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The Environmental Kuznets Curve (EKC) Hypothesis for Greenhouse Gas Emissions: Analysis for Saudi Arabia

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Abstract

This paper empirically investigates the Environmental Kuznets Curve (EKC) hypothesis validation for GHGs emissions over the period 1980-2010 in Saudi Arabia. It examines the relationship between economic growth and environmental quality by using the Ordinary Least Squares (OLS) regression for two types of GHGs namely: CO_2 emissions and other GHG emissions (HFC, PFC and SF6); the gases in brackets are termed other GHG emissions for ease of discussion in this study. The results showed that the EKC hypothesis is not valid for either CO_2 emissions or other GHG emissions in Saudi Arabia. Even though there is an inverted U-shape for both models, the turning point is very high compared with GDP in that period. Thus, Saudi Arabia needs to implement new policies by adopting new technologies that could support the technical effect, which contributes to improving the environmental quality or raising the current source efficiency, in order to achieve sustainable development in the future.

Key Words: *CO_2 Emissions, Other GHG Emissions, EKC, OLS Regression, Turning Point.*

Introduction

Economists have begun to show an interest in the relationship between economic growth and the environment after environmental degradation and increasing attention towards environmental effects on economic growth. Many studies focus on the relationship between economic growth and environmental quality and researchers have gone beyond this to determine the nature of this relationship; this relationship takes an inverted U-shape. In other words, environmental pollution accrues in the early stage of economic growth and improves when the economy develops in a later stage; this systematic has been called the EKC hypothesis (Dinda, 2004). The Environmental Kuznets Curve (EKC) was hypothesised by Simon Kuznets (1955) and popularised by Grossman and Krueger (1991). The EKC hypothesis indicates that at low income levels, environmental degradation increases, whereas at high levels of income, economic growth will improve environmental quality, which means advanced economic growth will lead to improving environmental quality.

Over the past two decades, many researchers have employed the EKC hypothesis to examine the relationship between economic growth and environmental degradation for many countries using several types of pollutants (see the literature review study). Therefore, since we have estimated the long-run relationship between economic growth and environmental pollution represented in GHGs emissions in Saudi Arabia and got a positive relationship between our variables, which is in line with the first and second laws of thermodynamics, now we need to determine the type of relationship between economic growth and environmental pollution in Saudi Arabia. Thus, this study aims to explore the existence of the

EKC hypothesis for Saudi Arabia, in other words, examine the existing technical effect, which contributes to improving the environmental quality to find out if Saudi Arabia has to follow any mitigation policy through employing environmental technology. A time series will also be used for the period 1981-2010 for Saudi Arabia, to provide an estimation of the long-run parameters for the variables under consideration. Also, this paper attempts to fill the gap in the literature review related to validation of the EKC hypothesis for Saudi Arabia.

The paper is organised as follows: Related literature is in the next section. Section (3) provides the econometric framework and economic factors of the EKC hypothesis. Methodology and data are given in Sections (4) and empirical results in Section (5). Finally, Section (6) draws conclusions on the basis of these findings.

Related Literature

Alwan and Altarawneh (2014) investigated the long-run relationship between CO_2 emissions, GDP and energy consumption over the period of 1980-2010 in Jordan. The results indicated that the model sign followed the EKC hypothesis, which means the relationship between economic growth and CO_2 takes an inverted U-shape. In the same context, Suri and Chapman (1998) applied two models: the first model measured the relationship between energy consumption, GDP per capita and GDP per capita squared. They found that GDP had a positive sign while GDP squared had a negative sign and the turning point was equal to three times the highest level of GDP per capita. The second model included international trade which implied that trade effects raise pollutant emissions.

A study carried out by Markandya, Golub and Galinato (2006) related to the relationship between economic growth and SO_2 emissions for 12 Western European countries covering the period from 1850-2001. They found an inverted U-shaped relationship which means SO_2 emissions increased in the early years then decreased in the later years. Also, the study found that emissions declined due to certain environmental regulations and these regulations shifted the turning point to the left meaning a lower GDP per capita. Also, Opoku, Amoako and Amankwa (2014) investigated the impact of economic growth and trade openness on CO_2 emissions over the period 1970-2010 for Ghana. This study examined the Environmental Kuznets Curve hypothesis using data for CO_2 emissions measured in metric tons, real GDP per capita, real GDP per capita squared and trade openness measured as a percentage of GDP. The study found that real GDP per capita had positive effects on CO_2 emissions but real GDP per capita squared had a long-run negative impact on CO_2 emissions. The results of this study implied that Ghana follows the EKC hypothesis, but this study did not mention a turning point, which means the existence of an inverted U-shape does not mean the EKC hypothesis is valid for this country (as we will also see in this study).

McCarney and Adamowicz (2005) examined the effects of trade liberalisation on CO_2 emissions and water pollutants by applying the EKC hypothesis for 143 countries using panel data from 1970- 2000. They obtained results showing that liberalisation significantly increased CO_2 emissions and organic water pollutants, thus freer trade decreased the quality of the environment. Another study by Gürlük (2009) employed the EKC hypothesis to explain the relationship between GDP per capita and industrial pollution in the Mediterranean Region, which has a different background economically and institutionally. The results showed that developed Mediterranean countries have higher technology and stringent environmental policies, therefore enabling cheaper environmentally-friendly products. Meanwhile, the developing Mediterranean regions in the industrialisation path have no turning point yet.

In a critical review, Wen and Cao (2009) examined the EKC hypothesis for China through using data for main pollutant indicators and the national income per capita from the period 1989-2008. They found, after a run regression, that many pollutant emissions continue to increase with economic growth, which means the relationship between economic development and environmental pollution does not follow the EKC hypothesis. In line with the previous study, Arouri, et al. (2014) investigated the validation of the EKC hypothesis for the relationship between real GDP and Sulfur SO_2 emissions for 12 MENA countries for the period 1981-2005. The findings were that an inverse U-shaped relationship existed between SO_2 per capita and GDP per capita for 9 countries, but there was a problem in the position of the threshold compared to the GDP level. Thus, they concluded that the EKC hypothesis was not valid for ten of the countries, except Egypt and Tunisia who followed the EKC hypothesis. Also, Boopen and Vinesh (2011) examined the relationship between the CO_2 emissions and economic growth for Mauritius for the period 1975- 2009. The result showed that there was no EKC inverted U-shape found for Mauritius.

Kubicová, (2014) examined empirically the existence of the KEC hypothesis between GHGs emissions and GDP per capita in Slovakia over the period 1993-2011. The results showed the existence of EKC was not confirmed between GHGs and GDP per capita; only the case of methane followed the EKC. Moreover, Dijkgraaf and Vollebergh (2001) found that there was no existence of the Environmental Kuznets Curve between GDP per capita and CO_2 using panel data for OECD countries over the period of 1960-1997. Hettige, Mni and Wheeler (2000) examined the presence of the EKC hypothesis for industrial water pollution using international data over the period of 1989-1995. Their findings have shown the rejection of the EKC hypothesis regarding industrial water pollution. Moreover, a postal questionnaire survey in Scotland about household transport emissions and income established in testing the EKC hypothesis showed no evidence of EKC present in household transport emissions (see Cox, et al., 2012). From the previous presentation of literature, there are studies about GHGs emissions in general but there are no specific empirical studies about HFC, PFC and SF6.

In terms of the studies that discussed the EKC for Saudi Arabia, Taher and Alhajjar (2014) stated that, environmental pollution caused by GHGs emissions and GDP per capita increased in tandem in Saudi Arabia during 1980-2010. Moreover, environmental pollution has increased in tandem with energy consumption and energy production. Also, they stated that there are studies around the world in which findings demonstrate a turning point for developed countries located to the right of the EKC turning point whereas the turning point of developing countries was located on the left of the EKC turning point.

Another study about Saudi Arabia indicated that 90% of the total CO_2 emissions from the energy sector showed domestic fossil fuel consumption was continually increasing. Moreover, the rapid industrialization, development and electricity generation could also increase the GHGs (Rahman and Khondaker, 2012, p 2448). An empirical study by Alkhathlan, Alam and Javid (2012) has employed VECM and ARDL tests to examine the relationship between GDP per capita (as a dependent variable) and CO_2 per capita emissions, energy consumption per capita and an employment ratio for Saudi Arabia during the period between 1980 and 2008. Their findings indicated a long-run and short-run relationship between the variables in the model, implying that increased CO_2 emissions led to increased GDP in Saudi Arabia. Due to increasing energy consumption, GDP will rise within the country which means more CO_2 emissions. CO_2 emissions are associated with rapid economic growth and industrialization in Saudi Arabia (Taher and Alhajar, 2014). A study on MENA countries including Saudi Arabia by Arouri, et al. (2014) investigated the validation of the EKC hypothesis for the relationship between real GDP and Sulfur SO_2 emissions over the period of 1981-2005. Their findings showed that there was an inverse U-shape for Saudi Arabia but the turning point compared with Saudi GDP was very low.

Overall, the findings revealed that some studies followed the EKC hypothesis and others did not based on the country's economic development trajectory. Given the results of the literature reviewed in this section, it is obvious that there are a few studies that investigate empirically the validation of the EKC hypothesis for Saudi Arabia. However, none of this literature has empirically examined the validation of the EKC hypothesis for other GHG emissions for Saudi Arabia. Therefore, it is important to conduct empirical investigation to explore the environmental pollution trends in future in order to support policymakers to determine a suitable environmental policy that enhances the country to reach sustainable development. Thus, we will try in this study to fill the gap in this area.

Econometric Framework and Economic Factors of EKC

Econometric Framework

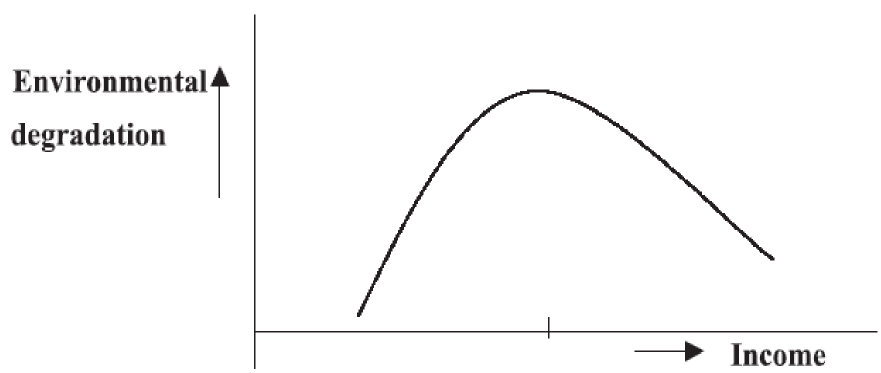
As mentioned previously, the EKC hypothesis describes the relationship between economic growth and environmental degradation, which takes an inverted U-shape. In other words, the EKC hypothesis assumes that at low levels of economic growth the environmental quality will go down but at high levels of economic growth it will lead to improved environmental quality, meaning there is a turning point. Thus, the turning point (TP) means when the income transition is seen as improving environmental quality (see Figure 1). The EKC model is simple quadratic functions of income levels (Stern, 2004); the standard EKC regression is:

$$Ln(E/P)_{it} = \alpha_i + \gamma_t + \beta_1 \ln(GDP/P)_{it} + \beta_2 (\ln(GDP/P))^2_{it} + \varepsilon_{it} \qquad (1)$$

Where E is emissions, P is population, i is a country and t is the year. α, β and γ are parameters. TP is from $x^* = (-\beta_1/2\beta_2)$. Where, β_1 and β_2 are the coefficients of GDP and GDP squared respectively (see Equation (1). Dinda (2004) used the following model in Equation (2) to test the relationship between income levels and pollution:

$$y_{it} = \alpha_i + \beta_1 x_{it} + \beta_2 x^2_{it} + \beta_3 x^3_{it} + \beta_4 z_{it} + \varepsilon_{it} \qquad (2)$$

Where y is environmental indices, i is a country, t is time, x is GDP, z is other variables that affect the environment, α is constant and β is the coefficient of variables. Dinda (2004) continued that Equation (2) and provided seven different types of income-environment relationships. In the early 1990s, Grossman and Krueger gave the first empirical study which applied the EKC hypothesis. Grossman and Krueger (1991) used a cubic function of the EKC hypothesis to study the relationship between economic growth and air quality for 42 countries for its potential effect on the North American Free Trade Agreement (NAFTA). Suri and Chapman (1998) stated that the model does not always include GDP cubic because the estimation of the relationship between GDP and environment degradation rises again at higher levels of income in some models which had added GDP cubic. This means an inverted U-shape was achieved but after specific income levels the relationship between economic growth and environmental pollution became positive, which was then called an N-shaped curve (Dinda, 2004). Table 1 summarises the seven cases that Dinda (2004) mentioned.



Source: Dinda (2004).
Figure 1: The Environmental Kuznets Curve (EKC)

Table 1: The seven kinds of relationship for the EKC

Case	Coefficients	Interpretation
1	$\beta_1>0$ and $\beta_2 = \beta_3 = 0$	A linear relationship between x and y.
2	$\beta_1 < 0$ and $\beta_2 = \beta_3 = 0$	Decreasing relationship between x and y.
3	$\beta_1>0$, $\beta 2 < 0$ and $\beta_3 = 0$	An inverted-U-shaped relationship, EKC.
4	$\beta_1<0$, $\beta_2>0$ and $\beta_3 = 0$	A U-shaped relationship.
5	$\beta_1>0$, $\beta_2 < 0$ and $\beta_3>0$	N-shaped. As GDP increases further environmental pollution rises again.
6	$\beta_1<0$, $\beta_2>0$ and $\beta_3 < 0$	Opposite N-shaped.
7	$\beta_1 = \beta_2 = \beta_3 = 0$	No relationship between x and y. Horizontal line.

Source: Dinda, 2004.

For the case of no relationship between economic growth and environmental degradation, the EKC will be a horizontal line. Dasgupta, et al. (2002) stated that growth in research knowledge, regulation and people concern, means developing societies could improve environmental quality. Thus, it may be that at low levels of income, there is no or low environmental pollution. This then shows the Environmental Kuznets Curve (EKC) as becoming lower and flatter.

Economic Factors Driving the EKC Hypothesis

The logic of the EKC shape is based on three possible explanations: (1) Society behavior change, which means society in the beginning is interested in achieving high levels of consumption but after that their intention is towards environment quality. (2) Technology progress; firms employed technologies to raise resources efficiency and to get cleaner production. (3) The Lewis growth model explains the economic development through three stages: in the first stage society puts resources into main sectors such as agriculture to achieve necessary consumption, and then resources are transferred from the main sector to secondary sector, such as manufacturing. Stage 3: society switches to the tertiary sector (services sector) meaning lower levels of pollution (Everett, et al., 2010).

According to Everett, et al. (2010), there are three economic factors that are responsible for the changes in environmental effects and may drive environmental pollution to increase or decrease during economic development. (1) The scale effect: Expanding production and consumption causes environmental degradation, which means economic growth affects the environment negatively. (2) The composition effect means the production structure changes along the economic development path. It was a shift from agriculture to manufacturing then to production services because supply and demand changes the decrease in environmental damage. (3) The technical effect: developing technology involves a change in production efficiency and this will change the impacts on the environment, such as technology that improves the energy efficiency. Thus, based on the technical effect we can say that if the country with a high level GDP improves environmental quality that means this country employs environmental policies utilising technology that contribute to improving environmental quality.

Empirical Methodology

The main aim of this study is to examine a validation of the EKC hypothesis for the relationship between economic growth and environmental pollution in Saudi Arabia, which is the case study for this paper. The environmental indicators are two types of GHGs: CO_2 emissions and other GHG emissions. Regression approaches will be employed to estimate the long-run relationship for all models in this chapter. Then, turning point (TP) will be calculated for each model. As such, the data used in this analysis will be time series in nature from 1981-2010 for CO_2 and other GHG models. The sample size is determined by the availability of data.

The Data

We choose these two types of GHGs emissions due to their contribution to climate change and that these gases are from fossil fuels, which the Saudi Arabian economy is based upon. According to IEA (2015), the millions of tons (Mt) of carbon dioxide (CO_2) was still increasing during the period of 1971- 2013 because of coal, oil and natural gas. CO_2 emissions from fossil fuels by region were increasing during the period of 1973-2013 in China, the Middle East and Asia. Other GHGs emissions in this study namely; hydrofluorocarbons (HFC), perfluorocarbons (PFC) and sulfur hexafluoride (SF6) are used widely in the semiconductor industry for electronic controls and devices which began in the late 1970s and became widespread by the early 1990s. However, information on the trends of global emissions and the magnitude of these are limited, (see Bartos and Burton, 2000). According to Olivier and Bakker (2000), the Kyoto Protocol to the United Nations will incorporate the emissions of HFC, PFC and SF6 in the greenhouse gases, but emissions estimates for countries have not yet been made. The global CO_2 equivalent emissions for SF6 are 13%, PFCs 8% and 10% emissions from HFCs (p.2).

CO_2 data source was from the Carbon Dioxide Information Analysis Center (CDIAC) online database; GHG data and GDP were taken from the World Bank database. GDP expected signs are based on the Environmental Kuznets (EKC) hypothesis that $\beta_{1,}$ β_2 and β_3 (the coefficients of GDP and GDP squared) are expected to be positive and negative, respectively.

Models

Multiple regression models have been employed to take into account variables that were reported in the previous section. This paper will estimate two models: The first is testing the validation of the KEC hypothesis for CO_2 emissions. The second model is testing the validation of the EKC hypothesis for other GHG emissions. Most studies included only GDP and GDP squared as independent variables in their models without including the GDP cubic, so our models are also employed without the GDP cubic. However, the two types of GHGs are dependent variables as functions of GDP and GDP squared covering the period 1981- 2010 for Saudi Arabia.

Econometric Results

The CO_2 models

This section will examine CO_2 emissions as a function of GDP and GDP squared.

CO_{2t}= f (GDP_t , $(GDP_t)^2$)

Where, CO_2 is carbon dioxide emissions in metric tons (dependent variable), GDP is measured in billions of Riyals (independent variable). GDP^2 is squared (independent variable) and t is time.

On the basis of this, the model equation is as follows:

$$CO_{2t} = \alpha + \beta_1 \, GDP_t + \beta_2 \, (GDP_t)^2 + \varepsilon_t \qquad (3)$$

Logarithmic transformation is deflated. Thus, the equation we employ becomes:

$$lnCO_{2t} = \alpha + \beta_1 \, lnGDP_t + \beta_2 \, (ln(GDP_t))^2 + \varepsilon_t \qquad (4)$$

ln is the natural logarithm, $lnCO_{2t}$ is the logarithm of CO_{2t}, $lnGDP_t$ is the logarithm of GDP_t and $(ln(GDP_t))^2$ is the logarithm of GDP_t squared. β_1, β_2 and β_3 are elasticity coefficients and ε is error term.

Ordinary Least Squares (OLS)

The model of Equation (4) showed evidence of Auto-correlation (AR) which has been removed by adding an Autoregressive term (AR) within the model. Trend (T) was added to remove any upward or downward movement in the series. Table 2 shows the OLS regression results which indicate that signs of GDP and GDP squared meet the expectation of the study. The relationship between CO_2 emissions and GDP is positive, while the relationship between CO_2 and GDP squared is negative. The equation that is implicitly defined is as follows:

$$LCO_{2t} = 1.5825\ LGDP_t - 0.0503\ L(GDP)_t^2 + 0.0224\ T + 0.6759\ AR(1) + \varepsilon_t$$

When gross domestic product (LGDP) is increased by 1%, CO_2 emissions will rise by 1.58% in Saudi Arabia at a 5% significance level. In other words, economic growth in the long-run in Saudi Arabia leads to an increase in CO_2 emissions. Additionally, when GDP squared $L(GDPc)^2$ is increased by 1%, CO_2 emissions will decrease by 0.05% at a 5% significance level which means that at a higher economic growth CO_2 emission levels will fall.

With regard to the presence of an inverted U-shape, the OLS regression results showed that long-run variable coefficient signs followed the EKC hypothesis which means $\beta_1$is (+0.10) and β_2 is equal to (-0.78). Thus, there is an inverted U-shape in this model.

Table 2: OLS Estimation of Variable Long-Run Coefficients

Dependent Variable LCO_2			
Variables	Coefficient	Standard Error	t-statistic
LGDP	1.58*	0.15	10.11
$L(GDP)^2$	-0.05*	0.01	-3.88
@trend(1980)	0.02	0.01	1.37
AR(1)	0.67*	0.14	4.60
R^2	0.90		
Diagnostic tests			
Autocorrelation, LM test	0.10 (0.7478)		
Normality Test, JB-test	0.78 (0.6762)		
ARCH	1.42 (0.2331)		

*denotes significance at a 5% level. LCO_2 is a log of carbon dioxide emissions, LGDP is a log of GDP and $L(GDP)^2$ is a log of GDP squared. Number in brackets is p value.

Table 2 presents diagnostic tests of the model: the auto-correlation LM test implies there is no serial correlation problem and the ARCH test shows there is no heteroskedasticity in the model. For the normality test, the result implies that the residual has normal distribution.

Turning point (TP)

Since the OLS regression results have shown that there is an inverted U-shaped relationship between CO_2 emissions and economic growth for Saudi Arabia, a turning point (TP) for CO_2 model Equation (4) will be calculated:

$$LCO_{2_t} = 1.5825\ LGDP_t - 0.0503\ LGDP_t^2$$

The turning point is – (1.5825 / 2 (0.0503)) = 15.73 (in logarithm), equal to 6659097.68 which means that TP occurs when GDP reaches 6659097.68 Riyal.

The turning point is roughly six times the highest level of GDP[1] and this means the number we obtained was located outside the sample. In the next part, we will examine the last model, which is to represent other GHG emissions using similar procedures.

The other GHG emissions model

The GHG emissions are as a function of GDP and GDP squared.

$GHG_t = f(GDP_t, (GDP_t)^2)$

Where GHG is another greenhouse gas emission (HFC, PFC and SF6) measured in thousands of metric tons of CO_2 equivalent (dependent variable), GDP is GDP measured in billions of Riyals (independent variable), GDP^2 is GDP squared (independent variable) and t is time.

On this basis, the following model follows the equation:

$$GHG_t = \alpha + \beta_1 GDP_t + \beta_2 (GDP_t)^2 + \varepsilon_t \qquad (5)$$

After logarithmic transformation has been deflated for data, the model for the equation we employ becomes:

$$\ln GHG_t = \alpha + \beta_1 \ln GDP_t + \beta_2 (\ln(GDP_t))^2 + \varepsilon_t \qquad (6)$$

ln is the natural logarithm, $\ln GHG_t$ is the logarithm of GHG_t, $\ln GDP_t$ is the logarithm of GDP_t and $(\ln(GDP_t))^2$ is the logarithm of GDP_t squared. α is the intercept, β_1 and β_2 are elasticity coefficients and ε is error term.

Ordinary Least Squares (OLS)

Since the GHG model of Equation (6) showed evidence of auto-correlation, it has been removed by adding autoregressive terms AR (1) and AR (2) within the model. Thus, the OLS regression results shown in the equation below indicate that the relationship between GHG emissions and GDP is positive and significant at a 5% level. This means that when the GDP increases by 1% in Saudi Arabia, it will increase the GHG emissions by 1.03%. The OLS regression results also showed that there is a negative relationship between GDP squared and GHG emissions. Thus, when GDP squared increases by 1%, the GHG emission at a 5% significance level in Saudi Arabia will fall by 0.3% (see Table 3). The equation is implicitly defined as follows:

$$LGHG_t = 1.0305\ LGDP_t - 0.0346\ L(GDP_t)^2 + 1.6488\ AR(1) - 0.6760\ AR(2)$$

In other words, an increase in economic growth in Saudi Arabia will lead to an increase in GHG emissions, although, at higher economic growth levels, the GHG emissions will fall. Therefore, this model has an inverted U-shape based on long-run parameter coefficient signs, which means that the β_1 sign is positive, equal to (+ 1.03) and the β_2 sign is negative, equal to (- 0.03).

Table 3 presents diagnostic tests of the model; as a result, we can conclude that the model we used passed the required diagnostic tests.

[1] GDP_{max} for study period of 1981-2010 is SR 1,975,543 billion

Tables 3: OLS Estimation of Variable Long-Run Coefficients

Dependent Variable LGHG			
Variables	Coefficient	Standard Error	t-statistic
LGDP	1.03*	0.09	11.44
$L(GDP)^2$	-0.03*	0.01	-5.29
AR(1)	1.64*	0.13	11.77
AR(2)	-0.76*	0.14	-5.30
R^2	0.94		
Diagnostic tests			
Autocorrelation, LM test	2.41 (0.1199)		
Normality Test, JB-test	2.69 (0.2604)		
ARCH	0.0003 (0.9845)		

*denotes significance at a 5% level. LGHG is a log of greenhouse gases, LGDP is a log of GDP and $L(GDP)^2$ is a log of GDP squared. The number in brackets is p value.

Turning point (TP)

The OLS regression results in Table 3 have shown there is an inverted U-shaped relationship between GHG emissions and economic growth for Saudi Arabia. Thus, a turning point (TP) for the GHG model for Equation (6) will be calculated as:

$$LGHG_t = 1.0305\ LGDP_t - 0.0346\ LGDP_t^2$$

The turning point is – (1.0305 / 2(0.0346)) = 14.89 (in logarithm) which is equal to 2813251.75 meaning that TP occurs when GDP reaches 2813251.75 Riyal. The turning point for the other GHG emissions (HFC, PFC and SF6) model lies at 2,813,251.75 Riyal, which is outside the sample.

Both models, CO_2 and other GHG models, are acceptable in terms of GDP and GDP squared coefficient signs and R^2 value. In view of these results, as Saudi Arabia does not follow the EKC hypothesis due to the turning point occurring at very high levels of economic growth, the country does not employ any environmental policies and there is no technology effect appearing. Therefore, the Saudi Arabian government has to increase effectiveness of the environmental policies, regulations and raise public awareness of pollution. However, according to Saudi Arabian initiatives to mitigate GHGs emissions in future plans called the Vision 2030[2], we can say that it is likely to reach the turning point in the future.

In general, these key findings are in line with literature in terms of the existence of a turning point (see Gürlük (2009), Wen and Cao (2009), Boopen and Vinesh (2011), Dijkgraaf and Vollebergh (2001), Kubicová (2014) and Cox, et al. (2012)). Also, our findings are in line with both the Arouri, et al. (2014) result that Saudi Arabia has an inverted U-shape but the turning point was very low and with what Taher and Alhajjar (2014) stated about the turning point for developing countries being located on the left of the EKC turning point.

Conclusion

This paper investigated the nature of the relationship between economic growth and environmental quality for Saudi Arabia. In other words, does this relationship take an inverted U-shaped curve? Is there a technical effect? To find an answer we examined the validation of the Environmental Kuznets Curve

[2] For more details about Vision 2030, see http://vision2030.gov.sa/en/node

(EKC) hypothesis through the employment of the OLS regression to test the EKC hypothesis for two types of GHGs emissions namely, CO_2 emissions and other GHG emissions. As well as this, we have calculated the turning point (TP) for the two models.

The model testing validation of the EKC hypothesis for CO_2 findings showed that there is an inverse U-shape for all CO_2 models in terms of the signs of the GDP and GDP squared coefficients, which followed the EKC hypothesis expectation. Also, there was an inverse U-shape for the other GHG model. The results of turning point (TP) showed that for both the CO_2 model and the other GHG model the turning point was located outside of the sample range but not far away from the GDP maximum value. This means that the EKC hypothesis was valid for this model. Saudi Arabia may reach the turning point of CO_2 emissions models and other GHG emissions models in the future based on its initiatives to reduce GHGs emissions and based on the Vision 2030.

In sum, it is impossible to solve environmental pollution by economic growth itself. The government has to choose the right path for its economic growth by taking into account the environmental issues whilst turning towards sustainable development. However, Saudi Arabia needs to adopt new strategies and new technologies to mitigate the GHGs emissions. This study also explored the current situation and future of environmental pollution in Saudi Arabia and whether the country applies environmental policies or not, through the existence of a turning point. Our finding showed that there is no turning point; this means there is no technical effect that contributes to reducing environmental pollution. Even though Saudi Arabia has environmental organisation and has signed environmental protection treaties, the country needs to employ environmental reduction policies using environmental instruments to reach the turning point.

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