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THE INTERPLAY BETWEEN ECONOMIC DIVERSIFICATION, FOREIGN DIRECT INVESTMENT, AND CLIMATE CHANGE IN SAUDI ARABIA

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Abstract

This study examines the short-run and long-run repercussions of export diversification and foreign direct investment on climate change and greenhouse gas emissions in Saudi Arabia. In addition, the specification includes gross domestic product, total energy use, and urbanization as control variables. The outcomes of the study are as follows. First, the ARDL model provides empirical evidence supporting long-run cointegrating relationships among the variables. Second, export diversification, gross domestic product, and urbanization increase greenhouse gas emissions in the short-run and long-run. Nevertheless, the long-run adverse consequences of these variables tend to be greater than their short-run effects. Third, foreign direct investment inflows reduce greenhouse gas emissions and enhance short- and long-run environmental conditions. Finally, energy use has no significant impact on environmental conditions. These conclusions are robust against many empirical issues, including autocorrelation, heteroskedasticity, misspecification, and normality. The cumulative sum of recursive residuals and cumulative sum of recursive residuals of squares plots confirm the stability of long-run parameters and the validity of the ARDL estimations. The findings offer significant perspectives on measures that should be taken to preserve the environment.

Keywords:

Climate change;
GHG emissions;
economic diversification;
foreign direct investment;
Saudi Arabia;
ARDL.

1 Introduction

Climate change refers to significant and long-lasting variations in global or regional climate patterns over an extended period, typically lasting decades or longer. According to [1], the temperature has increased by 2 degrees over the past two centuries. Greenhouse gases (GHG), particularly carbon dioxide (CO_2), represent the main factors behind climate change [2,3]. According to [4], the occurrence of climate may induce various natural disasters, including flood and drought. Global warming can result from these gases holding heat in the atmosphere of Earth. Governments and international institutions have discussed climate change and global warming due to their disastrous consequences on the environment and consequently on various elements of human life, such as the economy, finance, society, and health [5]. [6] highlighted consider air pollution as the most serious environmental health hazard, accounting for an estimated 7 million deaths each year. Given these considerations, scholars and academics have been interested in identifying the factors that contribute to the rise in GHG and the occurrence of climate change [7-9].

Although a wide range of factors have been analysed, the implications of economic diversification and foreign direct investment (FDI) on climate change have received less attention. On the one hand, transitioning away from fossil fuel-dependent industries, such as oil and gas, can mitigate climate change by reducing GHG emissions. Furthermore, redirecting the economy's attention towards cleaner industries, including clean energy, eco-tourism, and sustainable agriculture, might reduce reliance on carbon-intensive sectors. Greenhouse control may also be one of the solutions that may be implemented to diversify the economy and protect the environment [10]. Allocating resources to clean technology as part of economic diversification strategies may decrease GHG emissions. For example, countries that diversify their energy mix to include a larger share of solar, wind, and hydroelectric power can reduce emissions and contribute to global initiatives to tackle climate change. Economic diversification can stimulate innovation and technical advancement, resulting in the emergence of novel environment-friendly technologies and strategies to address and adapt to climate change.

FDI can exert both favourable and unfavourable effects on GHG emissions and climate change, contingent upon the characteristics of the investment and the industries involved. The positive consequences stem from the fact that FDI may promote the transfer of green technologies, skills, and appropriate procedures from rich to developing countries, assisting the latter in transitioning to more sustainable growth. The negative consequences stem from the fact that FDI in high-carbon-emitting industries, such as coal mining or heavy manufacturing, can increase GHG emissions and accelerate climate change. Additionally, FDI involving deforestation, land degradation, or other environmentally harmful activities can decrease biodiversity and deteriorate the ecosystem. Policies and regulations may impact the extent to which FDI contributes to climate change. Governments can encourage FDI in sustainable businesses by providing favourable regulatory frameworks, tax incentives, and subsidies. Additionally, they can implement environmental protections and standards to mitigate adverse environmental impacts. In addition, FDI in green energy projects can promote economic diversification by creating job opportunities, promoting economic growth, and reducing GHG emissions. Nonetheless, there could be contradictions between economic growth and climate change mitigation efforts. Countries that depend on exporting fossil fuels may face difficulties diversifying their economy if the fossil fuel industry is important. Therefore, economic diversification and FDI can influence GHG emissions and climate change outcomes through their effects on technology transfer and sectoral development.

Given the prior discussion, the objective of this study is to assess empirically the interplay between economic diversification, FDI, and GHG emissions in Saudi Arabia between 1980 and 2014. Confronted with the urgency of climate change and environmental concerns, Saudi Arabia strives to achieve more economic diversification and attract FDI to promote sustainable growth and achieve long-lasting economic success. Therefore, examining how economic diversification, FDI, and climate change interact in Saudi Arabia is crucial to determine their combined impact on achieving sustainable development. The heavy reliance of Saudi Arabia on oil and gas exports makes it susceptible to swings in oil and gas prices and changes in the global market. Therefore, achieving economic diversification and allocating resources to different industries is crucial to strengthen sustainable development and achieve long-lasting economic stability. Furthermore, the rapid and unpredictable changes in climate and their harmful impacts on the environment, economy, and society pose challenges for adaptation. Furthermore, the expansion of FDI in Saudi Arabia and its implications for the enduring goals of environmental sustainability must be thoroughly examined. Understanding the short-term and long-term positive and negative impacts of FDI and economic diversification on environmental quality is crucial, which is why this study is important. Conducting this study will enable the design and implementation of strategies to promote sustainable growth in Saudi Arabia. The results are also of great significance to Saudi Arabia as it tackles global economic and environmental issues. This is especially crucial considering the current emphasis on development and diversification plans under the Saudi Vision 2030.

The paper is structured as follows. Section 2 presents previous studies, while Section 3 is reserved for the methodological issues and data. The empirical results are discussed in Section 4. Finally, Section 5 includes the most important findings, policy recommendations, and limitations of the study.

2 Literature Review

The research focuses on how economic diversification, FDI, and GHG emissions interact in Saudi Arabia. Studies examining the linkages between FDI, economic diversification, and GHG emissions have highlighted the importance of economic transformation and diversification. This could be particularly important for Gulf Cooperation Council (GCC) countries due to their dependence on natural resources and the sharp fluctuations in oil prices. Some studies examined the correlation between economic diversification and GHG emissions, while others concentrated on the impacts of FDI on the environment.

2.1 The environmental effects of economic diversification

Promoting economic diversification can help alleviate the negative consequences of climate change while also promoting sustainable development. Moreover, it can potentially decrease CO2 emissions and improve environmental conditions. The implementation of sustainable practices, policies, and economic diversification is critical in addressing climate change issues and promoting environmental and economic sustainability over the long term. One way to achieve this is by directing economic diversification towards industries that promote renewable energy sources and ecologically friendly projects. On the contrary, economic diversification, particularly export diversification, may be associated with a rise in the foreign demand for new products that require more production, energy use, and GHG emissions [11]. Therefore, economic diversification may deteriorate or improve environmental quality.

Based on data collected from 19 industrialized nations between 1962 and 2010, [12] employed the Autoregressive Distributed Lag (ARDL) model and panel quantile estimators to check the repercussions of export product concentration on CO2 emissions. The ARDL model indicates that CO2 emissions will fall as export product concentration rises. Additionally, in the top quantiles of the panel quantile, there is a significant concentration of exported products. [13] examines the effects of product export diversification on emissions from 1971 to 2014. The authors found that across the global sample and in both developed and developing nations, export diversification significantly affects reducing CO2 emissions. In addition, a 1% rise in export diversification result in a global fall of CO2 emissions by 0.334%, with developed nations experiencing a decrease of 0.247% and developing nations seeing a decrease of 0.236%. Therefore, export diversification affects environmental quality in countries with different income levels differently. Furthermore, [14] analysed the impacts of export diversification on CO2 emissions. The findings indicate that export diversification has a long-term effect in reducing CO2 emissions. [15] studied the outcomes of export diversification in Poland from 1990 to 2015. According to the analysis, when a country diversifies its exports, it leads to an increase in CO2 emissions and a decline in the quality of the environment. [11] checked the consequences of export product diversification on CO2 emissions in several regions of China. The diversification of export items reduces emissions in many regions of China. In their study, [16] investigated the impact of export diversification on sulphur dioxide emissions. The findings corroborate with [11], since they demonstrate that diversifying export products decreases in emissions. Finally, [17] analysed the implications of economic diversification and FDI on the environment in 5 Asian countries. The results show that economic diversification reduces CO2 emissions, while FDI has no significant effects. Recently, [18] investigated the impacts of economic complexity on the environment in 24 European countries between 2000 and 2018. The outcomes show that economic complexity is good for the environment as it allows for the reduction and improvement of pollution. Finally, [19] explored the outcomes of economic complexity on pollution throughout the period of 2007 to 2016. The analysis indicates that there is a beneficial impact of economic complexity on the long-term state of the ecosystem.

2.2 The environmental effects of FDI

The impacts of FDI flows on economic growth have been widely studied in previous literature. It has been shown that FDI flows have beneficial effects on economic growth [20,21]. However, recent literature has focused on the environmental effects of FDI [22-24]. Indeed, FDI flows may have contradictory implications on GHG emissions, environmental quality, and climate change [25]. On the one hand, while FDI can bring about positive outcomes, such as increased foreign capital flows and economic development developing nations, it is crucial to acknowledge the potential adverse detrimental consequences. This phenomenon may arise due to the utilization of energy sources that emit fossil fuels, the adoption of inefficient production methods, and the production of environmentally detrimental goods, all of which have the potential to contribute to an increase in GHG emissions [26-28]. This concept is referred to as the Pollution Haven Hypothesis. On the other hand, FDI can also be associated with transferring environmentally beneficial technologies and the promotion of green trade, which can reduce GHG emissions and safeguard the environment [29]. The hypothesis above is often referred to as the Pollution Halo Hypothesis. According to [25,28], the environmental effect of FDI is contingent upon several factors, such as the educational attainment level in the host country. Indeed, low educational levels might result in the arrival of FDI, which introduces polluting technologies and increases GHG emissions. On the contrary, FDI flows may reduce GHG emissions in the presence of people with higher levels of education [30]. The implications of FDI on GHG emissions can be influenced by financial development. Indeed, the consequences of financial development on GHG emissions can vary between industrialized and developing economies [31-33].

[34] examined the effects of FDI on CO2 emissions in GCC nations, specifically Saudi Arabia, from 1980 to 2017. The authors conclude that FDI increases emissions in the long-run and reduces them in the short-run. Therefore, the impact of FDI on the environment depends on the horizon. [35] also explored the response of CO2 emissions to FDI in Saudi Arabia from 1980 to 2016. In addition, [36]) investigated the environmental repercussions of FDI in GCC countries between 1990 and 2019.

The spatial analysis suggests that FDI flows reduce territory-based CO2 and increase consumption-based CO2. [37] examined the consequences of FDI on CO2 emissions in 123 countries for the period 1996-2018 using the MG, PMG estimators, CCEPMG and CCEMG estimators. The analysis indicates that FDI inflows lead to a decrease in emissions across the entire sample. When disaggregating the full sample into developed and developing countries, FDI enhances the environment in developed countries while causing a decline in the environment in developing countries. [29] examined the impact of FDI on the Environmental Performance Index and showed no consequences of FDI on environmental quality. Recently, [22] explored the implications of FDI on the ecological footprint (EF) in Pakistan between 1976Q1 and 2020Q4. The wavelet analysis suggests the presence of a strong linkage between FDI and environmental quality in Pakistan. In addition, [23] analysed the effects of FDI on EF in India during the period 1990-2016. The author showed that FDI has a long-term negative implication on EF. Moreover, [24] explored the asymmetric effects of FDI on EF in Indonesia. The outcomes show that FDI inflow has an asymmetric effect since positive shock on FDI increases EF.

The discussion of the existing literature suggests the lack of empirical studies investigating the implications of economic diversification and FDI on GHG emissions and climate change in Saudi Arabia. The aforementioned factors hold significant importance in the context of Saudi Arabia, since it initiated the process of economic diversification and enhanced the attraction of FDI under the umbrella of the 2030 Vision. This study aims to cover this gap by undertaking an empirical examination of the impact of economic diversification and FDI on climate change in Saudi Arabia.

3 Data and Methodology

3.1 Data

This study aims to examine the effects of economic diversification and FDI on climate change in Saudi Arabia between 1980 and 2014. The period is dictated by data availability, particularly export diversification. The most recent update, conducted in July 2017, included data up to 2014. The dependent variable is represented by GHG emissions, which include carbon dioxide (CO_2), Methane (CH_4), Nitrous oxide (N_2O), and Fluorinated gases (F-gases). The advantage of using GHG emissions instead of CO2 emissions as a measure of environmental degradation is that it encompasses a wider range of gases. Data on GHG are obtained from Climate Watch. Economic diversification is measured in this study by export diversification. Indeed, as the economy becomes more diversified, a large number of diversified products will be exported. Data on export diversification are extracted from the International Monetary Fund (IMF). In addition, the data on FDI are provided by the World Development Indicators (WDI). Moreover, the specification includes a number of control variables. 1. The choice of control variables is not arbitrary but is based on the STIRPAT model developed by [38]. According to the authors, pollution is induced by three factors: population, affluence, and technology. According to the existing research, the population is assessed using urban population data [39,40], affluence is measured by GDP per capita [32,41], and finally, technology is measured by energy consumption [42]. Although the two variables come from the WDI, the last variable is obtained from the Energy Institute. Table 1 presents the data used in this research.

Table 1. Definitions and sources of variables

Acronym	Definition	Source
lnGHG	Greenhouse gas emissions (MtCO2e)	Climate Watch
lnED	Export diversification	IMF
lnFDI	FDI, net inflows (% of GDP)	WDI
lnGDP	GDP per capita (constant 2015 US$)	WDI
lnEC	Primary energy consumption (TWh)	Energy Institute
lnURB	Urban population	WDI

Figure 1 plots the variables used in the empirical study. As shown, there has been a decline in GHG emissions at the beginning of the period. However, between 1985 and 1993, emissions grew and declined from 1994 to 1998. Then, emissions increased steadily to reach the highest levels in 2014. Figure 1 also shows a fluctuating trend for GDP per capita, FDI inflows, and export diversification over the whole period. However, primary energy consumption and urbanization have increased over the period under study.

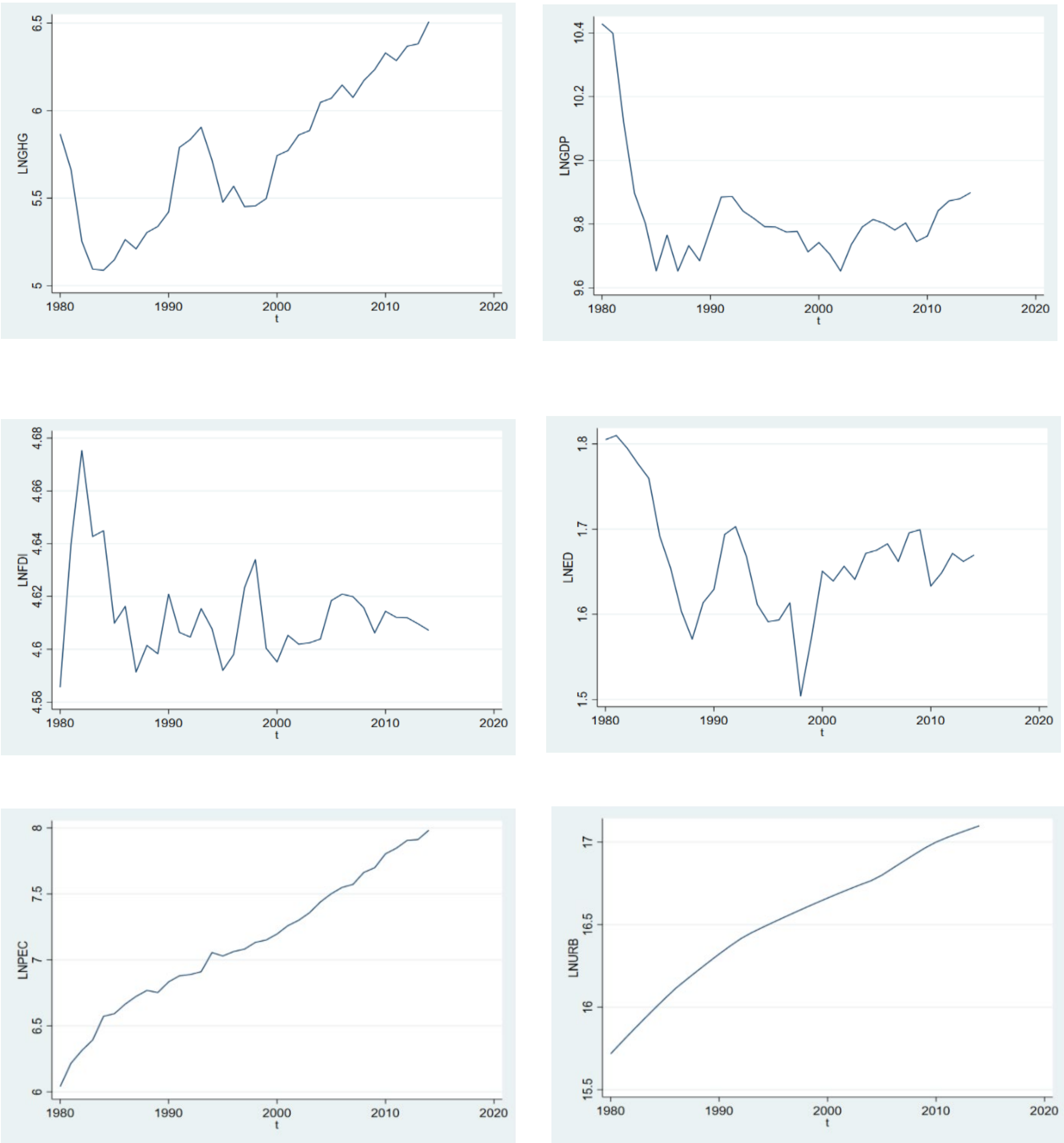


Figure 1. Plots of variables
Source: The authors, based on data from Climate Watch (LNGHG), IMF (LNED), WDI (LNGDP, LNFDI, LNURB) and Energy Institute (LNPEC)

This could be linked to the Saudi economy being based on energy as a primary input for all economic sectors. More specifically, the economy relies on fossil fuel energy, particularly oil and natural gas. The growth in urban population is associated with the expansion of large cities in recent decades.

3.2 Methodology

The study estimates the effects of economic diversification and FDI on climate change in Saudi Arabia. We use the ARDL model to assess the short-run and long-run implications. Figure 2 summarizes the empirical methodology.

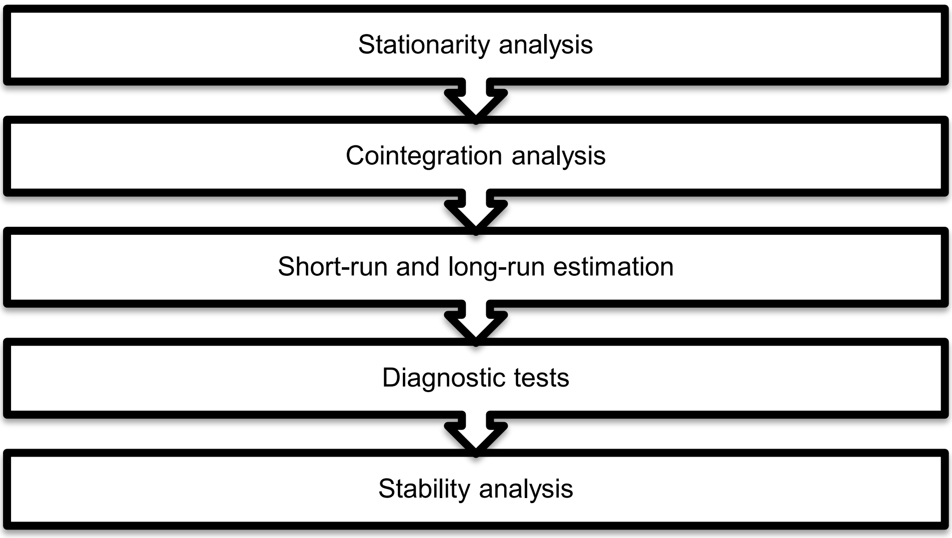


Figure 2. Empirical methodology

The mathematical representation of independent and dependent variables may be written as follows:

$$lnGHG_t = \alpha_0 + \alpha_1 lnED + \alpha_2 lnFDI + \alpha_3 lnGDP + \alpha_4 lnEC + \alpha_{51} lnURB + \epsilon_t \quad (1)$$

where *GHG*, *ED*, *FDI*, *GDP*, *EC*, and *URB* represent GHG emissions, export diversification, foreign direct investment, gross domestic product per capita, energy consumption, and urbanization, respectively.
The long-run coefficients are obtained using the equation:

$$lnGHG_t = \alpha_0 + \sum_{n=1}^{p} \beta_n \, lnGHG_{t-n} + \sum_{m=1}^{q1} \gamma_m \, lnED_{t-m} + \sum_{j=1}^{q2} \rho_j \, lnFDI_{t-j} + \sum_{s=1}^{q3} \vartheta_s \, lnGDP_{t-s} + \sum_{k=1}^{q4} \theta_k \, lnEC_{t-k} + \sum_{h=1}^{q5} \tau_h \, lnURB_{t-h} + \omega_t \quad (2)$$

Finally, the short-run coefficients are obtained using the following equation:

$$\Delta(lnGHG_t) = \alpha_0 + \sum_{n=1}^{p} \beta_n \, \Delta(lnGHG_{t-n}) + \sum_{m=1}^{q1} \gamma_m \Delta(\, lnED_{t-m}) + \sum_{j=1}^{q2} \rho_j \, \Delta(lnFDI_{t-j)} + \sum_{s=1}^{q3} \vartheta_s \, \Delta(lnGDP_{t-s}) + \sum_{k=1}^{q4} \theta_k \Delta(\, lnEC_{t-k}) + \sum_{h=1}^{q5} \tau_h \, \Delta(lnURB_{t-h}) + \pi_{t-1} + \varepsilon_t \quad (3)$$

where π_{t-1} is the error correction term (ECT).

3.3 Correlation analysis

We initiate the analysis by evaluating the correlation among the various variables. The findings are included in Table 2. As shown, there is a high correlation between lnEC and lnGHG (0.813) and lnURB and lnGHG (0.802). Therefore, one can confirm from the table that lnEC and lnURB are positively related to lnGHG in Saudi Arabia. In addition, there is a moderate and negative association between lnFDI and lnGHG (-0.251). Furthermore, lnGDP has a positive correlation with emissions. Finally, a weak correlation between lnED and lnGHG is observed.

Table 2. Correlation matrix

	lnGHG	**lnED**	**lnFDI**	**lnGDP**	**lnEC**	**lnURB**
lnGHG	1.000					
lnED	0.043	1.000				
lnFDI	-0.251	0.436	1.000			
lnGDP	0.100	0.696	0.297	1.000		
lnEC	0.813	-0.372	-0.241	-0.422	1.000	
lnURB	0.802	-0.431	-0.293	-0.445	0.990	1.000

4. Empirical Findings

4.1 Stationarity analysis

Before estimating the outcomes of export diversification and FDI on GHG emissions, checking the existence of a unit root is mandatory. In this study, different unit root tests are tested. First, we use the DF-GLS unit root test suggested by [43]. Then, we use the unit root test of [44], which has the advantage of accounting for structural breaks. The outcomes are presented in Table 3.

Table 3. Unit root test outcomes

Variables	DF-GLS test		ZA test			
	level	1st difference	level		1st difference	
			Statistics	Time break	Statistics	Time break
lnGHG	-2.302	-4.186***	-3.772	2000	-5.795***	1986
lnED	-1.940	-5.536***	-3.619	1987	-5.548***	2001
lnFDI	-3.530**	-4.890***	-7.033***	1988	-5.115***	1991
lnGDP	-1.968	-5.019***	-5.419***	2003	-5.421***	1987
lnEC	-2.443	-3.695***	-5.014***	2003	-5.490***	1990
lnURB	-1.181	-2.014	-3.642	1991	-5.413***	2005

*** and ** mean that the variable is stationary at at 1% and 5%.

The DF-GLS test indicates that all variables at levels exhibit a unit root, with the exception of lnFDI. However, upon considering the first difference, the same test indicates that all variables, with the exception of lnURB, exhibit stationarity. Therefore, all variables are integrated of order one, except urbanization. It should be noted that the DF-GLS test does not account for structural breaks. Therefore, we move to the ZA test. This test suggests that lnGHG, lnED, and inURB are integrated of order one, while lnFDI, lnGDP, and lnEC are integrated of order zero. The test also shows that different time breaks are detected for the variables under study. In summary, the unit root tests indicate that the variables possess different levels of integration, either being integrated of order zero (I(0)) or integrated of order one (I(1)). In this case, the ARDL model is appropriate for checking the presence of cointegration.

4.2 Cointegration analysis

The existence of long-run cointegration is examined based on the ARDL bounds testing approach for cointegration. As shown in Table 4, two statistics are estimated: The F-statistic and the t-statistic. Based on the results of the F-test, the statistic has a value of 6.578, which exceeds the upper critical value of 4.68 at the 1% level. Furthermore, the t-test yields a significance level of -4.853%, which surpasses the upper critical value of -4.79 at the 1% level. Therefore, the two tests provide strong evidence of cointegration between the variables. Therefore, it can be inferred that there is a substantial long-term relationship between lnGHG, lnED, lnFDI, lnGDP, lnEC, and lnURB in Saudi Arabia. As a result, it It is critical to determine the short- and long-term effects on GHG emissions of the various variables, such as export diversification and FDI.

Table 4. Findings of the ARDL bounds test for cointegration

Bounds testing for cointegration				
Statistics		Value		Decision
F-statistic		6.578***		Cointegration
t-statistic		-4.853***		Cointegration
Pesaran/Shin/Smith (2001) critical values				
		10%	5%	1%
F-statistic	I(0)	2.26	2.62	3.41
	I(1)	3.35	3.79	4.68
t-statistic	I(0)	-2.57	-2.86	-3.43
	I(1)	-3.86	-4.19	-4.79
The critical values are derived from the study conducted by [45]. *** means the presence of cointegration at 1%.				

4.3 Short-run and long-run estimation

Given the presence of cointegration, it is essential to compute the implications of the different variables on GHG emissions using the ARDL model. The estimated short-run and long-run coefficients are summarized shown in Table 5.

Table 5. Estimation results

	Long-run effects		Short-run effects	
	Coeff.	**Std. Err.**	**Coeff.**	**Std. Err.**
ECT	-	-	-0.735***	0.151
lnED	2.950***	0.576	1.110***	0.392
lnFDI	-4.026**	1.873	-2.960*	1.450
lnGDP	0.573*	0.344	1.145***	0.303
lnEC	-0.067	0.824	-0.049	0.221
lnURB	1.140***	0.405	0.838**	0.343
constant	-	-	-3.919	6.674
***, **, and * mean that the coefficient is significant at 1%, 5% and 10% levels.				

First, the table indicates that the error correction term is negative and significant at 1%. This finding %, which supports the results of Table 4 and supports the long-run cointegrating linkage between the different variables. In addition, the ECT is equal to -0.735, which means that the adjustment speed is relatively high. Indeed, approximately 73.5% of the deviation from short-term equilibrium to long-term equilibrium is corrected within the same year. Furthermore, the long-term analysis reveals that the coefficient associated with export diversification is 2.950. Consequently, a rise in export diversification by 1% will cause a rise in GHG emissions by 2.950% in the long-run. The findings validate the claim that export diversification has adverse long-term consequences for environmental quality and contributes to the acceleration of climate change. In fact, economic diversification may be associated with a rise in the foreign demand for new products that require more production, energy use, and GHG emissions [11]. In the short-run, export diversification also has adverse effects on GHG emissions. Nevertheless, the short-run effects are determined to be smaller in magnitude compared to the long-term effects. Therefore, the adverse effect of export diversification on emissions becomes more pronounced with the extension of the time frame. Moving to FDI, the table shows that it has negative coefficients in both the long-run (-4.026) and short-run (-2.960). Therefore, a rise in FDI inflows reduces short- and long-term emissions, thereby improving environmental quality. A rise in FDI induces a reduction in emissions by 4.026% in the long-run and 2.960% in the short-run, which means that the long-run effects are more important than those of the short-run. The beneficial effect of FDI can be linked to its concentration on sectors that employ clean energy and facilitate the transfer of innovative and environmentally friendly technologies. The table also suggests that GDP per capita has a positive coefficient in the short-run and long-run. Therefore, increased economic growth during the last decades led to increased output and GHG emissions. Urbanisation has also a negative implication on the environment. Indeed, the movement of people and businesses into big cities, along with changes in how land is used, are all signs of urbanisation. This could lead to a rise in energy use and waste production, both of which have negative environmental impacts. Finally, the coefficients of lnEC are not significant, which means that energy consumption does not affect GHG emissions in Saudi Arabia.

4.4 Diagnostic tests

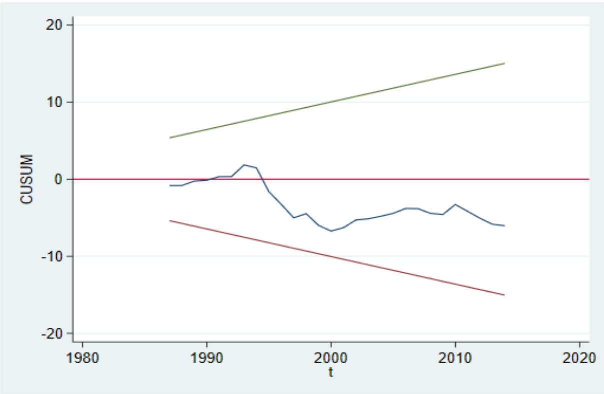
The validity of the ARDL model findings stated above is contingent upon successfully passing a series of diagnostic tests. To this end, we conduct a series of validation tests to check the presence of econometric problems (autocorrelation, normality, appropriateness of the functional form of the regression). The findings are reported in Table 6. The estimation findings indicate that the null hypothesis of no serial correlation in the residuals is not rejected. Given that the p-value is higher than 0.05, we accept the null hypothesis of homoscedasticity for the LM test for autoregressive conditional heteroskedasticity and Breusch-Pagan test. The p-value obtained from the Jarque-Bera test is above the significance level of 0.05, indicating the normality of residuals. Finally, the Ramsey Regression Equation Specification Error Test (RESET) test shows the accuracy of specifications and the absence of omitted variables. To summarize, the various diagnostic tests demonstrate the absence of econometric issues and the accuracy of ARDL model estimates.

Table 6. Validation tests

Test	Statistic	p-value
Breusch-Godfrey LM test for autocorrelation	1.849	0.173
Jarque-Bera normality test	1.025	0.599
LM test for autoregressive conditional heteroskedasticity	0.000	0.982
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity	0.090	0.758
RESET test	0.800	0.504

4.5 Stability analysis

The stability of ARDL long-run parameters is evaluated using the CUSUM and CUSUM of squares techniques established by [46]. Figure 3 illustrates the results of the two tests. These figures indicate the stability of the long-term impacts.



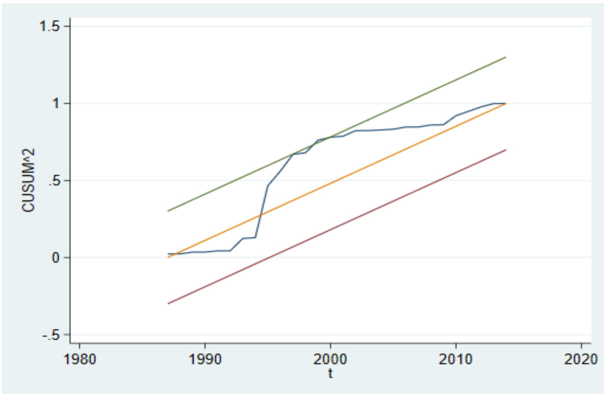


Figure 3. Long-run stability test

Source: The authors.

5. Conclusion, Policy Implications and Limitations

Despite the growing number of studies devoted to analysing the drivers of climate change in GCC countries, scarce research has been devoted to the implications of export diversification and FDI. This paper seeks to contribute to literature by exploring the consequences of economic diversification and FDI on GHG emissions in Saudi Arabia between 1980 and 2014. The ARDL model provided evidence supporting long-term relationships among the dependent variable (GHG emissions), export diversification, FDI, GDP per capita, energy consumption, and urbanization. Moreover, the empirical analysis indicates that export diversification, GDP per capita and urbanization increase emissions in the short-term and long-term. However, the long-run adverse effects of these factors are generally higher than short-run effects. On the contrary, FDI inflows are found to reduce emissions and improve environmental quality. Finally, energy consumption has no significant effects on the environment. These findings are not sensitive to autocorrelation, heteroskedasticity, misspecification and normality issues. In addition, the CUSUM and CUSUM of squares plots confirm the stability of the ARDL long-run parameters.

The outcomes of this paper are important for developing specific policy recommendations in Saudi Arabia. First, it has been shown that export diversification increases GHG emissions and deteriorates the environment. Consequently, it is recommended to focus on clean projects when initiating economic diversification. This could be done by concentrating on sectors that use renewable energy sources as inputs instead of fossil fuels. Second, urbanization also deteriorates the environment. Therefore, policies and strategies should be adopted to decrease the detrimental implications of urban cities on the environment. This could be done by reducing and managing solid waste, developing collective transport systems, and improving air quality. Third, FDI is found to enhance environmental conditions. This is important as Saudi Arabia is seeking more and more foreign capital, which will bring not only economic and financial benefits but also environmental benefits. Therefore, more efforts must be made to attract more FDI flows and to set environmental regulations to avoid the development of foreign investments that are harmful to the environment. In addition, financial incentives may be provided for green FDI flows that allow for promoting economic activity and boosting employment without rising GHG emissions and damaging the environment.

Although this study provided new evidence on the consequences of economic diversification and FDI on pollution in Saudi Arabia, it may be improved by incorporating the following points. First, it is important to consider the different types of energy sources, including renewable and non-renewable energy. This has the potential to enhance comprehension of the ecological impacts associated with energy use. Second, future studies may consider the nonlinear effects of economic diversification and FDI on GHG emissions by using a nonlinear ARDL model. Finally, this study has the potential to be extended to encompass additional GCC nations.

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