RELATIONSHIP BETWEEN THE CONSUMPTION OF ELECTRICITY OF NON-RENEWABLE ORIGIN AND ECONOMIC GROWTH IN TUNISIA: CAUSALITY ANALYSIS

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Abstract

This article addresses the issue of electricity consumption and economic growth in Tunisia. Our first objective is to investigate and analyze the causal relationship between electricity consumption and economic growth in Tunisia over the period from 1980 to 2010. To examine this relationship we used a multivariate approach to cointegration, an error correction model based on recent advances in time series econometrics is estimated.

The empirical results showed that there are short-term relationships and a long-term relationship between GDP and electricity consumption in Tunisia. The results also indicate the existence of a unidirectional causal relationship between GDP and electricity consumption. Our empirical results support the idea that in Tunisia the current energy deficit is a huge burden on the state budget.

Keywords: energy; growth; causality; MCE; Cointegration.

Introduction

The proliferation of industrial products, development at four corners of the world in the automotive, aviation and faster transport of any kind have mobilized an increasing amount of fossil fuels, in 1950 coal, gas and oil gradually emerged as the engine of the global economy. In 1900 the global fossil fuel consumption was about 500 Mtoe for a population of 1.6 billion people, in 2011 consumption was multiplied by 24 to reach 12,274 million tonnes while the population has increased by 4.46.

Energy has become an essential commodity for the operation of our civilization, and access to these sources has become a major issue for the functioning of the economy, the development of the aerospace automotive industry, naval construction, rail and electrical equipment, in international relations, and therefore an important factor in national politics.

The energy sector covers more area, environmental and economic challenges facing the sector are properly colossal, on the battlefields States : producers, exporters or importers of energy, public and private companies which are directly or indirectly involved in the sector.

1. The energy, the engine of the global economy

World consumption of energy at the end of the twentieth century is of the order of 12 billion (toe) per year thus for 7 billion people, per capita consumption of about 1 .7 toe per year, this result hides wide disparities and very large inequalities. For example, the United States consumes only 25% of world energy while it represents less than 5% of the population, their annual consumption per capita is around 7.5 toe though it is a 3.5 tonnes on average for a European who nevertheless has an annual income of about 75% of the American income.

Per capita consumption of energy in poor countries is a few hundred pounds a year, nearly 2 billion people lack access to modern energy sources, these individuals use firewood whose collection worsens some areas affected by rapid and worrying desertification. These inequalities in energy consumption generally correspond to the unequal distribution of wealth. There is a strong but complex link between economic development and energy consumption.

The three major fossil fuels dominate the global demand for energy. Our consumption of primary energy depend on 40% oil, 25% coal and 25% natural gas. The remaining 10% is the participation of hydro, nuclear and renewable energy such as wind power, solar power and biomass.

For over 90% of our consumption, we depend on non-renewable energy, which by definition is finite, Even though the actual volume of stocks is probably more important than is generally believed, in fact when producing a ton of coal, crude oil, or natural gas, a volume of one tonne of geological stock is reduced.

The share of renewable energy has increased very little that they remain expensive compared to traditional energy sources, they do not cover political, economic and financial comparable to oil or natural gas issues. This illustrates the high degree of structural rigidity of the global energy system, it is marked by the weight of history, particularly with the rapid development of transport based on cheap oil, today the road, air and maritime sectors consumes more than half of the world's oil.

A multitude of various actors ensure the proper functioning of the physical and financial flows ; coal, oil, and natural gas production; pipelines transportation, by ships and trucks, distribution, storage, financial transactions, etc.

The world's primary energy supply inherently represents large regional inequality related to local availability of natural resources and conducted policy, some countries produce almost all of the energy they consume, others import almost all of energy they need. Each country has a given energy situation which depends on national energy resources and energy policy followed with constraints and flexibilities more or less important.

2.Dependency on fossil fuels

In less than a century, we have built a strong dependency vis-à-vis oil. If oil flows are interrupted, cars and trucks stop, aircraft fleet is grounded, ships are in ports, millions of people will find themselves without electricity or heating. we do not have, for a very short-term, alternative energy, except some industrial plant that can use either fuel oil, natural gas or coal. Certainly a total interruption is unthinkable but partial interruptions, local, accidental are possible.

Since 1945 the oil flowing from the Gulf has been threatened several times but the sudden disappearance of a particular source has been offset by the regulatory function of neighboring countries and the political and military vigilance of the Western powers.

Since 1970 we can say that the biggest majority of oil-exporting countries have increased their dependency vis-à-vis their oil exportation. For all of these countries, exports significantly contribute to the financing of States budgets and are a very important source of foreign exchange.

Major industrialized oil-importing countries, which in 1973 had realized at what point they were dependent, have instead sought to reduce their dependency. The share of oil in the production of added value to decreased greatly since the first oil shock. This is due to a structural transformation of the value added by efficiency and diversification of energy.

Thus the external energy bill, which was between 2 and 5% of GDP after the first oil shock, fell less than 1% in major industrialized countries. Yet facing oil shocks, the economy of these countries has become less vulnerable. However, the increase in weight of the whole transport sector in GDP shows that it is still very dependent on oil imports, but this dependency varies from one country to another if one takes into account the tax deductions and modal structure of the transport sector.

To mitigate their growing dependency on oil, importing countries can use, as part of their energy policy, a set of instruments to reduce dependency and master their consumption. Stockpiling of security to respond quickly to a relatively short crisis is a very effective strategy.

In this regard, a system of coordination of strategic stocks has been established under the auspices of the IEA. Other tools include: improving energy efficiency, diversification of supply sources and energy mix. As for diversification and following the first oil shock the French state proceeded with the construction of a major nuclear park to grow from 25 to 50% share of energy aims.

The situation is more and more difficult for developing or importing fossil fuel countries which their economic growth rate is lower than their rate of energy consumption. Energy costs weigh heavily on their balance of trade and finance as their energy system is not effective. They also have lesser freedom to use the tools available in industrialized countries.

At every point of view, it is to reduce energy dependency, to protect the use of deficit reduction and climate change, the way of reproducing energy is in the process of undergoing a profound change, oil will not come out of our life in the near future, but if we are to meet energy challenges we have to find alternatives to fossil fuels .

3.Tunisia and the current energy situation

Since 2002 the structure of energy production recorded a single change in the area of wind power production which increased by 2% in 2010 against 0.4% in 2002, otherwise production capacity has not changed. Natural gas remains in Tunisia the fuel mostly used yet other forms of energy are less involved in this 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 possible oil crisis, to face this handicap, measures to diversify production electricity must be taken, with recourse to other forms of renewable and nuclear energy.

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

The structure of primary energy resources is composed of 53% crude oil and 45% natural gas. The share of renewable energy is negligible. The primary energy demand has declined during 2011, reaching 13,230 GWh against 13551Gwh 2010, thus a decrease of 2.36%. This results in an energy saving of about 321 GWh.

The share of natural gas in electricity generation has largely increased, it increased from 95.39% in 2009 to approximately 98.92% in 2011, while that of petroleum products has declined from 0.0619% in 2011 against 3.45% in 2009 . The renewable production progressed to reach a rate of 0.67% in 2011 against a rate of 0.63% in 2009. This is explained by the incentive of Government to replace energy production from oil by the renewable energy and natural gas, following the rise in oil prices which has several negative consequences on the balance of payments and energy bills to pay.

In 2011, energy consumption is estimated 13230Gwh, in which the industry is in first place with 36.25%, the stability of the energy consumption in the industrial sector is due to the emergence of new industry more energy efficient and / or development sectors and activities consuming less energy as the service sector. Residential energy consumption developed with an increasing rate from 3723Gwh in 2010 to 3920Gwh, thus achieving an increase of 5.29%, this is due to the increase in living standards of households.

4.Evolution of the energy balance

The energy sector in Tunisia despite weak fossil energy resources, played a decisive role in social and economic development of the country. Unfortunately in recent years the Tunisian energy balance recorded a neat deterioration. Marked by an ever-increasing demand for energy of all economic sectors and a decline in participation of energy in the GDP.

Generally, the energy balance of Tunisia gone through three phases, one phase between (1990-1994) which was in surplus, the second phase (1994-2000) qualified as an equilibrium situation and then the last phase since (2001) which is a deficit.

5.Review of empirical literature

GDP energy relationship has been studied by many researchers during the last decade. In Hong Kong, India, Portugal, Taiwan and Malaysia, it was found that energy consumption and economic growth are cointegrated, even more, a causal relationship between economic growth and energy was found .

Similarly, the relationship of cause and effect between electricity consumption and economic growth has been found in Bangladesh and Côte d'Ivoire. However, a bi-directional causality relationship was found in Malawi and Poland and between economic growth and energy consumption.

Cointegration relationship was found in the former Soviet republics and by Bildirici Kayakci, Nigeria by Akinlo, Lebanon by Abosedra et al, China by Shiu and Lam, Bangladesh by Ahamad and Islam, Malaysia by Chandran et al. Fiji Islands Narayan Singh, China by Shengfng et al, and the Middle-East by Narayan and Smyth. The same results were also found in Turkey by Altinay Karagol and Pakistan by Jamil and Ahmad.

Yet, in Malaysia, Tang and Tan found a relationship of bidirectional causality rather than cointegration between energy consumption and economic growth. These results were reached by Ouedraogo in Burkina Faso, in South Africa by Odhiambo, in Algeria by Abderrahmani and Belaid, in Pakistan by Shahbaz and Lean. Moreover, Narayan and al. Showed that energy consumption increased economic growth for all seven major developed countries except the United States country.

The relationship between energy consumption and economic growth ranged between African countries on the basis of Wolde Rufael, he found that energy consumption and economic growth are cointegrated in several African countries. Also it was found that some African countries have a unidirectional causality from economic growth to energy consumption, also a two-way causal relationship between the variables was found in the rest of African countries.

Squalli also found mixed results for Petroleum Exporting Countries (OPEC), while for some countries economic growth depends on energy, other countries are less dependent or independent. Yoo and Kwak found that the causal relationship between energy consumption and economic growth varied for the South American countries where causality was unidirectional energy consumption to economic growth in Argentina, Brazil, Chile, Colombia and Ecuador. They also found that the causal relationship between energy consumption and economic growth was bidirectional in Venezuela.

However, no causal link has been found between the two variables in Peru. Similarly, Narayan and Prasad found a cause and effect mix between energy consumption and economic growth in the Organization for Economic Cooperation and Development (OECD) where the causal unidirectional consumption energy for economic growth has been found in a number of OECD countries, while the rest of the countries have no causal relationship between them.

Different causal relationships have been defined in the ASEAN countries by Yoo, who has linked a bidirectional causality between energy consumption and economic growth in Malaysia and Singapore while a unidirectional causal relationship of energy consumption to economic growth was found in Indonesia and Thailand.

In addition, Apergis and Payne concluded that the relationship between energy consumption and economic growth varied between countries according to their level of economic development growth. The results of the study indicated that a bi-directional causality between energy consumption and economic growth has been found in a large country with upper and lower middle income.

Causation-way has not been found in low-income countries. However, Ozturk and Acaravci concluded that there is no long term relationship or short-term relationship between energy consumption and economic growth in a number of Middle-East and North Africa (MENA) and in countries in transition..

Table 1: Study on the causal relationship between electricity consumption and GDP

Author(s)	Countries and period	methods	conclusions
Apergis and Payn	Emerging countri (1990–2007)	Cointegration test of pedroni FMOLS	- the renewable and non-renewable ener and GDP growth are cointegrated - Renewable electricity and non-renewab have a long term effect on GDP growth
Ho et Siu	Hong Kong (1966–2002)	Johansen Cointegration Test error correction model	Energy and GDP growth are cointegrated. Energy consumption → GDP growth
Payne	U.S.A. (1949–2007)	Causality test of Tod Yamamoto	Unidirectional causality EC to EG
Apergis and Payn	Eurasia 1992–2007	Pedroni cointegration test FMOLS ECM Granger causality	-the renewable and non-renewab electricity and GDP are cointegrated. renewable electricity and has a long ter effect on GDP growth.
Shahbaz and al	Portugal 1971–2009	ARDL test Johansen Cointegration Test	Energy and GDP growth are cointegrat and have a long term relationship

		ECM Granger causality	Electricity consumption → GDP growth India
Apergis and al	19 countries developed a developing chann 1984–2007	ECM Granger causality	Negative relationship between NEC a CO2, positive relationship between C and REC
Salim and Rafiq	Brazil, Chir India,Indonesia, Philippines and Turk 1980–2006	Granger causality test	In the long term, REC is significant determined by E in Brazil, China, Ind Indonesia, the Philippines and Turke There is a bi-directional causality betwe short-term REC and EG
Tugcu and al	G-7 1980–2009	Johansen Cointegration Test	neutral hypothesis for France, Italy, Cana and the USA.
Shiu and Lam	China 1971–2000	Johansen Cointegration Test ECM Granger causality	Energy and GDP growth are cointegrated Energy consumption → GDP growth

Table 1: Study on the causal relationship between electricity consumption and GDP (continued)

Yoo	South Africa 1970–2002	Johansen Cointegration Tes ECM Granger causality	Electricity and GDP are cointegrated GDP growth → energy consumption
BélaÏd a Abderrahmanl	Algeria 1971–2010	Hansen cointegration test VECM Granger causality	GDP growth → energy consumption
Bowden a Payne	USA 1949–2006	Causality test of Tod Yamamoto	Unidirectional causality residential RE to EG.
Gurgul and Lac	Pologne 1982–2007	Johansen Cointegration Tes Causality test of Tod Yamamoto	Energy and GDP growth are cointegrate GDP growth → energy consumption
Apergis a Payne	88 countries 1990–2006	Panel cointegration test ECM Granger causality	Energy and GDP growth are cointegrate GDP growth → energy consumption middle-income countries. Energy consumption → GDP growth low-income countries.
Yoo and Kwak	7 countries in Lat America 1975–2006	Johansen Cointegration Tes Granger causality test ECM Granger causality	GDP growth → electricity consumption Argentina, Brazil, Chile, Colomb Ecuador and Electricity consumption → GDP grow in Venezuela. Electricity consumption → GDP grow in Peru
Narayan a Smyth	Middle- East 1974–2002	ECM Granger causality Westerlund par cointegration	Energy and GDP growth are cointegrat and electricity has a positive long-te impact on GDP growth Energy comsuption → GDP growth

6. Empirical Analysis of the relationship between electricity consumption and economic growth

6.1: Data source

Statistics are collected from the database of the World Bank (WBI 2010) available free on its website. These include the following series: GDP, gross fixed capital formation.

Data on the total workforce were collected from the database of UNCTAD and finally electricity consumption is collected from the site of US Energy Information Administration.

6.2: Data Definition

- LP: This is the logarithm of real Gross Domestic Product, GDP is an aggregate measure of production equal to the sum of the gross values added of all resident institutional units engaged in production (plus any taxes, and minus any subsidies, on products not included in the value of their outputs. (WDI 2013)

- LE: logarithm of the consumption of electricity generated from fossil fuels (oil, gas or coal). measures the production of electricity power plants, (US EIA 2013)

- LF: logarithm 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 2013)

- LE: logarithm of the total active population comprises all persons who supply labor for the production of goods and services during a given period. This definition includes both workers and job seekers, people looking for their first job, the staff of the armed forces and seasonal or part-time workers. (WDI 2013)

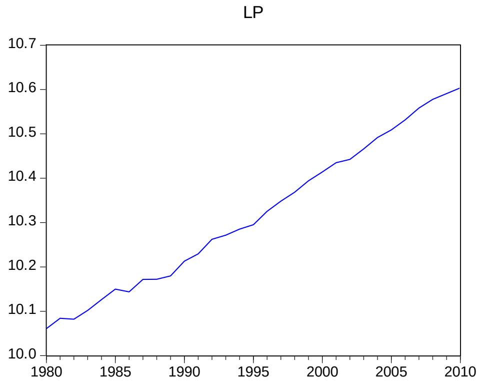


Fig.1. Evolution of Gross Domestic Product

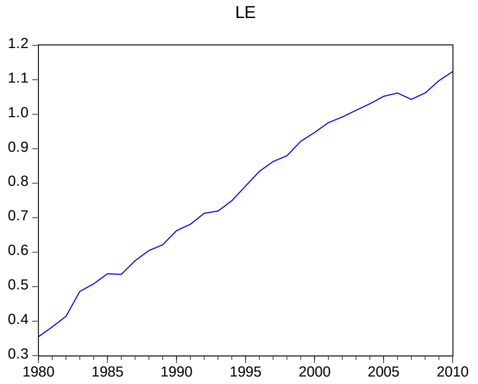


Fig.2. Electricity consumption

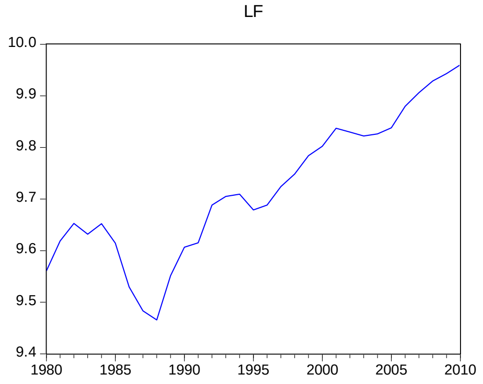


Fig.3. Gross fixed capital formation

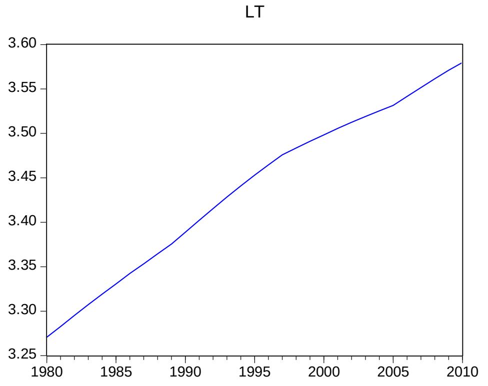


Fig.4. Total labour

6.3 : Analysis of stationary series

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

The Dickey-Fuller test (DF) is based on an autoregressive model of order 1 (AR (1)) of the form

$X_t = \mu + \theta X_{t-1} + \varepsilon_t$ (1)

Where μ and θ are parameters and ε_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 a series follows an AR (p) process.

One way to ensure the stationary time series is to apply the unit root test Dickey-Fuller Increases (ADF). The ADF test performs a parametric EQ high correlations to one order.

Table 2 shows the results of the serial analysis. These series were regressed using the following specification:

$\Delta X_t = \mu + \beta_t + \rho X_{t-1} + \theta \Delta X_{t-1} + \xi_t$ (2)

Table 2: Results of ADF test of Dickey-Fuller

Variables	μ	β	ρ	θ	*ADF test* Stat	Seuil	$\overline{R}^2$	*D.W.*
ΔP	0.022	0.00024	-1.432	0.132	-4.39	1%	0.61	2.01
ΔE	0.042	-0.0007	-1.175	0.107	-3.82	5%	0.47	1.78
ΔT	0.024	-0.0003	-1.64	0.878	-5.91	1%	0.56	1.84
ΔF	-0.00031	0.00005	-0.747	0.160	-3.46	1%	0.27	2.01

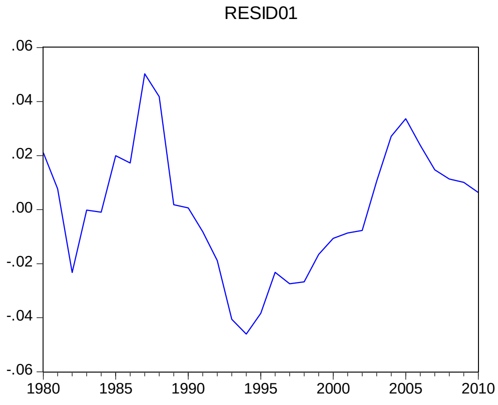
Source: Our calculations based on output EVIEWS 6.0

The Augmented Dickey Fuller test indicates that the four series LP, LE, LT, LF are non-stationary in levels and stationary in first differences; the four series are I (1) there is a risk of Cointegration. Cointegration test is made from the residue of the model estimation

LP = LE + LP + LT (3)

Analysis of the Augmented Dickey Fuller test on the residue suggests a stationary state of the residue, Thus, the four variables are cointegrated.

Table 3: residue



Null Hypothesis: RESID01 has a unit root
Exogenous: None
Lag Length: 1 (Fixed)

		t-Statistic	Prob.*
Augmented Dickey-Fuller statistic		-2.041787	0.0413
Test crit values:	1% level	-2.647120	
	5% level	-1.952910	
	10% level	-1.610011	

*MacKinnon (1996) one-sided p-values.

6.4: Determining the number of delay

Table 4: Number of delay

Lag	LogL	LR	FPE	AIC	SC	HQ
0	211.0588	NA	4.44e-12	-14.78992	-14.59960	-14.73174
1	390.3457	294.5426	3.88e-17	-26.45326	-25.50169	-26.16236
2	425.6802	47.95404*	1.05e-17*	-27.83430	-26.12147*	-27.31067*
3	441.7253	17.19119	1.30e-17	-27.83752*	-25.36343	-27.08117

6.5: Johansen Test

Table 5: Test of the Trace

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.727810	69.99259	47.85613	0.0001
At most 1 *	0.556274	33.55748	29.79707	0.0176
At most 2	0.319961	10.80616	15.49471	0.2237
At most 3	0.000329	0.009213	3.841466	0.9232

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

- There is Cointegration because the null hypothesis of no cointegration was rejected (69.99257> 47.85613) and (0.0001 <0.05) at 5%.

- The null hypothesis that there is at most one cointegration relationship was rejected because (33.55748> 29.79707) and (0.0176 <0.05) at 5%.

Table 6: Test Maximum Eigenvalue

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.727810	36.43511	27.58434	0.0028
At most 1 *	0.556274	22.75132	21.13162	0.0293
At most 2	0.319961	10.79695	14.26460	0.1647
At most 3	0.000329	0.009213	3.841466	0.9232

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

- There is Cointegration because the null hypothesis of no cointegration was rejected (36.43511> 27.58434) and (0.0028 <0.05) at 5%.

- The null hypothesis that there is at most one cointegration relationship was rejected because (22.75132> 21.13162) and (0.0293 <0.05) at 5%.

6.6: Identification of related Cointegration

Table 7: Estimated Cointegration relationship

1 Cointegrating Equation(s):		Log likelihood	424.9466
Normalized cointegrating coefficients (standard error in parentheses)			
LP	LE	LF	LT
1.000000	2.368901	-0.819312	-5.901677
	(0.74211)	(0.10384)	(1.68548)
Adjustment coefficients (standard error in parentheses)			
D(LP)	0.038270		
	(0.04638)		
D(LE)	-0.135505		
	(0.05960)		
D(LF)	0.634215		
	(0.13208)		
D(LT)	0.007395		
	(0.00640)		

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

$$P = -2.368901\,E + 0.819312\,F + 5.901677\,T \qquad (4)$$

The equation of the long-term relationship show an increase of 1% in the consumption of electricity in Tunisia, leading to a reduction of 2.36% of GDP in the long run, this is due to the Tunisian state grant for petroleum product that depends 97% electricity generation, this grant represents 4% of GDP and 10.6% of the state budget, in 2012 it surpassed 2700 MD versus 550 MD in 2010 . As for the handwork if it increases by 1% GDP increases by 5.9% and gross capital formation increases by 1% it leads to an increase of 0.81% of GDP.

6.7: Estimated Error Correction Model

The choice of model error correction theorem comes from Engle and Granger have shown that for non-stationary series which have a unit root and are cointegrated should be represented as a model error correction. We note the following two models MCE:

$$\Delta LP_t = 0.026892 + 0.038270\,\mu_{t-1} - 0.346244\,\Delta LP_{t-1} - 0.496127\,\Delta LP_{t-2} - 0.180480\,\Delta LE_{t-1} +$$

(1.6) (0.82) (-1.61) (-2.12) (-1.43)

(5)

$$0.313228\,\Delta LE_{t-2} + 0.035373\,\Delta LF_{t-1} + 0.103595\,\Delta LF_{t-2} - 0.651008\,\Delta LT_{t-1} + 0.846982\,\Delta LT_{t-2}$$

(2.73) (0.61) (1.55) (-0.41) (0.4)

$$\Delta LE_t = 0.068953 - 0.135505\,\mu_{t-1} - 0.692788\,\Delta LP_{t-1} - 0.229420\,\Delta LP_{t-2} - 0.002668\,\Delta LE_{t-1} -$$

(3.2) (-2.27) (-1.61) (-0.76) (-0.01)

(6)

$$0.122206\,\Delta LE_{t-2} + 0.058620\,\Delta LF_{t-1} - 0.026461\,\Delta LF_{t-2} - 6.340949\,\Delta LT_{t-1} + 3.972760\,\Delta LT_{t-2}$$

(-0.82) (0.78) (-0.3) (-3.15) (1.48)

The analysis of the error correction model shows that there is no long-run relationship between electricity consumption and GDP, it has a positive coefficient (0.038270) and is not significant (t = 0.825183). By cons there is a long-term relationship of GDP to consumption electrics With a coefficient (-0.135505) is significant (t = 2273)). The Wald test shows a bidirectional short term relationship between electricity consumption and GDP.

In the short term if we have an imbalance, GDP has an equilibrium level in the long term statistically significant, it adjusts at a rate of (3.8%) slower than electricity consumption with a speed of convergence of (13.55%), the gross fixed capital formation fits with 63.43% and employment with 0.7%. In the short term there is a depressive effect exerted by electricity consumption, On the growth rate (-0.18%) for a one-period lag.

The short-term electricity consumption is negative and significant. So that in the short term, this variable affects negatively the evolution of GDP growth. In the long run, this coefficient is not significant and has a negative sign. Thus, an increase in electricity consumption by 1%, would reduce GDP by 0.18% in the short term and a decrease of 2.36% in the long term.

6.8: Short run relationship

Table 8: Direction of short term relationship between GDP and electricity consumption

Short term relationship of energy to GDP				Short term relationship of GDP to energy			
Wald Test: Equation: Untitled				Wald Test: Equation: Untitled			
Test Statistic	Value	df	Probability	Test Statistic	Value	df	Probability
Chi-square	8.176187	2	0.0168	Chi-square	6.380725	2	0.0412

According to the Wald test and based on the statistics of Chi-square there is a relationship of short-term electricity consumption to GDP because we have (0.0168 <0.05) and a short-term relationship of GDP to electricity consumption because we have (0.0412 <0.05).

6.9: Testing causal

The existence of cointegration between the variables suggests the existence of a causal relationship between these variables, bidirectional or unidirectional causality. Determining the direction of causality is an important element in the development of economic policy or to make predictions.

The study of direction of causality between economic variables namely, GDP, electricity consumption. Gross fixed capital formation and the work will allow us to better know the Tunisian economic and energy reality.

Table 9: direction of causality between GDP and electricity consumption, employment and gross fixed capital

Null Hypothesis:	Obs	F-Statistic	Prob.
LE does not Granger Cause LP	28	3.33522	0.0535
LP does not Granger Cause LE		4.78807	0.0183
LF does not Granger Cause LP	28	0.96729	0.3950
LP does not Granger Cause LF		0.60111	0.5566
LT does not Granger Cause LP	28	0.25492	0.7771
LP does not Granger Cause LT		1.06934	0.3597
LF does not Granger Cause LE	28	0.22219	0.8025
LE does not Granger Cause LF		0.18385	0.8333
LT does not Granger Cause LE	28	5.14989	0.0142
LE does not Granger Cause LT		0.13477	0.8746
LT does not Granger Cause LF	28	0.16702	0.8472
LF does not Granger Cause LT		0.48084	0.6243

From this table, twelve hypotheses were tested simultaneously, ie the causality between the four variables taken in pairs. We therefore tested the hypothesis of knowing whether the development of electricity consumption does not cause economic growth and vice versa. The same assumptions were taken between gross fixed capital formation and GDP, and between the level of employment and GDP.

We note that the 5% threshold, the Granger test suggests a unidirectional causality between GDP and electricity consumption. ie in the case of Tunisia. it's GDP that causes increased electricity consumption and not vice versa, supporting the thesis that the Tunisian government wants subsidies for energy 4% of GDP are very large and worsens the budget deficit of the state.

Tunisia, to ensure its economic expansion and cope with its energy deficit in 2013 which reached 2 million tons oil equivalent (TOE), should use a different mode of energy generation, such as nuclear or renewable energy that will allow them to ensure its energy independence vis a vis fossil fuel products and energy exporting countries.

Furthermore, still at 5%, the level of employment measured by the active labor force affects the energy consumption and not vice versa. This follows from the increasing energy demand in Tunisia from industry with 4796 GWh and public services and commercial with 3363 GWh.

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 for 3.1% energy deficit reached 1.9 Mtoe in 2013, and would reach 3.5 Mtep in 2020 and risking to attend 7 Mtep in 2030.

With this current rate of growth the energy deficit will become more important as we will not find another source of oil or gas that is why we should implement measures and instruments to secure and ensure our energy supply, improve power production 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. The energy will be the engine of economic activities wholes and an indicator of social dynamics on which Tunisia will bet.

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ANNEX A

Test de cointegration de johansen

Date: 01/20/14 Time: 16:10
Sample (adjusted): 1983 2010
Included observations: 28 after adjustments
Trend assumption: Linear deterministic trend
Series: LP LE LF LT
Lags interval (in first differences): 1 to 2

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.727810	69.99259	47.85613	0.0001
At most 1 *	0.556274	33.55748	29.79707	0.0176
At most 2	0.319961	10.80616	15.49471	0.2237
At most 3	0.000329	0.009213	3.841466	0.9232

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized		Max-Eigen	0.05	

No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.727810	36.43511	27.58434	0.0028
At most 1 *	0.556274	22.75132	21.13162	0.0293
At most 2	0.319961	10.79695	14.26460	0.1647
At most 3	0.000329	0.009213	3.841466	0.9232

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):

LP	LE	LF	LT
-28.12538	-66.62623	23.04346	165.9869
-54.01961	147.8210	19.76005	-273.2076
-28.15761	-18.06589	9.600306	95.72687
53.76205	-20.28206	-2.545719	-32.90582

Unrestricted Adjustment Coefficients (alpha):

D(LP)	-0.001361	9.26E-05	0.002551	9.58E-05
D(LE)	0.004818	-0.005285	0.000959	7.92E-05
D(LF)	-0.022550	-0.007942	0.003976	0.000120
D(LT)	-0.000263	9.74E-05	-0.000440	9.68E-06

1 Cointegrating Equation(s): Log likelihood 424.9466

Normalized cointegrating coefficients (standard error in parentheses)

LP	LE	LF	LT
1.000000	2.368901	-0.819312	-5.901677
	(0.74211)	(0.10384)	(1.68548)

Adjustment coefficients (standard error in parentheses)

D(LP)	0.038270
	(0.04638)
D(LE)	-0.135505
	(0.05960)
D(LF)	0.634215
	(0.13208)
D(LT)	0.007395
	(0.00640)

2 Cointegrating Equation(s): Log likelihood 436.3223

Normalized cointegrating coefficients (standard error in parentheses)

LP	LE	LF	LT
1.000000	0.000000	-0.608877	-0.816533
		(0.06494)	(0.10117)
0.000000	1.000000	-0.088832	-2.146626
		(0.02490)	(0.03879)

Adjustment coefficients (standard error in parentheses)

D(LP)	0.033268	0.104348
	(0.10042)	(0.26735)
D(LE)	0.149987	-1.102229
	(0.10441)	(0.27796)
D(LF)	1.063222	0.328446

	(0.26230)	(0.69834)		
D(LT)	0.002134	0.031916		
	(0.01380)	(0.03673)		
3 Cointegrating Equation(s):		Log likelihood	441.7207	
Normalized cointegrating coefficients (standard error in parentheses)				
LP	LE	LF	LT	
1.000000	0.000000	0.000000	-3.076236	
			(0.48676)	
0.000000	1.000000	0.000000	-2.476305	
			(0.07401)	
0.000000	0.000000	1.000000	-3.711261	
			(0.82369)	
Adjustment coefficients (standard error in parentheses)				
D(LP)	-0.038555	0.058266	-0.005038	
	(0.10302)	(0.25048)	(0.04888)	
D(LE)	0.122986	-1.119553	0.015796	
	(0.11402)	(0.27724)	(0.05410)	
D(LF)	0.951272	0.256619	-0.638379	
	(0.28206)	(0.68582)	(0.13384)	
D(LT)	0.014526	0.039866	-0.008360	
	(0.01351)	(0.03285)	(0.00641)	

*** The variables are expressed in logarithms**

ANNEX B

Error correction model

Vector Error Correction Estimates
Date: 01/16/14 Time: 00:36
Sample (adjusted): 1983 2010
Included observations: 28 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1			
LP(-1)	1.000000			
LE(-1)	2.368901			
	(0.74211)			
	[3.19210]			
LF(-1)	-0.819312			
	(0.10384)			
	[-7.88978]			
LT(-1)	-5.901677			
	(1.68548)			
	[-3.50147]			
C	16.07379			
Error Correction:	D(LP)	D(LE)	D(LF)	D(LT)
CointEq1	0.038270	-0.135505	0.634215	0.007395
	(0.04638)	(0.05960)	(0.13208)	(0.00640)

	[0.82518]	[-2.27355]	[4.80174]	[1.15485]
D(LP(-1))	-0.346244	-0.692788	-1.917769	-0.035166
	(0.21453)	(0.27570)	(0.61096)	(0.02962)
	[-1.61395]	[-2.51287]	[-3.13892]	[-1.18716]
D(LP(-2))	-0.496127	-0.229420	0.113012	-0.046164
	(0.23399)	(0.30070)	(0.66638)	(0.03231)
	[-2.12028]	[-0.76295]	[0.16959]	[-1.42883]
D(LE(-1))	-0.180480	-0.002668	0.461346	-0.008504
	(0.12554)	(0.16133)	(0.35751)	(0.01733)
	[-1.43768]	[-0.01654]	[1.29043]	[-0.49061]
D(LE(-2))	0.313228	-0.122206	0.336953	-0.000327
	(0.11464)	(0.14733)	(0.32650)	(0.01583)
	[2.73216]	[-0.82947]	[1.03203]	[-0.02064]
D(LF(-1))	0.035373	0.058620	0.666307	0.007901
	(0.05780)	(0.07427)	(0.16460)	(0.00798)
	[0.61204]	[0.78924]	[4.04811]	[0.99009]
D(LF(-2))	0.103595	-0.026461	0.244580	0.003973
	(0.06664)	(0.08564)	(0.18979)	(0.00920)
	[1.55451]	[-0.30897]	[1.28870]	[0.43176]
D(LT(-1))	-0.651008	-6.340949	-2.112497	0.913667
	(1.56479)	(2.01092)	(4.45636)	(0.21606)
	[-0.41604]	[-3.15326]	[-0.47404]	[4.22874]
D(LT(-2))	0.846982	3.972760	18.85377	0.160027
	(2.07741)	(2.66968)	(5.91623)	(0.28684)
	[0.40771]	[1.48810]	[3.18679]	[0.55789]
C	0.026892	0.068953	-0.161797	0.000666
	(0.01674)	(0.02151)	(0.04766)	(0.00231)
	[1.60694]	[3.20619]	[-3.39486]	[0.28804]
R-squared	0.423351	0.694318	0.673912	0.825772
Adj. R-squared	0.135026	0.541477	0.510868	0.738658
Sum sq. resids	0.001370	0.002263	0.011115	2.61E-05
S.E. equation	0.008726	0.011213	0.024850	0.001205
F-statistic	1.468312	4.542740	4.133316	9.479192
Log likelihood	99.21727	92.19374	69.91302	154.6557
Akaike AIC	-6.372662	-5.870982	-4.279501	-10.33255
Schwarz SC	-5.896875	-5.395194	-3.803714	-9.856766
Mean dependent	0.018636	0.025337	0.010985	0.010169
S.D. dependent	0.009382	0.016560	0.035531	0.002357
Determinant resid covariance (dof adj.)		4.52E-18		
Determinant resid covariance		7.72E-19		
Log likelihood		424.9466		
Akaike information criterion		-27.21047		
Schwarz criterion		-25.11701		

*** The variables are expressed in logarithms**