The Relationship between Disaggregate Energy Consumption, Economic Growth and Environment for Asian Developing Economies

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Introduction

- The relationship between economic growth, consumption of energy and environment attract economists, policy makers, researchers, and analyst.
- Previous studies on aggregate level of energy consumption (Sadorsky, 2012; Apergis and Payne, 2009)
- Over time coal, petroleum, electricity, renewable energy consumption has become important component
- As huge amount of money spent to import these components and an increase in petroleum price and LPG shortage affect the smooth operation of many businesses in the country (Kwakwa, 2011).
- .This motivates me to examine the role of disaggregated energy consumption on economic growth and enviroment.

Literature Review

- Lee and Chang (2008) find long run association between energy consumption and real GDP and unidirectional Granger causal association is found from energy consumption to economic growth in long run but not in the short run.

- Sadorsky (2012) shows long run affiliation between capital, output, labor, energy and trade. The result also justifies that causal connection between trade and energy consumption in long run.

- Apergis and Payne (2010) verify that cointegration exist between energy consumption and economic growth. The results also shows that energy consumption impact carbon dioxide emissions positively while inverted U shaped Kuznets curve also exist.

- Jalil and Mahmud (2009) support the existence of Kuznets curve when cubic term is added in the model. According to this study energy consumption and income are main determinants of carbon dioxide emissions.

Objective of the Study

- To examine the impact of disaggregated energy consumption including control variables (financial development and trade openness) on economic growth.

- To examine the impact of disaggregated energy consumption including growth, financial development, trade openness on environment (CO2 emissions).

Significance of the Study

- This study considers both, the impact of disaggregate energy consumption on growth, and then growth and energy consumption impact on environment (CO2 emissions)

- Financial development and trade openness which increase economic growth and also increase environment degradation is considered.

- *"twenty first century is going to be Asia centered economically",* this study explores the role of disaggregated energy use in developing countries of Asia.

- The relationship between economic growth, disaggregated energy use and environment is very important and need to evaluate for developing new valuable energy and environmental policies.

Theoretical Framework

- In literature classical macroeconomic growth theories primarily focus on labor and capital and do not consider the role of energy resources which are having the significant role for economic growth and production (Stern and Cleveland, 2004).

- Neo Classicals considered energy as intermediate factor.

- Energy economists states “energy is an important factor as well as play a major role in production process; it can be used directly as a final product” (Stern, 1997).

- Theoretically Kuznets curve theory is expanded by adding energy consumption, financial development and trade openness

Methodology

Energy Consumption and Growth

- By extending the Cob Douglas production function this study uses following empirical specification of the model as suggested by (Sadorsky, 2012)

- GDP is a function of capital, labor, energy, financial development and trade openness respectively. Taking natural log on both sides the model becomes

$$\ln Y_{it} = \nu_i + \alpha \ln K_{it} + \beta \ln L_{it} + \gamma \ln E_{it} + \theta \ln F_{it} + \psi \ln T_{it} + \varepsilon_{it}$$

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Energy Consumption and Environment

- The environment is captured by CO2 emissions. To examine the impact of energy consumption on environment the study extends model of inverted U shaped Kuznets curve by including energy consumption, financial development and trade openness

$$\ln CO2_{it} = \nu_i + \alpha \ln E_{it} + \beta \ln Y_{it} + \gamma \ln Y_{it}^2 + \theta \ln F_{it} + \psi \ln T_{it} + \varepsilon_{it}$$

Data

- The annual data is taken from
- WDI (world, development indicators)
- EIA (energy, information administration)
- For 8 Asian developing countries (Bangladesh, Pakistan, Indonesia, China, Philippines, India, Sri Lanka, and Thailand).

Estimation Technique

- Panel co integration (Pedroni, Kao) tests are applied to verify the long run relationship between economic growth, disaggregated energy consumption, and environment.
- FMOLS is used for find long run elasticity's.
- For short run VECM is applied.
- For this analysis first step is to verify the stationarity of data and panel based unit root tests are applied for this purpose.

Results and Discussion

Variables	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)
Capital	0.389*** (10.101)	0.323*** (7.101)	0.390*** (8.138)	0.378*** (7.891)	0.404*** (7.851)
Labor	0.329*** (3.004)	0.331** (2.585)	0.630*** (5.688)	0.655*** (6.363)	0.792*** (7.098)
T Energy	0.552*** (7.371)				
Electricity		0.313*** (5.792)			
Petrol			0.288*** (3.971)		
Renew				0.265*** (5.033)	
Coal					0.035** (2.149)
FD	-0.093*** (-3.150)	-0.093*** (-2.897)	-0.134*** (-3.707)	-0.029 (-0.781)	-0.113*** (-2.943)
TO	0.123** (2.239)	0.232*** (4.090)	0.203*** (3.096)	0.195*** (3.094)	0.350*** (5.121)

Results and Discussion

Variables	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)
GDP	1.649*** (4.506)	1.814*** (7.222)	2.540*** (5.990)	4.140*** (7.428)	4.271*** (4.617)
GDPS	-0.030*** (-4.456)	-0.021*** (-4.580)	-0.041*** (-5.357)	-0.068*** (-6.311)	-0.065*** (-3.763)
T Energy	1.091*** (15.817)				
Electricity		0.479*** (12.301)			
Petrol			0.596*** (8.621)		
Renew				0.224*** (3.177)	
Coal					0.017 (0.694)
FD	0.061*** (2.633)	0.103*** (3.979)	-0.001* (-1.761)	0.001 (0.924)	0.005 (0.104)
TO	0.079* (1.731)	-0.136*** (-5.216)	0.404*** (3.935)	0.589*** (4.196)	0.137 (1.346)

Causality

Model 1	Short run						Long run
Dependent variables	Δ GDP	Δ TEnergy	Δ Capital	Δ Labor	ΔFD	ΔTO	ΔECT
Δ GDP	-	0.57***	0.17**	0.18*	-0.15*	0.22**	-0.03***
Δ TEnergy	1.727	-	0.30*	0.31	0.26**	0.38*	-0.01***

Model 2	Short run						Long run
Dependent variables	Δ GDP	Δ Elec	Δ Capital	Δ Labor	ΔFD	ΔTO	ΔECT
Δ GDP	-	0.31***	0.51***	0.09*	-0.53***	0.45***	-0.03***
Δ Elec	3.15***	-	-1.62*	-0.29	1.67***	-1.44***	-0.01***

Model 3	Short run						Long run
Dependent variables	Δ GDP	Δ Petrol	Δ Capital	Δ Labor	ΔFD	ΔTO	ΔECT
Δ GDP	-	0.24*	0.81***	0.02*	-0.20***	0.20***	-0.08*
Δ Petrol	12.30***	-	10.05***	0.36	2.54***	2.46***	-0.01*

Model 4	Short run						Long run
Dependent variables	Δ GDP	Δ Renew	Δ Capital	Δ Labor	ΔFD	ΔTO	ΔECT
Δ GDP	-	0.32***	0.30	0.35**	-0.06*	0.01*	-0.04***
Δ Renew	16.02	-	22.29**	7.52	1.38	2.19*	-0.01***

Model 5	Short run						Long run
Dependent variables	Δ GDP	Δ Coal	Δ Capital	Δ Labor	ΔFD	ΔTO	ΔECT
Δ GDP	-	0.01*	0.93***	-0.07*	-0.19***	0.06	-0.03**
Δ Coal	7.53		1.49*	5.51	1.94	2.72*	-0.01***

Causality

Model 1		Short run					Long run
Dependent variables	Δ CO2	Δ TEnergy	Δ GDP	Δ GDPS	Δ FD	Δ TO	ΔECT
Δ CO2	-	0.96***	3.02***	-0.06***	0.22***	0.03	-0.08**
Δ TEnergy	0.74**		2.82**	-0.06*	0.08	0.35*	-0.03***
Model 2		Short run					Long run
Dependent variables	Δ CO2	Δ Elec	Δ GDP	Δ GDPS	Δ FD	Δ TO	ΔECT
Δ CO2	-	1.49*	18.22**	-0.31**	1.91**	-1.91**	-0.01***
Δ Elec	1.42		24.6***	-0.46***	1.095*	1.41**	-0.01***
Model 3		Short run					Long run
Dependent variables	Δ CO2	Δ Petrol	Δ GDP	Δ GDPS	Δ FD	Δ TO	ΔECT
Δ CO2	-	0.84***	7.19***	-0.13***	-0.32***	0.33**	-0.04***
Δ Petrol	2.26***		-16.29***	0.30***	0.72***	0.76***	-0.02***
Model 4		Short run					Long run
Dependent variables	Δ CO2	Δ Renew	Δ GDP	Δ GDPS	Δ FD	Δ TO	ΔECT
Δ CO2	-	0.50***	11.8***	-0.20***	0.75***	0.32*	-0.02***
Δ Renew	2.46		12.20*	-0.28**	0.85*	0.19	-0.01***
Model 5		Short run					Long run
Dependent variables	Δ CO2	Δ Coal	Δ GDP	Δ GDPS	Δ FD	Δ TO	ΔECT
Δ CO2		0.33*	3.94***	-0.07**	0.07*	0.62	-0.01***
Δ Coal	3.02		11.92**	-0.22**	0.22	1.89*	-0.01**

Conclusion

- Cointegration tests verify long run relationship among all variables.
- FMOLS confirms that all forms of disaggregate energy consumption explain positive and significant impact on economic growth.
- Results also show that all forms of disaggregate energy use illustrate in positive and significant impact on CO2 emissions (except coal consumption)
- Findings also validate existence of Environmental, Kuznets curve.

Policy Implications

- The results support to promote renewable energy sector because its increase economic growth and its impact on environment degradation is low as compare to other sectors.

- Investment in renewable energy sector is beneficial for private and public sector.

- For this purpose cost and benefit analysis, of various forms of energy sector needs to be adopted.