradation level. Algeria is still operating at the first phase of development that negates the environmental development in ensuring fast economic development. There could be inclusive sustainable development in Algeria if only robust policies such as economic diversification will be pursued with the help of revenue generated from resources production. This finding is support of the finding from Leitão et al. (2022) and Sun et al. (2022). This asserts that Algeria faces with trade-off between environmental quality and economic performance at the current level of economic development. Due to prioritizing economic development to environmental quality and aiming to reach the sustainable development goals at targeted time, sustainable, balanced and inclusive economic targets lose their importance in Algeria.

In detail, when economy grows with the help of natural resource rent, technological innovation and financial development, government can generate new policies to invest more in mining and would extract more natural resources. This creates employment opportunity to local people, decreases demand deficient unemployment and increases productivity in sectors. This needs strong and well-designed policies to minimize the opportunity cost of investing in mining sector and increase the living standards in the country.

Moreover, a 1% increase in positive (negative) variation in technological innovation mitigates the environmental degradation by 0.155% (0.548%), on average. This helps us to highlight the importance of use of new technologies, patents and/or concepts to mitigate the environmental degradation and reach to sustainable development goals. The patent application by residents and non-residents, innovation of carbon cutting technologies, storage technologies, sustainable green building concepts, etc. increase from day to day in Algeria, and its rank continuously increases among upper middle-income countries. Thus, the results affirm that TI significantly upsurges the environmental quality and mitigates the CO_2 emission in both short run and long run. This indicates that for every innovative attempt in the country, environment is prioritized, and environmentally friendly technologies, production or economic activities occur in the country. This finding aligns with the findings from Lingyan et al. (2022), Pradhan and Ghosh, (2022), Leitão et al. (2022) and Sun et al. (2022). This proves that the use of old technology in production and primary traditional energy source dependency in production process will increase CO_2 emission in Algeria and significantly increases environmental degradation level.

5.2 In model 2

The estimated coefficients of technological innovation increase pertaining to economic performance. The results affirm that Algeria has adopted to smart and environmentally friendly technology in its manufacturing sectors, which contributes to environmental quality and economic performance at the same time. This is because negative shocks on innovative activities will lead to sustain import and energy dependency, which also cause to stay behind the competitors in terms of efficiency. This finding attests to the findings from Zhang et al. (2022).

Furthermore, financial development and natural resource rent will lead to increase economic performance. Implying that, overdependence on NRR positively affects environmental quality with good management and conservation policies. This is because the development in financial sector helps economic actors to easily access to credits and money which leads more economic activity in country. As mentioned before, with a judicious plan stemming from the revenue generated from natural resources and ease of accessing credits, the sustainable economic development is bound to be achieved through diversification policies. This finding aligns with the findings from Zhang et al., (2022 for financial development and natural resources, Usman and Balsalobre-Lorente, (2022) and Khan et al., (2022a, 2022b, 2022c) for the case of natural resources and economic growth.

Findings from Dynamic Ordinary Least Square (DOLS) support the findings from NARDL; hence:

Overall results indicate that all explanatory variables are significant determinants of estimated models. The long-run estimation implies identical results with the short run. These results, on the one hand, show the importance of financial development and technological innovation to increase the revenues from rents gathered from natural resources and on the other hand the significance of revenues generated from natural resources as engine of GDP growth in Algeria. In this sense, the government of Algeria should pursue implementation of new reforms and negotiations to strengthen the existing economic reforms and better integrated into the global economy. To achieve this, the government should also promote domestic corporations to speed up the green innovations. Hence, government of Algeria should invest more on infrastructure to develop the quality for industries and promote policies to attract foreign direct investment inflows. Additionally, results show the importance of natural resource rent for Algerian government. The wealth of its economy heavily depends on availability of natural resources and their prices. However, this makes the country dependent on the trade of oil and natural gas and sensitive to volatility in energy prices in the future. Therefore, the government should promote new policies to alter the revenues from natural resource and support innovation for green energies for sustainability**.**

6 Conclusion and policy recommendation

6.1 Conclusion

This is a study of sustainable development goal (SDGs) of Algeria. The economic factors and indicators (such as natural resources) of Algeria suggest the country is accelerating on one sided development, economic growth. Many studies have been done on the country's economic development with little studies focusing on its environmental development. Hence, the present study is an inclusive (both economic and environmental) study of Algeria's sustainable development. The main goal of this study is to examine the Algeria's ability to achieve its sustainable (economic and environmental) development goals amidst economic activities that are centered on fossil fuels and natural resource rent. For this reason, we adopt two models (growth and environment) for insight into the inclusive sustainable development. Focusing on the environmental development of the country, we mediate the interactions that exist amongst economic growth, natural resource and financial development with technological innovation to expose Algeria's sustainable development amidst the selected variables. For clarity in our study, we adopt both linear and nonlinear scientific methods in our estimations. Dynamic Ordinary Least Square (DOLS) and nonlinear autoregressive distributed lag (NARDL) are adopted for this purpose. With the application of NARDL method, the impact of the selected variables is decomposed into positive and negative shocks which helps to capture the all dimensional impact of the variables on the dependent variable (CO_2 which proxy environment), while the DOLS is adopted as a confirmation to the findings from the nonlinear (NARDL) approach.

Findings from NARDL exposed the impacts of the selected explanatory variables on environment and economic growth, hence giving credence to the objective rooted questions from the introduction section. Thus, for environment model, except economic growth, the positive shocks to financial development, technological innovation and natural resources improve environmental quality, while their negative shocks degrade the environmental quality. This trend is repeated in both periods (short run and long run). For the economic growth model, except for the case of CO_2, a positive shock to financial development, technological innovation and natural resources tends to improve the economic situation of Algeria, while their negative shocks tend to decline the economic development of the country. The same scenario is noticed in the long run. Further, the output of the DOLS supports the output from the NARDL; hence, the outputs from the two methods support each other thereby pointing toward achieving SDGs for Algeria with the trio indicators (technological innovation, financial development and natural resources).

6.2 Policy recommendation

Following the findings from both methods on the adopted models, we observed that the trio selected indicators (natural resources, technological innovation and financial development) have positive implication on both economic and environmental development. Hence, a little increase in any of the variables will decrease carbon emissions (improve environment) and increase the economic growth in both models, respectively. With this, policy framing toward sustainable development goals should focus on increasing technological innovation through financial development which will transcend to improvement on both environment and economic situation of Algeria. Some financial policies such as subsidy from government in financing research projects, and lifting embargo on loan through reduction in interest rate and increase on financial literacy through sensitization on how to go about securing loans are to be considered when framing lasting policies targeting the Algeria's SDGs. Omission of some economic factors such as FDI and liberalization policies stand as among the limitation to our study; thus, future research could adopt the mentioned omitted variables in their studies for better assessment of the sustainable development of Algeria.

Conclusively, the findings from the scientific estimations have answered the listed objectives rooted questions which also justify the motivation of our study, hence, environmental cum economic implication of the trio (technological innovation, financial development and natural resources) indicators on sustainable development goals of Algeria. The findings and conclusion of our study have implication and relevance to other emerging countries (especially natural resource based economies in Africa and other emerging countries) in the category of Algeria and also open room for more discussion on this topic.

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Declarations

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Ethical approval The authors confirm that this study has not been submitted to any publication outlet and hereby give their consent to participate in the publication of this study.

Consent for publication The authors give their consent for publication of this study.

Availability of data and material The data will be made available on request.

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Authors and Affiliations

Nazakat-Ullah Khan[1] · Edmund Ntom Udemba[2,3] · Firat Emir[4] · Sadam Hussain[5]

✉ Edmund Ntom Udemba
eudemba@gelisim.edu.tr; eddy.ntom@gmail.com

Nazakat-Ullah Khan
nazakat.khan@iiu.edu.pk

Firat Emir
firat.emir@final.edu.tr

Sadam Hussain
sadam_2iqbal@yahoo.com

1 School of Accounting, Dongbei University of Finance and Economics, Dallian 116025, Lianning Province, China

2 Business School, Shanxi Technology and Business College, 99 Wucheng South Road, Xiaodian District, Taiyuan 030000, Shanxi, Turkey

3 Faculty of Economics, Administrative and Social Sciences, Department of International Trade and Finance, Istanbul Gelisim University, Istanbul, Turkey

4 Department of Business Administration, Faculty of Economics, Administrative and Social Science, Final International University, Kyrenia, North Cyprus, Via Mersin 10, Turkey

5 Center for Industrial and Business Organization, Dongbei University of Finance and Economics, Dallian 116025, Lianning Province, China