

**An Empirical Study of Nexus between
Economic Growth and Energy
Consumption: A Causality-Co-integration
Testing for India 1971-2004**



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Presentation plan

- Objectives of the paper
- Critical review of literature
- Data definition and sources
- Methodology
- Discussion on empirical findings
- Conclusions and policy suggestions



Objectives of the paper

- Empirically examine the relationship between economic growth and total energy consumption
- To find out the relationship between economic growth and sub-sets of energy consumptions
- Empirically prove, which sub-sets of energy consumption to be conserved
- Suggest an appropriate policy for demand side management

Relevance of energy research for India



- Is economic growth propel demand for energy and vice versa?
- Is population growth enhancing demand for electricity?
- Is increased electricity prices reduce the energy consumption and vice versa?
- Is the use of electricity by different categories contribute economic growth and vice versa?
- Can India pursue energy conservation policy? If yes which kind of subset of energy consumption to be addressed?



Data definition and sources

- Period of study:1971-2004
- Hand book on Indian Statistics (R.B.I.)
- All India Electricity Statistics; General Review (Central Electricity Authority of India)
- Central Statistical Organization and Indian Planning Commission



Methodology

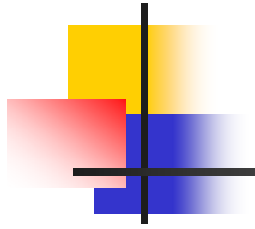
- **Unit root test:** we used well acknowledged Augmented Dickey-Fuller (ADF) and the Phillip-Perron (PP) Unit Root test
- **Co-integration test:** Johansen test (Johansen, 1988; Johansen and Juselius, 1990)
- **Vector Error Correction Model (VECM)**



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- **Dynamic Error correction model**
(Engle and Granger which is known as *Granger Representation Theorem*)

Findings from Pair-wise Granger Causality tests



Null Hypothesis	Obs. (lag)	F-Statistic	Probability
LPOP does not Granger Cause LTECON	30(4)	4.4171	0.00953
LTECON does not Granger Cause LPOP		0.07428	0.98924
LGDPFC does not Granger Cause LDOMECON	33(1)	1.24443	0.27348
LDOMECON does not Granger Cause LGDPFC		14.572	0.00063
LGCF does not Granger Cause LTECON	33(1)	4.59799	0.04023
LTECON does not Granger Cause LGCF		2.62815	0.11545
LCPIIW does not Granger Cause LTECON	32(2)	3.38778	0.04867
LTECON does not Granger Cause LCPIIW		0.11023	0.89603

Co-integration tests and Dynamic Error Correction Model

- We use Johansen Maximum likelihood methodology (Johansen, 1988, Johansen and Juselius, 1990) for co-integration analysis
- After establishing pair wise co-integration Dynamic Error Correction Model is used in the following form:

$$\Delta Y_t = \alpha + \sum_{i=1}^k \beta_i \Delta Y_{t-k} + \sum_{i=1}^k \gamma_i X_{t-1} + \delta \varepsilon_{t-1} + \mu_t \quad (4)$$

$$\Delta X_t = \alpha + \sum_{i=1}^k \beta_i \Delta X_{t-k} + \sum_{i=1}^k \gamma_i Y_{t-1} + \delta \varepsilon_{t-1} + v_{tk} \quad (5)$$

Results using Vector Error Correction Model

Equation No	Dependant variables	Independent variables		Error Correction term
		$\Delta\text{totecon}_{t-i}$	$\Delta\text{lgdpfc}_{t-i}$	
1	$\Delta\text{totecon}$	.....	-0.26 (0.79)	1.18 (0.24)
	Δlgdpfc	-0.66 (0.55)	.....	-1.78 (0.08)**
2	$\Delta\text{comecon}$	.....	-0.38 (0.78)	-1.49 (0.14)
	Δlgdpfc	-1.96 (0.06)**	.....	-1.98 (0.05)*
3	$\Delta\text{lindecon}$	.....	-2.03 (0.05)*	-0.93 (0.05)
	Δlgdpfc	-0.61 (0.55)	.....	-0.27 (0.79)
4	$\Delta\text{ndomecon}$	.....	-2.20(0.03)*	0.06(0.95)
	Δlgdpfc	-1.09 (0.28)	.....	-1.20(0.24)
5	Δlpci}	.....	0.55 (0.58)	-0.20 (0.84)
	Δltecon	-1.90 (0.06)**	.....	1.16 (0.25)

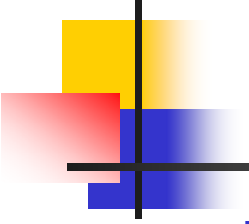
1. P values in parentheses.
2. *, ** shows statically significant at 5% and 10%.

Finding using Vector Error Correction

Model

- Equation 1 does not show any kind of causality between total energy consumption and economic growth. However, negative sign of vector of error term point out that in the long run, model will be in the equilibrium
- Equation 2 reveals unidirectional causality runs from commercial energy consumption to economic growth in the short run and same variables will have equilibrium in the long term
- The equations number 3 and 4 show that causality operates from economic growth (GDP) to industrial energy consumption and non-domestic energy consumption respectively
- Equation number 5 shows that per capita income Granger causes total energy consumption in the short term but in the long run no equilibrium takes place

Conclusions

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- Unidirectional causality runs from population to total energy consumption, and domestic energy consumption to economic growth. Results appeared on these two pairs suggest that population causes energy consumption and energy consumed for domestic purpose promotes economic growth in India hence, energy conservation policy for domestic sector can not be implemented in Indian condition.
 - Capital formation and total energy consumption pair reveals bilateral causality between capital formation and energy consumption. This finding supports the importance of capital formation from both directions
 - unidirectional relationship between electricity tariff and energy consumption is observed. A meaning of this causation is that electricity consumption is influenced by tariff rates hence if the tariff rates are revised in upward direction that may hurt volume of energy consumption



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- equation 1 shows long term causality runs from total energy consumption to economic growth, this result is matching with results drawn by Masih and Masih (1996) in Indian case and Yu and Choi (1985) for Philippines
- Equation 2 reveals unidirectional causality between commercial energy consumption to economic growth in the short run; this finding is similar with earlier study of Paul and Bhattacharya (2004) on Indian data. However their study did not find long run casual relation but we find it between both the series. Our finding of the equation 2 about causality that runs from commercial energy consumption to economic growth in the short run and in the long run are similar with study made by Asafu- Adjaye (2000) in Indian case
- The equations number 3 and 4 show that causality operates from economic growth (GDP) to industrial energy consumption and non-domestic energy consumption respectively. This finding suggests that energy conservation policy pursued in respect of these two factors does not make an adverse impact on economic growth of the economy
- Equation 5 also exhibits the unidirectional causality that runs from per capita income to total energy consumption in the short run. It means in the long run, this relationship may not exist. This finding is equivocal with conclusion drawn by Mozumder and Marathe (2007) in respect of Bangladesh



Policy suggestions

- We advocate energy conservation policy for industrial and non-domestic sectors which may not hurt the process of economic growth in India
- We found unidirectional relationship between electricity tariff and energy consumption. A meaning of this causation is that electricity consumption is influenced by tariff rates hence if the tariff rates are revised in upward direction that may hurt volume of energy consumption
- We therefore suggest no tariff revision for energy used for domestic purpose and high tariff for industrial, commercial, traction and other users



Thank you

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