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The Causal Nexus of Urbanization, Industrialization, Economic Growth and Environmental Degradation: Evidence from Pakistan

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ABSTRACT

The paper analyzes the causal relation between eeconomic growth, urbanization, industrialization and environmental degradation of Pakistan. The study used time series data for the sample span of 1975-2017, retrived from World Bank Development Indicators (WDI, 2017). Vector Auto Regressive (VAR) model is used for analyzing the causal link amongst the variables, namely economic growth, urbanization, industrialization and environmental degradation. The Granger causality test is used for identifying the order of the causal association. Before estimating VAR, Augmented Dickey Fuller (ADF) as well as Phillips Perron (PP) tests are used for confirming the stationarity characteristic of all variables, first with intercept and then, with intercept along with a linear deterministic trend. Akaike Information Criterion (AIC) is used for selection of optimum lag. The Johansen Cointegration test is adopted for identifying long run associations. The result of the VAR model reveals, If any innovation of one standard deviation from outside the model occurred, it will take about 13 years for CO2, 19 years for urbanization,16 years for industrialization and about 12 years for economic growth in adjustment. These results further indicate that most of the variation in all variables is explained in their own. The study confirmed two unilateral causalities, that is runs from CO2 to urbanization as well as economic growth. The findings of the research work propose that policy makers required to develop policy helpful to the environment which will encourage verifiable economic growth in Pakistan. The policy makers need to plan for environmental issue while making policies regarding urbanization, industrialization and economic growth.

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1. Introduction

Carbon Dioxide (CO_2) emission is a major component of Green House Gas (GHGs) emissions that is a major factor behind global warming and degradation of natural environment. Environmental degradation

increases since the 19th century, with the increasing trend of urbanization and industrialization so the issue of environmental degradation and its relationship with urbanization and industrialization has got much attention from researchers both in developed and developing countries.

Pakistan is also facing a higher trend of urbanization with 207.77million population, it has become the sixth most populous country in the world. The major reason behind the trend is the increase growth rate of population as well as migration. The rate of urbanization in Pakistan is 36.38%, which is projected to reach at 50% in the upcoming 15 years (Afzal et al., 2018). As much as industrial growth is concerned, it remains poor throughout the history. The government wants to achieve high growth rate of industrialization which is not satisfactory at present due to political instability, high tax burden and energy crisis. The economic growth of Pakistan remains volatile throughout the history (Pakistan Economic Survey, 2016-17). The main objective of the study is to analyze empirically causal link in economic growth, urbanization, industrialization with environmental degradation.

The rest of the paper is organized into five sections. Section 2 consists of the previous literature. Section 3 is about the data along with methodology. Section 4 presents the empirical results whereas Section 5 concludes the study and presents some policy implications.

2. Literature Review

Rich empirical work has been done on analyzing the causal link of many variables with CO_2 emissions like, Liu and Bae (2017) analyzed the causal association between industrialization, urbanization, per capita real GDP, intensity of energy with CO_2 emissions, and confirmed the long-term bidirectional causalities in industrialization, per capita real GDP with CO_2 emissions. Sarkodie and Owusu (2017) studied the causal link between industrialization, population, per capita GDP along with CO_2 emissions through the Granger causality test, and confirmed a unidirectional causal association of industrialization to per capita GDP, from population to industrialization as well as per capita GDP, from population towards CO_2 emissions. Al-Mulali and Ozturk (2015) confirmed the causal link in industrial development, urbanization and energyuse both in the short and long time period. Kasman and Duman (2015) used data of new European Union member countries and confirmed a unidirectional causal association of urbanization with CO_2 emissions**.** Likewise, Liddle and Lung (2014) found the same association in CO_2 emissions and urbanization for 105 countries, but they were unable to found granger causality in case of urbanization and electricity consumption.

Another group of researchers studied the causal link in economic growth, urbanization, with CO_2 emissions like, Xuemei et al. (2012) found a close relationship between these variables as confirmed, economic growth promotes urbanization and vice versa. Yansui et al. (2016) used data of China for the period of 1997 to 2010, studied the link between CO_2 emissions with economic growth as well as urbanization. The work was based on Panel co-integration test along with granger causality. The result showed the studied variables increase CO_2 emissions there. The results also suggested a two-way long term association in the variables, meaning that urbanization has causal effect over economy growth in the long period and these have a causal association with CO_2 emissions too. Jebli et al. (2015) found two-way causal association for economic growth with CO_2 emissions for 24 economies in Sub Saharan Africa, in the span of 1980 to 2010. The analysis was based on panel co-integration technique. Mingxing et al. (2014) presented a two-way causality of urbanization with economic growth. The conclusion of Xuemei et al., (2012) were also the same. Most of the studies are conducted on panel data for analyzing the causal association between urbanization, economic growth with CO_2 emissions like, Al Mulali et al. (2015) used heterogeneous panel data of 129 states for the span of 1980 to 2011. The researchers used economic growth, financial growth, urbanization, as well as CO_2 emissions in analysis. Interestingly, the result of Granger causality showed that due to financial development, all the variables have a direct impact on the environment, in the short and long run meaning that these variables does not increase CO_2 emissions. Al Mulali and Ozturk (2015) worked for 14 MENA states for the span of 1996 to 2012. The results of Granger causality confirmed short term and long term causal link among urbanization, industrial

development and environmental degradation**.**

Literature also analyzed a causal link of energy use with CO_2 emissions based on the idea that economic growth increases energy use that results to CO_2 emissions increase . Wang et al. (2011) used data of 28 provinces of China and presented bidirectional causality in economic growth, energy use with CO_2 emissions. Li and Cheng (2006) confirmed two-way causality for urbanization and economic growth whereas a Shahbaz et al. (2014) confirmed, urbanization along with economic growth causes increase in CO_2 emissions. Likewise, Yazdi and Shakouri (2014) used data of Iran for the period from 1975 to 2011 and worked on the association in energy consumption, economy growth, urbanization with CO_2 emissions**.** The study found a one-way causal linkage from urbanization towards CO_2 emissions**.** Vidyarthi (2014) worked on the data of five states of South Asian for the span of 1972 to 2009 and found a two-way association in economic growth with energy use, whereas a one-way causal association of CO_2 emissions with energy use. Omri (2013) used simultaneous equations model for studying the same association in MENA states, confirmed a two-way causal association for economic growth with energy use, whereas a one-way causal association of economic growth with CO_2 emissions**.** Likewise, Ang (2009) concluded that economic growth along with energy use contributes CO_2 emissions in China, Zhang and Cheng (2009) conducted a multivariate causal study in China and concluded a unidirectional causal association for energy use towards CO_2 emissions but not contributed towards economic growth. In addition, Hwang and Yoo (2014) concluded in Indonesia a two-way causal association in energy use with CO_2 emissions. For Saudi Arabia, Alshehry and Belloumi (2015) whereas for French, Ang (2007), confirmed a causal association in energy usage, economic growth with CO_2 emissions**.** Apergis and Payne (2010) found this association in ASEAN economies. Lotfalipour et al. (2010) presented a one-way causal association in energy use , gross domestic product with CO_2 emissions.

Interestingly, Samuel and Abu (2017) found a trade-off for economic growth with CO_2 emissions for Nigeria. They found that whenever GDP per capita increases, it also increases CO_2 emissions while when CO_2 emissions increase, it did not contribute to economic growth. In Pakistan, studies like Mukhopadhyay and chakraborty, (2005); Bukhari, (2012) has done on the impact of macroeconomic variables such as trade openness, population growth, urbanization on environmental degradation. Asjad and Aqeel (2014) found a one-way causal association among GDP, population growth, energy usage with CO_2 emissions.
In table 1 the summary of the previous research work done about the causality in economic growth, urbanization, industrialization with CO_2 emissions for developed as well as developing countries is presented. The purpose of the present work is to analyze the causal link in CO_2 emissions, urbanization, economic growth and industrialization in case of Pakistan.

Table: 1 Summary of research work done about causality in economic growth, urbanization, industrialization, and environmental degradation

Authors	**Sample and time period**	**Variables**	**Methodology**	**Results**
Zhang and Cheng (2009)	China (1960-2007)	CO_2 emissions, GDP, energy use	multivariate model, Granger causality test	Unidirectional causal association of GDP with energy use, of energy use with CO_2 emissions
Hossain (2011)	Newely industrialized countries (1971-2007)	CO_2 emissions, energy use, Economic growth, urbanization.	Fisher panel cointegration test, Granger causality test	Unidirectional relationship of urbanization with economic growth. Unidirectional relationship found of economic growth with CO_2 emissions, urbanization, as well as energy consumption

Omri (2013)	Fourteen MENA Countries (1990-2011)	CO_2 emissions, GDP, energy use.	Simultaneous equations model	Bidirectional causal association of energy use with GDP. Unidirectional causal association of CO_2 emissions with GDP.
Liddle and Lung, (2014).	105 countries(1971-2009)	CO_2 emissions Urbanization, electricity use	Cointegraton, Granger causality test	Granger causality from urbanization to electricity usage.
Vidyarthi (2014)	Five Asian countries (1972-2009)	Energy use, CO_2 emissions, Economic growth.	Granger causality test	Bidirectional causality for energy usage with economic growth. Unidirectional causal association in energy use with CO_2 emissions in long term.
Alshehry and Belloumi (2015)	Saudi Arabia	CO_2 emissions, Economic growth, energy prices, energy use	Granger causality test	Unidirectional relationship exists from emissions of CO_2 to price of energy and economic growth in short period. Unidirectional causal association in energy use, emissions of CO_2 emissions and GDP in long period.
Asjad and Aqeel (2014)	Pakistan	CO_2 emissions, GDP per capita, energy consumption, population growth.	Granger causality test	Unidirectional causality found in the variables
Saidi and Hammami (2015)	six oil-exporting countries (1990-2012)	CO_2 emissions, GDP, energy usage.	GMM model Bootstrap panel Granger causality test,	Two way granger causality for UAE for economic growth and CO2.
Al-Mulali and Ozturk (2015)	Fourteen MENA states (1962-2012)	Urbanization, energy use, industrial development.	fully modified OLS, Granger causality test	All the variables have short and long term causalities.
Sarkodie & Owusu (2017)	Rwanda (1965-2011)	CO_2 emissions, GDP per capita, population, industrialization.	ARDL, Granger causality test	Unidirectional causality found for industrialization to per capita GDP, population towards GDP per capita, population towards industrialization, population towards CO_2 emissions.
Liu and Bae (2018)	China (1970-2015)	CO2 emissions, real GDP, industrialization, urbanization, energy consumption.	ARDL, VECM	All variable have positive impact on CO_2 emissions. Granger causality exists in Industrialization, energy consumption and CO_2

3. Data and Empirical Method

3.1 Data Source and Variables

The research study is based upon time series data for the span of 1975 to 2017 that is retrived from World Bank Development Indicators (WDI, 2017). The main variables that are employed in the study are economic growth, which is represented by a percentage growth in real GDP, urbanization represented by urban population as a percentage of the total population, industrialization represented by industry including construction value added whereas for environmental degradation, CO_2 emissions is used as a proxy. VAR model is used for identifying causalities among the macroeconomic variables, namely economic growth, urbanization, industrialization, CO_2 emissions with granger causality test for identifying the directions of causalities in the studied variables.

3.2 Model Specification

The causal link between CO_2 emissions with macroeconomic variables has been analyzed by different econometric techniques. The present study follows the analytical techniques used by Zhao and Wang (2015). Prior to conducting econometric techniques, the data are analyzed for stationarity through Augmented Dickey- Fuller (1979) along with Phillips and Perron(1988) tests, both with intercept and with a linear deterministic trend. Stationarity of the variables allow us to use co-integration test for identifying long run association in the variables. For this purpose, Johansen co-integration (1991, 1995) test is used. The Impulse Response Function (IRF) and variance decomposition is used to examine the vibrant impact of the errors on the variable's system. Granger causality test is used for identifying the direction of causality amongst the variables.

The paper deals with the empirical investigation of the causal relationship between economic growth, urbanization, industrialization and environmental degradation using Pakistan data. We hypothesis our model for empirical analysis pursuing Zhao and Wang (2015), Liddle, B., & Lung, S. (2014). More specifically, the general functional form the model is:

$$CO_{2t} = \alpha_{it} + \sum_{j=1}^{k} \alpha_j \, Ur_{t-j} + \sum_{j=i}^{k} \beta_j \, Ind_{t-j} + \sum_{j=i}^{k} \gamma_j \, CO_{2t-1} + \sum_{j=i}^{k} \vartheta j \, Eg_{t-j} + \mu_t \qquad (i)$$

$$Ur_t = \alpha_{it} + \sum_{j=1}^{k} \alpha_j \, Ur_{t-1} + \sum_{j=i}^{k} \beta_j \, Ind_{t-j} + \sum_{j=i}^{k} \gamma_j \, CO_{2t-j} + \sum_{j=i}^{k} \vartheta j \, Eg_{t-j} + \mu_t \qquad (ii)$$

$$Ind_t = \alpha_{it} + \sum_{j=1}^{k} \alpha_j \, Ur_{t-j} + \sum_{j=i}^{k} \beta_j \, Ind_{t-1} + \sum_{j=i}^{k} \gamma_j \, CO_{2t-j} + \sum_{j=i}^{k} \vartheta j \, Eg_{t-j} + \mu_t \qquad (iii)$$

$$Eg_t = \alpha_{it} + \sum_{j=1}^{k} \alpha_j \, Ur_{t-j} + \sum_{j=i}^{k} \beta_j \, Ind_{t-j} + \sum_{j=i}^{k} \gamma_j \, CO_{2t-j} + \sum_{j=i}^{k} \vartheta j \, Eg_{t-1} + \mu_t \qquad (iv)$$

Where CO_2 is representing Carbon Dioxide Emissions, Ur represents urbanization, Ind stands for industrialization, Eg represents economic growth, k represents lag length and ut represents error term.

3.3 Empirical Results

- **Result of ADF and Phillips- perron (PP) unit root tests**

  For stationarity analysis, we use Augmented Dickey-Fuller (ADF) 1979 and Phillips and Peron (1988) tests. The mathematical form of ADF test is

$$\Delta z_t = \partial z_{t-1} + \acute{y} \, \sigma + \epsilon_t \qquad (v)$$

  Where $\partial = \rho\text{-}1$ $-1 \leq \rho \leq 1$, with hypothesis as under:

$$H_0: \partial = 0 \; or \; \rho = 1$$

$$H_1: \partial < 0 \; or \; -1 \leq \rho \leq 0$$

Phillips- Perron (PP) test is used to adjust the coefficiat (t-ratio) of the ADF test, when test statistic distribution got affected by any serial correlation. The PP test is presented as

$$t_{\partial}^{'} = t_{\partial}\left(\frac{\gamma_0}{f_0}\right)^{1/2} - \frac{T(f_0-\gamma_0)\left(se(\hat{\partial})\right)}{2f_0^{\frac{1}{2}}s} \quad (vi)$$

Where γ_0 is the appraisal of error variance while $f_0$is the zero occurrence of error. Table 2 represents the results of the above mentioned tests. The table shows that economic growth is stationary at level whereas urbanization, industrialization as well as CO_2 emissions were non stationary that are converted into stationary after taking the first difference in both tests.

Table. 2 Results of Unit root test

Variables	Result ofADF test		Result of PP- test	
	Intercept	Intercept and Trend	Intercept	Intercept and Trend
Eg	-11.136*	-11.910*	-9.283*	-11.271*
Ur	0.379	-0.818	0.264	-1.383
	-7.281*	-7.306*	-7.277*	-7.247*
Ind	-2.511	-2.705	-2.322	-2.537
	-7.210*	-7.174*	-8.021*	-8.492*
CO_2	-2.235	-2.149	-4.043	-1.741
	-7.627*	-8.259*	-7.627*	-17.127*

*Significant at 1% significance level

3.4 Cointegration Test

For identifying the presence of long term association in the used variables, Johansen(1988) presented two likelihood ratio tests that are maximum Eigen value and trace statistics. These tests are represented in two equations:

$$J_{max} = -Tln\left(1-\widehat{\lambda_{r+1}}\right) \quad (vii)$$

$$J_{trace} = -T\sum_{i=r+1}^{n}\ln(1-\hat{\lambda}_i) \quad (viii)$$

Where in T both equations represent the size of the sample, λ^i is the ith largest known associations. Table 3 shows the results of cointegration test. The results show that for all 4 variables, the null hypothesis of no cointegration is rejected at 1% significance level.

Table. 3 Results of Cointegration test

A. Hypothesis		Trace Statistics	
N.Hypothesis		Statistic	Critical Value
r = 0	r = 1	73.92*	47.86
r ≤ 1	r = 2	31.84*	29.80
r ≤ 2	r = 3	17.74*	15.06
r ≤ 3	r = 4	6.74*	3.84

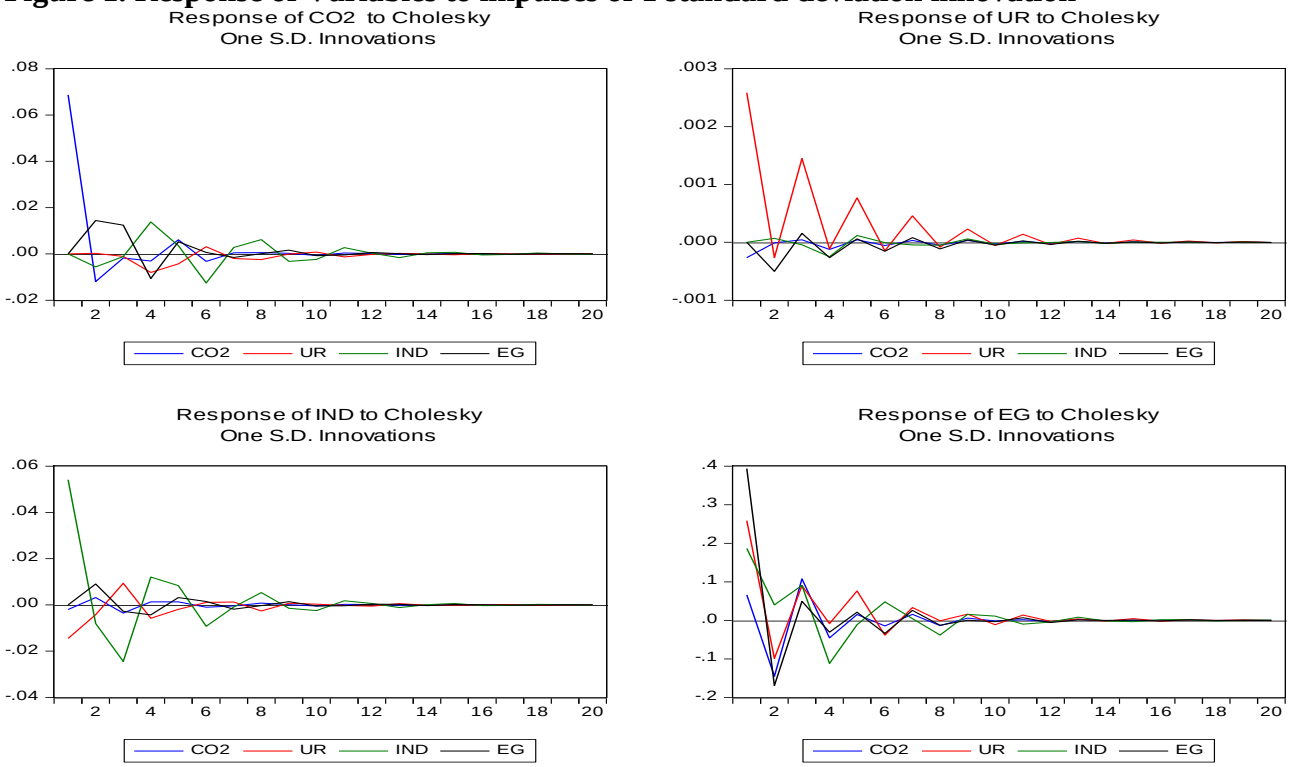
Levels of significance: *p < 0.01

3.5 Impulse Response Function (IRF) Results

IRF is used to know about the response of dependent variables to any change or innovation in error term. Figure (1) presents the estimation of 4 variables that are, CO_2 emissions, urbanization, industrialization, economic growth in IRF terms to unitary innovation or shock from outside. The graphs show that if one standard deviation innovation or shock occurs from outside, the CO_2 will takes 13 years, urbanization will takes 19 years, industrialization will take 16 years and economic growth will takes 12 years to

absorb the shocks.

Figure 1. Response of Variables to impulses of 1 standard deviation innovation



3.6 Variance Decomposition Results

Variance decomposition analysis is used to identify that how much of the variations in dependent variable are lagged by there own variance and by other variables. Table 4 shows the variance decomposition of the employed variables. The first group referred to the values of variance decomposition of CO_2.The values of standard error (S.E) values which is explained by CO_2 itself ranging from 100% to 82%. Economic growth is also explaining much of variations in CO_2, ranging from 4.09% to 8.52%. Similarly, the variation in CO_2 explained by industrialization and urbanization are ranging from 0.62% to 7.62% and 0.02% to 1.74% respectively. The second group represents the values of variance decomposition of urbanization. The values of standard error explained by urbanization itself, ranging from 99% to 94%. The second variable that explains most of the variation in urbanization is economic growth that explains 3.57% to 3.84% variation. Similarly, CO_2 explains 1.04% to 0.95% variation and industrialization explained 0.06% to 0.89% variation in urbanization. In a similar way the values of the variance decomposition for industrialization and economic growth can be interpreted.

Table 4. Values of Variance Decomposition

Variance Decomposition of CO_2

Period	S.E.	CO_2	Ur	Ind	Eg
1	0.0687	100.0000	0.0000	0.0000	0.0000
2	0.0713	95.2936	0.0012	0.6159	4.0894
3	0.0725	92.4464	0.0224	0.6217	6.9096
4	0.0751	86.4072	1.1595	3.9799	8.4535
5	0.0757	85.6066	1.4681	4.1339	8.7914
6	0.0769	83.2002	1.5832	6.6833	8.5333
7	0.0761	83.0070	1.6455	6.7951	8.5524
8	0.0772	82.4011	1.7333	7.3760	8.4896
9	0.0774	82.2217	1.7296	7.5311	8.5168
10	0.0774	82.1319	1.7361	7.6154	8.5158

Variance Decomposition of Ur

Period	S.E.	CO_2	Ur	Ind	Eg
1	0.0026	1.0421	98.9578	0.0000	0.0000
2	0.0027	0.9951	95.3750	0.0642	3.5657
3	0.0030	0.7886	96.1344	0.0702	3.0068
4	0.0031	0.9367	94.6304	0.7297	3.7032
5	0.0032	0.8984	94.7619	0.8279	3.5117
6	0.0032	0.9254	94.5247	0.8244	3.7255
7	0.0032	0.9150	94.5502	0.8258	3.7090
8	0.0032	0.9383	94.3863	0.8475	3.8278
9	0.0032	0.9429	94.3576	0.8760	3.8234
10	0.0032	0.9501	94.3198	0.8863	3.8439

Variance Decomposition of Ind

Period	S.E.	CO_2	Ur	Ind	Eg
1	0.0561	0.1296	6.7216	93.1488	0.0000
2	0.0576	0.4288	6.9157	90.1731	2.4824
3	0.0635	0.6687	7.8809	89.2175	2.2329
4	0.0650	0.6779	8.3033	88.4470	2.5718
5	0.0657	0.7038	8.2256	88.3215	2.7491
6	0.0663	0.7111	8.0835	88.4619	2.7435
7	0.0663	0.7149	8.1064	88.3589	2.8198
8	0.0666	0.7221	8.1950	88.2840	2.7988
9	0.0666	0.7214	8.1986	88.2390	2.8411
10	0.0667	0.7256	8.1885	88.2436	2.8422

Variance Decomposition of Eg

Period	S.E.	CO_2	Ur	Ind	Eg
1	0.5107	1.6656	25.6034	13.3006	59.4304
2	0.5674	7.9035	23.7860	11.2723	57.0382
3	0.5935	10.5154	24.0396	12.6282	52.8167
4	0.6065	10.6401	23.0406	15.4812	50.8382
5	0.6119	10.5116	24.1891	15.2418	50.0574
6	0.6161	10.4247	24.2526	15.6373	49.6854
7	0.6178	10.4335	24.4099	15.5591	49.5976
8	0.6192	10.4328	24.2954	15.8647	49.4071
9	0.6197	10.4274	24.3282	15.9044	49.3400
10	0.6199	10.4211	24.3461	15.9235	49.3094

Cholesky ordering: CO_2 Ur Ind Eg

3.7 Granger Causality Results

Granger causality test (1969) is adopted for identifying the directions of causal link in these variables. Once, long run cointegration is confirmed in variables, then the Granger unidirectional or bidirectional causality test can make clear the direction between the used variables Feng et al. (2009). The estimates of granger causality are given in table5. The results identify two unilateral causalities. One is running from CO_2 to urbanization and the other is from CO_2 to economic growth.

Table 5. Results of Granger Causality

Null Hypothesis	F-ratios	Prob.
UR ≠ CO_2	1.83816	0.1737
CO_2 ≠ UR	5.81056	0.0065
IND ≠ CO_2	0.39351	0.6776
CO_2 ≠ IND	0.25946	0.7728

EG ≠ CO_2	0.77482	0.4683
CO_2 ≠ EG	3.75681	0.0330
IND ≠ UR	0.33006	0.5230
UR ≠ IND	2.09155	0.1382
EG ≠ UR	2.30943	0.1139
UR ≠ EG	1.44316	0.2495
EG ≠ IND	0.16602	0.8477
IND ≠ EG	0.82584	0.4460

Note: ≠ represents null hypothesis i.e., does not Grangers cause

4. Concluding Remarks

Economic growth is the desire of every country. The role of urbanization and industrialization cannot be ignored in the growth process of a country. The macroeconomic variables urbanization, industrialization, economic growth are associated with CO_2 emissions too. The purpose of this work is to analyze any causal association in urbanization, industrialization, economic growth with CO_2 emissions. The results of VAR model indicate that if innovation of 1 standard deviation is given, it takes about 13 years for CO_2, 19 years for urbanization, 16 years for industrialization and 12 years for economic growth to adjust. It follows that in Pakistan the policies regarding economic growth, industrialization, urbanization and CO_2 emissions are not effective as it takes much longer time to adjust. Furthermore, the case of urbanization is much alarming, therefore special attention is needed in policy formulation for urbanization, and further the policy must be objective oriented and also proper check on its implementation is required. In addition, for all variables, the causality result indicates that the response of every variable to their own shock/ innovation was much better as compare to shock in other variables. Granger causality results identify only two unilateral causalities, that is from CO_2 emissions towards economic growth, and urbanization. There found no bidirectional causality and independent type relationships were found in economic growth and urbanizations, economic growth with industrialization, urbanization with industrialization and industrialization with CO_2 emissions. The issue of CO_2 emissions must not be ignored at the time of framing policy for industrialization.

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