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Relationship between Renewable Energy Consumption and Economic Growth in Tunisia: Causality Analysis

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Abstract:

Tunisia is ranked among the countries with low energy diversification, but this configuration makes it too dependent on fossil fuel exporting country and therefore extremely sensitive to any oil crises, a late deal has this disability measures to diversify production electricity must be taken in making use of other forms of renewable and nuclear energy.

One of the solutions required to escape this dependence is the liberalization of the electricity industry which can lead to an improvement of supply, energy diversification, and reducing some of the negative effects of the trade balance.

This paper examines the issue of renewable electricity and economic growth in Tunisia consumption. The main objective is to study and analyze the causal link between renewable energy consumption and economic growth in Tunisia over the period 1980-2010. To examine the relationship of short-term and long-term relationship as casual, we used a multidimensional approach to cointegration based on recent advances in time series econometrics (test Zivot - Andrews, Test of CointegrationJohannsen, Granger causality test, error correction model (ECM)).

Introduction

The renewable energy market in Tunisia is growing, the state has implemented various instruments, projects and policies to exploit the abundance of energy resources in the region and thus contribute to economic growth and improving energy security. While investments are lower than those of other countries, but in recent years there has been increased investment in this industry.

Among the contributing factors, a marked increase in energy demand, high population growth, urbanization and economic development, all these factors have resulted in an urgent need for energy supplies. With the high price of fossil fuels, renewable energy has become an alternative more attractive consumption of oil and natural gas. Renewable energy is also cited as an opportunity for electricity exports.

The use of renewable energy has increased by 136% between 2008 and 2011, the share of renewables in electricity generation and advanced 1.01%, however, given the lower cost of modern renewable energy technologies and the rising cost of fossil fuels, wind and solar energy can meet the growing energy needs throughout the country and may be the preferred technologies for the foreseeable future.

The trend is already evident in the recent data. In 2011, electricity production from renewable sources reached about 163 GWh, with an increase of 136% compared to 2008, it should be noted that the production of renewable energy has gained share on conventional energy sources, despite strong growth in demand for electricity, which makes the growth of the share of renewable energies significant and deserve to be highlighted.

More recently, Tunisia has seen the share of renewable energy to increase by at least 4 percentage points in the last two years, reaching 6%, the production of modern renewable electricity has increased at a much faster rate than conventional energy sources, wind energy remains the primary source of renewable energy for electricity generation in the region, ella has registered a growth of 12.37% and currently develepoe 139 GWh in 2009 against 97Gwh. against and by the same period the hydrolic has registered a decrease of 31.64% from a 79Gwh 54Gwh.

The growth of renewable energy production is due to the energy security and reduction of dependence on imported oil HAS become expensive, desalination, air conditioning, electricity generation with Increased Rapidly Increasing demand driven by GDP growth, urbanization and population growth in much of the area.

1. Current energy mix

Since 2002 the structure of energy production recorded a single change in the wind sector production increased by 2% in 2010 against 0.4% in 2002, if production capacity has not changed. Natural gas remains in Tunisia fuel used by against other forms of energy involved in this low energy mix.

Tunisia is ranked among the countries with low energy diversification, but this configuration makes it too dependent on fossil fuel exporting country and therefore extremely sensitive to any oil crises, a late deal has this disability measures to diversify production electricity must be taken in making use of other forms of renewable energy and nuclear.

One of the solutions required to escape this dependence is the liberalization of the electricity industry which can lead to an improvement of supply, energy diversification, and reducing some of the negative effects of the trade balance.

2. The Tunisian Solar Plan

The Tunisian Solar Plan is a program that includes 40 projects, whose implementation extends from 2010 until 2016 is program was implemented in response to the need to improve energy diversification, provided the country's dependence on fuel fossils, promote renewable energy and start a successful energy efficiency policy.

With a total cost of € 2 billion Tunisian solar plan fits into the international programs promoting renewable energy, it integrates all areas of renewable energy and energy efficiency, to reduce electricity demand. Tunisia installed for the production of electricity from renewable energy capacity will reach 1,000 MW in 2016, 16% of the total installed capacity.

The projects of the Tunisian Solar Plan has resulted in an overall reduction de22% of national energy consumption, energy saving 660 ktoe per year and a reduction of 1.3 million tonnes of CO_2 per year.

Projects for the production of electricity from renewable sources connected to the network in 2016 will total capacity of approximately 525 MW distributed as follows after 40 MWp photovoltaic installations including 2 10 MWp plant, 350 MW wind after (190 MW STEG autoproduction 60 MW and 100 MW by IPPs), solar thermal power plants (CSP) of 110 MW, 25 MW after the energy recovery from waste. (ANME).

Wind and solar energy are not sufficiently exploited in Tunisia and whose good management can create a surplus production for export without forgetting the possibility of exporting the regional energy from Tunisia.

3. Review of literature

Several empirical studies have examined the relationship between renewable energy consumption and economic growth, the results of some studies have shown a unidirectional causality from the renewable energy consumption to economic growth and the other hand, other work n have not found causation and / or bidirectional causality between renewable energy consumption and economic growth.

For the period 1994-2003, Sadorsky used a model error correction for a group of 18 emerging countries to test the relationship between economic growth and renewable energy consumption. The empirical results show that a real income gain were positive and statistically significtif and has an impact on the renewable energy consumption per capita. For the G7, Sadorsky indicates that the increase in oil prices had a negative impact on renewable energy.

Salim and Rafiq used the method of ordinary least squares modified (FMOLS) , the method dynamic ordinary least squares (DOLS) and Granger causality tests to determine the relationship between the consumption of renewable energy and GDP in Brazil , China , India, Indonesia, Philippines and Turkey for the period 1980-2006 . The results suggest that the consumption of renewable energy is largely determined by the long-term income.

Payne has examined the causal relationship between energy consumption and GDP biomass using Granger causality tests with in the framework of a multivariate analysis to the United States for the period 1949-2007. Empirical tests show a unidirectional causality from the biomass energy consumption to GDP.

Bowden and Payne use causality test of Toda Yamamoto long term for the United States for the period 1949 to 2006 to examine the causal link between the origin of renewable energy and non-renewable commercial and industrial sector and GDP. The test results suggest a neutral assumptions of renewable energy, commercial and industrial sector consumption and GDP, but they suggest the hypothesis of a feedback effect between the consumption of non-renewable energy industrial and commercial and GDP. Also, there is a unidirectional causality from the residential renewable energy consumption to GDP.

Apergis et al have used a model error correction for a group of 19 developed and developing countries for the period 1984-2007 to determine the causal relationship between the use of nuclear energy, renewable energy consumption and economic growth. For the long term, the empirical results show a negative association between the consumption of nuclear energy and CO_2 emissions, but a positive relationship between emissions and renewable energy consumption. In the short term, the results of Granger causality tests suggest that the use of nuclear energy is important for the reduction of CO_2 emissions.

Payne and apergis use it the same way for a group of six Central American countries to examine the causal relationship between renewable energy consumption and economic growth for the period 1980 2006. In the short and long term, the results suggest a hypothesis of feed-back.

4. Data description

4.1: Source of data

The statistics are collected from the database of the World Bank available free on its website. These include the following series: GDP, gross fixed capital formation.

Data on the total labor force were collected from the database of UNCTAD and finally electricity consumption is collected from the site of the U.S. Energy Information Administration.

4.2: Data Definition

- LP: This is the logarithm of real Gross Domestic Product, GDP is defined as the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. (WDI)
- LER: logarithm of the electric energy produced from renewable energy (. Solar, wind power, geothermal, biomass, etc.) Measures the production of power plants and CHP plants less transmission and distribution losses transmission and use of energy power plants and CHP. (U.S. EIA)
- LF: log of gross capital formation consists of outlays on additions to the fixed assets of the economy plus net changes in inventories. Fixed assets include land improvements, factories, machinery and equipment purchases, road construction, etc..including schools, offices, private residential dwellings, and commercial and industrial buildings. (WDI)
- LT: logarithm of the total active population includes all people who supply labor for the production of goods and services during a given period. This definition includes workers and job seekers, people looking for a first job, the staff of the armed forces and seasonal or part-time workers. (WDI)

5. Empirical Results

5.1: Analysis of stationary series

Before reviewing the results of estimates it is imperative to study the stationarity of time series which will carry our regressions. The principle is a statistical series is not stationary if it is auto correlated persistent, ie its value at each period depends heavily on its past achievements. Variables whose autocorrelations are close to unity, and only decreasing slowly, while remaining significantly different from zero up to a certain order, are non-stationary variables.

Dickey-Fuller test (DF) is based on an autoregressive model of order 1 (AR (1)) of the form $X_t = \mu + \theta X_{t-1} + \varepsilon_t$ where θand μ are parameters and $\varepsilon_t$is assumed to be white noise. But, if the series is correlated with high levels of delays, then the white noise assumption is violated. Assuming that series follows an AR (p) process, a way to ensure the stationarity of time series is to apply the unit root test of Dickey-Fuller Increases (ADF). The ADF test makes a parametric correction correlation higher than 1 order.

Table 2 shows the results of serial analysis. These series were regressed using the following specification: $\Delta X_t = \mu + \beta t + \rho X_{t-1} + \theta \Delta X_{t-1} + \xi_t$.

Table 1: Results of ADF test of Dickey-Fuller

	LP^l	LP^{fst}	LER^l	LER^{fst}	LF^l	LF^{fst}	LT^l	LT^{fst}
Test ADF	-2.67	-4. 39*	-3.56	-4.58*	-3.25	-3.46*	-1.97	-5.91*

* : stationary series in first difference, l: *Level, fst : 1st difference*

The Augmented Dickey Fuller indicates that the four series LP, LER, LT, LF are non-stationary in levels and stationary in first differences, the four series are I (1), there is a risk of Cointegration.

5.2: Johansen cointegration test

Based on the results of the Johansen cointegration test, we note that the analysis of the trace and the maximum value in the plausibility shows in the confidence interval of 5% Cointegration relationship long term.

$$LP = O.245945\ LER + 0.485655\ LF + 0.701388\ LT$$

The equation of the standard long-term relationship show a 1% increase of electricity consumption in Tunisia led to a rise of 0.24% of GDP in the long term, this is the potential of renewable energy decreases grant from the Tunisian state for petroleum product which depends 97% electricity generation, this grant represents 4% of GDP and 10.6% of the state budget. As for labor if it increases by 1% GDP increases by 0.70% and gross capital formation increased by 1% leads to an increase of 0.48% of GDP.

5.3: Estimation of Error Correction Model

The choice of model error correction theorem comes from Engle and Granger showed that for non-stationary series which have a unit root and are cointegrated should be represented as a model error correction.

$$\Delta LP_t = 0.032960 + 0.022227\,\mu_{t-1} - 0.363514\,\Delta LP_{t-1} - 0.103331\,\Delta LP_{t-2} + 0.006974\,\Delta LER_{t-1} - 0.002426\,\Delta LER_{t-2} + 0.057762\,\Delta LF_{t-1} + 0.026263\,\Delta LF_{t-2} - 0.238736\,\Delta LT_{t-1} - 0.437282\,\Delta LT_{t-2}$$

$$\Delta LE_t = 0.318964 + 3.250096\,\mu_{t-1} - 2.518846\,\Delta LP_{t-1} - 6.420135\,\Delta LP_{t-2} + 0.224524\,\Delta LER_{t-1} + 0.238312\,\Delta LER_{t-2} - 0.639422\,\Delta LF_{t-1} + 2.195464\,\Delta LF_{t-2} - 24.46782\,\Delta LT_{t-1} + 8.652577\,\Delta LT_{t-2}$$

The analysis of the error correction model shows that no bidirectional a long-term relationship between electricity consumption and GDP, In the short term if we have an imbalance, which has a GDP equilibrium long-term statistically significant adjusts a speed of (2.2%) slower than consumption electrics which has a speed of convergence (325%), In the short term there is exercised by the consumer electrics positive effect. The growth rate (0.006%) for a one-period lag.

The electrics short-term consumption is positive and significant. So that in the short term, this variable has a positive effect on the evolution of GDP growth. In the long run, this coefficient is not significant and has a positive sign. Thus, an increase in electricity consumption by 1% would result in an increase in GDP of 0.6% in the short term, an increase of 0.24% in the long term.

5.4: Causality test

The existence of cointegration between the variables suggests the existence of a causal relationship between these variables, bidirectional or unidirectional causality. Determine the direction of causality is an important element in the development of economic policy or to make predictions. Research direction of causality between economic variables namely GDP, consumer electrics allow us to better know the Tunisian economic and energy reality.

Table 3: direction of causality between GDP and electricity consumption

Null Hypothesis:	Obs	F-Statistic	Prob.
LRE does not Granger Cause LP	28	0.47708	0.6266
LP does not Granger Cause LRE		0.30758	0.7382

From this table, two hypotheses were tested simultaneously, namely causality between the four variables taken in pairs. We thus tested the hypothesis of knowing whether the development of consumer electrics does not cause economic growth and vice versa.

We note in the 5% level, the Granger test does not bode link bidirectional causality between GDP and consumer electrics. Ie in the case of Tunisia, GDP does not cause increased consumption of electrics and vice versa, supporting the thesis that wants the development of electricity consumption from renewable energy sources in Tunisia too slow and does not participate in the diversification of the energy balance and the mobilization of which remains dependent on the adaptation of the existing regulatory and legal framework, on the one hand, and the development of network and electrical interconnection.

Tunisia to ensure its economic growth and to face its energy deficit in 2013 reached 2 million tonnes of oil equivalent (toe) is expected to increase the production of energy, such as nuclear or renewable energy that will allow them to ensure its energy independence vis a vis products of fossil fuels and exporter of its energy.

Conclusion

Tunisia's energy mix is marked by a decline in output of around 5 % and an increase in demand of 6%. During the last twenty years the hydrocarbon production was 7 Mtoe but face a growing annual demand of 3.1 % energy deficit reached 1.9 Mtoe in 2013, and will reach in 2020 and in 2030 he 3.5Mtoe danger of reach 7Mtoe.

With the current rate of growth the energy deficit will become more important as we will not find another gas field or oil that is why we should implement measures and instruments to secure and ensure our energy supply, improve electricity generation and diversify our energy mix.

Today Tunisia needs to develop plans for energy transformation to ensure a better future and escape to a growing dependence on fossil fuels explorer countries. Energy is the engine wills wholes economic activity and an indicator of social dynamics on which Tunisia will build.

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