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Renewable and Sustainable Energy Reviews

journal homepage: www.elsevier.com/locate/rser

Carbon emissions and oil consumption in Saudi Arabia

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ARTICLE INFO

Article history:

Received 7 November 2014

Received in revised form

28 January 2015

Accepted 7 March 2015

Keywords:

STSM

UEDT

CO₂

Oil

Saudi Arabia

ABSTRACT

This study attempts to analyze the effect of total oil consumption and oil consumption in the transport² sector on the environmental quality of Saudi Arabia over the period from 1971 to 2013. A structural time series technique is used in this study to expose the underlying energy demand trend (UEDT) for the total carbon emissions and carbon emissions from the domestic transport sector. The results reveal that the trend is nonlinear and stochastic both for carbon emissions and for carbon emissions from the transport sector. In both models, the elasticity of carbon emissions with respect to income and the square of income are positive and significant, which implies that there is a monotonically increasing relationship between carbon emissions and income in Saudi Arabia. The results further reveal that the elasticity of carbon emissions with respect to total oil consumption and transport oil consumption are positive and significant. The empirical findings of this study demonstrate that a growth in real income forces CO₂ emissions to grow, whereas the reverse is not true for both models.

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1. Introduction

Over recent decades, Saudi Arabia has enjoyed rapid economic growth, which has led to a high per capita income. The vast

petroleum reserves in Saudi Arabia and revenues earned from petroleum exports have led to considerable economic development. The oil sector in Saudi Arabia accounts for 47% of GDP, 90% of revenues and 90% of export earnings [25]. In addition to oil sector, others contributing factors in GDP of Saudi Arabia are expressed in Fig. 1. Domestic oil consumption in Saudi Arabia has increased drastically in the past four decades, from 0.41 million barrels per day (mbd) in 1970 to 3.07 mbd in 2013, and this oil consumption is one quarter of Saudi Arabian oil production [6]. Similarly, OPEC's oil consumption has increased sevenfold in 40 years, and this oil consumption constitutes one-quarter of production [12]. High

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E-mail addresses: kathlan@ksu.edu.sa (K. Alkhatlan),javid@pide.org.pk (M. Javid).¹ Tel.: +966 555227217.² Oil consumption in the transport sector includes jet oil fuel consumption, gasoline consumption, and light fuel oil consumption.

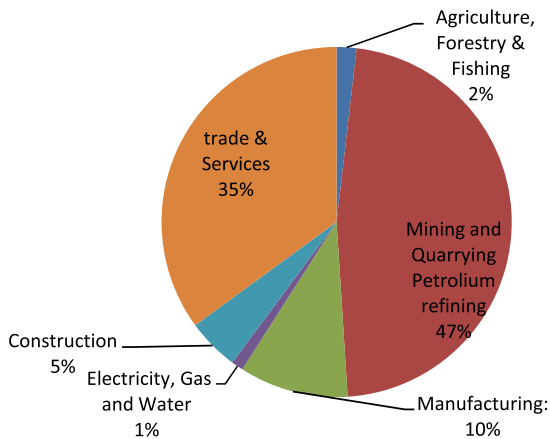


Fig. 1. GDP breakdown by Economic activity for year 2013.
Data source: SAMA (Saudi Arabian Monetary Agency) [25]

economic growth rates accompanied by high rates of population growth are continuously increasing pressure on the country's natural resources.

The high growth rate of domestic consumption of oil in Saudi Arabia has multiple effects at both national and international levels. On the international scene, the emergence of Saudi Arabia as a major consumer of oil will essentially affect Saudi Arabia's oil exports. That is, an increase in domestic consumption of oil will ultimately reduce Saudi Arabia's ability to supply enough oil to the international market. At the national level, because the Saudi Arabian economy depends largely on oil, the Kingdom has to address global environmental issues such as climate change. Increased domestic oil consumption is strongly linked to sustainable economic growth and to environmental degradation in Saudi Arabia. That is, high domestic oil consumption plays the dual role of providing the basis for economic activity and human well-being on the one hand while acting as the driving force for environmental degradation on the other hand. Oil production and exportation are indispensable for economic activities because Saudi Arabia is an oil dependent economy; at the same time, the production, processing and transportation of oil have strong implications for environmental quality. According to U.S Energy Information Administration [30] Saudi Arabia is the largest consumer of petroleum in the Middle East, particularly in the area of transportation fuels and direct crude oil burn for power generation. Similarly the BP Statistical Review of World Energy [6] argues that in 2013, Saudi Arabia was the world's 12th largest consumer of total primary energy, of which about 60% was petroleum-based. Lahan and Stevens [23] argue that Saudi Arabia's growing domestic demand of oil would threaten the country's ability to export to global markets. The finding of Alkhatlan and Javid [2] indicate that energy consumption (oil, gas, and electricity) leads to economic growth in Saudi Arabia in the long term and an increase in energy consumption could result in a deterioration of environmental quality by increasing the carbon emissions in the country. Narayan and Narayan [26] find a positive and statistically significant effect of income on carbon dioxide emissions in Saudi Arabia in the short-run and as well as in long-run.

Environmental protection issues in Saudi Arabia are linked to natural resource development and domestic consumption of oil. In this study, we attempt to assess the effect of total oil consumption and oil consumption in the transport sector of Saudi Arabia on environmental quality over the period from 1971 to 2013. Having precise information on the relationship between environmental quality and domestic consumption of oil is essential from a policy point of view. Oil prices are extremely low in Saudi Arabia; therefore, this study will assist policy makers in planning the

necessary strategies for meeting future domestic oil consumption and explore the potential for the market to realize energy conservation policy for protection of the environment domestically.

This study contributes to existing literature on oil consumption and carbon emissions in two ways. The first contribution of this study is to estimate the impact of total oil consumption and transport oil consumption on carbon emissions in Saudi Arabia. This analysis will help policy makers to identify the contribution of transport oil consumption in environmental degradation most polluted components of oil so that policy makers can take remedial measures in this sectors. A large number of studies probe the relationships among carbon dioxide emissions, real GDP and energy consumption in Saudi Arabia and the Middle East [for example, Mehrara [24], Sari and Soytaş [27], Narayan and Narayan [26], [5], Alkhatlan et al. [1], Alkhatlan and Javid [2], Alshehry and Belloumi [3]]. None of these studies has investigated the effect of oil consumption on environmental quality. Therefore, this study focuses on the impact of oil consumption on the environment in Saudi Arabia.

The second contribution is that the study develops a structural time series modeling approach that has been used to take into account the underlying energy demand trend (UEDT). Hunt and Ninomiya [19], Hunt et al. [17,18], Dimitropoulos et al. [10] and Dilaver and Hunt [7,8] argue that the structural time series modeling (STSM) approach developed by Harvey [14,13] is the appropriate methodology to efficiently capture the effect of unobservable factors (trends in energy efficiency, technological progress and consumer preference).

We used annual data from 1971 to 2013 for analyzing oil consumption and environmental quality in Saudi Arabia. CO₂ emissions data were obtained from the BP Statistical Review of World Energy June [6] online database. The data for total oil consumption and oil consumption in the transport sector were obtained from the Energy Information Administration (EIA) and Saudi Arabian Monetary Agency. Transport oil consumption was calculated as the sum of Motor Gasoline, Aviation Fuels, and Gas Oil. Data on real GDP were obtained from World Development indicators.

2. Domestic oil consumption and carbon emissions in Saudi Arabia

Table 1 summarizes the levels and growth rates for the consumption of oil, real income, population and CO₂ emissions for Saudi Arabia and some industrialized economy over the period from 1971 to 2013. Because of strong economic and industrial growth, along with high population growth, total oil consumption in Saudi Arabia increased abruptly during the 1971–2013 period. In 2013, total oil consumption in Saudi Arabia was approximately 3.07 mbd, 7.5 times the level in 1971. The annual average growth rate in total oil consumption was 5.2% during the period 1971–2013. The 1970s witnessed the highest growth rate, with 7% annual growth. Oil consumption in the transport sector increased dramatically during the 1971–2013 period. In 2013, oil consumption in the transport sector was 1.3 mbd: 41% of total oil consumption and 61 times the level in 1971.

With respect to size of the economy and population, Saudi Arabia's oil consumption is much higher than the advance industrialized countries. Saudi Arabia consumes more than three million barrels oil per day that is higher than the consumption of, the advance industrialize countries Germany and Canada. German population is three times the population of Saudi Arabia and an economy is about six times as larger as the economy of Saudi Arabia. Japan, an industrialized country with more than four time population and economy nearly nine times as large as the economy

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