

Impact of Energy Consumption and Environment on Economic Growth in Pakistan

Khurram Shehzad¹ and Faisal Munir²

<https://doi.org/10.62345/jads.2019.8.2.4>

Abstract

The study determines the impact of climate change and energy consumption on economic growth in Pakistan over the period from 1981 to 2014. With advanced energy appliances energy uses are increasing day by day and the use of this highly consumption rate taking implications on macroeconomic policies and structure. The study estimated ARDL approach of cointegration and UECM technique used to establish the long run and short run relationship among economic growth, CO₂ emissions, energy consumption and the employment ratio. The results show that there are long run and short run relationships among the variables in the model. There is positive and significant impact of CO₂ emissions, energy consumption, and employment ratio on per capita GDP in the long run. The results for direction of causality indicate that there is unidirectional relationship of carbon emissions per capita and energy consumption per capita on GDP per capita, but employment ratio causes GDP per capita in the short run. On the basis of our empirical findings, it can be concluded that energy conservation policies and controlling carbon dioxide emissions, are likely to have no adverse effect on economic growth in Pakistan in the short run..

Key Words: Energy Consumption, CO₂, Employment, Economic Growth

Introduction

Energy plays the key role in the economic growth of a country. The efficiency and productive of the country can improve by the use of energy. The role of energy in economic development is well established in the energy economics literature.

Climate changes and global warming is main issue of the world for last two decades. CO₂ is major source of green houses which contributes 58.8% of green house gases emissions (world bank 2007). Thus the impact of global warming and climate changes has been assessed by academics. The united nation also take active part and try to reduce the effects of global warming and force the world to reduce the emission of CO₂ by binding agreements such as Kyoto protocol. The Kyoto protocol is a protocol aiming to reduce global warming. The protocol was formed on 11 December, 1997 in Kyoto, Japan and come into force on 16 Febourary, 2005. Pakistan signed the Kyoto protocol in 2005.

The choice of studying Pakistan is motivated because Pakistan is 6th most populated country in the world and its exports are mostly manufactured goods which cause high CO₂ emission. Secondly in Pakistan the mostly energy producing plants are also on fuel due to which the Pakistan has produced one of the largest volume of CO₂ in the world. Many development theories also predict that in developing nations there is high pressure on environment.

Pakistan national assembly has passed the "Pakistan environment protection act" in 1997 to protect the natural resources and environment of the country. The study empirically examine

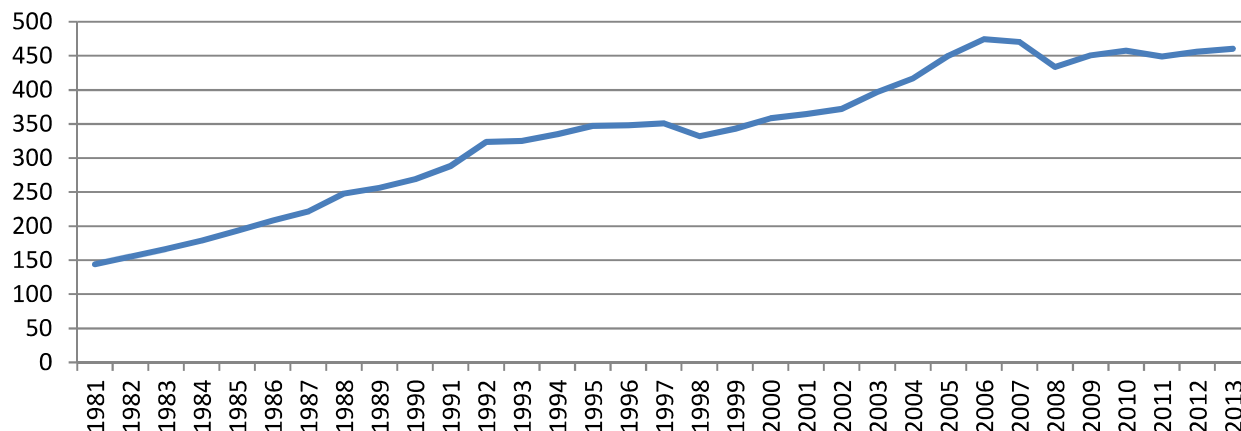
¹ Lecture in Punjab institute of Minis and Minirals Katas, Punjab, Pakistan

² MPhil Economics, University of Gujrat, Pakistan



the long run and short run relationship of energy consumption, CO_2 emission an employment ratio and economic growth in a multivariate frame work for Pakistan during 1981 to 2013 periods. At present, Pakistan is facing a worse energy crisis in the history. It is expected that if the country is growing at the rate of 6% then the energy consumption must grows in double digit. Pakistan's energy requirements are expected to double in the next few years.

Figure No:1 Energy Consomtion Per Capita



Source: World Bank

The importance of energy lies in all aspect of development -when energy products are exported it increased the foreign earning by increasing foreign investment, transfer of technology in the process of exploration, production and marketing; the employment in energy sector is increased; the worker welfare improved by increasing the salaries and wages, it improved the infrastructure and socio-economic activities in the country. Thus in the quest for optimal development and efficient management of available energy resources, equitably allocation and efficient utilization can put the economy on the part of sustainable growth and development. Arising from this argument, adequate supply of energy thus becomes central to the radical transformation of the nation's economy.

The main purpose of the study to see effects of economic growth on CO_2 , energy consumption and employment ratio. If energy consumption effects positively on economic growth then these energy conversation laws will affect the economic growth adversely. The study used an auto regreesive distributed lag (ARDL) model and vector error correction model (VECM) to establish the long run and short run relationships among the variables. One of the interesting features of the study is that it differentiates short run and the long run effect because it has been observed that impact of energy consumption varies from short to long run for the same country. For this purpose, we have employed ARDL modeling to co-integration to find out long run and short run effect. Unit root problem of the data is handled by ADF test. In coming sections there is debate on literature review, Methodology and data descriptions, and results and conclusion at the end.

Literature Review

Since the initial study by Kraft and Kraft (1978) the causal relationship between energy consumption and economic growth has under taken. This energy consumption and growth relations also provide for environment policies.

Ilhan et al (2010) shows that for existence of granger causality neither CO_2 emissioonn per capital nor energy consumption per capita cause real GDP per capita both employment ratio cause GDP raito per capita in short term Turkey case. Ugur et al (2007) found that income does not granger caus carbon emission in long run however energy use have granger cause.

Pao and Tsai (2010) found that in BRIC countries there is bi-directional strong causality between energy consumption and CO_2 emission. They also found that energy consumption and output have bi-directional long run causality. However uni-directional causality between energy consumption and CO_2 emission with output respectively.

In a study on economic growth and energy consumption in six central American economies, Apergis & Payne (2009) found that there is short run and long run causality between energy and consumption and economic growth. Hye and Riaz (2010) found bidirectional causality between economic growth and energy consumption in the short run and unidirectional causality in the long run.

In the study of economic growth and energy consumption in 19 African countries, Nondo & Kahsai (2009) found that long run and short run causality is unidirectional between economic growth and energy consumption. Alam et al (2012) in his study on Bangladesh found unidirectional causality between economic growth and energy consumption both in short run and long run. While bidirectional causality between electricity consumption and economic growth.

Population is strongly connected with energy consumption (Barliwala & Reddy, 1993). Limited and exhausted resources of energy cause all countries to struggle for the great economic growth. Every year, the world population increase and the energy resources are increasingly needed in numerous human's activities. However, the limited resources of energy can limit the economic activities and thus hindering the economic development. People consume energy for various activities such as transportation, agriculture, and industries. We are unable to imagine that if exhausted energy occurs in the world; it can certainly cripple all countries economy. Lower population can probably reduce the demand in energy but a reduction in energy consumption can affect the economic growth. Shaari, et.al (2013), Ighodaro (2010) Lise & Monfort, (2006) stated that if a decrease in energy consumption can affect economic growth. Therefore energy consumption is a strong determinant of economic growth. This study is to examine the relationship among population, energy consumption and economic growth.

In the case of Pakistan, Riaz (1984) investigated the relationship between EC and EG using log linear regression analysis. The regression analysis of the energy-growth relationship has shown independence between socioeconomic variables and EC. Masih and Masih (1996) found a co-integrated relationship between EC and GDP in India, Pakistan, and Indonesia, but no such evidence in the case of Malaysia, Singapore, and the Philippines. Yang (2000) investigated the causal relationship between GDP and EC—including that of coal, natural gas, and electricity—analyzing the aggregate as well several disaggregated categories and found a bidirectional causality between total EC and GDP in India; in the case of Pakistan and Indonesia, GDP was found to cause EC. Anjum and Butt (2001) found that EG caused total EC, but further investigation indicated that EG did not lead to growth in petroleum consumption, while in the case of the gas sector, neither EG nor gas consumption affected each other. In the power sector, however, electricity consumption was found to lead to EG without feedback. Finally, EC was found to directly cause employment. Alam and Butt (2002) concluded that EC, EG, capital, and labor were co-integrated and that causality ran from EC to EG in the short and long run.

Model and Econometric Methodology:

In this study the relationships among economic growth, CO_2 emissions, energy consumption and the employment ratio in Pakistan is examine by applying multivariate model analysis techniques. The country has the 6th largest population with growing economy and is expected to have high levels of energy consumption and CO_2 emissions. The study is based on the assumption that economic growth is driven by high energy consumption that is likely to

produce CO2 driven economic growth in the country (Ozturk and Acaavci, 2010). The basic form of the relationship between the variables can be expressed as:

$$Y_t = f(COP_t, ENP_t, LAP_t)$$

where, (Y) represents GDP, (COP) represents CO2 emissions, (ENP) represents energy consumption and (LAP) represents the employment ratio or the total labor force ratio to total population. The relationship can be expressed in an equation as follows:

$$Y_t = \alpha + \beta COP_t + \delta ENP_t + \theta LAP_t + \varepsilon_t \dots \dots \dots (i)$$

The study employed a log-linear model specification, and is thus likely to give more definitive results. The equation (i) can be modified in a logarithmic form:

$$lY_t = \alpha + \beta lCOP_t + \delta lENP_t + \theta lLAP_t + \varepsilon_t \dots \dots \dots (ii)$$

The coefficient β , δ and θ represents their respective elasticities, and ε is the disturbance term in the model.

Where, Y_t = GDP Per capita (GDPt/Nt)

COP_t = Carbon Dioxide per capita (COP_t/N_t)

ENP_t = Energy consumption per capita (ENP_t/N_t)

LAP_t = Total labor force ratio to total population

Empirical Results

Table 1 presented the result of Dicky fuller (1979) and Augmented Dicky fuller (1981) test. The results reveal that some variable integrated at level and some are not.

Table 1 Unit root test of ADF

Variable	Augmented Dickey-Fuller Test Results				
	At level		At first difference		Decision
	Intercept	Trend and intercept	Intercept	Trend and Intercept	
PCI	-1.264[1] (0.6334)	-2.214[1] (0.4660)	-3.580[0] (0.0120)**	-3.674[0] (0.0390)**	I(1)
EPC	-1.890[0] (0.3326)	-1.251[0] (0.8823)	-4.386[0] (0.0015)***	-4.449[0] (0.0040)***	I(1)
LFP	-2.241[0] (0.999)	-1.254[0] (0.881)	-4.290[0] (0.002)***	-5.427[0] (0.000)***	I(1)
CO2	-1.890[0] (0.2848)	-2.1047[0] (0.523)	-7.230[0] (0.000)***	-7.919[0] (0.000)***	I(1)

ARDL approach for co-integration

Table No. 2 VAR Lag Order Selection Criteria

Endogenous variables: PCI EPC LFP CO2						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	291.0105	NA	5.76e-14	-19.13404	-18.94721	-19.07427
1	430.4720	232.4358	1.55e-17	-27.36480	-26.43067*	-27.06596
2	442.4489	16.76765	2.16e-17	-27.09659	-25.41516	-26.55869
3	474.0469	35.81102*	9.06e-18*	-28.13646*	-25.70772	-27.35948*

* indicates lag order selected by the criterion

The results of VAR model suggested that lag selection criterion of AIC indicated three lags

as optimal lags to incorporate in the ARDL model. In the second step in ARDL the study applied the following model for bond testing to check co-integration among the variables.

$$DPCI_t = \beta_1 + \beta_{2i} \sum_{i=1}^3 DEPC_{t-i} + \beta_{3i} \sum_{i=0}^3 DCO2_{t-i} + \beta_{4i} \sum_{i=0}^3 DLFP_{t-i} + \beta_5 PCI_{t-1} + \beta_6 EPC_{t-1} + \beta_7 LFP_{t-1} + \beta_8 CO2_{t-1} + \varepsilon_t \dots \dots (II)$$

In model 5.1 there are two kinds of coefficients in the equation which includes short run as well long run coefficients. For testing the existence of co-integration the study applied Wald test on following hypothesis.

$$H_0: \beta_7 = \beta_8 = \beta_9 = \beta_{10} = \beta_{11} = 0$$

(No co-integration exists between variables)

$$H_1: \beta_7 \neq \beta_8 \neq \beta_9 \neq \beta_{10} \neq \beta_{11} \neq 0$$

(There is Co-integration)

The results of Wald test determined that H_0 is rejected in favor of existence of co-integration among the variables. F-statistics is 4.123 and probability value is 0.0175 which is significant at 1% level of significance (Table A.1 in Annexes). The F-statistics is compared with F-critical from Pesaran et al. (2001). Bond test results are given in table.

Table 3 Bond test results

Test Statistics	Value	K
F-statistics	4.123	4
Critical Bond values		
Significance	I0 Bond	I1 Bond
10%	1.99	2.94
50%	2.77	3.28
2.5%	2.55	3.61
1%	2.88	3.99

Table indicates that the value of F-statistics is greater than 1% level upper bond value which indicated that there is co-integration exists among the variables used in the model.

Table 4: Long run results

Dependent Variable: PCI				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	113.525	133.046	0.853	0.4003
EPC	1.652***	0.424	3.893	0.0005
CO2	898.168***	307.370	2.922	0.0065
LFP	2443.490***	696.892	3.506	0.0015
Diagnostics				
R-squared	0.989179	F-statistic	914.1629	
Adjusted R-squared	0.988097	Prob(F-statistic)	0.0000	

Table 5: Short run ECM Model

Dependent Variable: DPCI				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	5.171	8.267	0.625	0.5399
DPCI(-1)	0.300*	0.146	2.047	0.0564
DPCI(-2)	0.142	0.134	1.065	0.3015
DPCI(-3)	0.236**	0.105	2.236	0.0390
DEPC	1.915***	0.286	6.691	0.0000
DEPC(-1)	-0.699	0.475	-1.470	0.1596
DEPC(-2)	-0.875**	0.357	-2.450	0.0254
DCO2	602.201***	175.563	3.430	0.0032
DLFP	-783.602	955.613	-0.820	0.4236
DLFP(-1)	-597.726	1092.826	-0.546	0.5915
DLFP(-2)	1638.964	1155.981	1.417	0.1743
DLFP(-3)	-2733.154**	1171.627	-2.332	0.0322
ECM(-1)	-0.357***	0.099	-3.586	0.0023
Diagnostics				
R-squared	0.887563	F-statistic		11.18298
Adjusted R-squared	0.808196	Prob(F-statistic)		0.0000

Diagnostics tests which are applied on the short run ECM model one are, Breusch-Godfrey Serial Correlation LM Test, Heteroskedasticity Test of Breusch-Pagan-Godfrey, Jarque-Bera Test of Normality, and Ramsey RESET Test. The results of the diagnostics tests are given in the following Table 5.7.

Table 6 Diagnostic tests for ECM Model One**Breusch-Godfrey Serial Correlation LM Test**

F-statistic	0.3890	Prob.	0.5416
Obs*R-squared	0.7121	Prob. Chi-Square	0.3984

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	1.1225	Prob.	0.4034
Obs*R-squared	13.2624	Prob. Chi-Square	0.3503

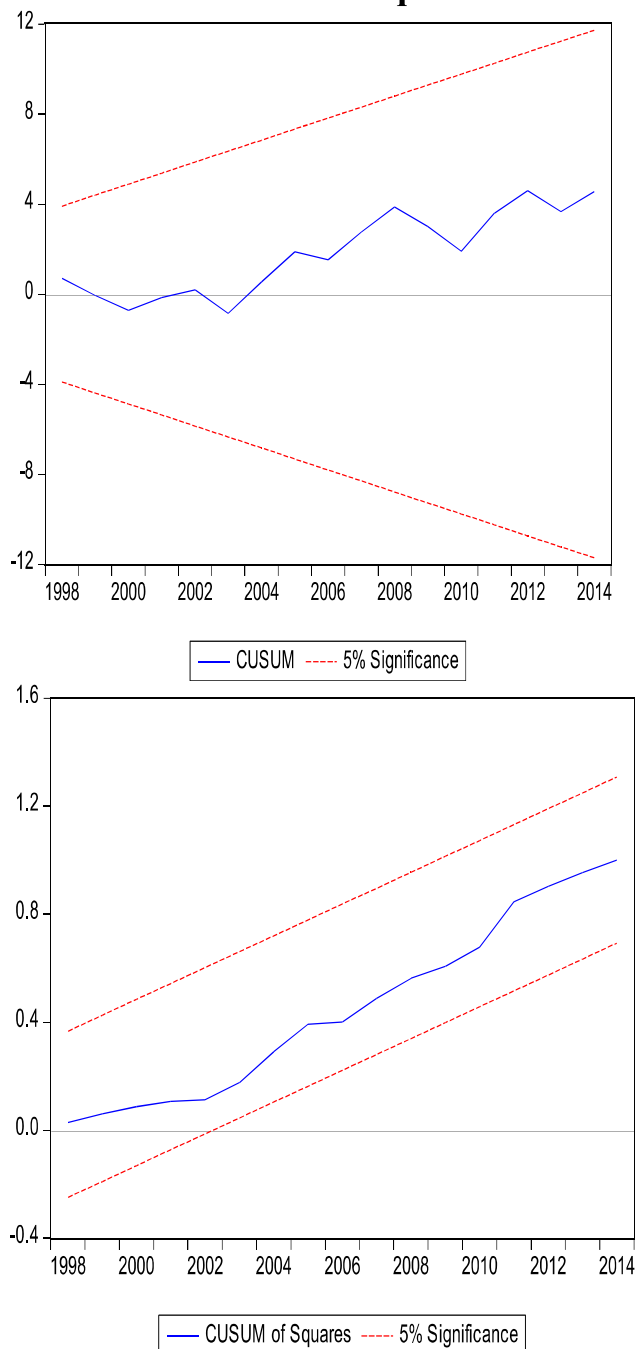
Jarque-Bera Test of Normality

Jarque-Bera	1.0347	Prob.	0.5960
-------------	--------	-------	--------

Ramsey RESET Test

t-statistic	0.9210	Prob.	0.3716
F-statistic	0.8482	Prob.	0.3716

CUSUM and CUSUM squared



Conclusion

This paper used the ARDL test and VECM based test techniques to establish the short run and long run relationships between the variables in the model. It is very difficult for the policy makers to control the CO₂ emission in the growing economy so the environmental protection is an important challenge. This paper examines the relationships among economic growth, CO₂ emissions, energy consumption and the employment ratio in Pakistan during the period of 1980-2011. The estimated long run coefficients of CO₂ emissions per capita, energy consumption per capita and employment ratio are positive and significant. In long run there is positive and significant relationship between energy consumption and GDP. It is due that the development of Pakistan economy is based on energy intensive industry and our energy intensive lifestyles in buildings and transport sectors. The energy consumption also

increases due to rapid increase in GDP in last decade of the data. High energy consumption is encouraged due to expansion in middle class in the country. The elasticity of CO₂ emissions per capita intensity in Pakistan is lower than the elasticity of energy consumption per capita intensity. This implies that CO₂ intensity is at a slower pace than energy consumption intensity

The application of the ECM-based Granger Causality test is found to be consistent with the outcomes of the ARDL test. The results indicate that GDP does not Granger Cause CO₂ emissions and demonstrate that in a logarithmic model, the EKC hypothesis does not hold in the case of Pakistan. In the Short run, the Granger causality results support the neutrality hypothesis that there is no causal relationship between economic growth and energy consumption in Pakistan. However, the long run income elasticity of carbon emissions is greater than the short run income elasticity of carbon emissions, which implies that income leads to greater carbon dioxide emissions in the country. The significant and positive impact of energy consumption on economic growth suggests that energy consumption is crucial for growth, but the rapid pace of CO₂ emissions requires the adoption of alternative sources of energy and approaches to development to protect the environment in Pakistan

References

- Abaidoo (n.d.), Economic Growth and Energy Consumption in an Emerging Economy: Augmented Granger Causality Approach: *Research in Business and Economics Journal*, 01-15.
- Adebola (2011), Electricity Consumption and Economic Growth: Trivariate investigation in Botswana with Capital Formation: *International Journal of Energy Economics and Policy*, 1(2), 32-46.
- Adjaye (2000), The Relationship between Energy Consumption, Energy Prices and Economic Growth: Time Series Evidence From Asian Developing Countries: *Energy Economics* 22 _2000. 615-625.
- Adnan and Riaz (2008), Causality between Energy Consumption and Economic Growth: The Case of Pakistan: *The Lahore J. Econ.* 13(2):45-58.
- Ahmad et.al. (2012), Energy Consumption and Economic Growth: Evidence from Pakistan: *Vol.2 No.06 [09-14] | September-2012, Australian Journal of Business and Management Research*.
- Alam et.al. (2012), Energy Consumption, Carbon Emissions and Economic Growth Nexus in Bangladesh: Cointegration and Dynamic Causality Analysis: *Energy Policy* 45 (2012) 217–225.
- Cherfi and Kourbali (2012), Energy Consumption and Economic Growth in Algeria: Cointegration and Causality Analysis: *Vol. 2, No. 4, 2012, pp.238-249,ISSN: 2146-4553*
- Dickey and Fuller (1979), Distribution of Estimators for Autoregressive Time-series, with Unit root: *Journal of American Statistics Association* 74, 421-431.
- Dinda (2004), Environmental Kuznets Curve Hypothesis: A Survey: *Ecological Economics* 49, 431-455.
- Engel and Granger (1987), Cointegration and Error Correlation: Representation, Estimation and Testing: *Econometrica* 55, 251-276
- Fergusun et.al. (2000), Electricity Use and Economic Development: *Energy Policy* 28, 923- 934
- Harris and Sollis (2003), Applied Time series Modeling and Forecasting: *John Wiley and Sons Ltd. Chichester*.
- Hayashi, (2000) *Econometrics: Princeton University Press, Princeton*
- Ismail et al. (2012), Energy Use, Emissions, Economic Growth and Trade: A Granger

Non-Causality Evidence for Malaysia: *MPRA Paper No. 38473, posted 30. April 2012 12:46 UTC.*

- Johansen(1988), Statistical Analysis of Cointegration Vectors: *Journal of Economic Dynamics and Control*, 12, 231-254.
- Kalyoncu et.al. (2013), Causality Relationship between GDP and Energy Consumption in Georgia, Azerbaijan and Armenia: *Vol. 3, No. 1, 2013, pp.111-117, ISSN: 2146-4553, International Journal of Energy Economics and Policy*,
- Kirchgässner and Wolters, 2008, Introduction to Modern Time Series Analysis: *ISBN 978-3-540-73290-7 Springer Berlin Heidelberg New York*
- Kraft and Kraft (1978), On the Relationship between Energy and GNP: *Journal of Energy Development* 3, 401-413
- Lise and Montfort (2005), Energy Consumption and GDP in Turkey: Is There a Co-Integration Relationship? : *EcoMod2005 International Conference on Policy Modeling, June 29 – July 2, 2005, Istanbul, Turkey*
- Mackinnon (1996), Numerical Distribution Functions for Unit root and Cointegration Test: *Journal of Applied Econometrics* 11, 601-618.
- Mahadevan and Adjaye (2007), Energy Consumption, Economic Growth and Prices: A Reassessment Using Panel VECM for Developed and Developing Countries: *Energy Policy* 35, 2481-2490
- Masih and Masih (1998), A Multivariate Cointegrated Modeling Approach in Testing Temporal Causality between Energy Consumption, Real Income and Prices with an Application to Two Asian LDCs: *Applied Economics* 30, 1287-1298.
- Masood, A. (2010). Gap Analysis on Energy Efficiency Institutional Arrangement in Pakistan.
- Siddiqui et.al. (2011), Demand for Energy and the Revenue Impact of Changes in Energy Prices.
- Soytaş and Sari (2006), Can China Contribute More to the Fight Against Global Warming?: *Journal of Policy Modeling* 28(8), 837-846
- Soytaş and Sari (2007), Energy Consumption, Income and Carbon Emissions in the United States: *Ecological Economics* 62, 482-489.
- Soytaş and Sari (2009), Energy Consumption, Economic Growth, and Carbon Emissions: Challenges Faced by An EU Candidate Member: *Ecological Economics* 68 (2009) 1667 – 1675
- Soytaş et.al. (2007), Energy Consumption, Income, and Carbon Emissions in The United States: *Ecological Economics* 62 (2007) 482 – 489,
- Verbeek, 2008, A Guide to Modern Econometrics: *ISBN 0-470-85773-0 (pbk. : alk. paper)*
- Yu and Choi (1985), The Causal Relationship between Energy and GNP: An International Comparison: *Journal of Energy and Development* 10, 249-272.
- Yuan et.al. (2008), Energy consumption and economic growth: evidence from China at both aggregated and disaggregated levels: *Energy Econ.* 30, 3077–3094