WP/17/2

SAMA Working Paper:

Revisiting the Nexus between Economic Growth and Energy Consumption in Saudi Arabia

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Abstract: The paper investigates the dynamic relationship between Saudi economic growth, energy consumption, government spending, and carbon dioxide emissions through the 1971-2013. By implementing the Vector Error Correction Model (VECM) cointegration approach and Granger causality analysis, the finding of this paper supports the conservation hypothesis, which is in favour of policymakers to reduce energy consumption while economic growth is unaffected. Cutting subsidies and reducing energy consumption are largely favourable to boost efficiency and maintain a sustainable economic growth. Additionally, the outcome of this paper is in line with ambitious goals of the National Transformation Program 2020 and Saudi Arabia's Vision 2030 in order to achieve efficiency and promote private sector beyond oil.

Keywords: Economic Growth, Energy Consumption, Saudi Arabia, Cointegration, Vector Error Correction Model (VECO), Causality Analysis

(JEL Classification):

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1. Introduction

The Saudi Arabian economy is one of the biggest oil producers and exporters. Oil exports are considered a significant component of GDP growth in Saudi Arabia. The GDP annual growth rate averaged 4.6 percent from 2004 until 2013, reaching 2.7 percent in 2013, compared with 8.0 percent in 2004. Since the decline in oil prices, the oil sector GDP growth in Saudi Arabia during the 2013 reached -1.6 percent, compared with 7.0 percent in 2007. The growth rates of carbon dioxide emissions (co_2), energy consumption, and government expenditures averaged 5.6 percent, 2.9 percent, 14.4 percent in 10 years, respectively. The following table basically shows the growth rate of variables under study:

Year	*GDP Growth*	*Oil Sector GDP Growth*	*CO_2 Emissions Growth*	*Energy consumption Growth*	*Gov. Expenditure Growth*
2004	8.0	7.0	20.9	3.3	10.9
2005	5.6	4.2	0.4	-0.6	21.5
2006	2.8	-1.4	8.8	7.9	13.5
2007	1.8	-3.9	-10.3	0.7	18.5
2008	6.2	4.4	10.9	8.8	11.5
2009	-2.1	-9.5	8.9	3.9	14.7
2010	5.0	-0.1	11.1	8.6	9.6
2011	10.0	12.2	-3.8	-6.3	26.4
2012	5.4	5.1	13.0	9.8	5.6
2013	2.7	-1.6	-4.3	-6.3	11.8
10-Year Average	**4.6**	**1.6**	**5.6**	**2.9**	**14.4**

Source: General Authority for Statistics in Saudi Arabia, and World Bank.

The main challenge for Saudi Arabia is associated with the decline of oil prices since June 2014. Oil prices declined sharply through 2014 and have remained almost constant at much lower levels during early 2017. Since then, Saudi Arabia faced a budget deficit and a building up of public debt. In this regard, the Saudi government launched the vision 2030 alongside the National Transformation Plan 2020; both reflect Saudi Arabia's willingness to shape its economy toward a well-diversified economy in order to promote long-term sustainable growth beyond oil.

A sustainable economic growth and flourishing industrial development create high demand for oil and its products. Therefore, many initiatives for promoting energy efficiency have been implemented. In 2010, the Saudi Energy Efficiency Center (SEEC) was created in order to enhance energy efficiency using bottom-up designed initiatives. The objectives were to develop the energy efficiency and coordinate all activities between stakeholders. Furthermore, the Saudi Energy Efficiency Program (SEEP) was founded by SEEC in 2012. The stream of this program was to concentrate on demand side only with three sectors (buildings, transport, and industry).

During 2016, the government applied energy price reforms for promoting non-oil revenues and reducing CO_2 emissions , i.e. gradual removal of gasoline subsides. The recent standards published by Saudi Arabian Standards Organization (SASO) contributed significantly to energy saving and reduce energy demand.

Analysing the relationship between energy consumption, CO_2 emissions and economic growth is essential for policy makers to build up the efficient energy policies. Many studies have examined the energy consumption and economic growth nexus in advanced and emerging economics and the results were mixed due to many factors such as country-specific characteristics, development stages, methodologies and data. However, few studies examined the relationship between economic growth and the energy consumption in Saudi Arabia (Alqudair (2011), Alkhathlan et al. (2012), Alkhathlan and Javid, 2013; Mehrara (2007), Alshehry and Belloumi (2014), Damette and Seghir (2013), Al-Iriani (2006)). Our paper is different in some aspects. First, government spending has been added as the fiscal policy is dominant in the Saudi economy. This will enhance the results analysis and support examining the energy consumption and economic growth nexus. Second, direct of causalities was documented. Finally, the span of the study has covered most of important incidents in the oil market developments.

The rest of this paper is organized as follows: section 2 provides the literature review and section 3 discusses the methodology approach and data. Section 4 presents the empirical results and; finally, section 5 summarizes the conclusion, findings and recommendations for policy makers.

2. Brief of Literature Review

Since the work of Kraft and Kraft (1978) which found that there was a relationship between energy consumption and economic growth in the USA, several studies have varied results on the direction of causality between these variables. The literature shows that there are four hypotheses on this context. The first one is that the economic growth is less dependent on energy consumption, which means that the economic growth is less affected by conservative energy policies (Kraft and Kraft (1978); Mehara (2007); Alshehry and Belloumi (2015)). The second hypotheses is that the energy consumption led growth which suggests a unidirectional causality form energy consumption to economic growth (Menyah (2010); Lee and Chein-(2010) for G-7 countries). Accordingly, reducing energy consumption may bring on a decline in economic growth. The third assumption states the existence of bi-directional causality between energy consumption and economic growth, where expansive energy positively affects economic growth, and vice-versa (Francis, et al. (2007); Erdal et al. (2008)). The fourth one is no causality between energy consumption and economic growth. Both polices expansive and conservative will not affect economic growth (Eddrief-Cherfi and Kourbali (2012)).

In case of Saudi Arabia, few studies examined the dynamic relationship between energy consumption, CO_2 emissions and economic growth. Alshehry and belloumi (2014) examined the long-run causality between fossil fuels consumption, CO_2 emissions and economic growth in Saudi

Arabia over the period 1971-2012 and found that there exist a long relationship between fossil fuels consumption, CO_2 emissions and economic growth. Moreover, bidirectional causality between CO_2 emissions and economic growth with relationship exists between energy consumption, CO_2 and economic growth. Alqudair (2011) investigated the relationship between energy consumption and economic growth for Saudi Arabia over the period from 1970- 2008 using cointegration approach and his results show that there exists a long–run unidirectional causality from economic growth to energy consumption. Moreover, Alkathlan et al. (2012) examined the relationship among energy consumption, CO_2 emissions , and economic growth in Saudi Arabia over the period 1980 -2008 and found a long run relationship between the studied variables.

Sustainable environment and economic growth relationship is linked through the relationship between energy consumption and economic growth. It is essential to know the energy consumption and economic growth relationship to adapt optimal energy polices and supporting environments policies as well.

3. Methodology and data

To examine the relationship between economic growth and energy consumption in Saudi Arabia, annual data has been used[1]. The period covered is 1971-2013 based on available data for energy consumption and CO_2 emissions. Following the literature, we have investigated the relationship between energy consumption and Saudi economic growth using the cointegration VECM and Granger causality as well. The proposed long-run equation is as follows:

$$\mathrm{LGDP}_t = f(LEC_t, LCO_{2t}, LGS_t)$$

[1] SAMA annual report, 2015 are used, but data for energy consumption and CO_2 emissions have been obtained from the World Bank database.

where LGDP is the natural logarithm of real GDP per capita, LEC is the natural logarithm of energy consumption per capita, LCO_2 is the natural logarithm of Carbon Dioxide per capita, and LGS is the government spending per capita. The trend of the variables that we will investigate are shown in figure (1). A cointegration relationship might exist from the first look at figure (1).

In addition to the VECM long-run equation, Granger causality will be implemented to determine the direction of causality, which is of high importance for policy makers to verify whether the energy consumption affects GDP growth or vise-versa.

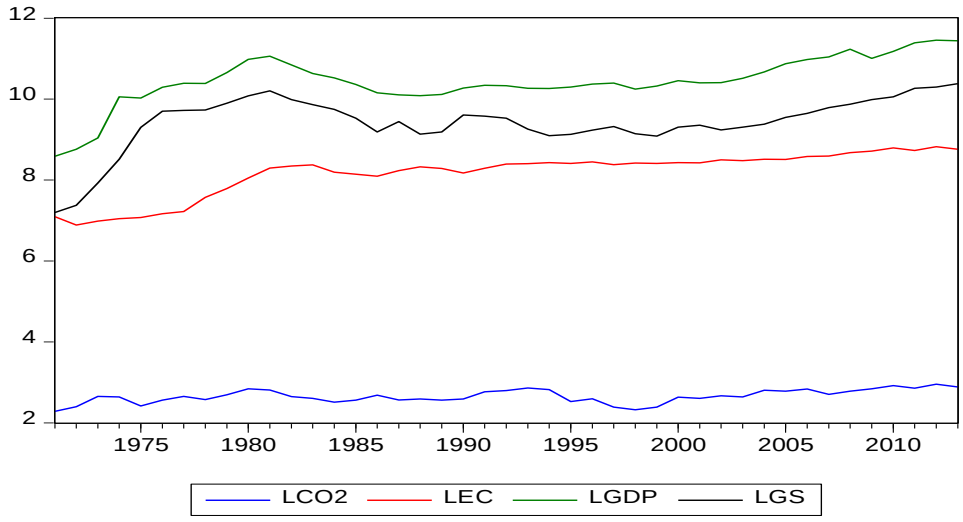

Figure (1): Plot of trend of variables of GDP, energy consumption, $\mathbf{CO_2}$ and government spending

4. Empirical Results

4.1Unit Root Tests

As in augmented Dickey–Fuller (ADF) (1979) and Phillips–Perron (PP) (1988), ADF and PP tests are used to examine for unit roots (i.e., Stationarity); either variables of GDP, energy consumption , government spending and CO_2 emissions are stationary I(0) or integrated of order one I(1). In order to run the VECM, data must be integrated of the same order. Table (1) indicates that all the time series are integrated of order one; thus,

stationary at their first differences. Now, we can proceed with VECM and long-run and short-run causality analysis.

Table 1. Unit root test results:

Variables	ADF		Phillips-Perron	
	At level	At first difference	At level	At first difference
LGDP	-2.2754	-4.8683*	-1.3422	-4.8412*
LEC	-1.7168	-2.9516**	-1.6475	-4.6085*
LCO_2	-3.0838	-6.1324*	-3.0838	-6.3388*
LGS	1.7787	-3.3038*	1.1029	-3.3038*

Note: *, **, and *** denote significance at 1%, 5% and 10% level, respectively.

4.2VECM results

In the second stage, the long-run relationship will be delivered by the VECM results using the Ordinary Least Square (OLS) method. Then, conducting Granger causality measures will also establish the direction of causalities between variables.

The long-run equation can be documented as follows:

$$\underset{}{\text{LGDP}_t} = \underset{}{2.91} + \underset{(-3.47)}{0.49\,LEC_t} - \underset{(1.86)}{0.87\,LCO\,2_t} + \underset{(-9.65)}{1.23\,LGS_t} \quad [2]$$

The above equilibrium shows the long-run relationship between the Saudi economic growth, energy consumption, government spending and CO_2 emissions. As expected, a 1% increase in government spending would lead to 1.23% rise in economic growth in line with the dominance of fiscal policy in the Saudi economy. Additionally, a 1% increase in co_2 will diminish economic growth by 0.87%. As our economy is heavily dependent on oil, energy consumption play a major role in enhancing economic growth as a 1% increase at the energy consumption will increase economic growth by 0.49% in the long-run.

4.3Results of Granger causality tests

[2] Coefficients are statistically significant at 5%, and 10% level.

The causality direction between variables based on Granger causality test is documented in Table 2. The direction of cause runs from the CO_2 emissions to both energy consumption and economic growth. The finding of this research supports the conservation hypothesis in which the direction of causality runs from the real GDP per capita to real energy consumption per capita. That means a unidirectional causality running from economic growth to energy consumption but not vice-versa.

Table 2: Granger causality test results

Dependent Variable	Short-run Causalities F-statistics				Long-run Causality
	$\triangle LGDP$	$\triangle LEC$	$\triangle LCO_2$	$\triangle LGS$	EC_{t-1}
$\triangle LGDP$		1.4123	4.2781	0.44567	-0.2843*
		(0.2419)	(0.0453)**	(0.5083)	(0.0727)
$\triangle LEC$	13.5271**		5.2198**	16.2610**	0.2291
	(0.0007)		(0.0279)	(0.0002)	(0.0727)
$\triangle LCO2$	0.3329	0.0441		0.6807	0.0035
	(0.5672)	(0.8347)		(0.4143)	(0.1188)
$\triangle LGS$	4.7856**	3.8405*	3.3038		0.0228
	(0.0348)	(0.0572)	(0.1543)		(0.1937)

Note: ** and * denote significance at 5% and 10% level, respectively.
Numbers in parenthesis represent the p-values.

Conclusion

The aim of this study is to determine the dynamic relationships among variables of the Saudi economic growth, energy consumption, government spending and CO_2 emissions for the period 1971-2013. This paper is of high importance for several reasons. First, government spending has been added to the model, which is quite essential as a result of the fiscal dominance in the Saudi economy. Second, the span of the paper has covered more events for an oil exporting country as Saudi Arabia. Third, the direction of causality has been documented using the Granger causality analysis.

Interestingly, the finding of this work supports the conservation hypothesis, which states that economic growth is affecting the energy

consumption but not vice-versa. Our research outcome is line with Alqudair (2011), Alkathlan et al. (2012), and Alshehry and Belloumi (2014). This finding is indeed has important implications for the Saudi economy in terms of policymaking. Cutting subsidies and reduce energy consumption are largely favourable to boost efficiency and maintain a sustainable economic growth. The overuse of energy in Saudi Arabia stemming from low prices apparently leads to negative consequences and creates inefficiency in several sectors. The findings of this paper indicate that positive effects of the reforms would be in the long-run; while in the short-run the economy might face some slowdown.

The Saudi economy has suffered low oil prices since the mid-2014 and the government has implemented and will do a series of polices in order to diminish the negative impact of lower oil prices and reduce the pressures on public finance. In particular, in January 2016, the Saudi Arabian government implemented the first phase of subsidies removal where the next move of subsides lifting is planned to be implemented by end-2017. The aim of this reform is to try to let the domestic fuel price are at international levels by 2020.

Some work can be done in future research in this realm. For instance, examining the relationship between the same variables but at disaggregated levels would be interesting. Gauging how various sectors react to lifting subsidies worth considering. More research on this issue to achieve the Saudi Arabia's vision for 2030 goals will also be imperative.

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