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Abstract

In this paper, the Environmental Kuznets Curve (EKC) is used to investigate the connections between CO_2 emissions, energy consumption, economic growth, trade openness and urban population in Pakistan over the period of 1971-2010. The Autoregressive distributed lag (ARDL) bounds testing approach to co-integration has been taken for long run relationship, and for the short run dynamics Granger causality considered within the vector error correction model (VECM). The study presents that energy consumption, trade openness and urban population serve as the main factors contributing to CO_2 emissions in the long run. The results are in line with hypothesis in long run, and in short run inverted U-shape relation was found between CO_2 emissions and the economic growth. Trade openness and urban population Granger are responsible for CO_2 emissions. The facts about the existence of an EKC relation can help the policy makers in creating all-inclusive economic and environmental policies for the sustainable economic growth, and preserve clean environment.

Keywords: EKC, ARDL, VECM, CO_2

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1. Introduction

Climate change has been worldwide attention seeker towards the global environment issues. Many studies examined the connection between economic growth, energy consumption, carbon dioxide (CO_2) emissions and per capita income over the last two decades (Dindas, 2004).

For researchers, it also became the main focus from different science fields. In this context, the link of economic development and environmental performance is considered the main concentration of increasing attention. The issue of environmental degradation whether it raises monotonically, declines monotonically, or grows at initial stages and then declines in the transitional stages of development, undergoes critical suggestions for policy. Whereas development through industrial sector in an economy causes increase in income and welfare, this shows to act like "*magnifier*" of environmental degradation. On the other hand, rising environmentalism tends to act like an impediment to economic development. Economic growth through fast industrialization and increasing environmental awareness both have raised a question how economic growth may be connected with environment (Dindas, 2004).

The relation of environmental quality with economic development aroused much debate in the last decade (i.e.; 1990) and considerable literature on the environmental degradation and economic growth relationship has augmented in recent period. The World Development Report (1992) concluded cross-sectional evidences on the relation among various environment quality indicators and income per capita between different countries (Dindas, 2004). Other studies[1], have examined an inverted-U shaped association between environment filth and income. The mutual argument of all studies is the claim that the environment deteriorates at initial phases of development but after a level of income per capita, the trend converses as income cross the threshold levels shown in figure (Stern, 2004).In earlier stages of growth, environmental pressure rises rapidly than the income and slows down in higher levels relative to GDP growth. This systematic inverted connection is called the Environmental Kuznets Curve (EKC) following the concept presented by Kuznets (1995).

The EKC narrates the problem of the effect of economic development on environment. In order to understand this phenomenon, one should consider the fact, why and how economic development issues get connected to Concerns concerning the environmental degradation requires a well-organized study. Basically, detailed studies are required to understand the shape and the specific nature of Environmental Kuznets Curve (EKC). Re-examination of connection between economic growth and environment quality thus remains an open issue.

The EKC results propose that the economic growth can be compatible with the environmental improvements provided suitable policies are taken. Simultaneously, the effective policies can be introduced in case income increases. However, it is important to understand the nature and the casual linkages between economic growth and environmental quality before introducing an effective policy (Dindas, 2004).

1.1. Environment Condition of Pakistan Economy

Economic growth can be promoted by attaining sustainable environmental development. Numerous remedial actions have been taken by Government of Pakistan throughout the country towards the sustainable economic growth. In 2005, the Government of Pakistan introduced National Environmental Policy (NEP). The main objectives of NEP were to conserve and to restore and to protect the natural atmosphere of Pakistan, to improve the standard of living of the citizens by sustained economic growth. Economic development is reinforced by all sectors including industry, agriculture and services as well. The increasing economic growth in Pakistan is due to the development of the manufacturing sectors especially in contributing the country national savings[2].The economic growth in all sectors particularly in industrial sector; increased energy demand and resulted increase in environmental degradation (i.e. water pollution, air pollution, emissions etc.).

During 2002-2003, the total energy used by industrial sector is 36% whereas 33% is used by transportation.

In Pakistan, higher consumption of petroleum in transport sector is a major cause of high emissions of CO_2. Most of the CO_2 emissions are emerging from gas combustion mostly added by power production and consumption of coal adds approximately 50% of the CO_2 emissions of natural gas. Pakistan added 0.4% of total world CO_2 emissions in 2005, and this “contribution of emissions” is increasing day by day.

The purpose of the study is to examine empirically the Environmental Kuznets Curve (EKC) hypothesis in case of Pakistan, by analyzing data (time series) from year 1971 to 2010.

2. Literature Review

Emissions of CO_2 are directly associated with energy consumption since each extra energy consumption results in higher level of economic growth but it produces high emissions (Apergis & Payne, 2010). Ang (2007) discussed the link between output, energy consumption and pollutant emissions. The study found that all these variables were interrelated and thus the variables relation must to be analyzed for co-integration and Vector Error Correction (VEC) modeling. The empirics give data support a vigorous long relationship among variables. The causality result indicates that GDP has a casual impact on the consumption of energy and pollution in long run whereas; the outcomes of short-run indicated a unidirectional causality from energy consumption towards the GDP. This study was extended by Apergis and Payne (2010) by analyzing the casual link amongst energy consumption, CO_2 emission and GDP using a panel VEC model for six Central American countries (El Salvador, Cost Rica, Honduras, Guatemala, Panama and Nicaragua) for the period of 1971-2004 and also for eleven commonwealth countries (Azerbaijan, Armenia, Belarus, Kazakhstan, Georgia, Russia, Moldova, Tajikistan, Kyrgyzstan, Ukraine and Uzbekistan), respectively. For long run, the study concluded that, the energy consumption has significantly positive connection with emissions but the real GDP showed an inverted U shaped pattern related with EKC hypothesis. For short run, dynamic relation showed causality (unidirectional) from GDP and energy consumption towards emissions and bi-directional causality amongst real GDP and energy consumption. Whereas, in long run the causality (bi-directional) was found amongst energy consumption and real GDP.

Apergis and Payne (2010) adopting co-integration and unit root test approaches to discover the connection between energy consumption, CO_2 emissions, and GDP for twelve (12) Middle East and North America (MENA) countries for the period of 1981-2005. The results show that energy consumption has a significantly positive effect on emissions in the long run whereas real GDP revealed a quadratic relation with CO_2 emissions in total for this region. However, long run estimates of per capita income and its square respectively support the EKC hypothesis in most examined countries. The critical points are lower in several cases while higher in others, hence providing weak evidence in favor of EKC hypothesis. The policy implication of the MENA reveals that reduction in CO_2 emissions achieved in MENA countries showed economic development and the region proves that reduction in future CO_2 emissions might be attained at the same time as GDP achieved in MENA.

Hossain (2011) discussed about the significance of urbanization in the connection amongst trade, CO_2 emissions, GDP and consumption of energy. The exact outcomes demonstrate the dynamic causal connection between each one of these factors in the setting of recently industrialized nations (NIC: China, Brazil, Mexico, South Africa, India and Turkey) by utilizing data of period 1971-2007. Panel root outcomes show that factors are cointegrated of order 1, I(1). Johansen panel co-integration test outcomes give that there exist a co-integration vector error among the factors. The Granger Causality examination bolster that there was no indication of long run causal relationship, however there was unidirectional short run causality from GDP and trade openness towards CO_2 emanations, from GDP to energy consumption, from exchange receptiveness towards GDP, from urban populace to GDP, from trade openness to urbanization. The investigation found that the elasticity of CO_2 emission with a specific end goal to energy consumption was greater than the short-run. This infers energy consumption in NIC for 1971-2007 presents' increment in additional CO_2 emissions leaving a negative effect over environment. But as for GDP, trade openness and urbanization observed to be balancing out the environment over the long run. In addition to the above writing, there have been various studies talking about the hypothesized relationship of EKC.

3. Theoretical Model

The study used multivariate model analysis techniques to investigate the effect of energy consumption, urbanization, trade openness and per capita income on carbon emissions in case of Pakistan. The relationship among variables can be expressed as;

$$Ct = f\,(Y_t\,,\, Y_t^2\,,\, E_t\,,\, TR_t\,,\, U_t) \qquad (1)$$

Where C stands for carbon emissions (per capita), E is energy consumption, whereas, Y represents real GDP (per capita) and Y^2 refer to its square, U refers to urban population (as a share of total population), TR denotes trade openness (per capita). The relationship can be stated in an equation follows;

$$C_t = \beta_1 + \beta y\, Y_t + \beta_{Y^2}\, Y_t^2 + \beta_E\, E_t + \beta_{TR}\, TR_t + \beta_U\, U_t + \mu_t \qquad (2)$$

The study used log-linear model as it gives more efficient and appropriate results. In logarithmic form the equation (2) can be modified as follows:

$$\ln C = \beta_1 + \beta_Y \ln Y_t + \beta_{Y^2} \ln Y_t^2 + \beta_E \ln E_t + \beta_{TR} \ln TR + \beta_U \ln U_t + \mu_t \qquad (3)$$

Where μ_t is the error term, we constructed a hypothesis that, the economic activities cause a rise in energy consumption, resulting increase in the energy use. This leads us to expect that $\beta_E > 0$. The Environmental Kuznets Curve hypothesis suggests that $\beta_Y > 0$ and $\beta_{Y^2} < 0$. The trade openness $\beta_{TR} < 0$, if the production of the pollutant intensive products is decreased because of environmental regulations and take such products from developed countries which have flexible environmental laws. Other studies such as Grossman & Krueger (1991) and (Halicioglu, 2009)) claims that β_{TR} has positive sign ($\beta_{TR} > 0$) if industrial sector of developing countries are involved in producing more CO_2 emissions. Finally, population specifies the proxy urbanization through urban share of total population. Urbanization shows demographic growth on environment. This increase in urban population cause greater demand for energy which may result in more pollution. Therefore, we expect $\beta_U > 0$.

4. Methodology

4.1. Data

Data for the analysis covering the period of 1971-2010 and was selected due its easy accessibility. Data used for estimation purpose are GDP and energy consumption, carbon dioxide (CO2) and trade ratio. Data for the study had collected from World Development Indicator (WDI) where GDP per capita and its square respectively, (E) energy consumption, CO_2 emissions (C), trade openness (TR) ratio and urban population (U) of large cities as share of total population.

4.2. Estimation Strategy

4.2.1. Testing for Non-stationarity Property and Order of Integration

Analyzing the time series properties or non-stationary properties of the variables are imperatives, and the use of Ordinary Least Square (OLS) techniques with non-stationary variables can provide spurious outcomes. Thus, before further estimation of the variables, it is necessary to investigate stationary. For this purpose, the study used a unit root test (Dickey & Fuller, 1979) to examine the variable whether non-stationary, and if non-stationary the integration order is the same or not.

4.2.2. Augmented Dickey Fuller (ADF) Test

The Augmented Dicky Fuller (ADF) tests are applied for the existence of unit roots among the variables and determine the integration order of the variables. The ADF test requires the following equations;

$$\Delta y_t = \alpha_0 + \alpha_1 t + \theta y_{t-1} + \sum_{i=1}^{m} wi\Delta yt_{-1} + \epsilon_t \quad (4)$$

Where, Δ represents the difference operator, y represent the series being tested, t-1 shows the number of lagged differences and ϵ stand for error term

4.2.3. Bound Testing Approach for Co-integration

After the existence of the unit roots among the variables, the study applied autoregressive distributed lag (ARDL) model techniques to establish the long run relationships between energy consumption, CO_2 emissions, trade openness, per capita income and urbanization. ARDL approach is superior to co-integration since it provides more authentic results in case of small samples such as in our case. Unrestricted Error Correction Model (UECM) has flexibility to incorporate lags which captures the data creating method with agenda (general to specific) of specification (Laurenceson & UK, 2003).

The following UECM is employed for this study;

$$\Delta \ln C_t = \alpha_0 + \alpha_T T + \sum_{i=1}^{p} \varphi_i \Delta \ln C_{t-1} + \sum_{i=0}^{q} \chi_i \ln Y_t + \sum_{i=0}^{r} \sigma_i \Delta \ln Y_t^2 + \sum_{i=0}^{r} \varepsilon_i \Delta \ln E_t + \sum_{i=0}^{y} \omega_i \Delta \ln T_t + \sum_{i=0}^{s} \Omega_i \Delta \ln U_t + \lambda_c \ln C_t + \lambda_Y \ln Y_t + \lambda_Y^2 \ln Y_t^2 + \lambda_E \ln E_t + \lambda_{TR} \ln TR_t + \lambda_U \ln U_t + \mu_t \quad (5)$$

Where φ, χ, σ , ε and ω shows the short, and (λ_c , λ_Y , λ_Y^2, λ_E , λ_{TR} , λ_U) represents the long run connections amongst the variables. The null hypothesis (showing no-co-integration between variable) is

H_0: $\lambda c = \lambda Y = \lambda Y2 = \lambda E = \lambda TR = \lambda U = 0$.

whereas, the alternate hypothesis (showing co-integration between variables) is

H_1: $\lambda c = \lambda Y = \lambda Y2 = \lambda E = \lambda TR \neq \lambda U = 0$

The presence of co-integration relies on the calculated value of F-statistic.

4.2.4. Granger Causality

The Granger test suggests that Granger Causality exists at least in one direction if there is co-integration among the series in Eq (2) providing that the series are integrated order of one, i.e. I(1). Enger and Granger (1987) caution that the Granger Causality test based on the Vector Auto Regressive (VAR) technique in the first difference in the existence of long run relationship may produce inconsistent results in the existence of co-integration. So, adding a variable the Error Correction Term (ECT) will be helpful to check long run connection.

The error correction term formulated on the Granger Causality test in multivariate *p*th order vector error correction model.

$$(1-L)\begin{bmatrix} \ln C_t \\ \ln Y_t \\ \ln Y_t^2 \\ \ln E_t \\ \ln TR_t \\ \ln U_t \end{bmatrix} = \begin{bmatrix} \phi_1 \\ \phi_2 \\ \phi_3 \\ \phi_4 \\ \phi_5 \\ \phi_6 \end{bmatrix} + \sum_{i=1}^{p}(1-L)\begin{bmatrix} a_{11i} a_{12i} a_{13i} a_{14i} a_{15i} a_{16i} \\ b_{21i} b_{22i} b_{23i} b_{24i} b_{25i} b_{26i} \\ \delta_{31i} \delta_{32i} \delta_{33i} \delta_{34i} \delta_{35i} \delta_{36i} \\ \pi_{41i} \pi_{42i} \pi_{43i} \pi_{44i} \pi_{45i} \pi_{46i} \\ \theta_{51i} \theta_{52i} \theta_{53i} \theta_{54i} \theta_{55i} \theta_{56i} \\ \sigma_{61i} \sigma_{62i} \sigma_{63i} \sigma_{64i} \sigma_{65i} \sigma_{66i} \end{bmatrix} + \begin{bmatrix} \beta \\ \chi \\ \xi \\ \zeta \\ \rho \\ \psi \end{bmatrix} ECM_{t-1} + \begin{bmatrix} \eta_{1t} \\ \eta_{2t} \\ \eta_{3t} \\ \eta_{4t} \\ \eta_{5t} \\ \eta_{6t} \end{bmatrix} \quad (6)$$

(1-L) show lag operator, ECM_{t-1} is lagged error-correction term; Significant F-statistic provides evidence of the parameters of the 1^{st} differences series on short run causality direction, but the long run causality capture through t-statistic significance level pertaining towards ECM_{t-1}.

5. Results and Discussion

The fundamental step in this study was involved to examine the unit roots via augmented Dickey-Fuller test (Dickey & Fuller, 1979). Table 1 represents all variables were integrated of order I except for trade openness (TR), which indicates that all the variables were stationary at their first difference.

Table 1: Unit Root Estimation

Variables	Constant and Trend. At Level P value	Constant and Trend. At 1st difference P value	Order of Integration
lnC_t	0.5243	0.0000	I(1)
lnY_t	0.5160	0.0000	I(1)
lnY_t^2	0.6272	0.0001	I(1)
lnE_t	0.8145	0.0000	I(1)
$lnTR_t$	0.0005		I(0)
lnU_t	0.6332	0.0001	I(1)

The ARDL bounds test statistic requires lag length of variables. The lag length 2, selected using AIC as represented in Table 2.

Table 2: Criteria of selection of lag length : Var Lag Order Selection Criteria

Lag	LogL	R	FPE	AIC	SC	HQ
0	109.0412	NA	0.0001	-5.7245	-5.4605	-5.6323
1	110.6160	2.5371	0.0001*	-5.7356	-5.3826	-5.6489
2	111.2221	0.9428*	0.0001	-5.7345*	-0.3826*	-5.6117*

Note: * shows 10% level of significance

Table 3: **Co-integration Test Results**

Bounds Testing to Co-integration		Diagnostic Tests				
Estimated Models	**F-Statistics**	**B-Godfrey LM Test**	**ARCH LM test**	**Adjusted R^2**	**J-B Normality**	**Heteroskedasticity test**
$F_C(C/Y,Y^2,E,TR,U)$	12.0401	0.6536	0.5414	0.8488	0.0050	0.8340
$F_Y(Y/C,Y^2,E,TR,U)$	6.7080	0.4087	0.7627	0.6874	0.7146	0.8342
$F_{Y^2}(Y^2/C,Y,E,TR,U)$	5.4132	0.0547	0.6789	0.6280	0.6849	0.7561
$F_E(E/Y,Y^2,E,TR,U)$	8.7011	0.0639	0.7928	0.5770	0.9524	0.5830
$F_{TR}(TR/C,Y,Y^2,E,U)$	3.1220	0.4492	0.7842	0.4938	0.8742	0.5756
$F_U(U/Y,Y^2,E,TR,U)$	8.4743	0.0011	0.2809	0.9213	0.2603	0.2294

Significant Level	**Critical Values (T=40)**	
	Lower Bound I(0)	**Upper Bound I(1)**
1	3.8000	5.6432
5	2.7970	4.2110
10	2.3531	3.5412

The calculated value of F-statistic is sensitive to selected lag. Value of F-statistic is estimated from equation (5) using OLS. The value of F-statistic exceeds UCB, reference to the critical values which were provided by (Narayan, 2005). This confirms that there is co-integration among the variables at the 5 percent significance level.

Table 4 indicates that 1 percent rise in the consumption of energy increases the pollutants by 1.0997 per cent in long run. The result was similar to the findings of (Ozturk & Acaravci, 2010)) for Turkey. The coefficients obtained for GDP per capita linear and non-linear terms are 0.2434 and -0.0543 respectively, which confirms the presence of an EKC between per capita CO_2 emissions and economic growth in the case of Pakistan. Results provide some support in favour of EKC hypothesis that the pollution level increases at starting phases with income and stabilize, and decreases. Our study findings are broadly support the views of (Shafik, 1994) and (Selden & Song, 1995) who probed an inverted U-shape association amongst economic growth and pollution.

Table 4: Long Run Estimates

Dependent Variable= $\ln C_t$	**Coefficient**	**StdError**	**T-Statistic**	**Prob**
$\ln Y_t$	0.2434	0.2510	0.9701	0.3420
$\ln Y_t^2$	-0.0543	0.0417	-1.3012	0.2061
$\ln E_t$	1.0997	0.3411	3.2220	0.0042
$\ln TR_t$	0.2413	0.1024	2.3610	0.0270
$\ln U_t$	1.1313	0.2038	5.5501	0.0001
Diagnostic Tests				
Heteroskedasticity		0.9685		
Ramsey RESET		0.0021		
ARCH LM test		0.2266		

The study found positive association between the environmental degradation and trade openness. A 1 percent rise in foreign trade was likely to increase emissions by 0.2413 percent. It might be concluded that trade enhances economic growth (income per capita) which further impedes environmental in Pakistan by increased CO_2 emission. The outcome was consistent with the findings of Khalil & Inam (2006). They concluded that the international trade upsurges CO_2 emissions.

The effect of urbanization was significantly positive which implies that higher the urban population higher is the demand for energy consumption and hence increases emissions (CO_2). On the basis of our finding, a 1 percent increase in urban population will lead to an increase of 1.1313 percent in CO_2 emissions. The study result is according to our expectations ($\beta_{Ut}>0$).

The short run results are depicted in Table 5. The lagged ECM term has a negative and significant value at 5 percent level. Furthermore, the ECM value suggests that a change in CO_2 emissions (short to long run) equilibrium is adjusted by approximately 9 percent each year. Empirical results indicate that the consumption of energy leads to an increase in CO_2 emissions. A 1 percent increase in energy consumption increase emissions of CO_2 by 0.7337 percent. The sign of $\Delta \ln Y_t$ and $\Delta \ln_{Y_t}{}^2$, shows an inverted U shape connection amongst income and level of emissions. For a country, economic growth means to environmental improvement. That is, as an economy develops economically, moving from lower to higher per capita levels, overall environmental degradation eventually falls. (Linear and non- linear) terms of income are significant at 10 percent level of significance.

The results found positive link amongst environmental degradation and trade openness and was significant at 5 percent which means that, 1 percent increase in trade would lead to in CO_2 emissions by 0.2568 percent. This confirms that trade tends to extend the size of an economy with additional production and increases emissions. And coefficient of urban population is negative and insignificant. This implies that a 1 percent rise in urban population would lead reduce CO_2 emissions by 0.9033 percent.

Table 5: Short Run Estimates

Dependent Variable = ΔlnC_t	Coefficient	Std. Error	T-Statistics	Prob.
ΔlnY_t	-0.5975	0.3387	-1.7639***	0.0910
ΔlnY_t^2	0.1381	0.0696	1.9841***	0.0593
ΔlnE_t	0.7337	0.2424	3.0258*	0.0060
$\Delta lnTR_t$	0.2568	0.0543	4.7272*	0.0001
ΔlnU_t	-0.9033	2.5875	-0.3491	0.7302
ECM_{t-1}	-0.1107	0.0257	-4.3128	0.0003
Diagnostic Tests				
R^2				0.8057
Adjusted R^2				0.6959
F-statistic				7.3377
F-statistic Prob				0.0000
Akaike info				-6.1210
J-BeraNormality				0.8815
ARCH test				0.7949
Heteroscedisticity				0.2313
Durbin Watson				1.4127

The results found positive link amongst environmental degradation and trade openness and was significant at 5 percent which means that, 1 percent increase in trade would lead to in CO_2 emissions by 0.2568 percent. This confirms that trade tends to extend the size of an economy with additional production and increases emissions. And coefficient of urban population is negative and insignificant. This implies that a 1 percent rise in urban population would lead reduce CO_2 emissions by 0.9033 percent.

5.1. Stability Test and Sensitivity Analysis

The last stage of ARDL approaches is to check the stability of model. The diagnostic tests, the LM serial correlation test, normality of error term and the white heteroskedasticity, short run model clearly passed them. There was no evidence of white heteroskedasticity or autoregressive conditional heteroskedasticity. The Figure 1 of cumulative sum was significant at 5 percent (plots lies between the critical bounds) which depicts the stability of the parameters in the model.

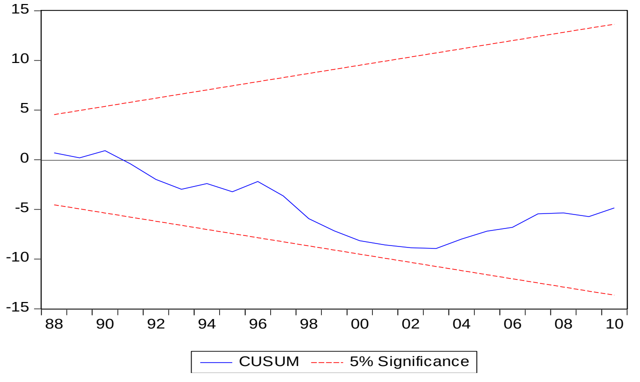

Figure 1: Plot of Cumulative sum of Recursive Residuals

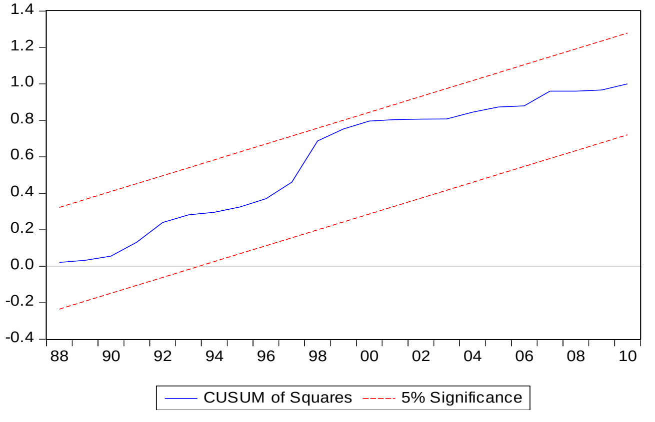

Figure 2: Plot of Cumulative sum of Squares of Recursive Residuals

5.2. VECM Granger Causality Analysis

Table 6 shows that, in long run, there exist bidirectional causality amongst economic growth and urbanization. We also found unidirectional causality from trade openness to economic growth, and from economic growth towards energy consumption, and from urbanization to trade openness.

In short run feedback hypothesis was found amongst economic growth and energy consumption. Urbanization and trade openness Granger causes to economic growth. The unidirectional causality was found from energy consumption to CO_2 emissions, from CO_2 emissions to economic growth and from economic growth to energy consumption. Overall results show that unidirectional causality was running from economic growth ($\ln Y_t$ and $\ln Y_t^2$) to CO_2 emissions in short and long run which lends support to the presence of the environmental Kuznets curve (EKC). These results were consistent with the findings of Maddison and Rehdanz (2008), Zhang and Cheng (2009) in case of China, in case of North America and Ghosh (2010) for India.

A significant of ECM_{t-1} for CO_2 emissions, economic growth and its square, and for energy consumption demonstrates the adjustment speed to the equilibrium in long run are (-0.1944), (-1.0050), (-4.4259), and (-0.1032) respectively, all equations were significant at 5 percent. The coefficient of urbanization is negative but insignificant.

Table 6: Granger Causality

Dependent Variable	Granger Causality types						
	Short Run						**Long Run**
	$\sum \Delta lnCt$	$\sum \lambda lnYt$	$\sum \Delta \ln Yt^2$	$\sum \Delta \ln Et$	$\sum \Delta lnTRt$	$\sum \Delta lnUt$	ECM_{t-1}
	F-Statistics						**Prob**
$\sum \Delta lnCt$	....	0.8806 (0.3480)	1.2033 (0.2727)	4.8413** (0.0278)	0.0001 (0.9918)	0.0757 (0.7832)	-0.1944 [-2.3548]
$\sum \lambda lnYt$	3.3932*** (0.0655)	....	2.6924 (0.1008)	1.3226 (0.2501)	5.3541** (0.0207)	4.1725** (0.0411)	-1.0051 [-5.5833]
$\sum \Delta \ln Yt^2$	2.0260 (0.1546)	1.8842 (0.1699)	....	1.6646 (0.1970)	2.8863*** (0.0893)	4.1450** (0.0418)	-4.4259** [-4.7902]
$\sum \Delta \ln Et$	1.1018 (0.2939)	3.1974*** (0.0738)	3.4430*** (0.0635)	....	0.0402 (0.8410)	0.2848 (0.5935)	-0.1033** [-2.3179]
$\sum \Delta lnTRt$	0.5100 (0.4751)	2.0240 (0.1548)	1.4606 (0.2268)	0.2273 (0.6335)	....	4.4140** (0.0356)	
	0.3680 (0.5441)	2.5680 (0.1090)	2.8393*** (0.0057)	0.4147 (0.5196)	0.2840 (0.5940)	....	-0.0003 [-0.0750]

*Note: Significance at 5% and 10 % level is indicated by **, *** .In the parentheses is the F-statistics probability*

6. Conclusions and Policy Recommendations

The findings confirmed a long-term relation between variables and gave indication in the favour of EKC in Pakistan. The significant existence of an inverted U-shape EKC reveals the effort of country to shorten CO_2 emissions. However this empirical analysis may not able to explain the actual environmental quality condition of Pakistan. The effective environmental regulations are necessary at the urban and rural levels. There is a need of strict laws and environmental taxes like green tax.

Moreover, trade openness positively affects environment quality in Pakistan. This might because of Pollution Haven Hypothesis (PHH). The outcome of this study suggest that Pakistan needs to replace dirty and obsolete technology by new and cleaner technology which will promote the production also improve the environmental quality due to technological progress, ceteris paribus.

The analysis of causality revealed that economic growth Granger causes CO_2 emission, also confirms the presence of EKC in Pakistan. Trade openness and urbanization Granger affects the economic growth. A rise in the level of income, trade openness, urban pollution/emissions and Granger cause economic growth thus supports trade-led-economic growth, urbanization-led-economic growth. Urbanization and economic growth granger cause one other. Whereas, short run two-directional causality was observed between economic growth and consumption of energy. Unidirectional causality from economic growth towards energy consumption was also found.

Our study findings suggest that Government of Pakistan should explore and introduce more renewable energy resources to sustain economic development and also protect the environment from depletion. More focus is required to implement efficient technologies and climate friendly policies to grow domestic manufacture and to mitigate adverse effect of CO_2 emissions and other GHG emissions on environment.

The prompt future as consequence of high urban populace does not appear to be brilliant. The principle reason is that urban populace will proceed unabated because of jobs in rural ranges. The present level of rural-urban movement is unmanageable, affecting the environment condition. Government ought to make arrangements for openings for jobs in rural ranges, finance small entrepreneurial skills in long and short run. In long-haul setting, accentuation ought to be set on human capital formation and need based skill creation.

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