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CARBON DIOXIDE EMISSIONS, ENERGY CONSUMPTION AND ECONOMIC GROWTH IN SAUDI ARABIA: A MULTIVARIATE COINTEGRATION ANALYSIS

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ABSTRACT
This paper applied the ARDL and VECM test techniques on economic growth, CO_2 emissions, energy consumption and the employment ratio to establish the long run and short run relationships between these variables in Saudi Arabia. The results show that there are long run and short run relationships among the variables in the model. The estimated elasticity coefficients of CO_2 emissions, energy consumption, and employment ratio have positive and significant impacts on GDP in the long run. The results for direction of causality indicate that neither carbon emissions per capita nor energy consumption per capita cause GDP per capita, but employment ratio causes GDP per capita in the short run. On the basis of our empirical findings, it can be concluded that energy conservation policies and controlling carbon dioxide emissions, are likely to have no adverse effect on economic growth in Saudi Arabia in the short run. However, the long run income elasticity of carbon emissions is greater than the short run income elasticity of carbon emissions, which implies that in the long run income leads to greater carbon dioxide emissions in the country.

Keywords: GDP; CO_2; energy; causality; ARDL; VECM.

1. INTRODUCTION

Climate change and global warming have attracted considerable worldwide attention. Many studies have focused on the relationships between growth and carbon dioxide (CO_2) emissions, growth and energy over the last two decades. It has been observed that higher economic growth causes environmental degradation and threatens the sustainability of the environment because economic growth is closely linked to energy consumption (Ozuturk and Acaravci, 2010). Higher economic growth requires a higher level of energy consumption and is responsible for higher levels of CO_2 emissions. This notion attracted the world's attention in the 1990s because of the potential threats to the ecosystem. It became the general consensus that higher economic growth should not be pursued at the expense of the environment and this issue raised the question of how economic growth can be made more sustainable. Brundtland (1987) defines sustainable development as development that meets the needs of the present without compromising the ability of future generations to meet their own needs. [1]International organizations around the world continuously attempt to reduce the adverse impacts of global warming. One such attempt is the Kyoto Protocol agreement, titled the United Nations Framework Convention on Climate Change (UFCCC), made in 1997 as an attempt to reduce the adverse impacts of global warming. Among the variety of polluting substances, CO_2 is a major one and represents 58.8 percent of greenhouse gas emissions (World Bank, 2007). The choice of studying Saudi Arabia is motivated by the fact that the country is the largest oil producer and exporter of total petroleum liquids in the world. Saudi Arabia also produced the 14th largest volume of CO_2 emissions in the world in 2008. Growth theory predicts that in the initial stages of development, the pressure on the environment is high because the use of energy is crucial to economic growth and development.

Saudi Arabia has revised its General Environmental Laws and the rules for their implementation (2001), in line with Article (32) of the constitution and under the responsibility of the Presidency of Meteorology and Environment (PME), to conserve and protect the natural resources and environment of the country[2]. To that end, this study seeks to empirically examine the long run and causal relationship between economic growth, CO_2 emissions and energy consumption in a multivariate framework for Saudi Arabia during the 1980-2008 periods.

The main objective of this study is to see the effect of these environmental friendly laws on economic growth in Saudi Arabia. If energy consumption causes economic growth then these energy conservation laws will negatively affect the growth by affecting energy consumption and vice versa. The study employed an Auto Regressive Distributed Lag (ARDL) model and Vector Error Correction Model (VECM) techniques to establish the long run and short run relationships between the variables in the model. The study applied an error correction model based Granger causality test to evaluate the possible causal relationship between the variables in the model.

The remainder of the study is organized as follows. The second section outlines the brief literature about the relationships between economic growth, CO_2 emissions and energy consumption. The third section presents the model specifications, data and methodology. The fourth section presents the empirical results, and the last section includes important findings and valuable suggestions.

2. LITERATURE REVIEW

The links between economic growth and CO_2 emissions have been primary concerns of the empirical research, particularly since the 1990s. A number of empirical studies have enumerated the possible risks of CO_2 emissions and impediments to sustainable development[3]. The available literature can be categorized into growth, CO_2 emissions nexus and growth, energy consumption nexus. The previous studies have found a variety of relationships between economic growth and environmental quality. In empirical studies, Shafik and Banhyopadhayay (1992), Shafik (1994) and Fodha and Zahdoud (2010) found a linear relationship between economic growth and environmental quality. Studies by Friedl and Getzner (2003), Zarzoso and Maranco (2004), established an N-shaped relationship. Studies by Grossman and Krueger (1999), Shafik and Bandyopadhyay (1992), Panayotou (1993) and Galeotti et al. (2006) have instead found an inverse U-shaped relationship and challenged the Environmental Kuznets Curve (EKC). The EKC was popularized by Grossman and Krueger (1991) and based on a hypothesis made by Simon Kuznets (1955). The theory states that in the early stages of economic growth, environmental quality decreases with an increase in per capita income, but after a certain level, it starts decreasing with the increase in the level of per capita income, thus resulting in an inverted U-shaped curve.

Many empirical studies have considered CO_2 emissions and observed that CO_2 accounted for 60 percent of the greenhouse effect (Ozturk and Acaravci, 2010). Grossmann and Krueger (1995) used sulfur dioxide (SO_2) per capita, Panayatou (1993) included a trade component, Panayotou (1997) included population and Paul and Bhattacharya (2004) included energy consumption to show the direction of the relationship between economic growth and environmental quality.

Ratnayake and Kim (1999) used air pollution, water pollution, administrative strictness and registered vehicles per capita. Perman and Stern (2003) and Stern (2004) observed that the available econometric literature on the EKC is weak. Narayan and Narayan (2010) noted that studies using income-squared and cubic variables suffer from the problems of colinearity or multicollinearity. They also observed that defining the turning point for the relevance of the EKC hypothesis suffers from model misspecification problems. They proposed that environmental quality can be judged by comparing the short run income elasticity and the long run income elasticity. They argue that if the long run income elasticity is less than the short run income elasticity, then it can be inferred that over time increased income leads to decreased carbon dioxide emissions.

The links between economic growth and energy consumption have been examined by a number of empirical studies, and most of these studies have found that energy consumption has a direct impact on environmental quality. Economic theory predicts that higher economic growth requires higher energy consumption and is responsible for higher emissions. Kraft and Kraft (1978) observed that a unidirectional causality flows from output to energy consumption. Hye and Mashkoor (2010) observed bidirectional causality between economic growth and environmental sustainability. In a study on economic growth and energy consumption in four Asian developing economies, Asafu-Adjaye (2010) found a combination of unidirectional and bidirectional causality. Oh and Lee (2004) observed a unidirectional causality between economic growth and energy consumption in the short run and found a bidirectional causality in the long run. Erdal et al. (2008) observed bidirectional causality between energy consumption and economic growth in Turkey. Paul and Bhattacharya (2004) observed bidirectional causality between economic growth, energy consumption and environmental quality. Tsani (2010) found a unidirectional causality that runs from energy consumption to economic growth in the case of Greece. Menyah and Rufael (2010) observed a unidirectional relationship between energy consumption and economic growth in which causality runs from energy consumption to economic growth, in the case of South Africa. Lee and Chein (2010) found a unidirectional causality running from energy consumption to economic growth in their study of G-7 countries. There has been no systematic investigation to analyze the relationships among economic growth, CO_2 emissions and energy consumption in Saudi Arabia. The proposed study is an attempt to fill this gap.

3. MODEL AND ECONOMETRIC METHODOLOGY

The study applied multivariate model analysis techniques to examine the relationships among economic growth, CO_2 emissions, energy consumption and the employment ratio in Saudi Arabia. The country has the world's largest oil reserves and is expected to have high levels of energy consumption and CO_2 emissions. The study is based on the assumption that economic growth is driven by high energy consumption that is likely to produce CO_2 driven economic growth in the country (Ozturk and Acaavci, 2010). The basic form of the relationship between the variables can be expressed as:

$$Y = f(COP, ENP, LAP)$$

where, (Y) represents GDP, (COP) represents CO_2 emissions, (ENP) represents energy consumption and (LAP) represents the employment ratio or the total labor force ratio to total population. The relationship can be expressed in an equation as follows:

$$Y = \alpha + \beta COP + \delta ENP + \theta LAP + \varepsilon \text{...eq. (i)}$$

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The study employed a log-linear model specification, and is thus likely to give more definitive results. The equation (i) can be modified in a logarithmic form:

lY = α + βlCOP +δlENP +θlLAP +ε .... eq. (ii)

The coefficient β, δ and θ represents their respective elasticities, and ε is the disturbance term in the model.
Where, Y_t= GDP Per capita (GDP_t/N_t) COP_t= Carbon Dioxide per capita (COP_t/N_t)
ENP_t= Energy consumption per capita (ENP_t/N_t) LAP_t= Total labor force ratio to total population

3.1 Bound Testing Approach

This section outlines the application of ARDL techniques for cointegration developed by Pesaran et al. (2001) to establish the long run relationship among economic growth, CO_2 emissions, energy consumption and the employment ratio in Saudi Arabia. Econometric theory suggests that if the variables are cointegrated, there will be at least one linear combination of variables in the model. One implication is that most of the time, series data are non-stationary in nature, and the application of OLS techniques will result in spurious outcomes. This data requires that before the application of ordinary least squares (OLS) to estimate the relationship, it is necessary to establish the order of their integration: I(0) or I(1). For this purpose, the study applied a unit root test based on the Dicky-Fuller (1979) and the Augmented Dicky-Fuller (1981) tests to examine the time series properties of the data: Dickey and Fuller provide the following three possible forms of unit root test:

$$\Delta y_t = \gamma y_{t-1} + \sum_{i=1}^{p} \beta_i y_{t-1} + \varepsilon_t \qquad \text{(iiia)}$$
$$\Delta y_t = \alpha_0 + \gamma y_{t-1} + \sum_{i=1}^{p} \beta_i y_{t-1} + \varepsilon_t \qquad \text{(iiib)}$$
$$\Delta y_t = \alpha_0 + \gamma y_{t-1} + \alpha_2 t + \sum_{i=1}^{p} \beta_i y_{t-1} + \varepsilon_t \qquad \text{(iiic)}$$

We use general to specific approach to test the null hypothesis that there is unit root (γ=0) against the alternative that the series is stationary (γ<0).

After testing the non-stationary properties of the data, the study applied ARDL model techniques to establish the long run relationships between the variables in the model. In the first step of the ARDL analysis, we test the presence of long run relationships. General to specific modeling approach has been used. The number of lags of first differenced variables is selected on the basis of Akaike Information Criterion (AIC). Initially we set 2 lags and by using the general to specific methodology, we delete the insignificant variables from the model when justified by AIC and adjusted R^2 moving in the right direction. The ARDL specification of the equation (ii) can be stated as follows:

$$\Delta lY_t = \alpha_0 + \sum_{i=1}^{n-1} \alpha_{1i} \Delta lY_{t-i} + \sum_{i=0}^{n-1} \alpha_{2i} \Delta lCOP_{t-i} + \sum_{i=0}^{n-1} \alpha_{3i} \Delta lENP_{t-i} + \sum_{i=0}^{n-1} \alpha_{4i} \Delta lLAP_{t-i}$$
$$+ \beta_1 lY_{t-1} + \beta_2 lCOP_{t-1} + \beta_3 lENP_{t-1} + \beta_4 lLAP_{t-1} + \varepsilon_t \ \ldots\ldots \qquad \text{eq. (iv)}$$

Where, Δ represents the first difference and is a disturbance term. The above equation indicates that economic growth is influenced by its past values. The null hypothesis that there is no cointegration relationship among the variables in the model, that is H_0:β_1=β_2=β_3=β_4=0, whereas the alternative hypothesis that a long run relationship exists is

H_1: $\beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq 0$. If the values of F-statistics are greater than the upper bound critical values, we reject the null hypothesis of no cointegration among the variables in the model. If the value of the F-statistic is lower than the lower bound critical value, we accept the null hypothesis of no cointegrating vector among the variables in the model. If the value of the F-statistic lies within the two critical values, the results will be inconclusive.
The long run estimates can be obtained from the reduced form of equation (iv) when $\Delta LY = \Delta LCOP = \Delta LENP = \Delta LAP = 0$ (Pesara and Shin, 1999)

$$LY = \gamma_0 + \gamma_1 LCOP_t + \gamma_2 LENP_t + \gamma_3 LAP_t + v_t \qquad (v)$$

Where $\gamma_0 = -\alpha_0/\beta_1,\ \gamma_1 = -\beta_2/\beta_1,\ \gamma_2 = -\beta_3/\beta_1,\ \gamma_3 = -\beta_4/\beta_1$

3.2 Application of the ECM Technique

The study also applied the ECM based Granger Causality test to trace the causal relationship among the variables included in the model. ECM model can be written as follows:

$$\Delta lY_t = \alpha_0 + \sum_{i=1}^{n-1} \alpha_{1i} \Delta lY_{t-i} + \sum_{i=0}^{n-1} \alpha_{2i} \Delta lCOP_{t-i} + \sum_{i=0}^{z-1} \alpha_{3i} \Delta lENP_{t-i} + \sum_{i=0}^{r-1} \alpha_{4i} \Delta lLAP_{t-i} + \delta_n ECM_{t-1} + \varepsilon_t \ldots\ldots eq.(vi)$$

Where ECM can be stated as

$$ECM = LY - \gamma_0 - \gamma_1 LCOP_t - \gamma_2 LENP_t - \gamma_3 LAP_t$$

Where, the respective elasticity coefficients are the short run dynamic coefficients to the long run equilibrium, and the δ coefficients are expected to have negative signs and reflect the speed of adjustment in the model.

Annual time series data from 1980 to 2008 have been used in this study. The data on all variables used in the paper are taken from the World Bank (2011), online database.

4. GRANGER CAUSALITY

The Engel Granger (1987) test reveals whether Granger Causality exists at least in one direction provided that the variables are integrated of order (1). One implication is that applying the Granger Causality test based on the Vector Auto Regressive (VAR) model in the first difference in the long run relationship in equation (v) may yield inconsistent results in the presence of cointegration. Therefore, to capture the long run relationship, an additional variable, the Error Correction Term (ECT), is incorporated in the model. The error correction term based on the Granger Causality test in a multivariate framework of the ρth order can be formulated as:

$$(1-L)\begin{pmatrix} lY_t \\ lCOP_t \\ lENP_t \\ lLAP_t \end{pmatrix} = \begin{pmatrix} \beta_1 \\ \beta_2 \\ \beta_3 \\ \beta_4 \end{pmatrix} + \sum_{i=1}^{p}(1-L)\begin{pmatrix} \mu_{11i} & \mu_{12i} & \mu_{13i} & \mu_{14i} \\ \mu_{21i} & \mu_{22i} & \mu_{23i} & \mu_{24i} \\ \mu_{31i} & \mu_{32i} & \mu_{33i} & \mu_{34i} \\ \mu_{41i} & \mu_{42i} & \mu_{43i} & \mu_{44i} \end{pmatrix}\begin{pmatrix} \Delta lY_{t-i} \\ \Delta lCOP_{t-i} \\ \Delta ENP_{t-i} \\ \Delta lLAP_{t-i} \end{pmatrix} + \ldots\ldots$$

$$+\begin{pmatrix} \mu_{11k} & \mu_{12k} & \mu_{13k} & \mu_{14k} \\ \mu_{22k} & \mu_{22k} & \mu_{23k} & \mu_{24k} \\ \mu_{31k} & \mu_{32k} & \mu_{33k} & \mu_{34k} \\ \mu_{41k} & \mu_{42k} & \mu_{43k} & \mu_{44k} \end{pmatrix}\begin{pmatrix} \Delta lY_{t-k} \\ \Delta lCOP_{t-k} \\ \Delta lENP_{t-k} \\ \Delta lLAP_{t-k} \end{pmatrix}\begin{pmatrix} \delta_1 \\ +\delta_2 \\ \delta_3 \\ \delta_4 \end{pmatrix} EC_{t-1} + \begin{pmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \\ \varepsilon_{4t} \end{pmatrix} \ldots\ldots\ldots\ldots equ\ (vii)$$

5. EMPIRICAL RESULTS

The study applied the Dicky-Fuller (1979) test and the Augmented Dicky-Fuller (1981) test, and the results are presented in Table 1. The results reveal that all variables are integrated of order I (1).

The application of the ARDL test based on Pesaran et al. (2001) on the basis of SBC lag criteria are presented in Table 2. The ARDL test accounts for the existence of long run relationship between the variables in the model. The computed F-statistics are greater than the upper bound critical values based on Pesaran et al. (2001) at the 10%, 5% and 1% significance levels.

Table 3 presents the estimated long run coefficients of the selected model. The estimated long run coefficients of CO_2 emissions per capita, energy consumption per capita, and employment ratio are positive and significant. The positive and significant relationship between energy consumption and GDP in the long run, is due to the fact that Saudi Arabia's economy is an oil based economy. The development of the economy is based on energy intensive industry, as well as on energy intensive lifestyles in buildings and transport sectors. High energy consumption is encouraged by low energy prices in the country.

The elasticity of CO_2 emissions per capita intensity in Saudi Arabia is lower than the elasticity of energy consumption per capita intensity. This implies that CO_2 intensity is at a slower pace than energy consumption intensity.

The estimated elasticity coefficient of the employment ratio is positive and significant and indicates that an increase in the employment ratio has an effect on the GDP growth rate in the country. The diagnostic tests reported at the bottom of the table indicate that the model satisfies the statistical requirements. The adjusted R-square indicates that 65 percent of the variation in the dependent variable is explained by the independent variables. The CUSUM and CUSUM squared tests, as depicted in Fig.1 (Appendix 1), indicate that the residual lines fall within the 5 percent critical bound values. The results of the ECM-based application are presented in Table 4. The results indicate that the ECM is negative and significant at a 5 percent significance level. This implies that 91 percent of the deviation in the short run can be corrected in the next period. The estimated elasticity coefficients indicate that CO_2 emissions per capita are positive and significant in the short run. The results also present positive coefficients for the impact of energy consumption on GDP in the short run. The comparison of long run and short run income elasticity of carbon dioxide emissions gives an interesting avenue for judging whether Saudi Arabia has reduced carbon dioxide emissions over time as income rises. Narayan and Narayan (2010) argue that if the long run income elasticity of carbon emissions is less than the short run income elasticity of carbon emissions, then it can be inferred that over time, income increases leads to decrease carbon dioxide emissions. In our estimated model, we find that the long run and short run income elasticities of CO_2 are 2.94 and 1.57 respectively[4]. Since the long run income elasticity is greater than the short run, and then this implies that income leads to greater carbon dioxide emissions in Saudi Arabia.

Table 1. Unit root test for stationary

Variables	DF test		Significance level			ADF test		Significance level		
	Level	First difference	1 %	5%	10%	Level	First difference	1 %	5%	10%
lIY	0.344	-3.051	-2.653	-1.954	-1.610	-0.216	-4.621	-3.700	-2.976	-2.627
lIENP	-0.966	-1.030	-2.665	-1.956	-1.610	-1.743	-6.146	-3.724	-2.986	-2.633
lICOP	-2.176	-5.206	-2.653	-1.954	-1.610	-2.548	-5.111	-3.700	-2.976	-2.627
lILAP	-0.444	-1.623	-2.653	-1.954	-1.610	-1.153	-1.755	-3.700	-2.976	-2.627

Table 2. Bounds test results of long run relationship

F-Statistics	9.189			
Significance level	Pesaran et.al (2001)		Narayan (2005)	
	Lower bounds	Upper bound	Lower bounds	Upper bound
10%	4.13	5.0	6.19	4.42
5%	3.10	3.87	4.19	5.34
1%	2.63	3.35	3.39	7.88

Note: Based on Pesaran et al (2001), Table CI (iii) Case III. Narayan (2005) is taken from Hye and Ma

Table 3. Estimated long run coefficients for the selected ARDL dependent variable (lY)

Variables	Coefficients	t-statistics
Constant	-1.910	[-2.330]
lCOP	0.340	[1.719]
lENP	0.417	[2.427]
lLAP	2.693	[4.076]
Diagnostics Test		
Adjusted R-square	0.645	
Jarque-Bera Normality test	1.490(0.475)	
Breusch-Godfrey Serial	0.594(0.568)	
Correlation test		
ARCH Test	0.294(0.748)	
Ramsay Reset Test	0.360(0.783)	
Durbin Watson Test	1.913	

Table 4. Results of the ECM for the selected ARDL model dependent variable: GDP (lY) per capita

Variables	Coefficients	t-statistics	Short Run	Elasticities
Constant	-1.124	-4.532	Constant	-9.77
ΔlY(-1)	0.601	4.697	ΔlCOP	0.63
ΔlY(-2)	0.514	3.744	ΔlENP	4.92
ΔlCOP	0.379	3.210	ΔlLAP	2.69
ΔlCOP(-2)	-0.452	-3.931		
ΔlENP	0.122	0.672		
ΔlENP(-1)	-0.688	-3.669		
ΔlLAP(-2)	3.094	2.107		
ECM(-1)	-0.910	-6.680		
Diagnostics Test Adjusted R-square	0.708			
Jarque-Bera Normality Test	1.490(0.475)			
Breusch-Godfrey Serial Correlation Test	0.450(1.471)			
ARCH Test	0.294(0.653)			
Ramsay Reset Test	0.115(0.892)			
Durbin Watson Test	1.913			

The study also applied an error correction based on the Granger causality test to establish the direction of causal relationships between the variables in the model in the short run and long run. The results of the application of these techniques are presented in table 5.The results show that lCOP and lENP do not Granger causes output in the short run. It can also be inferred that GDP does not cause CO_2 emissions and energy consumption but employment ratio granger causes GDP. These Granger causality results support the neutrality hypothesis that there is no causal relationship exist between economic growth and energy consumption. The results establish that GDP does not cause CO_2 emissions and indicate that in a logarithmic model, the EKC hypothesis does not hold for Saudi Arabia. It can also be observed that lENP Granger causes neither GDP nor CO_2 emissions but does cause the employment ratio in the country. There is an evidence of a bidirectional causality running from energy consumption to the employment ratio and unidirectional causality running from the employment ratio to economic growth.

Table 5. Results of the granger causality test

	F-statistics				
Dependents	ΔIY	ΔICOP	Δ IENP	ΔILAP	EC_{t-1}
ΔIY		0.358(0.703)	3.233(0.587)	3.813(0.038)*	-0.851[-4.63]*
ΔICOP	1.730(0.201)		0.249(0.782)	0.949(0.403)	-0.041[-0.485]
ΔIENP	0.612(0.551)	0.641(0.536)		2.636(0.094)*	0.028[0.368]
ΔILAP	2.422(0.112)	2.084(0.148)	4.275(0.027)*		-0.003[-0.086]

*Notes: *denotes the 5% & 1% levels of significance. The numerals in the brackets depict t-values and those in parenthesis are p-values.*

The results of the Granger causality test of our study are consistent with the findings of Ozturk and Acaravci (2010). However, our findings do not support the findings of Narayan and Narayan (2010) who found that long run and short run income elasticity of carbon dioxide emissions for Saudi Arabia are equal. The difference of our results from those of Narayan and Narayan (2010) could be referred to the fact that we have used different econometric methodology, model specification and data span in this study.

6. CONCLUSIONS AND SUGGESTIONS

The environmental protection is an important challenge for the policymakers of a highly oil dependent economy such as Saudi Arabian economy. The growing economy requires more energy consumption which produces more carbon dioxide emissions. This paper examines the relationships among economic growth, CO_2 emissions, energy consumption and the employment ratio in Saudi Arabia during the period of 1980-2008. The study applied the ARDL test and VECM based test techniques to establish the short run and long run relationships between the variables in the model. Empirical findings suggest that a long run relationship between economic growth, energy consumption and the employment ratio exist in Saudi Arabia. The long run estimated elasticity coefficient of CO_2 emissions is positive and significant, implying that an increase in per capita CO_2 emissions will increase GDP in the country. Since more energy consumption leads to more economic growth, which causes more CO_2 emissions, then it is expected to have such positive and significant relationship between these two variables. The results indicate that the elasticity of CO_2 emissions intensity is lower than that of energy consumption in Saudi Arabia. The estimated elasticity coefficient of the employment ratio reflects a significant increase in the GDP over a possible change in the employment ratio in the country.

The application of the ECM-based Granger Causality test is found to be consistent with the outcomes of the ARDL test. The results indicate that GDP does not Granger Cause CO_2 emissions and demonstrate that in a logarithmic model, the EKC hypothesis does not hold in the case of Saudi Arabia. In the Short run, the Granger causality results support the neutrality hypothesis that there is no causal relationship between economic growth and energy consumption in Saudi Arabia. Therefore Saudi Arabia's environmental friendly policy adopted since 2001, to conserve and protect the natural resources and environment of the country, will not affect the growth process of the country. However, the long run income elasticity of carbon emissions is greater than the short run income elasticity of carbon emissions, which implies that income leads to greater carbon dioxide emissions in the country. The significant and positive impact of energy consumption on economic growth suggests that energy consumption is crucial for growth, but the rapid pace of CO_2 emissions requires the adoption of alternative sources of energy and approaches to development to protect the environment in Saudi Arabia.

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