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Analyzing Long-run Relationship between Energy Consumption and Economic Growth in the Kingdom of Bahrain

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Abstract

Since the relation between energy consumption and economic growth is important to design effective energy policies that will promote economic growth, this study investigates the short run dynamics and causality among energy consumption, co2 emissions, oil prices and economic growth in Kingdom of Bahrain. To do so, annual data that covers the period from 1960 till 2015. Empirical work tests for unit root, co-integration relationship using Johansen (1988) approach and then estimate both long and short run dynamics using the vector error correction model (VECM). Results indicate that there is a long-run relationship between the suggested variables. Since economic growth has a predictive power to estimate the energy demand of Kingdom of Bahrain, it is recommended that the government of Bahrain and policy designers shed the light on energy efficiency strategies and carbon emissions reduction policy in the long run without impeding economic growth in order to move towards sustainability.

Key Words: emissions; energy consumption; economic growth; Bahrain

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1 Introduction

Energy is not only essential for economic development, it is indeed fuels the economy from resource and material extraction to the technologies producing electricity. Energy carriers and end-use equipment are also needed to deliver the desired energy services. Accordingly, the amount of energy demand has witnessed a considerable boom in last ten years. The threat of global warming problem which is foremost a problem of excessive build-up of carbon dioxide (CO2) emissions in the atmosphere due to the burning of fossil fuels has raised a global concerns about energy consumption. A key central question is: how much energy do economies need to function smoothly and thus being able to augment social development and well-being.

Looking at BP annual report 2015, the GCC member countries are major oil and natural gas producers, holding about 40% and 24% of worldŠs proven oil and gas reserves, respectively (BP 2015). The GCC collectively produced higher CO2 emissions than EU-25 and Organization for Economic Co-Operation and Development (OECD) countries on both a per capita and per GDP basis Patlitzianas et al. (2006). As such, the general thought among international analysts and observers is that there is considerable scope for the GCC group to contribute to global emission reductions via energy efficiency improvement and/or development of renewable energies. All GCC member states had ratified the Kyoto Protocol by 2006. Being Non-Annex I parties, they are committed to reduce GHG emissions without any binding reduction targets. However, the GCC as a cohesive trade group has always acted concertedly in climate change negotiations and policies. The action of a single member country may derail or delay the decision-making process (Reiche, 2010). To date there has been lack of consistent and coherent policies and strategies across the GCC member states with respect to energy conservation, development of renewable energies and emission reductions. While no GCC country to date has a consistent national policy to deal with energy efficiency and renewable energy development, all GCC member states have created administrative capacities to address climate change issues (Reiche, 2010). Given increasing global concerns on climate change, it can be expected that the GCC member states will inevitably embark on promoting energy efficiency, emission reductions and renewable energies in the near future. The vital question is this: Is it possible for GCC countries to realize a sustained economic growth in the long run without accumulation of pollution? In particular, if economic growth induces CO2 emission then growth policies may lead to greater degradation of the environment. However, depending on the nature of the long run relationship between CO2 emissions, economic growth and energy consumption, countries may resort to different policy options in contributing to the fight against global warming (Soytas and Sari, 2009).

Bahrain is a small GCC country which highly dependent on both oil and gas for boosting economic growth. However, acknowledging Bahrain's aspiration to limit the rise in CO2 emissions has mainly motivated this study. The problem of increasing energy efficiency in Bahrain by reducing energy consumption might slow down the economic growth where it depend on fossil fuels, in particular oil. Thus, analyzing the relationship between the economic growth as presented by gross domestic product (GDP) and energy consumption is very important in setting energy policies in Bahrain. Therefore, this paper attempts to shed some light on energy consumption, carbon emissions and economic growth relation in the case of Bahrain taking into account the fluctuation in oil price. To our knowledge the choice of Bahrain as a case study of the GCC group has not yet implemented using advanced econometric techniques that link energy consumption, CO2 emissions and economic growth taking into account the historical fluctuations in oil price.

In what follows, we first provide the material and methods used in this paper in Section 2. Section 3 describes the data and empirical methodology, where empirical results and discussion are represented in Section 4. Finally a conclusion and policy implications are provided in Section 5.

2 Background

2.1 Brief Literature Review

The literature concerning the relationship between energy consumption and economic growth has led to the emergence of a number of empirical investigations. A major strand

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has scrutinizes the linkage between energy consumption and output, suggesting that energy consumption and output may be jointly determined and the direction of causality between these two variables needs to be tested. Following the seminal work of Kraft and Kraft (1978), several others including Masih and Masih (1997), Yang (2000), Wolde-Rufael (2009), Apergis and Payne (2009) and Ozturk et al. (2010) have tested the energy consumption and economic growth nexus with a variety of techniques and for different panel of countries. Looking at the region of Gulf Cooperation Council (GCC), Al-Iriani (2006) investigates the causality relationship between gross domestic product (GDP) and energy consumption in the six countries of the Gulf Cooperation Council (GCC). Recently developed panel cointegration and causality techniques are used to uncover the direction of energyŰGDP causality in the GCC. Empirical results indicate a unidirectional causality running from GDP to energy consumption. Evidence shows no support for the hypothesis that energy consumption is the source of GDP growth in the GCC countries. Such results suggest that energy conservation policies may be adopted without much concern about their adverse effects on the growth of GCC economies. In the same context context, Hamdi et al. (2014) explores the relationship between electricity consumption, foreign direct investment, capital and economic growth in the case of the Kingdom of Bahrain. The Cobb-Douglas production is used over the period of 1980 - 2010. Using autoregressive distributed lag (ARDL), a cointegration relationship has been detected among the series. It is found that electricity consumption, foreign direct investment and capital add in economic growth. However, empirical works do not provide any precise answer, and there is still no consensus among economists whether there is a causal relationship or not and if it exists, there is no clear-cut answer about the direction of this causation (Ozturk, 2010). The contradictory results may occur due to the differences in data sets, characteristics of the investigated countries, variables that are included in the studies, and the diversification in using econometric methodologies (Ozturk, 2010).

Another stream of research has emerged, examine the dynamic relationship between carbon emissions, energy consumption and economic growth. Some of the recent studies using this approach are as follows: Akbostancı et al. (2009), Soytas and Sari (2009), Ozturk and Acaravci (2010), Apergis and Payne (2010) and Al-Iriani (2006). Arouri et al. (2012) investigate the relationship between carbon dioxide emissions, energy consumption, and real GDP for 12 Middle East and North African Countries (MENA) over the period 1981 - 2005. Results show that in the long-run energy consumption has a positive significant impact on CO2 emissions. More interestingly, we show that real GDP exhibits a quadratic relationship with CO2 emissions for the region as a whole. However, although the estimated long-run coefficients of income and its square satisfy the EKC hypothesis in most studied countries, the turning points are very low in some cases and very high in other cases, hence providing poor evidence in support of the EKC hypothesis. Thus, our findings suggest that not all MENA countries need to sacrifice economic growth to decrease their emission levels as they may achieve CO2 emissions reduction via energy conservation without negative long-run effects on economic growth.

Many researchers argue that if the estimated model does not account for other possible determinants such as that of energy prices, then results may be biased. For example, Glasure (2002) indicates that the real oil price is a major determinant of real national income and energy consumption. Hence, literature has included oil prices in many studies as an additional explanatory variable in energy growth models in order to improve the accuracy of the results. Yang (2000) proposes that the pattern of energy consumption may also influence the efficiency of the model as it differs over time. Looking at the aggregated energy consumption would accordingly ignore the change in the importance of different energy sources through time. Therefore, the performed studies end up with different results over different periods of time even for the same country.

2.2 Overview on energy sector in Bahrain

Although Kingdom of Bahrain is a small country within the GCC group, it appears to be an interesting case study due to the clear increase in it's CO2 emissions which have grown exponentially over the last 30 years. The levels of CO2 emission and fossil fuel consumption over the period 1980 - 2007 increased by 172% and 212%, respectively (calculated based on WDI, 2011). Currently, per capita energy consumption among Bahrainies is one

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of the highest in the world - it uses two folds more energy per capita than Japan. In 2007, an average Bahraini consumed 9456 kg oil equivalent of energy. By comparison, Japan and the US have per capita energy uses of 4033 and 7747 kg, respectively. Figure (1) shows per capita energy consumption in Bahrain as compared with neighboring countries (Oman and UAE) and selected developed countries. Such a high consumption rate of energy in Bahrain may have contributed to a high per capita emission level.

Looking at Figure (2), it is clear that energy sector still represents the biggest contributor to the kingdom's GDP, although its share of the economy has been falling as non-oil sectors continue to drive growth. The kingdom's financial sector represents the second-largest contributor to GDP, accounting for 16.5% in 2014, with Bahrain recognised as a pioneer in Islamic finance, having been the first country in the world to introduce and implement rules specific to Islamic banking in 2001. Manufacturing is the third-largest GDP contributor, at 14.4% of the total in 2014, with the kingdom home to one of the world's largest aluminuim smelters. Meanwhile, Bahrain continues to invest in considerable infrastructure upgrades, and these are expected to enhance the kingdom's logistics offerings, as well as help facilitate greater tourism numbers. For its part, tourism has been identified as an area with significant potential for growth, with the Supreme Council for Tourism created to help guide and develop the sector.

Although the global drop in crude oil prices is a concern, the early adoption of economic diversification efforts has created positive growth trajectories in non-oil sectors in Bahrain, such as construction and transport. Hydrocarbons continue to form the bulk of government revenues in Bahrain, with oil and gas accounting for 24.1% of Bahrain's GDP in 2014. Neighbouring Saudi Arabia remains a vital energy partner for the kingdom, and recent Saudi investments in its Eastern Province have benefitted both countries in terms of hydrocarbons processing. Meanwhile in June 2014 Bahrain opened its first solar energy facility in the town of Awali. The 5-MW facility relies on the concept of a smart grid that harvests energy through photo-votaic panels dispersed around the city.

The most important measure in the energy balance of Bahrain is the total consumption of 11.69 billion kWh per year, where it is with an average of 8,681 kWh per capita.

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Bahrain could provide itself completely with self-produced energy. However, the local demand of energy has been increased recently due to many factors such as population growth and increase in electricity demand as summarized in Table (1). The total production of all energy producing facilities is 13 bn kWh. Thats 113% of the countries own usage. Despite this Bahrain trades its energy with foreign countries. Along with pure consumptions the production, imports and exports play an important role. Total per capita energy consumption is 10.8 toe (including about 19 400 kWh of electricity) (2014). Consumption has almost doubled since 2000 and reached 14.8 Mtoe in 2014. Looking at energy companies, the gas exploration and exploitation activities in the country are managed by Bahrain National Gas Company (BANAGAS), which is owned by the State (75%), Chevron Bahrain (12.5%) and Boubyan Petrochemical Company K.S.C. (BPC) (K.S.C, 12.5%). In general, energy Consumption per capita is 10.8 toe (including about 19 400 kWh of electricity) (2014). Therefore, government of Bahrain is considering developing renewable energies to diversify its power supply.

3 Data and Econometric Methodology

3.1 Data

The yearly data-set used in this paper cover the period from 1960 to 2015 for Bahrain. The set of variables are time-series variables that include real GDP per capita (GDP), energy consumption per capita (EC), carbon dioxide emission per capita (Co2) and real oil prices (OP). Oil consumption are obtained from BP Statistical Review of World Energy (2011) where OC is measured in thousand barrels daily. Real GDP per capita measured based on purchasing-power-parity (PPP) per capita in constant 2000 international dollars from the World Development Indicators (WDI, 2011). Real West Texas Intermediate (WTI) oil prices are defined as the US dollar prices of oil. Following Lee and Chiu (2011), oil prices are converted to the domestic currencies and then deflated by the domestic consumer price indices (CPIs), which is derived from International Financial Statistics (IFS, 2011) published by the International Monetary Fund (IMF). Descrptive statics are provided in

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Table (2).

3.2 Econometric Methodology

Before conducting cointegration analysis, stationary tests are essential for identifying the order of integration of the proposed variables. The most popular tests in literature are the Agmented Dickey and Fuller (1979) (ADF), Phillips and Perron (1988) (PP) and Kwiatkowski et al. (1992) (KPSS). The difference between the ADF, PP and the KPSS tests is that the formulation of the null hypothesis is different.[1]. The ADF (augmented Dickey-Fuller) testing procedure to test the unit root hypothesis following:

$$\Delta y_t = \theta_0 + \gamma_0 t + \gamma_1 y_{t-1} + \sum_{i=0}^{p} \theta_i \Delta y_{t-1} + \varepsilon_t \tag{1}$$

where y_t is the variable in period t; Δy_{t-1} the $y_{t-1} - y_{t-2}$; ε_t the i.i.d. disturbance with mean 0 and variance 1; t the linear time trend and p is the lag order. In order to test the null hypothesis for the presence of a unit root in y_t, we conducted the hypothesis testing that $\gamma_1 = 0$ in Equation (1). If γ_1 is significantly less than zero, the null hypothesis of a unit root is rejected. Phillips-Perron test uses similar models as the ADF tests, but lack of sensitivity to the heteroscedasticity and the autocorrelation of the residuals. Moreover, ADF tests and PP tests may be inefficient on small samples. KPSS stationarity test is more effective for small samples when it chooses a lower lag truncation parameter.

Then, to select the optimal number of lag length, k, Akaike (AIC), Hannan and Quinn (HQIC), and Schwarz's Bayesian (SIC) information criteria are used to build a decision.[2]

Once all variables are integrated of the same order, this study proceed to examine the existence of long-run relationship(s) among series. Precisely, a cointegration methodology that starts with a general approach and move to a more specific is applied to estimate the long-run relationship(s) between the variables included in vector Z_t, where Z_t includes a

[1] ADF and PP tests have non stationary series as the null hypothesis while on the other hand, KPSS assumes that the series to be investigated is stationary. In this study, all these tests are utilized to verify the variables' order of integration, I_d

[2] In the case of conflicting results of the different Information criterion, the choice done based on AIC results as suggested by Pesaran and Pesaran (1997).

number of integrated series at the same level. To do so, long-run relationships between the variables included in vector Z_t are estimated using Johansen Maximum Likelihood approach. Specifically, one can write Z_t as a vector autoregressive process of order k (i.e., VAR(k)):

$$Z_t = A_0 + \sum_{i=1}^{k} A_i Z_{t-i} + u_t \tag{2}$$

$$\Delta Z_t = A_0 + \Pi Z_{t-1} + \sum_{i=1}^{k} \Gamma_i \Delta Z_{t-i} + u_t \tag{3}$$

Where Z_t denotes (4×1) vector containing GDP, energy consumption, Co2 emissions, and real oil prices $(Z_t = (GDP_t, EC_t, CO2_t, OP_t))$. The four variables are measured by their natural logarithm so that their first difference approximate their growth rates. Any long-run relationship(s) are captured by the (4×4) matrix Π shown in Equation (3). To examine the long-run relationship(s) between the suggested variables, Johansen (1988) test has been established in order to test for the existence of $r \leq 3$ cointegration relationships among the four variables of the model. This is equivalent to testing the hypothesis that the rank of matrix Π in Equation (3) is at most r. Reduced-rank regression can then be used to form a likelihood ratio test of that hypothesis on the basis of the so-called trace statistic, or alternatively, the maximum eigenvalue statistic. Lüutkepohl et al. (2001) investigate the small sample properties of both tests and conclude that the trace testis slightly superior, and therefore, we favor it in our analysis. Thus, the rank of the matrix Π is imposed to estimate the un-restricted model shown in Equation (3). However, this matrix (i.e. Π) can be decomposed as shown below in Equation (4) to provide better understanding for the full system:

$$\Delta Z_t = A_0 + \alpha\beta' Z_{t-1} + \sum_{i=1}^{p} \Gamma_i \Delta Z_{t-i} + u_t, \qquad u_t \text{ is } iid \sim N(0, \Sigma) \tag{4}$$

where the cointegrating vectors are presented in a $(4 \times r)$ matrix named β and the speed of adjustments are shown in a $(4 \times r)$ matrix called α. Γ_i represents (4×4) matrices that guide short run dynamics of the model.

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4 Empirical Results and Discussion

It is clear from Table 3 that the null hypothesis of no unit roots for all the time series are rejected at their first differences since the ADF and KPSS test statistic values are less than the critical values at 1% levels of significance. Thus, the variables are stationary and integrated of same order, i.e., I (1). All variables became stationary and do not contain unit root in first difference.

Table 4 reports lag-order selection statistics using Akaike, Hannan and Quinn and Schwarz's Bayesian information criteria (i.e. AIC, HQIC and SBIC), respectively. Since the results are conflicting, we use AIC results as suggested by Pesaran and Pesaran (1997). Accordingly, this empirical work has proceeded using three lags.

Based on Π rank test developed by Johansen (1988), the results of testing for the number of cointegrating vectors are reported in Table (5), which derives two likelihood estimators named Eigen value and trace statistics test. The cointegration rank (r) can be formally tested with the trace and Eigen value statistics taking into accounts the 5% critical value of the test. Thus, results shown in Table 5 reveals that the trace statistic either rejects the null hypothesis of no co-integration among the variables or does not reject the null hypothesis that there is one co-integration relation between the variables. Start by testing a maximum rank of 0, if it is rejected, then repeat for next option where the maximum rank tested for 1. When a test is not rejected, then stop testing there and that value of r is the commonly-used estimate of the number of cointegrating relations. Here, r = 1 is not rejected at the 5% level. In other words, this trace test result does not reject the null hypothesis that these two variables are not cointegrated. The final number of cointegrated vectors with two lags is equal to one, i.e. rank (r) =1. Since, the rank is equal to 1 which is more than zero and less than the number of variables; the series are cointegrating among the variables.

Table (6) presents results of the long-run elasticities. There exists a positive relationship between energy consumption and economic growth in Bahrain, where a one percentage point increases in energy consumption significantly increases economic growth by almost 1.2%. This implies that consuming more energy - which is in fact mainly fossil

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fuels at the meantime- stimulates the economic growth significantly in Bahrain. However, it is also revealed that although this consumption stimulates economic growth, it is indeed affecting the level of emissions and contribute to the build up of carbon dioxide emissions. Thus, an increase of 1% level in Co_2 emissions in Bahrain results a significant increase economic growth by 0.49%. It is also worth to note that the relationship between oil prices and economic growth in Bahrain is positive, taking into consideration that Bahrain is in fact an oil exporting country. Looking at the lower part of table (6), the estimated short run model shows that the ECT term is negative and significant as expected in the economic growth model shown in the second column. This reflect that if the economic growth model deviates in the long-run, it could be adjusted and restored by 3.5%. However, the energy consumption model cannot be adjusted if it faces any deviation in the long-run. This may be attributed to the type of energy used in Bahrain, where the only available type used at the meantime is fossil fuels. Results suggest that energy consumption has a predictive power for economic growth in Bahrain. With regards to carbon dioxide emissions, results suggest that there is a unidirectional causality running from CO2 emissions to economic growth, where increases in CO2 emissions lead to increases in economic growth.

5 Conclusion and Policy Implications

Reducing the excess build up of CO_2 emissions has been prompted by world leaders in order to find solutions that minimize global warming problem. Kyoto Protocol represents one of global initiatives that aim to reduce the amount of global warming substances and Bahrain has ratified it and thus, being obliged to reduce it's GHG emissions. However, there has been a lack of clear and coherent policies on climate change and energy conservation within the GCC member states, including Bahrain. This might be due inter alia to concerns over the impact of energy conservation policies on the economic growth of GCC member states. This paper examined the causal relationship between economic growth, pollutant emissions, energy consumption, urban population and capital in Bahrain for the

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Acknowledging the intensive energy dependency of Bahrain's economy, one of the important challenges for the country is to reduce this dependency which will accordingly reduces the carbon emissions as required by the Kyoto Protocol. However, depending on the relationship between energy consumption, economic growth and carbon dioxide level in Bahrain, several outcomes are anticipated.

The estimation results show that there are significant relationships between GDP, energy consumption, CO2 emissions and oil prices in Bahrain. One of the significant relationships is that energy consumption causes CO2 emissions, while causality does not run from energy consumption to economic growth in the short-run estimated models. This signifies that while the implementation of energy conservation policies in Bahrain may not affect Bahrain's economic growth significantly, such policies may provide significant scope to reduce the country's CO2 emissions. The latter implication may be due to the large level of emissions attributed to conventional fuels including oil, and more significantly gas, in that country.

The main policy options shall focus on energy conservation strategies, including more efficient use of energy from both the production and user perspectives as well as the development of the renewable energy sector. The long run pursuit of high economic growth given sustained increases in energy efficiency may also reduce CO2 emissions intensity per unit of GDP. It is also important to note here that the energy conservation strategies may not exert any significant impact on the country's GDP, but may have substantial inter sectoral or equity impacts within the economy in which some sectors may gain, while some others may lose. An interesting future study would be to appraise the inter sectoral impacts of energy conservation or CO2 emissions reduction in Bahrain.

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Figure 1: Energy Consumption per capita for Bahrain and other selected neighbor countries

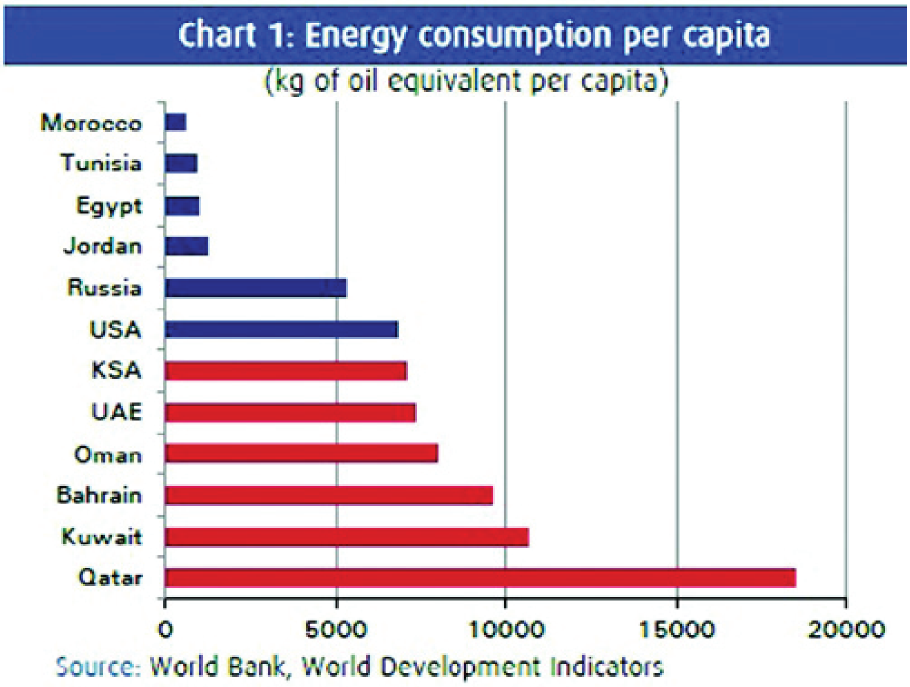

Figure 2: Share of Bahrain's GDP

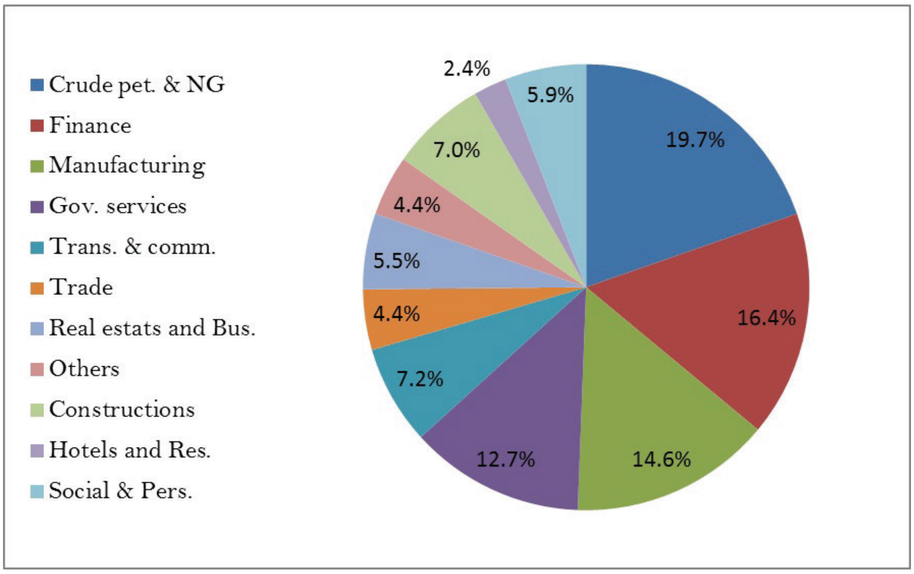

Table 1: Energy Statistics for Bahrain

Variables	1990	2013
Energy production (total million metric tones of oil equivalent)	14.3	22
Energy use (fossil fuels % of total energy use)	100	100
Energy use growth (%)	4.5	

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Table 2: Descriptive Statistics

Variables	GDP	EC	Co2	OP
mean	9.914	9.08	2.902	1.527497
SD	0.1071	0.244	0.555	0.3154876
Skewness	-0.444	-0.98	-1.719	-0.1252766
Kurtosis	1.638	2.863	4.765	1.777607

Table 3: Tests of Unit Root

Unit root test	ADF	lags	PP (4)	KPSS	lags
levels					
GDP	0.79	4	-1.834	0.666***	4
EC	0.519	4	-3.141	0.274*	4
Co2	0.623	4	-3.159	0.235*	4
OP	0.286	4	-1.715	0.677	4
first difference		4			4
GDP	-2.379**	4	-6.147***	0.055	4
EC	-3.080**	4	-9.464***	0.049	4
Co2	-4.758***	4	-9.473***	0.048	4
OP	-2.242**	4	-6.862**	0.051	4

Notes: Table entries are the results obtained from unit root tests. Tests are shown in the first row: augmented Dickey and Fuller (1979) (ADF), Phillips and Perron (1988) (PP), and the stationarity test by Kwiatkowski et al. (1992) (KPSS). Regression include an intercept and trend. The variables are specified in the first column: oil price (OP), oil consumption (OC), nuclear energy consumption (NC) and real GDP (Y). All variables are in natural logarithms, while the lag length determined by Akaike Information Criteria and are in parentheses. '*' and '**' indicate significance at the 10% and 5% level, respectively. The nulls for all test except for the KPSS test are unit root.

Table 4: lag Selection Criteria

K	AIC	HQIC	SBIC
1	-5.886	-5.596	-5.533*
2	-6.017	-5.496	-5.128
3	-6.915*	-6.163*	-4.653
4	-6.683	-5.699	-4.945

Notes: AIC, HQIC and SBIC stand for Akaike, Hannan and Quinn and Schwarz's Bayesian information criteria, respectively. In the case of conflicting results, we use AIC results as suggested by Pesaran and Pesaran (1997). '*' indicates significant at 5% level.

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Table 5: Johansen's Cointegration Test

max rank	LL	Eigenvalue	Trace statistics	95% c.v
$r = 0$	197.801	-	74.365	54.650
$r \leq 1$	222.007	0.598	25.954*	34.550
$r \leq 2$	230.719	0.280	8.528	18.170
$r \leq 3$	233.762	0.108	2.443	3.740
$r \leq 4$	234.984	0.045	-	-

Notes: The entries of the upper row show the name of the country in the first column, followed by the null hypothesis H_0, that tests for a cointegration rank of r, then H_1 shows the alternative. λ_{max} shown in the fourth column represents the maximum eigenvalue statistics, $Trace*$ shows the trace statics, $95\%c.v$ represents the critical values at 5% level, and finally $p - values$ are provided in the last column. '*', '**', and '***' indicate significance at the 10%, 5% and 1% level, respectively.

Table 6: VECM Estimation Results

Cointegration equations	Cointegrating Eq. (1)			
GDP (-1)	1			
EC (-1)	1.16***			
Co2 (-1)	-0.489***			
OP (-1)	0.447***			
Vector Error Correction	Δ GDP	Δ EC	Δ Co2	Δ OP
Δ GDP (-1)	0.359**	0.189	1.124*	-0.088
	(0.010)	(0.272)	(0.098)	(0.836)
Δ GDP (-2)	-0.713	0.0523	1.016	-0.047
	(0.603)	(0.831)	(0.131)	(0.912)
Δ EC (-1)	0.0365	-0.208	-0.156	0.097
	(0.611)	(0.105)	(0.657)	(0.644)
Δ EC (-2)	0.0859	-0.207*	0.169**	-0.323
	(0.218)	(0.095)	(0.620)	(0.013)
Δ Co2 (-1)	0.012	-0.067	-0.106**	-0.003
	(0.690)	(0.226)	(0.489)	(0.0497)
Δ Co2 (-2)	0.0604**	-0.0783*	-0.126	-0.052
	(0.019)	(0.087)	(0.319)	(0.514)
Δ OP (-1)	-0.055	-0.109	-0.175	0.0013
	(0.247)	(0.196)	(0.459)	(0.993)
Δ OP (-2)	-0.0543	0.077	-0.032	-0.034
	(0.262)	(0.370)	(0.892)	(0.820)
ECT_{t-1}	-0.0354**	0.189***	-0.007	0.231***
	(0.021)	(0.000)	(0.956)	(0.009)

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