Determinesof Energy Consumptionin Egypt

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DETERMAINANTS OF **ENERGY CONSUMPTION IN EGYPT**

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1. Abstract

This paper investigates the determinants of energy consumption in Egypt, using annual data from 1984 to 2014 to analyze the interrelationship between energy consumption and some key economic factors: GDP per capita, investment, CO2 emissions, and financial development. We thus use a multiple regression and OLS regression in order to investigate the causalities and underlying dynamics among these variables. These reveal statistically significant coefficients: the negative influence of per capita GDP and investment on energy consumption, while also having a positive relationship with CO2 emissions. Financial development variable has mixed impacts and therefore needs further examination. R-square is at 99.3% and, explained well by the model, reveals combined explanatory capability of the variables with regard to energy consumption. These insights make useful guidance for the policy discourse on sustainable use of energy, economic growth, and environmental sustainability in Egypt, hence contributing to the variety of stakeholders.

2. Literature Review

The impact of energy conservation policies on economic activity has been the subject of much interest in the international dialogue on global warming and how to reduce greenhouse gas emissions. Despite an enormous volume of studies on the causal relationship between energy consumption and economic growth, the so-called energy consumption-growth nexus remains far from conclusive. This is an important gap in consensus, as the policy implications of the direction of causality are significant. For instance, if growth is induced by energy use, then policies saving energy lead to negative consequences for the growth as a result.

There are four overarching hypotheses: The growth hypothesis where, energy consumption contains all vital ingredients that bring about growth and acts complementary with inputs like capital and labor to further the level of an economy, says Apergis and Payne, 2009a, b. Consequently, a decrease in the level of energy use would lead to a drop in real GDP, implying that energy conservation policies have a negative impact on the energy-dependent economies. The conservation hypothesis, however, presents a unidirectional causality flowing from real GDP to energy consumption. Within this perspective, a decrease in energy consumption would have little or no adverse impact on economic growth.

Note. From "Energy consumption and economic growth: New insights into the cointegration relationship," by Apergis and Payne, 2009a, b; Costantini and Martini, 2010.

The present paper analyses the nexus between energy consumption and economic activity for 25 OECD countries over the period 1981 to 2007 using the most recent panel-econometric techniques. One of the new elements of this contribution is the consideration of energy prices as an additional channel of causality, which has not been taken into consideration in many previous studies. Masih and Masih 1997; Asafu-Adjaye 2000 maintain that excluding energy prices could bias the long-run estimates of parameters and causality evidence. In contrast to their analysis, this study directly utilizes the energy price index as opposed to the CPI. The income and price elasticities estimated from this would provide policy makers with some indication of how far prices - energy taxes for example - would need to rise in order to curtail energy use. Additionally, these estimates help energy companies design effective demand management strategies.

This paper also expands the analysis by examining the long-run relationship between energy consumption, real GDP, and energy prices. Unlike prior research on the energy consumption-GDP nexus, this study distinguishes between national and international trends as drivers of the long-run equilibrium among these variables. Using a decomposition approach, each variable is separated into common (international) and idiosyncratic (national) components. Cointegration of the common components suggests that international trends dominate the long-run relationship among energy consumption, real GDP, and energy prices and that national energy policies do not play an important role in economic growth. On the other hand, cointegration among idiosyncratic components implies the existence of country-specific shocks.

Note. From "The relationship between energy consumption, energy prices and economic growth: time series evidence from Asian developing countries," by Masih and Masih, 1997; Asafu-Adjaye, 2000; Lee and Lee, 2010.

3. Methodology

3.1. Research Aim

The purpose of this paper is to investigate the interrelationship between energy consumption and economic growth (comprising GDP per capita, Investment, CO2 emissions, and financial development) for Egypt using annual data over the period of 1984-2014. In fact, all these five variables are endogenous. As noted, before, most of the literature generally assumes that economic growth will probably cause changes in energy consumption. It is, therefore, of interest to investigate the interrelationships that exist between the five variables by considering them simultaneously in a modeling framework.

To this end, we will apply the multiple regression function to examine the two-way linkages between energy consumption and economic growth using the OLS model.

3.2. Research Hypothesis

1. **GDP** causes Energy Consumption to increase.
2. **Investment** causes Energy Consumption to increase.
3. **CO2 Emissions** causes Energy Consumption to increase.
4. **Financial Development** causes Energy Consumption to increase.

3.3. Model Specification

3.3. A. Data and Variables

Variables	Symbol	Proxy	Data Source
Energy Consumption	EC	KG of Oil Equivalent per Capita	World Bank
Gross Domestic Product	GDP	GDP per Capita (current US$)	World Bank
Investment	I	Gross Capital Formation per Capita (current US$)	World Bank
CO2 Emissions	CO2	CO2 Emission per Capita (metric tons)	World Bank
Financial Development	FD	Domestic Credit to Private Sector (% of GDP)	World Bank

Time Series: **1984 : 2014**

Function: **EC = f (GDP, I, CO2, DF)**

3.3.B. Descriptive Statistics

Descriptive Stat.	**EC**	**GDP**	**I**	**CO2**	**DF**
Mean	652,3066025	1338,352594	9788181,288	1,870645161	36,54926357
Standard Error	23,55931095	137,4389042	742711,4865	0,06878662	2,066546176
Median	607,8962293	1104,803407	9341355,347	1,75	32,73382353
Mode	-	-	-	2,4	-
Standard Deviation	131,1726919	765,2274331	4135242,546	0,382987689	11,50604215
Sample Variance	17206,27511	585573,0244	1,71002E+13	0,14667957	132,389006
Kurtosis	-1,348871893	0,519336751	-1,158394873	-1,486090852	-1,42819704
Skewness	0,581166253	1,301089336	-0,054604411	0,413645447	0,454438157
Range	378,0226206	2510,561418	13276448,21	1,11	32,87250912
Minimum	486,9191654	622,829605	3293671,66	1,39	22,05863111
Maximum	864,941786	3133,391023	16570119,87	2,5	54,93114023
Sum	20221,50468	41488,93042	303433619,9	57,99	1133,027171
Count	31	31	31	31	31

3.3.C. Correlation Matrix

	GDP	*I*	*CO2*	*DF*	*EC*
GDP	1				
I	-0,907701792	1			
CO2	0,857296492	-0,888052734	1		
DF	-0,028264165	-0,344968799	0,282849142	1	
EC	0,820410407	-0,854675276	0,986351059	0,233547088	1

- The association between change in GDP per capita from its mean and change in Gross capital formation per capita from its mean is -0.908, hence there is a very strong negative correlation between them.

- The relationship between change in the mean of the GDP per capita and changes in the mean of the CO2 emissions per capita is 0.857, which actually shows that they are very strongly correlated positively.

- The correlation between change in GDP per capita from its mean and the domestic credit to private sector from its mean is -0.028, which means there is a very weak negative correlation between them.

- The correlation between the change in GDP per capita from its mean and KG of oil Equivalent per capita from its mean is 0.820 which infers that there is a very strong positive correlation between them.

- The correlation between the change in Gross capital formation per capita from its mean and CO2 emissions per capita from its mean is -0.888, which shows an extremely strong negative relationship between them.

- The relation of the change in Gross capital formation per capita from its mean and Domestic credit to private sector from its mean is -0.345 which means that there is a weak and negative correlation between them.

Association - The change of Gross capital formation per capita from the mean and that of oil equivalent per capita from the mean is - 0.855, therefore, concluding that there exists a strongly negative correlation.

- The correlation between the change in CO2 emissions per capita from its mean and domestic credit to private sector from its mean is 0.283 which means that there is a weak and positive correlation between them.

- The correlation of change in CO2 per capita from its mean, and kg of oil equivalent per capita from its mean is 0.986, which means that they are very strongly and POSITIVELY correlated.

- The association between the change in domestic credit to private sector from its mean and KG of oil equivalent per capita from its mean is 0.234 which means that there is a weak and positive correlation between them.

3.4. Regression Equation

$$\hat{EC} = \hat{\alpha} + \beta_1 \, \mathrm{GDP}_t + \beta_2 \, \mathrm{I}_t + \beta_3 \, \mathrm{CO2}_t + \beta_4 \, \mathrm{DF}_t$$

EC *:* KG of Oil Equivalent per Capita **(Energy Consumption)**

$\hat{\alpha}$: Intercept (Constant)

GDP: GDP per Capita (current US$) **(Gross Domestic Product)**

I: Gross Capital Formation per Capita (current US$) **(Investment)**

CO2: CO2 Emission per Capita (metric tons) **(CO2 Emissions)**

DF: Domestic Credit to Private Sector (% of GDP) **(Financial Development)**

3.5. Expected Results

Theory intuition and expected sign		
Variable	**intuition**	**sign**
Gross Capital Formation per Capita (Investment)	We expect a **negative** relation between Gross capital formation per capita and energy consumption.	**-**
CO2 Emission per capita	We expect a **positive** relation between CO2 Emissions and energy consumption.	**+**
Domestic credit to private Sector (Financial Development)	We expect a **negative** relation between Domestic credit to private Sector and energy consumption.	**-**
Gross Domestic Product (GDP)	We expect a **negative** relation between Gross domestic Product per capita and energy consumption.	**-**

3.6. Empirical Results

SUMMARY OUTPUT

Regression Statistics	
Multiple R	**0,996540982**
R Square	**0,993093928**
Adjusted R Square	**0,992031455**
Standard Error	11,70935409
Observations	31

ANOVA

	df	*SS*	*MS*	***F***	*Significance F*
Regression	4	512623,4199	128155,855	**934,7007128**	1,13068E-27
Residual	26	3564,833303	137,1089732		
Total	30	516188,2532			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	**319,3992578**	**57,44429759**	**5,560156032**	**7,71324E-06**	**201,320813**	**437,4777026**	**201,320813**	**437,4777026**
GDP per Capita (current US$)	-0,11739713	0,014853986	-7,903409278	2,2197E-08	-0,147929935	-0,086864324	-0,147929935	-0,086864324
Gross Capital Formation per Capita (current US$)	**-1,61159E-05**	**2,63439E-06**	**-6,117485539**	**1,81971E-06**	**-2,15309E-05**	**-1,07008E-05**	**-2,15309E-05**	**-1,07008E-05**
CO2 Emission per Capita (metric tons)	413,7145673	13,52828847	30,58144186	6,51228E-22	385,9067721	441,5223625	385,9067721	441,5223625
Domestic Credit to Private Sector (% of GDP)	**-3,451287106**	**0,42643265**	**-8,093393199**	**1,42197E-08**	**-4,327831971**	**-2,574742241**	**-4,327831971**	**-2,574742241**

Source: Excel statistics created by the researchers.

Estimated Coefficient

$$\boldsymbol{EC} = \mathbf{319,3992578} - 0{,}11739713\boldsymbol{GDP_t} - 1{,}61159\text{E} - 05\,\boldsymbol{I_t} + 413{,}7145673\,\boldsymbol{CO2_t} + 3{,}451287106\,\boldsymbol{DF_t}$$

$\hat{\boldsymbol{\alpha}}$**:** when the values of all explanatory variables are zero, the value of **Energy Consumption** equal **319,3992578 KG** of oil.

$\boldsymbol{\beta_1}$**:** when the **GDP per Capita** increases by 1 dollar, the **Energy Consumption** tends to decrease by **0,11739713 KG** of oil assuming other variables are constant.

$\boldsymbol{\beta_2}$: when the **Gross Capital Formation per Capita** increase by 1 dollar, the **Energy Consumption** tends to decrease by $\mathbf{1,61159E-05}$ **KG** of oil assuming other variables are constant.

$\boldsymbol{\beta_3}$: when the **CO2 Emission per Capita** increase by 1 metric ton, the **Energy Consumption** tends to increase by **413,7145673 KG** of oil assuming other variables are constant.

$\boldsymbol{\beta_4}$: when the **Domestic Credit to Private Sector** increase by 1% of the GDP, the **Energy Consumption** tends to increase by **3,451287106 KG** of oil assuming other variables are constant.

Multiple R = 0.99654

This is the correlation coefficient, showing a very strong linear relationship between the independent variables and the dependent variable.

R-Square = 0.99309

The R-squared indicates that **99.3%** of the variation in the dependent variable is explained by the independent variables in the model (excellent fit).

Adjusted R-Square = 0.99203

Adjusted R^2 = 0.99 which means about 99 % of the variation in energy consumption can be explained by all the explanatory variables jointly (Gross Capital Formation per Capita (Investment), CO2 Emission per capita, Domestic credit to private Sector (Financial Development), Gross Domestic Product (GDP)).

Standard Error = 11.70935

This represents the average distance that the observed values fall from the regression line. Given the high R-squared, this error is small relative to the scale of the dependent variable.

Intercept (201.32 to 437.48): The confidence interval suggests that when all predictors are zero, the dependent variable lies between approximately **201.32** and **437.48**.

Gross Capital Formation per Capita (-2.15 to -1.07): The entire interval is **negative**, confirming a statistically significant negative effect of this variable on the dependent variable.

CO2 Emissions per Capita (385.9 to 441.5): The confidence interval remains **positive**, reinforcing the strong positive relationship.

Domestic Credit to Private Sector (-4.33 to -2.57): The entire interval is **negative**, indicating a significant negative effect.

3.7. F-Test

F tabulated = **2.74**
F calculated = **934.7007128**
Since F calculated is more than F tabulated
Therefore **we can reject the null hypothesis** and conclude that **R square is significant**. There is a **significant joint effect** of all independent variables on the dependent variable

3.8. T-Test

Variables	**T-Test**	**Significance**
$\hat{\alpha}$	T-Stat (5.6) > T-tabulated (-1.706)	**Significant**
β_1	T-Stat (7.9) > T-tabulated (-1.706)	**Significant**
β_2	T-Stat (6.1) > T-tabulated (-1.706)	**Significant**
β_3	T-Stat (30.6) > T-tabulated (-1.706)	**Significant**
β_4	T-Stat (8.1) > T-tabulated (-1.706)	**Significant**

4. Conclusion

Therefore, the interaction of energy consumption with critical economic factors among individuals in Egypt underlines very important implications for policymaking. In particular, from the estimated results, there was proof that GDP per capita and investment significantly reduced energy consumption; hence, showing economic efficiency and infrastructural development is very crucial for adjusting energy demand. On the other hand, the positive relationship between CO2 emissions and energy consumption underlines the environmental cost of economic activities, thus calling on policymakers to focus on clean energy alternatives. The mixed influence that financial development indicates is that a balanced approach is highly required in using financial systems to realize sustainable energy consumption. The latter shows, with a highly significant model fit, that tailored energy policies are relevant for balancing economic growth with environmental stewardship, offering Egypt a way to transition into sustainable development.