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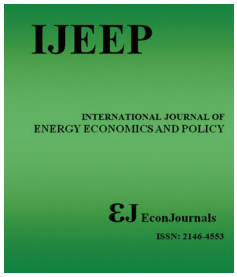

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Renewable Energy Consumption Impact on the Lebanese Economy

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ABSTRACT

This study examines the impact of renewable energy consumption on economic growth for Lebanon over the period 1990-2012. The renewable energy consumption with negative coefficient and statistically significant while the real gross fixed capital formation, and the labor force with the respective coefficients positive and statistically significant. The research data is from the Lebanese Central Bank, the International Monetary Funds and the world development indicators then it is regressed in basic time series analysis taking into consideration the different variables that have an influence on the economic growth. After testing its robustness and illustrated through ARMAX, the results show a statistically significant impact of renewable energy consumption on the Lebanese economic growth.

Keywords: Renewable Energy Consumption, Energy Consumption, Lebanese Economic Growth
JEL Classifications: O440, Q280

1. INTRODUCTION

In global energy consumption that highly dependent on fossil fuel consumption has generated discussions on its sustainability for many countries and mainly for the emergent oil importer economies. Renewable energy consumption in the Lebanon economy, as oil importer and highly dependent on fuel consumption as source of energy consumption in the Middle East is our aim of this study. The economic growth and renewable energy consumption relationship has recently studied in the literature. Several studies have investigated the causal relationship between renewable energy consumption and their economic growth for different countries with different level of development mainly by Ewing et al. (2007), Sadorsky (2009), Payne (2009), Apergis and Payne (2009a; 2009b; 2010a; 2010b), Bowden and Payne (2010), Bhattacharya et al. (2016), Jebli et al. (2016), Dogan and Ozturk (2017), Hassine and Harrathi (2017), Bekareva et al. (2017), Rafindadi and Ozturk (2017), Benavides et al. (2017). These studies results have not standardized with positive or negative relationship.

The theme of this research is to study the impact for the renewable energy consumption on the Lebanese economic growth. More recently, the economic base of Lebanon has gradually shifted from agricultural exports towards the manufacturing and tourism sectors. Because of this shift, the Lebanese dependence on energy imports, which comprise approximately more than three fourths of its total energy consumption, has raised questions as to the sustainability of the current energy consumption patterns and energy security in general. The evolution of the Lebanese economic base towards manufacturing and tourism along with the reliance on imported petroleum products has resulted in environmental concerns associated with pollution and greenhouse emissions (Ministry of Environment, 2010). The Lebanese ministry of energy developed a National Renewable Energy Action Plan with a target to reach 12% of usage for different renewable energy technologies needed by the year 2020. In 2010, Lebanese ministry, as the main authority to develop the energy sector, strengthened this vision in its Policy Paper for the Electricity Sector by stating that the target was to reach "12% of the electric and thermal supply" not just "12% of Lebanon's needs" (Ministry of Energy and Water, 2010).

In testing the impact of the Lebanese RE on its economic growth, data set in this research has collected from year 1990 until year 2012 - in total 23 yearly observations it is limited due to the availability of data. We regress the dependent variable (the

Lebanese real GDP) on the renewable energy consumption, labor force, and gross capital formation. In this study, the impact of renewable energy consumption on the Lebanese economic growth is analyzed using regression analyze. After we check the model robustness, we check the fitness of the model through running ARMAX model. We start the study by introducing the subject then by presenting a brief theoretical background for renewable energy consumption and the economic growth followed with a brief overview about the Lebanese renewable energy progress. Section 4 discusses the data, methodology, and empirical results. Concluding remarks are given in Section 5.

2. ENERGY CONSUMPTION–GROWTH LITERATURE

The energy consumption and economic growth relationship is largely studied in Literature (Apergis and Payne, 2009a; 2009b; 2010a; 2010b; Ozturk, 2010; Bouoiyour et al., 2014). Nowadays, the global economies now believe in the balance between the future energy and environmental needs for the sustainable development purpose. Renewable energy, as a main source of sustainable development, has a small portion of the overall energy consumption in most countries. The renewable energy consumption and economic growth relationship has been studied in two approaches supply and demand sides.

The supply-side approach focuses in studying the energy consumption contribution in economic activities using traditional production function framework. However, the demand-side approach focuses on studying the energy consumption, gross domestic product (GDP) and energy prices relationship widely known as tri-variate energy demand model (Lee, 2005). Other some recent researches included pollutant emissions in their studies such as Soytas et al. (2007).

Studying the renewable energy consumption in Lebanon is a not well covered in literature. This emergent oil importing country with new discovery of oil and gas in its off shore pre-salt zones. If an increase in energy consumption has a positive impact on economic growth, energy conservation-oriented policies that reduce energy consumption may have a detrimental impact of economic growth. Alternatively, there are a number of reasons for the possibility of an increase in energy consumption having a negative impact on economic growth. In a growing economy requires low energy consumption is required due to the shift of as production toward with less energy intensive service sectors, to capacity constraints, to energy supply inefficiency, to energy consumption concentration in unproductive sectors. We support this hypothesis in our tested case. Due to the weak and the inefficient use of the renewable energy in a growing economy in Lebanon, we suggest that it have a negative impact on the economic growth.

3. RENEWABLE ENERGY CONSUMPTION AND GROWTH IN LEBANON

The Lebanese first renewable energy power plant has installed in 1924. Between the 1920s and the 1970s, before the beginning of the Lebanese civil war, Lebanon experienced fast hydropower plants development. In 1976, about 70% of the Lebanese electricity production was hydroelectricity. With gradual decrease in the renewable energy usage, nowadays hydropower accounts between 2% and 4% of the total Lebanese electricity production (World Bank, 2011).

The Lebanese policy makers with the help form the United Nations Development Programme (UNDP) insist on the development of renewable energy sources (UNDP, 2012). However, the first real milestone for the development of RE came out in 2009 when the Lebanese Government committed to reach 12% of RE by 2020 (Chehab, 2010). Accordingly, many aspects of renewable energy development should be adopted. First, encouraging the private sector to investigate geothermal energy and to adopt for power generation waste-to-energy technology. Second, increasing the share of hydraulic power production. Third, introducing wind power via the private sector. Finally, increasing the penetration of solar water heaters with the collaboration-banking sector through credit facilities (Houri, 2006).

4. DATA, METHODOLOGY, AND RESULTS

Dataset used in the research was collected from the Lebanese Ministry of Energy, Lebanese Ministry of environment and World Bank - WDI statistics (world development indicator). In testing the impact of the Lebanese RE on its economic growth, Data set in this research has collected from year 1990 until year 2012 - in total 23 yearly observations it is limited due to the availability of data. The regressed data framework includes real GDP (Y) and real gross fixed capital formation (K) in constant 2000 U.S. dollars, the total labor force (L), and the natural logarithm of renewable energy consumption (RE) defined as percentage of total final energy consumption Pedroni (1999, 2000 and 2004). The research used multilinear regression equation using Ordinary Least Squares method. The research testing will start with the baseline-estimated regression before we run other robustness regression checking. In order to check the fitness of the model, we run the ARMAX. We end up with checking the public debt threshold that turns its impact on the Lebanese economic growth to negative.

We refer to Pedroni model. The Pedroni (1999 and 2004) studied the heterogeneous panel co-integration test is specified as follows:

$$Y = \alpha+\beta1RE+\beta2K+\beta3L+\varepsilon_t \quad (1)$$

According to the model equation, we consider that α is a constant variable; β is the regression coefficients; ε_t is the error term.

The research model considers two main hypotheses:

H_1: The main hypothesis is that the variability of the real GDP explained by the variability of the renewable energy consumption negatively due to the energy supply inefficiency, capacity constraints, high cost of production, energy consumption is excessive in unproductive sectors like the electricity production in the Lebanese economy.

H_2: The variability of real GDP growth rate explained by the variability of other control variables positively.

4.1. Results and Findings

In order to construct the above econometric model, we follow the methodology of general to specific in order to produce a parsimonious explanatory model. More specifically, we regress the dependent variable (the Lebanese real GDP) on the renewable energy consumption, labor force, and gross capital formation. In this study, the impact of renewable energy consumption on the Lebanese economic growth is analyzed using regression analyze. The regression model summary is clear in Table 1.

The results show that most of the explanatory variables are statistically significant and have the expected sign. The results suggest that the labor total force and the gross capital formation are statistically significant with positive impact on real GDP. While, the renewable energy consumption has a negative impact on the Lebanese real GDP and statistically significant. These findings are on Table 2.

4.2. Other Robustness Check

Another robustness-checking test based on Least absolute deviation, illustrate the baseline regression estimation with respect to the labor force, gross capital formation and the renewable energy consumption clearly explain its robustness (Table 2).

4.3. Running ARMAX

For better parsimonious description for our model, we run autoregressive–moving-average (ARMA) models based on auto regression and second moving average polynomial. The AR part involves regressing the variable on its own values while The MA part involves modeling the error term as a linear combination of error terms occurring contemporaneously and at various times in the past.

The ARMAX results show very similar significant results to the ones on regressed model variable coefficients. The coefficient labeled phi 1 is the estimate of the autocorrelation parameter. The root of this equation is 1/phi 1. The roots (or modulus) is >1 in absolute value thus the model is stationary. The same with theta as coefficient for MA parameter with root >1 to in Absolut value to prove it stationarity. The advantage to this approach is that we can see that the model is stable via the root analysis. The moduli are both roots are >1 and both AR and MA are stationary. The results in Table 3 show a good fit for the model.

6. CONCLUSIONS

The renewable energy consumption impact on the Lebanese economic growth is regressed using gross capital formation and Labor force as control variables. After checking the robustness of the model, the model proved stationary using ARMAX model. The results show that capital formation and labor forces are statistically significant with positive signs. However, the renewable energy consumption is statistically significant but negatively affect the Lebanese economic growth. Which is due to the low level of consumption and the establishment high cost in the Lebanese

Table 1: OLS, using observations 1990-2012 (T=23)

Dependent variable: Real GDP HAC standard errors, bandwidth 2 (Bartlett kernel)				
	Coefficient	**SE**	**t ratio**	**P value**
Constant	−5.80778	3.55822	−1.6322	0.11910
Gross fixed capital formation	1.25105	0.320119	3.9081	0.00095***
Labor force total	23850.8	3369.01	7.0794	<0.00001***
Log renewable energy consumption	−1.05461	3.22395	−3.2712	0.00402***
Mean dependent variable	1.97e+10	SD dependent variable		1.12e+10
Sum squared residual	4.92e+19	SE of regression		1.61e+09
R^2	0.982193	Adjusted R^2		0.979381
F (3,19)	445.5270	P value (F)		8.87e-18
Log-likelihood	−518.0095	Akaike criterion		1044.019
Schwarz criterion	1048.561	Hannan-Quinn		1045.161
rho	0.577059	Durbin-Watson		0.827142

Source: Author calculation, SE: Standard error, SD: Standard deviation

Table 2: LAD, using observations 1990-2012 (T=23)

Dependent variable: Real GDP				
	Coefficient	**SE**	**t ratio**	**P value**
Constant	−3.33484e+09	5.7137e+09	–0.5837	0.56632
Labor force total	22341.3	6399.91	3.4909	0.00245***
Gross fixed capital formation	1.2716	0.694397	1.8312	0.08280*
Log renewable energy consumption	−1.15665e+010	7.59236e+09	–1.5234	0.14412
Median dependent variable	1.76e+10	SD dependent variable		1.12e+10
Sum absolute residual	2.85e+10	Sum squared residual		5.26e+19
Log-likelihood	−520.4788	Akaike criterion		1048.958
Schwarz criterion	1053.500	Hannan-Quinn		1050.100

Source: Author calculation, SE: Standard error, SD: Standard deviation

Table 3: ARMAX, using observations 1991-2012 (T=22)

Dependent variable: Real GDP					
		Coefficient	SE	z	P value
Constant		−1.56792e+09	4.72355e+09	−0.3319	0.73994
phi_1		0.598502	0.3148	1.9012	0.05727*
theta_1		0.541201	0.757488	0.7145	0.47494
Labor force total		6984.98	10660.6	0.6552	0.51233
Gross fixed capital formation		0.894996	0.43862	2.0405	0.04130**
Log renewable energy consumption		−2.5581e+09	6.51139e+09	−0.3929	0.69442
Mean dependent variable			2.05e+10	SD dependent variable	1.08e+10
Mean of innovations			−20121386	SD of innovations	6.99e+08
Log-likelihood			−479.2644	Akaike criterion	972.5287
Schwarz criterion			980.1660	Hannan-Quinn	974.3279
		Real	Imaginary	Modulus	Frequency
AR	Root 1	1.6708	0.0000	1.6708	0.0000
MA	Root 1	−1.8477	0.0000	1.8477	0.5000

Source: Author calculation, SE: Standard error, SD: Standard deviation

market, to the excessive energy consumption in unproductive sectors of the Lebanese economy, capacity constraints, and an inefficient energy supply.

The results show that most of the explanatory variables are statistically significant and have the expected sign. Another robustness-checking test based on Least Absolute deviation illustrate the regression estimation and clearly explain its robustness and thus both research hypothesis are true. Policy makers should encourage the partnerships between the public and private sector in promoting the renewable energy production. In addition, some more initiatives incentives form the Lebanese Government policy could help such as renewable energy production tax credits, renewable energy portfolio standards, renewable energy systems installation rebates.

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