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Environmental Degradation and Economic Development Nexus in Pakistan: A Time Series Analysis

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Abstract
The cost of natural resource depletion is creating alarming situation for future generations in developing economies like Pakistan. Therefore, the current work is analyzing the relationship of economic evolution and environmental degradation in Pakistan. Johansen Co-integration used to examine the association between economic enlargement and environmental dilapidation in Pakistan. A time series data analyzed for the phase from 1972 to 2010. For this purpose, Carbon dioxide intensity used as environmental indicator while gross fixed capital as economic growth indicator. The empirical outcomes suggested that economic expansion has affirmative and significant contact with ecological imbalance for the case of Pakistan. Study suggested that economic expansion at the cost of environmental degradation in not affordable at long run and could be harmful for future generation. A "win-win" policy should adapt to make economic growth with protected environment.

Keywords: Economic Development; Environmental Degradation; Pakistan

I. Introduction

Environmental degradation is worldwide phenomena nowadays. Increasing exploitation of resources from the natural environment intimidates ecological imbalance and unsustainable natural resource protection (Madulu, 2004). The developing countries experience immediate environmental troubles related to insufficiency and security of drinking water: poor hygiene services: air smog in metropolitan localities; soil exhaustion and deprivation (Chaudhry, 1995).

Pakistan has been categorized 27th in CO_2 discharge out of 177 countries and this is reflecting 0.5% share of the world. Carbon dioxide emission found increasing trend from 80s (0.4 MT per capita) and now has crossed 0.7 (MT) per capita in 2000 (Ahmad et al. 2005). High population growth coupled with unplanned economic development lead towards deforestation. Khan et al. (2009) found that 2.5-3.1% per annum deforestation is occurring in the Pakistan which is the world's highest rate while there are only 4.2 million out of 85 million hectares of the land are covered with forests. The World Bank indicators (2011) showed that only 9.5% area of land in Pakistan is under national protection while only 27.6% is available for arable crop.

Economic growth is the path of welfare and prosperity of the people of any country. World history shows that those countries making good progress in economic growth, they are becoming the leader of the world. The impact of this growth can be seen in the change of their people's life style, health, medication and other essential and luxury facilities.

Economic growth pattern of Pakistan is very unpredictable. Some time it maintained healthy growth rate while many time experience minimum level. At present, Pakistan's yearly growth rate is 4.7% against the world overall growth rate 3.1% but among neighbors, it has 4th place after India 7.0%, Bangladesh 6.8% and Sir Lanka 5.0% (Ministry of Finance, 2016).

Blindly embarking to enhance the economic expansion and to achieve the sustainable economic expansion at the cost of natural resource depletion is creating disturbing situation for present and future generations in developing economies like Pakistan. Therefore, the current work analyzes the relationship of economic evolution and environmental degradation in Pakistan. The study will be planned in subsequent sections:

Section two will elaborate the literature review. Data collection and methodological issues will be presented in section three. Results will be discusses in section four. Finally, some concluding remarks will be presented in section five.

II. Literature Review

Sustainable development is the process of economic growth, environmental protection and balance of present as well as future generation's consumption pattern (Qi, 2011). For this Economic progress, natural resources are demanded as basic platform while environmental capacity for byproduct (Baojuan et al. 2011). Industrialization needs sufficient sources of energy while natural gas, oil, coal and fossil fuels, are the major sources of it. Thus burning of these natural resources from factories, motor vehicles and households' results in carbon dioxide emission and these are the main reasons of greenhouse effect (Alam, 2007).

Hoy & Belisle (1984) hold up the thought that, after the decolonization, countries of the third-world initiated their industrialization agendas for a swift

development. After independence, growth was the prime precedence for them and any environmental degradation was regrettable, but has fairly irrelevant side effect. Clarke (1993a) initiated that for the duration of revolution from agro based nation to mechanized nation, main concern of these nations was to make policies of economic growth to achieve the goal of poverty alleviation. Thus most of these nations confronted many environmental problems like indoor and outdoor smoke, industrialized pollution and water contamination, flooding and drought and urbanized blight by the end of 1970s (Chaudhry, (1995). For example Ang (2008) estimated Malaysian's yearly based data for the period 1971-1999 while Hossain (2011) explored 9 recently modernized economies (Brazil, China, India, Mexico, Malaysia, Philippines, South Africa, Thailand and Turkey) and found that a long-run positive and significant relation exists among economic growth, energy consumption, free trade and environmental depletion. Same results found by Pao and Tsai (2010) as they estimated BRIC economies (Brazil, Russia, India and China) annual panel data from 1971-2005 and established that a unit raise in energy consumption reasoned 1.85 units rise in CO_2 emissions. Akbostancı et al. (2009) examined panel data of 58 Turkish provinces from1992-2001 and concluded an "N" shaped association between air contamination and economic growth. Tamazian and Rao (2010) calculated panel data of 24 converging economies from 1993-2004 and established that economic expansion can be a reason for environmental degradation when a constrained endogeneity on the recommended indicators are not applied. Tunisia, a small and open emergent economy showed that emissions can be minimized though effectual environmental managing strategies without compromising economic growth (Fodha and Zaghdoud, 2010).

China which is the world fasting growing economy is also main contributor towards environmental degradation and carbon dioxide emission. Different studies with different time span and methods of evaluation have concluded the same results that without appropriate environmental policies, there is no hard and fast rule for environmental sustainability with economic growth. For example Song et al. (2008) looked into 29 provinces of China during 1985-2005 and brought into being that economic developed caused discrepancy in the ecological system of China's provinces. Jalil and Feridun (2010) and Zhang and Cheng (2009) analyzed China's time series data of 1953-2006 and 1960-2007 respectively. Both the studies found that a diminution in energy usage particularly fossil fuel based can play a part to reduce the CO_2 emissions in China. Hang and Sheng (2011) applied "IPAT" equation to evaluate time series data from 1980-2006 of china and confirmed that economic volume, population density and economic growth have optimistic and significant association with CO_2 emission.

On the other hand, modernized economies are facing another set of unlike problems of environmental degradation such as depletion of atmospheric ozone and acid rain, CO_2 and petrochemical smoke. This is happening due to over utilization of natural resources. USA which has only 6% of world population is consuming 30% of world energy. Due to fossil fuel and coal based energy, it releases sulfur and nitrogen oxides and cause of acid rain and byproduct. Nearly 81% of automobiles of this

world are running in industrialized economies which have just 16% of world population (Lassow and Goldberg, 1989). Roca et al. (2001) investigated Spanish data and concluded that economic growth might be problematic and pattern of energy consumption and transport system must be changed to control waste system and same has been found by Clarke and Ainsworth (1993b) that industrialized economies are over fishing the world's oceans, exhausting sources of energy and fresh water. Hettige et al. (2000) established that steady sectoral pollution-labor ratios have stable emission in OECD and ex-COMECON. Zarzoso et al. (2007) stated that one percent increase in GDPPC leads to a 0.42 % rise in CO_2 emissions, while 1% growth in energy caused 0.44% rise in CO_2 emissions in the case of some selected European economies. Arge (1971) and Kalipeni (1996) thought that most limited exposition proposes macroeconomic strategy tools and statements on economic growth policy have an unambiguous and often unpredictable collision with environment through their impacts on rates of resource withdrawal, per capita consumption growth, and interruption of natural food and energy chains.

III. Data and Methodology

To examine the collision of economic development with environmental degradation, a descriptive summary will be present as follows.

The following model will study the association between economic enlargement (GFC) and environmental dilapidation in Pakistan (CO2i). Some controlled variables like headcount ration (HCR), gross fixed investment (TGFI) and per capita income (PC) has also been used for better and clear picture. A linear function of this model can be written as:

$$CO2i = \propto_0 + \propto_1 GFC + \propto_2 HCR + \propto_3 TGFI + \propto_4 PC + \mu_i \rightarrow (1)$$

Table 1.1: Descriptive Summary of the above model

	CO2i	GFC	HCR	TGFI	PC
Mean	1.48	16.61	26.25	428078.50	404.07
Median	1.52	17.00	24.80	162861.00	370.00
Maximum	1.91	20.95	39.50	2210921.00	981.00
Minimum	1.08	11.43	17.30	6321.00	98.00
Std. Dev.	0.24	2.10	5.37	590790.70	196.70
Skewness	-0.19	-0.32	0.75	1.84	0.99
Kurtosis	1.99	3.36	2.80	5.44	4.11

Descriptive summary presents in table 1.1 to observe the association between economic growth and environmental degradation in Pakistan. Carbon dioxide intensity (CO2i) is dependent variable with 1.49 kt mean and 0.24 kt variations throughout the highlight time period of our investigation. Explanatory variables are Gross Fixed Capital (GFC), Head Count Ratio (HCR), Total Gross Fixed Investment (TGFI) and GDP Per Capita (PC). Gross Fixed Capital (GFC) has 16.7 mean and 2.1 is standard deviation. Head Count Ratio, a variable of poverty and population has 26.2 mean with 5.37 variations. Mean value of total gross fixed

investment (TGFI) 428078 while standard deviation is 590790 respectively. GDP per Capita has 410 mean with variation of 196.

Skewness is shown in 6 row of table 1.1. It suggested that all variables are modest skewed like Per Capita (PC), Head Count Ratio (HCR) and Total Gross Fixed Investment (EC) are positively skewed while Carbon dioxide Intensity (CO2i) and Gross Fixed Capital (GFC) are negatively skewed.

Outcome of Kurtosis have been exhibit in the seventh row of table 1.1 which suggested that the data are normally distributed, lapto-kurtic distributed or platy-kurtic distributed. Total Gross Fixed Investment (TGFI) and GDP Per Capita (PC) is lapto-kurtic distributed as these variables have values larger than three while other two variables Carbon Dioxide Intensity (CO2i) and Head Count Ratio (HCR) are platy-kurtic distributed because they have values fewer than three. Gross Fixed Capital (GFC) in this table only has normal distribution.

To test the multi-collinearity between dependent and independent variables, pair-wise correlation coefficient is applied. If $rx1x2 \geq 80$, then there is high coefficient of correlation and thus multi-collinearity exist between dependent and independent variables.

Table 1.2: Correlation Matrix of the Model

	CO2i	GFC	HCR	TGFI	PC
CO2i	1.00				
GFC	0.46	1.00			
HCR	-0.48	-0.61	1.00		
TGFI	0.78	0.45	-0.26	1.00	
PC	0.71	0.59	-0.45	0.73	1.00

Correlation matrix of equation (1) has been presented in table 1.2. Results of the correlation matrix show that dependent variable (CO2i) is weakly correlated with all independent variables. Thus, it established no multi-collinearity among variables.

After descriptive summary, an econometric association between environmental degradation variable and economic development variables can be explained as follows.

Empirical Estimation and Results:

A regression said to be spurious if time series is not stationarity. Augmented Dickey-Fuller (ADF) test has been applied to test the stationarity and use the right econometric technique.

Table 1.3: Results of ADF Test

Test of unit root with intercept				test of unit root with trends and intercept		
Variable	Level	1st difference	Conclusion	Level	1st difference	Conclusion
CO2i	-0.19	-11.21	I(1)	-2.44	-10.85	I(1)
GFC	-0.26	-3.37	I(1)	-2.03	-3.68	I(1)
HCR	-2.08	-3.46	I(1)	-2.52	-3.51	I(1)
TGFI	-1.45	-3.62	I(1)	-2.21	-4.68	I(1)
PC	-0.2.00	-4.24	I(1)	-2.06	-4.39	I(1)

Augmented Dickey-Fuller (ADF) results are presented in table 1.3. According to the outcomes, null hypothesis (data not stationary) is rejected at 1% significance level which suggest that time series is stationary at the first difference. Augmented Dickey-Fuller outcomes demonstrate that absolute values are below the 99% critical values.

To decide the existence of co-integration equation in available time series, the maximum likelihood applied on the base of Johansen method. Results of trace statistics are shown in table 1.4

Table 1.4.: Unrestricted Co-integration Rank Test

Hypothesized No. of CE(s)	Trace Statistic	Eigenvalue	0.05 critical Value	Prob.**
None *	94.34	0.69	69.81	0.0002
At most 1 *	51.92	0.54	47.85	0.01
At most 2	23.59	0.27	29.79	0.21
At most 3	11.98	0.23	15.49	0.15
At most 4	2.49	0.06	3.84	0.11

Note: * (*) indicates rejection of the hypothesis at the 5% significance level, L.R. test indicates three co-integration equations at the 5% significance level

Null hypothesis is rejected here as the trace statistics are higher than the critical value at 5%. To inspect the size and sign of long run association, Co-integration vector normalized on the dependent variable in table 1.5. All independent variables have significant relation with dependent variable. Except from gross fixed investment (TGFI), all the independent variables have positive relation with dependent environmental degradation while TGFI has negative association.

Table 1.5: Normalize Co-integration Coefficients

CO2i	GFC	HCR	TGFI	PC
1.00	0.11***	0.01*	-6.25**	0.003***
	(0.02)	(0.01)	(2.97)	(0.00078)
	[4.15]	[1.77]	[2.15]	[3.97]

Note:* indicates at 10% significance level, ** indicates 5% level of Significance and *** indicates 1% significance level.

Here Error Correction Model (ECM) is depicted in table 1.6 to examine the short-run association. It shows past disequilibrium as an explanatory variable in the active manner of present variable. It illustrates both short as well as long-run association between the variables which used in equation (1). The coefficient of EC_{t-1} which shows the speed of adjustment has acceptable sign (negative). Value of EC_{t-1} shows that there is 2.6% annual correction rate from short-run to long-run.

Table 1.6: **Result of ECM for Short Run Dynamics**

Dependent Variable = ΔCO2I			
Error Correction:	D(CO2i)	St. Error	t-statistics
		(0.026)	[-4.15]
ΔGFC(-1)	-0.11		
ΔHCR(-1)	-0.01	(0.01)	[-1.77]
ΔTGFI(-1)	6.25	(2.90)	[0.21]
		(0.0007)	[-3.95]
ΔPC(-1)	-0.003		
C	2.06	--	--
EC_{t-1}	-0.28**	(0.13)	[-2.15]

Note: ** indicate 5% level of significant.

Stability Test

Cumulative sum of recursive residuals CUSUM and cumulative sum of recursive residuals of square CUSUMS are plotted in figures 1& 2 to test the stability of the coefficients. CUSUM and CUSUMS statistics lie in the critical bounds which suggests that coefficient in this model is stable.

Figure 1

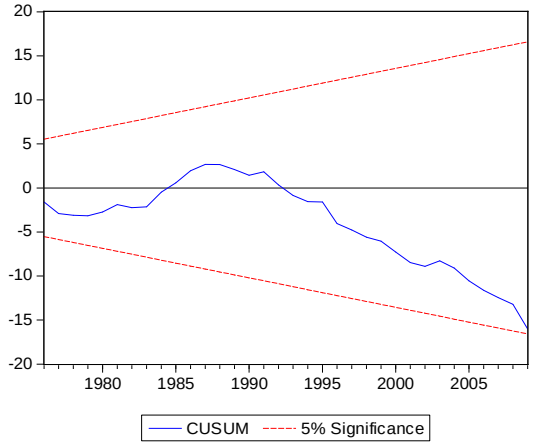
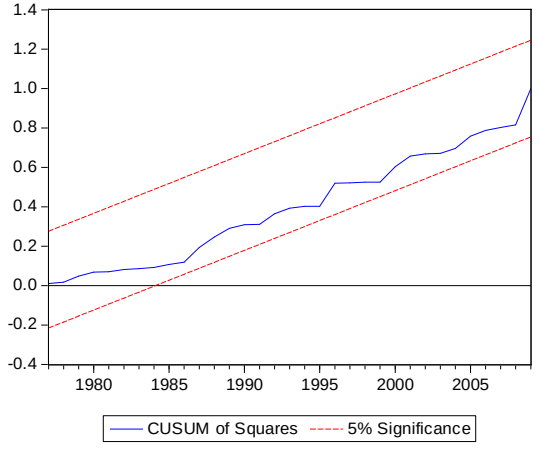


Figure 2



IV. Results and Discussions

This empirical work shows the association among environment, economic development and population growth. This study carried out on Pakistan's time series data from 1972-2010 while Johansen's co-integration and error correction model has been applied as econometric technique. Carbon dioxide emission intensity (CO_2i) represents environmental degradation indicator while gross fixed capital (GFC) shows economic development in Pakistan. This work observes that economic growth has significant and positive collision with environmental degradation for the case of Pakistan. Results suggest that growth in economic indicators may raise environmental degradation in Pakistan. The coefficient of the economic growth shows that a one unit increase in economic development may sources of 0.11 unit

rise in carbon dioxide emission intensity. Statistical results demonstrate that there is 99% level of confidence that economic development may cause environmental degradation if there is no interference by the governmental policies.

Same relation has been found between GDP per capita (PC) and environmental degradation (CO_2i) as well. A one unit growth in GDP per capita leads to 0.003 unit environmental degradation in Pakistan. Thus growth in gross fixed capital and GDP per capita confirm that unplanned and unrestricted economic growth rise environmental degradation in developing countries like Pakistan. This impression has also supported by the earlier literature as Wong (2011); Narayan and Narayan (2010), and Iwata et al. (2010) empirically tested and found weak/N-shaped/ or no evidence of an environment Kuznets curve. Thus it's concerning that to achieve sustainable development for the long run may demand to compromise environmental condition of the country if protective measures are not taken.

According to the definition of sustainable economic development, current prosperity must not be on the cost of next generation which mean that current generation is not allow to grow by using the natural resources of next generation. For the sustainable development, consideration of both connections of socio-economic system with environment and collision of human interaction with environment can be proving helpful for any country. Thus, coordination and integration of these dimensions is very important to make sustainable development theory operational and Quality of environment is necessary for the sustainable economic growth [Coondoo and Dinda (2008) and Akbostanci et al. (2009)].

The share of head count ratio (HCR) in environmental degradation is also significant and positive for the case of Pakistan. Coefficient values of HCR suggest that a one unit increase in poverty leads to 0.02 unit decrease in environmental conditions in Pakistan. Thus higher the poverty the higher will be the environmental destruction.

Environment is something which is necessary (food, water and air) for the survival of every human being as well as it help to get material goods (clothing, tolls and shelter) for pure subsistence and to beyond. The lack of these fundamental provisions comprises absolute poverty. Poverty and environmental destruction has head to head relation because root causes are same for both. Poor are victims as well as driving force of environmental destruction. Poor people over utilize natural resources for the sake of their survival and thus become threat to environment. For example, deforestation rate is increasing with increasing trends all over the world especially in poorer economies. Agriculture and forestry are producing half of the energy sources for these economies while natural resources represent a considerable part of their exports. Thus least developed countries (LDCs) are exhausting their natural resources and depleting environment due to poor quality of human capital and poor economic circumstances. For that reason, Poverty alleviation is pre-qualification for sustainable development and environmental sustainability.

Total gross fixed investment (INV) shows inverse association with ecological deprivation in Pakistan. This notion advocates that growth in total gross investment may assist to get better ecological conditions in Pakistan. Its coefficient demonstrates that a one unit rise in fixed investment may lead to 6.25 unit improvement in environmental condition of Pakistan. The findings can be justified on grounds that technological innovations and/or structural changes in the economy dependent regional investment rates in such a way to get better and help to sustain healthy environment in the country [Kahn and McDonald (1994), Neumayer (2002) and Shafik (1994), and].

V. Conclusion

This study empirically tested time series data of Pakistan during 1972-2010. Johansen Co-integration used as econometric technique to measure connection among economic growth, environmental dilapidation and poverty in Pakistan. Results of this study confirm that unrestricted economic growth and poverty can be a source of environmental degradation in Pakistan. The higher the unplanned economic growth and poverty in Pakistan, the higher will be environmental and resource depletion. Development is pre-requisition for per capita growth and well being of common man particularly for transitional economies since these economies are at an initial phase of growth but this should not be on the cost of environmental degradation and future generation. Thus, economic growth should be sustainable where sources use effectively and efficiently and appropriate environmental protection measures should be adapted to safeguards current condition of environment in the country. This will be the "win-win" circumstances for the country where economic development will make with protected environment.

References

Ahmad, H., Azhar, M. U., Wasti, A. S., Inam, Z., and Ghani, N. (2005). Interaction between Population and Environmental Degradation. *The Pakistan Development Review*, 44(4),1135-1150.

Akbostanci, E., Turut-Asik, S., and Tunc, G. I. (2009). The Relationship Between Income and Environment in Turkey: Is There an Environmental Kuznets Curve? *Energy Policy,* 37 (3), 861-867.

Alam, S., Fatima, A., and Butt, M. S. (2007). Sustainable Development in Pakistan in the Context of Energy Consumption Demand and Environmental Degradation. *Journal of Asian Economics*, 18, 825-837.

Ang, J. B. (2008). Economic Development, Pollutant Emissions and Energy Consumption in Malaysia. *Journal of Policy Modeling,* 30: 271-8.

Arge, R. (1971). Essay on Economic Growth and Environmental Quality. *Swedish Journal of Economics.*

Baojuan, S., Rongrong, Z., and Ying, Z. (2011). Empirical Analysis of Tangshan Economic Growth andEnvironmental Pollution. *Energy Procedia*, 5, 2392-2396.

Chaudhry, M. (1995). Global Population Growth, Economic Development and Environmental Impact, Case Study of India, 1991-2100. *Economic and Political Weekly*, 30(49), 3163-3167.

Clarke, K. R. (1993a). Nonparametric Multivariate Analyses of Changes in Community Structure. *Australian Journal of Ecology.* 18, 117-143.

Clarke, K. R. and Ainsworth, M. (1993b). A Method of Linking Multivariate Community Structure to Environmental Variables. *Mar. Ecol. Prog. Ser.* 92, 205-219.

Coondoo, D., and Dinda, S. (2008). The Carbon Dioxide Emission and Income: A Temporal Analysis of Cross-country Distributional Patterns. *Ecological Economics,* 65, 375-385.

Dinda, S., Coondoo, D., and Pal, M. (2000). Air Quality and Economic Growth: An Empirical Study. *Ecological Economics,* 34, 409-423.

Fodha, M., and Zaghdoud, O. (2010). Economic Growth and Pollutant Emissions in Tunisia: An Empirical Analysis of the Environmental Kuznets Curve. *Energy Policy,* 38: 1150-6.

Govt. of Pakistan. (2011). Pakistan Economic Survey 2011-12. Ministry of Finance, Islamabad, Pakistan.

Govt. of Pakistan. (2016). Pakistan Economic Survey 2015-16. Ministry of Finance, Islamabad, Pakistan.

Hang, G., and Yuan-sheng, J. (2011). The Relationship between CO_2 Emissions, Economic Scale, Technology, Income and Population in China. *Procedia Environmental Sciences*, 11, 1183 -1188

Hettige, H., Mani, M., and Wheeler, D. (2000). Industrial Pollution in Economic Development: The Environmental Kuznets Curve Revisited. *Journal of Development Economics,* 62(2), 445-476.

Hossain, S. M. (2011). Panel Estimation for CO_2 emissions, Energy Consumption, Economic Growth, Trade Openness and Urbanization of Newly Industrialized Countries. *Energy Policy,* 39, 6991-6999.

Hoy, D. R., and Belisle, F. J. (1984). Environmental Protection and Economic Development in Guatemala's Western Highlands. *Journal of Developing Areas*, 18(14), 161.

Iwata, H., Okada, K., and Samreth, S. (2011). A Note on the Environmental Kuznets Curve for CO_2: A Pooled Mean Group Approach. *Applied Energy,* 88: 1986-96.

Jalil, A., Feridun, M., (2010). The impact of growth, energy and financial development on the environment in China: A cointegration analysis. *Energy Economics*, 33, 284–291.

Kahn, H., and McDonald, A. (1994). *Deforestation in Post-War Philippines*. University of Chicago Press, Chicago, IL.

Kalipeni, E. (1996). Demographic Response to Environmental Pressure in Malawi. *Population and Environment,*17(4), 285-308.

Khan, H., Inamullah, E., and Shams, K. (2009). Population, Environment and Poverty in Pakistan: Linkages and Empirical Evidence. *Environment, Development and Sustainability,* 11(2), 375-392.

Lassow, R. D., and Goldberg, S. (1989). Amicus Brief Links Population Growth to Environmental Degradation. *Population and Environment*, 11(2), 141-152.

Madulu, F. N. (2004). Assessment of Linkages between Population Dynamics and Environmental Change in Tanzania. African Journal of Environmental Assessment and Management (AJEAM-RAGEE), 9, 88–102.
Narayan, P. K., and Narayan, S. (2010). Carbon Dioxide Emissions and Economic Growth: Panel Data Evidence from Developing Countries. *Energy Policy*, 38, 661-6.
Neumayer, E. (2002). Can Natural Factors Explain Any Cross-Country Differences in Carbon Dioxide Emissions? *Energy Policy*, 30, 7-12.
Pao, H. T., and Tsai, C. M. (2010). CO_2 Emissions, Energy Consumption and Economic Growth in BRIC Countries. *Energy Policy*, 38, 7850-60.
Qi, P., Deng, Z., and Wang, H. (2011). Energy Utilization, Environmental Quality and Sustainable Economic Development: Evidence from Shandong Province in China. *Energy Procedia*, 5, 314-321
Roca, J., Padilla, E., Farre, M., and Galletto, V. (2001). Economic Growth and Atmospheric Pollution in Spain: Discussing the Environmental Kuznets Curve Hypothesis. *Ecological Economics*, 39, 85-99.
Shafik, N. (1994). Economic Development and Environmental Quality: An Econometric Analysis. *Oxford Economic Papers*, 46(0), 757-773.
Song, T., Zheng, T., and Tong, L., (2008). An Empirical Test of the Environmental Kuznets Curve in China: A Panel Cointegration Approach. *China Economic Review*, 19, 381-92.
Tamazian, A., and Rao, B. B. (2010). Do Economic, Financial and Institutional Developments Matter for Environmental Degradation? Evidence from Transitional Economies. *Energy Economics*, 32, 137-145.
Wang, S. S, Zhou, P., and Wang, W. Q. (2011). CO_2 Emissions, Energy Consumption and Economic Growth in China: A Panel Data Analysis. *Energy Policy*, 39, 4870-5.
World Bank. (2011). World Development Indicators. Washington DC, USA.
Zarzoso, M. I., Morancho, B. A., and Lage, M. R. (2007). The Impact of Population on CO_2 Emissions: Evidence from European Countries. *Environment and Resource Economics*, 38, 497-512.
Zhang, X. P., and Cheng, X. M. (2009). Energy Consumption, Carbon Emissions, and Economic Growth in China. *Ecological Economics*, 68(10), 2706-2712.