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Growth of Energy Sector in India

Leena Sharma

Dept. of Economics

RGTU, Udaipur, India

ABSTRACT

While the general framework of economic analysis does not treat energy as a separate factor, because conventionally the energy was taken as free gift of nature,since the time immemorial. However, with the use of mineral oil and mineral resources and the upcoming shortages of these products, the story has taken a U turn. The use of energy has become a critical factor in the process of economic growth and more so in economic development. It has become sine quo non with national income determination, world ranking of nations,use of non-renewable resources for sustainable development and environment conservation too. No discussion regarding the human progress can take place without overt or covert mention of energy sources.

India is pitted amongst those nations which have a very large population, limited mineral oil resources and a high demand for energy. An inventory of the development of sources of energy look impressive. Its nexus to economic growth has been a matter of curiosity ,analysis, debate and concern too.

Key words : Growth , energy sector, India

Introduction

Electricity consumption and economic growth relationship is widely investigated topic since 1978 with the work of Kraft and Kraft (1978). The empirical literature for electricity consumption and economic growth relationship is analyzed in detail in the studies of Ozturk (2010) and Payne (2010). According to the literature survey, the direction of causality between electricity consumption and economic growth remains controversial. The literature that investigates the causal relationship between electricity consumption and economic growth yields mixed results in terms of the four hypotheses:

(1) Growth hypothesis: It infers that causality is running from electricity consumption to economic growth.

(2) Conservation hypothesis: It is also called unidirectional causality running from economic growth to electricity consumption. It stems from the assumption that energy can be saved in growth process by regulation

(3) Feedback hypothesis: It implies that there is bidirectional causality between electricity consumption and economic growth.

(4) Neutrality hypothesis: It is supported by the absence of a causal relationship between electricity consumption and economic growth. It is important to examine whether there is a causal relationship between electricity consumption and economic growth and the way of causality. This is because

the direction of causality has significant policy implications for designing and implementing energy policies.

The relationship between electricity consumption and economic growth has been the subject of intense research during the last decades. for American countries (e.g. Apergis and Payne (2009) and Apergis and Payne (2010)) Asian countries (e.g. Yoo (2006), Yuan et al. (2007), Gosh (2009) and Niu et al. (2011), European countries (e.g. Narayan and Parasad (2008), Beck et al. (2011) and Dobnick (2011)) and MENA (Middle East and North Africa) countries (e.g. Al-Mulati (2011), Ozturk et al. (2010), Acaravci and Ozturk (2011) and Arouri et al. (2012)).

Acaravci and Ozturk (2011) investigated the dynamic linkage between energy consumption and growth ratein selected European countries using co-integration analysis developed by Pesaran and Shin (1999), and Granger causality test. The co-integration test results show that there is no co-integration and causal relationship between the electricity consumption and the economic growth in three MENA selected

countries (Iran, Morocco and Syria).

There are also some panel data studies on the relationship between growth and specific components of energy consumption such as coal (e.g. Apergis and Payne, 2010), electricity (e.g. Narayan and Smyth (2009), Acaravci and Ozturk (2010) and Apergis and Payne (2011)), nuclear energy (e.g. Lee and Chiu, 2011), and renewable energy (e.g. Sadorsky, 2009) An increase in electricity consumption per capita can be viewed as a leading indicator of growing economy. In Middle east and North Africa (MENA) countries, 16.66% supported the growth hypothesis, 25% the conservation hypothesis, 33.33% the feedback hypothesis and 25% the neutrality hypothesis. However such studies should be taken with a pinch of salt becauseof the heterogeneous conditions prevailing in the countries. As it is evident from such studies that ,there are oil importers and oil exporter countries.Similarly there are low income and high income countries. The balance of payments problem creeps in influencing both the consumption profile and the growth scenario. Thus any generalization would be a curse rather than a bliss. The review of literature and even the most sophisticated instruments employed therein should be read and evaluated in the light of this argument.

However countries such as India may be taken as a genus of large species having high density of population, and high ratio of imports for their requirement and where the energy itself may become impediment to growth.

Data and methodology

For uniformity, historical series and convenience we have resorted to various issues of Energy Statistics for data on energy consumption, production, primary sources of energy and installation of generating capacity. For data on other macro economic variables we used Reserve Bank of India 'Handbook of Statistics on Indian Economy' The data used in this analysis are from 1970-71 to 2011-12.

Resource inventory of energy in India.

Today, India is the ninth largest economy in the world, driven by a real GDP growth of 8.7% in the last 5 years (7.5% over the last 10 years). In 2010 itself, the real GDP growth of India was the 5th highest in the world. This high order of sustained economic growth is placing enormous demand on its energy resources. The demand and supply imbalance in energy is pervasive across all sources requiring serious efforts to augment energy supplies as India faces possible severe energy supply constraints.(Energy Statistics 2013)

Twelfth Plan document of the Planning Commission indicates that total domestic energy production of 669.6 million tons of oil equivalent (MTOE) will be reached by 2016-17 and 844 MTOE by 2021-22. This will meet around 71 per cent and 69 per cent of expected energy consumption, with the balance to be met from imports, projected to be about 267.8 MTOE by 2016-17 and 375.6 MTOE by 2021-22.

India's energy basket has a mix of all the resources available including renewables. India's coal dependence is borne out from the fact that 54 % of the total installed electricity generation capacity is coal based and 67% of the capacity planned to be added during the 11 Five year Plan period 2007-12, was coal based. Furthermore, over 70 % of the electricity generated is from coal based power plants. Other renewables such as wind, geothermal, solar, and hydroelectricity represent a 2 percent share of the Indian fuel mix. Nuclear holds a one percent share..(Energy Statistics 2013) In 2011-12, India was the fourth largest consumer in the world of Crude Oil and Natural Gas, after the United States, China, and Russia. India's energy demand continued to riseinspite of slowing global economy.

As of March 2012, the per capita total consumption in India was estimated to be 879 kWh.India's electricity sector is amongst the world's most active players in renewable energyutilization, especially wind energy As of March 2012, India had an installed capacity of about 24.9 GW of new and renewable technologies-based electricity.

Table 1.

Growth rates of various sources of Installed, produced and consumed electricity

Name of the Variable	Compound Growth rate In Percentage	Name of the Variable	Compound Growth rate In Percentage
Generating Capacity of Hydro	4.3	Production of Electricity Natural gas	9.1
Generating Capacity of Thermal	7.0	Production of Electricity Hydro and nuclear	7.5
Generating Capacity of Nuclear	5.8	Production of Electricity coal & Lignite	5.3
Total Utility Generating capacity	6.1	Production of Electricity crude	5.1
Total Non Utility Generating capacity	**7.7**	**Total Primary Energy in PetaZule**	**5.2**

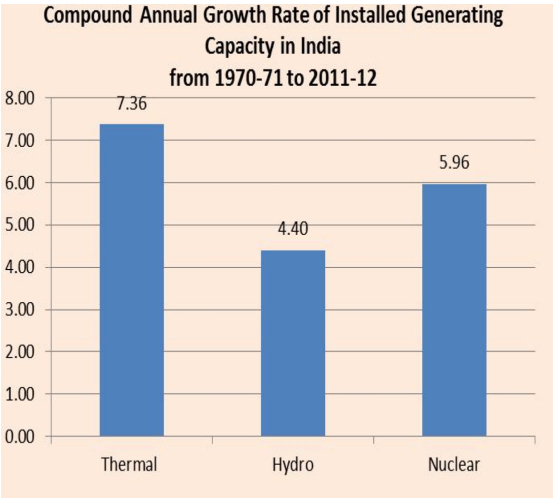
Total Generating Capacity	**6.3**	Coal Production of Primary source	4.3
Lignite Consumption	7.2	Lignite Production of Primary source	7.1
Natural gas consumption	11.4	Natural gas Production of Primary source	9.3
Coal consumption	5.2	Crude Production of Primary source	4.1
Total Electricity consumption	6.7	**Gross Domestic Product at Factor cost**	**5.4**

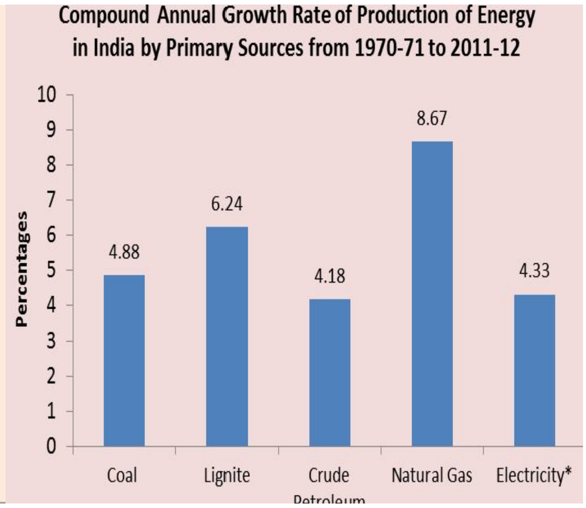
The following conclusions may be drawn from the above table

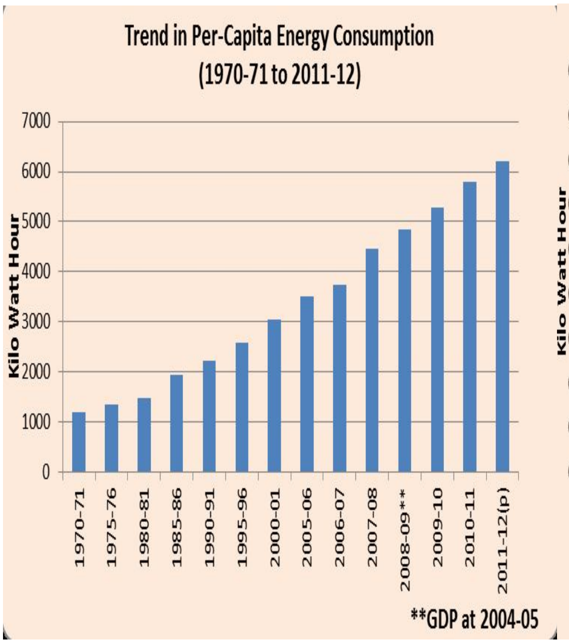
- The growth in generating capacity has not been reflected in the growth of actual production
- Total non utility generating capacity is higher than the total generating capacity
- Total Production of Primary source in GWh is less than Gross Domestic Product at factor cost. This indicates the shortage of electricity because the income elasticity of energy demand is normally more than one in emerging economies

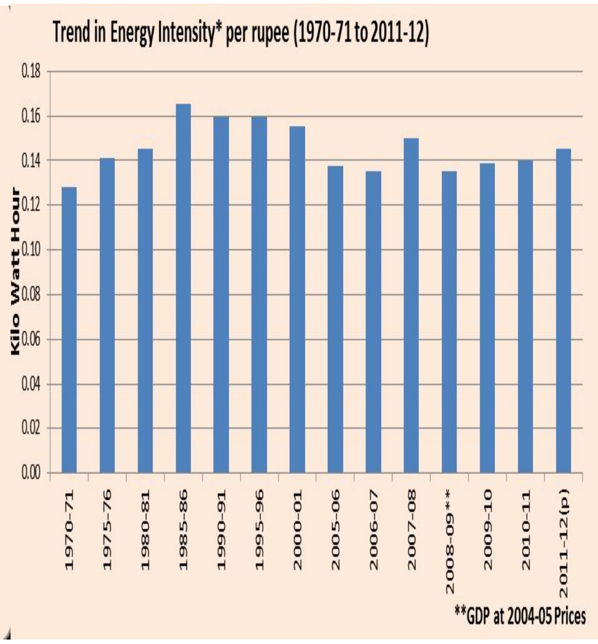
However, the use of non conventional energy may be up in future years.

- The installation capacity has increased 14.5 times , the production of primary sources of energy by 5.9 times , that of production of electricity by 9.2 times and the consumption by 17.3 times, while the growth rate of income at constant prices by 8.9 times. Thus there is great mismatch in installation, production of source, actual production and consumption.









Source : Energy Statistics 2013

Empirical Analysis

Step 1: testing for a unit root in d_Log EC

Augmented Dickey-Fuller test for d_l_EC

including 4 lags of (1-L)d_l_v4

sample size 36 unit-root null hypothesis: a = 1 test with constant

model: (1-L)y = b0 + (a-1)*y(-1) +... + e

1st-order autocorrelation coeff.for e: -0.093

lagged differences: F(4, 30) = 1.606 [0.1986]

estimated value of (a - 1): -0.408802

test statistic: tau_c(1) = -1.77202

asymptotic p-value 0.3949

Step 2: testing for a unit root in d_l_GDPFC

Augmented Dickey-Fuller test for d_l_v5

including 4 lags of (1-L)d_l_v5 sample size 36 unit-root null hypothesis: a = 1

test with constant

model: (1-L)y = b0 + (a-1)*y(-1) +... + e

1st-order autocorrelation coeff.for e: 0.027

lagged differences: F(4, 30) = 1.720 [0.1716]

estimated value of (a - 1): -0.444159

test statistic: tau_c(1) = -1.42079

asymptotic p-value 0.5737

Step 3: cointegrating regression

Cointegrating regression -

OLS, using observations 1972-2012 (T = 41)

Dependent variable: d_l_ EC

	coefficient	std. error	t-ratio	p-value	
const	0.0519933	0.00980789	5.301	4.82e-06	***
d_l_GDPFC	0.328704	0.160658	2.046	0.0475	**

Mean dependent var	0.069511	S.D. dependent var	0.031831
Sum squared resid	0.036599	S.E. of regression	0.030634
R-squared	0.096931	Adjusted R-squared	0.073775
Log-likelihood	85.76005	Akaike criterion	âˆ'167.5201
Schwarz criterion	âˆ'164.0930	Hannan-Quinn	âˆ'166.2721
rho	0.358505	Durbin-Watson	1.267737

Step 4: testing for a unit root in uhat

Augmented Dickey-Fuller test for uhat including 4 lags of (1-L)uhat

sample size 36 unit-root null hypothesis: a = 1

model: (1-L)y = (a-1)*y(-1) +... + e

1st-order autocorrelation coeff.for e: -0.150

lagged differences: F(4, 31) = 1.328 [0.2815]

estimated value of (a - 1): -0.397875

test statistic: tau_c(2) = -1.77679 asymptotic p-value 0.6417

There is evidence for a cointegrating relationship if:

(a) The unit-root hypothesis is not rejected for the individual variables.

(b) The unit-root hypothesis is rejected for the residuals (uhat) from the cointegrating regression.

Step 1: testing for a unit root in d_l_GDPFC

Augmented Dickey-Fuller test for d_l_v5 including 4 lags of (1-L)d_l_v5

sample size 36 unit-root null hypothesis: a = 1

test with constant

model: (1-L)y = b0 + (a-1)*y(-1) +... + e

1st-order autocorrelation coeff.for e: 0.027

lagged differences: F(4, 30) = 1.720 [0.1716]

estimated value of (a - 1): -0.444159

test statistic: tau_c(1) = -1.42079 asymptotic p-value 0.5737

Step 2: testing for a unit root in d_l_EC

Augmented Dickey-Fuller test for d_l_v4

including 4 lags of (1-L)d_l_v4 sample size 36 unit-root null hypothesis: a = 1

test with constant

model: (1-L)y = b0 + (a-1)*y(-1) +... + e

1st-order autocorrelation coeff.for e: -0.093

lagged differences: F(4, 30) = 1.606 [0.1986]

estimated value of (a - 1): -0.408802

test statistic: tau_c(1) = -1.77202

asymptotic p-value 0.3949

Step 3: cointegrating regression

Cointegrating regression -

OLS, using observations 1972-2012 (T = 41)

Dependent variable: d_l_GDPFC

	coefficient	std. error	t-ratio	p-value	
const	0.0327947	0.0109958	2.982	0.0049	***
d_l_EC	0.294889	0.144130	2.046	0.0475	**

Mean dependent var	0.053293	S.D. dependent var	0.030149
Sum squared resid	0.032834	S.E. of regression	0.029016
R-squared	0.096931	Adjusted R-squared	0.073775
Log-likelihood	87.98549	Akaike criterion	âˆ’171.9710
Schwarz criterion	-168.5438	Hannan-Quinn	-170.7230
rho	0.060511	Durbin-Watson	1.818542

Augmented Dickey-Fuller test for uhat

including 4 lags of (1-L)uhat sample size 36 unit-root null hypothesis: a = 1

model: (1-L)y = (a-1)*y(-1) +... + e

1st-order autocorrelation coeff.for e: 0.022

lagged differences: F(4, 31) = 1.811 [0.1518]

estimated value of (a - 1): -0.397443

test statistic: tau_c(2) = -1.36302 asymptotic p-value 0.8117

There is evidence for a co-integrating relationship if:

(a) The unit-root hypothesis is not rejected for the individual variables.

(b) The unit-root hypothesis is rejected for the residuals (uhat) from the co-integrating regression.

Conclusion and limitations of the study

The main problem with the previous studies mentioned in Table-1 below is that they did not pay attention to put other potential variables into model to examine the electricity consumption-economic growth nexus. In other words, they employed bivariate models which cause an omitted variable problem.

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