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Effect of Energy Consumption on Environment: A Case Study of China

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Abstract

The issue of environmental degradation was forced by significant energy consumption. This study examined the effect of energy consumption on environmental degradation in People's Republic of China region. To explore the relationship between dependent variables Carbon emission CO2 and independent variables Domestic Investment, Primary Energy Consumption, Population, FDI, Trade. The annual time series data used from 1990 till 2020. In this research, the study applied Ordinary Least Square Method (OLS), and Granger Causality Test. The result of OLS of model shows that there is a significantly positive impact of energy consumption, Population, Domestic Investment and, Trade on carbon emission CO2 and FDI negative impact on Carbon emission CO2. Findings of the study suggest that to reduce the positive effects of energy use on CO2 emissions, environmentally friendly technology should be promoted alongside increases in energy efficiency.

Key Words: Environmental Degradation; Primary Energy Consumption; Saving Rate; OLS; Granger Causality Test.

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Introduction

CO2 emission is a global issue, and the entire globe is at risk of the consequences of poor environmental quality. CO2 emission is one of the primary sources of greenhouse gas emissions, and it has received a lot of attention in the last year. The usage of Fossil Fuels like Coal, Oil, and Gas is responsible for the majority of CO2 emissions. CO2 emissions in a country are influenced by a variety of factors such as Income (IN), Energy-Consumption, Population, and so on. As a result, knowing the reasons for emerging nations' CO2 emissions is critical for policymakers.

China's energy consumption was 3249.4 million tonnes of standard coal equivalent (tce) in 2010, surpassing that of the United States for the first time, and is expected to surpass it by 68 percent in 2035. Meanwhile, China is one of the top three countries in the world in terms of coal-related emissions, surpassing the United States in 2006.

Literature Reviews:

Rahman et al(2021), Over the period 1979 to 2017, this article examines the effects of economic development, energy usage, exports, and human capital on the environmental quality of NICs. We used the DOLS, FMOLS, and PMG estimation techniques with the panel cointegration estimation approach. Economic growth as well as human capital increased in the long run, whereas energy use and exports degraded environmental quality. The energy variable's long-run elasticity is approximately one. The DOLS and PMG methodologies yield comparable results, indicating that economic growth has the greatest impact on CO2 emissions, followed by energy usage, human capital, and exports. The EKC hypothesis was not discovered in NICs, according to the study.

Zaman et al (2021), the association among education spending, female employment, renewable energy usage, and CO2 emissions in China is experimentally investigated. The study examined data from 1991 to 2015, a total of 25 years. To derive empirical findings, econometric techniques like ADF, P.P, Bound test, ARDL, and completely FMOLS were used. The bound test demonstrates a long-term link between the variables under consideration. Education spending, female employers, and renewable energy usage all have a negative relationship with CO2 emissions, according to the ARDL model's estimates. To examine the robust influence of independent factors on the study's dependent variable, the fully modified ordinary least square (FMOLS) method was utilised.

Agbede et al. (2021), studies how energy usage affects environmental quality in MINT nations, by using panel data from 1971 to 2017, and data analyzed by Panel PMG /

ARDL, and Granger Causality tests. Variables used in these studies are, Ecological

FootPrint, Real GDP, Primery Energy Consumption, Urbanization, and Bio-capacity. The empirical findings support the presence of a long-run relationship between the variables. Economic development, energy consumption, and bio-capacity all have a positive and statistically significant influence on environmental deterioration over time, according to the findings.

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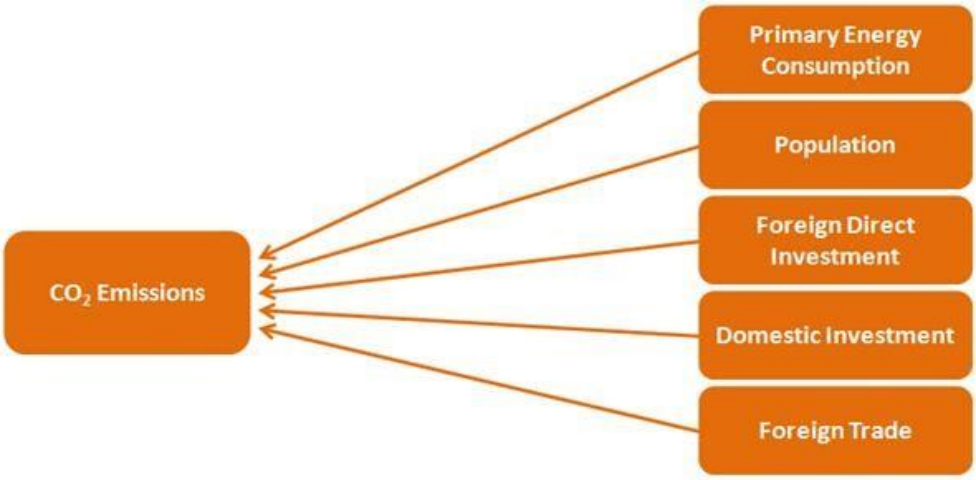
Zang and Zang (2021), by utilizing the method of VECM and Granger Causality to observe the effect of Tourism, Energy Consumption and GDP growth on CO2 emission in Case of China by using Time series data of different variables from 2000 till 2017, and data consist on, CO2 Emission, GDP growth, Tourism and Energy Consumption. The results indicate the bidirectional short-term causalities between GDP and tourism were statistically validated, according to the study. We also discovered bidirectional long-run causalities between CO2 emissions and GDP, CO2 emissions and tourism, and GDP and tourism, as well as unidirectional short-run causalities going from energy consumption to other examined variables.

Munir and Riaz (2020), empirically examine the impact of energy consumption on CO2 emission in case of Australia, USA and China, by utilizing the Panel data starting from 1975 till 2018. The study also used methodology of Non-Linear ARDL for the purpose of Long-Short Run Results. The panel data consists of different variables like CO2 emission, Coal Consumption, Gas Consumption, Oil Consumption, and electricity consumption are analyzed. The results of NARDL indicate that, increases in oil and coal consumption in Australia, oil, gas, as well as power consumption in China, and oil, coal, and gas consumption in the United States all contribute to increased carbon dioxide emissions in the long run, according to the findings.

Khan et al (2019), scrutinize the globalization, Energy consumption, and Economic factors impact on CO2 emission in the South Asian country Pakistan, by utilizing time series data from 1972 to 2018, time series data was analyzed by using dynamic ARDL. Data of different variables like CO2 emission, Fossil Fuels, urbanization, financial development, gdp percapita. Innovation, and trade. The Results of Dynamic ARDL indicate that, Energy consumption, financial development, trade, foreign direct investment, economic globalisation, social globalisation, and political globalisation all have a beneficial impact on CO2 emissions in Pakistan, but urbanisation, economic growth, and innovation all have a negative impact.

In the study of Majumder (2019), the influence of foreign direct investment on domestic investment, trade, education, labour force participation, and energy consumption in Bangladesh is investigated. For this purpose annual time series data is utilized from 1972 to 2015 and applied ARDL and ECM approaches on data of Domestic Investment, FDI, Saving Rate, GDP per Capita, Technology, Real Interest Rate and Energy Consumption. The findings reveal that foreign direct investment has a favourable impact on the country's domestic investment, education, labour force, and energy consumption. It indicates that FDI helps to promote the economy by assisting local investment, raising education levels, and increasing energy consumption.

Framework



Mathematical Equation

$CO_2 = f\ (PEC, POP, FDI, DI, TRADE)$

Econometric Equation

$CO_2 = \beta 0 + \beta 1\ PEC + \beta 2\ POP + \beta 3\ FDI + \beta 4\ DI + \beta 5\ TRADE + €$

Where;

CO_2	=	Carbon Dioxide Emission
PEC	=	Primary Energy Consumption (Total)
POP	=	Population Growth
FDI	=	Foreign Direct Investment
DI	=	Domestic Investment
TRADE	=	Foreign Trade
β0	=	Intercept
β1 β2 β3 β4 β5	=	Slope of Coefficient
€	=	Error Term

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Table:1 Variables Measurement

Sr.	Variables	Measurement	Sources
1	CO_2 Emission	Metric Ton Per Capita	World Bank (WDI)
2	Primary Energy Consumption	QBTU	US EIA
3	Population Growth	Annual %	World Bank (WDI)
4	Foreign Direct Investment	Net Inflow % of GDP	World Bank (WDI)
5	Domestic Investment (GFCF)	% of GDP	World Bank (WDI)
6	Foreign Trade	% of GDP	World Bank (WDI)

Summary of Variables

RESULTS AND DISCUSSION

Descriptive Statistics

Descriptive statistics is a technique used to summarize the major characteristic of collected data. Results of Descriptive statistics of dependent variable and independent variables are given in the Table.

Table: 2 Summary of Descriptive Statistic

	CO2	PEC	POP	FDI	DI	Trade
Mean:	0.614387	1.840302	0.111089	0.486236	1.569306	1.611737
Median:	0.649673	1.873245	0.115184	0.545678	1.587997	1.585769
Maximum:	0.87126	2.180725	0.149505	0.791472	1.648543	1.809418
Minimum:	0.282065	1.452921	0.055067	0.01488	1.380008	1.385126
Std. Dev:	0.217204	0.263167	0.027592	0.209627	0.071161	0.109406
Skewness:	-0.10703	-0.06879	-0.41459	-0.84325	-0.88661	0.127248
Kurtosis:	1.347678	1.387716	2.118488	2.742935	3.154277	2.412281
Jarque-Bera:	3.585653	3.382082	1.89179	3.759217	4.092166	0.529817
Probability:	0.166489	0.184328	0.388332	0.15265	0.12924	0.767276
Sum:	19.04598	57.04935	3.443768	15.07332	48.64849	49.96385
Sum Sq. Dev:	1.415331	2.077704	0.022839	1.3183	0.151916	0.359089
Observations:	31	31	31	31	31	31

Above table, shows the summary of Descriptive Statistics of selected variables. The first row shows the average of CO2, PEC, POP, FDI, DI, and Trade are (0.614387), (1.840302), (0.111089), (0.486236), (1.569306), and (1.611737) in the order. The Median value of CO2, PEC, POP, FDI, DI, and Trade are (0.649673), (1.873245), (0.115184), (0.545678), (1.587997), and (1.585769) are in the order. Next row shows the maximum values of the selected variables and also shows the minimum values of the data of selected variables. Further the table shows the values of skewness and kurtosis. Skewness corresponds to an inequity and irregularity from the mean of a data distribution in statistics. If we declare that data distribution is skewed, the mean is straight in the middle & top point of the bell curve and the mean, median and mode are same. In a normal distribution of data and entirely balanced bell curve, the median and mean are forever the similar value. Here we see that; CO2, PEC, POP, FDI, and DI, are negatively skewed, because their values of mean are less than their values of median. While, only Trade variable is skewed positively, because their values of mean are greater than their values of median. Now; the next row presents the values of kurtosis. Kurtosis is used to calculate the smoothness of data set relative to normal distribution. Kurtosis's value of normal distribution is equal to 3. If the kurtosis value is greater than 3, it means probability distribution is highly peaked and known as Leptokurtic. If the value of kurtosis is a smaller amount than 3, it means probability distribution showing flatness of data and it is known as Platykurtic. Here in the table above, only the value of Kurtosis of DI is greater than 3, so this variable is Leptokurtic. And the values of Kurtosis of CO2, PEC, POP, FDI, and Trade are less than 3, so these variables are Platykurtic.

Serial Correlation LM Test:

The problem of Autocorrelation is tackled by Serial Correlation LM test. According to this test, significant value shows the existence of autocorrelation and insignificant value shows does not existence of autocorrelation. The results of Serial Correlation LM test are given in the below:

Table: 4 Breusch – Godfrey Serial Correlation Test:

F-Statistic:	1.026995	Prob. F(221):	0.3754
Obs* R^2:	2.672843	Prob. Chi – Square:	0.2628

Results of Serial LM Test

The results indicate that, the probability values of LM test is insignificant (0.3754), this shows that the problem of Autocorrelation does not exist in the data set.

Heteroskedasticity Test:

The problem of Heteroskedasticity is tackled by Breusch – Pagan – Godfrey Test. According to this test, significant value shows the existence of Heteroskedasticity and insignificant value shows does not existence of Heteroskedasticity. The results of Breusch – Pagan – Godfrey Test are given in the below:

Table: 5 Breusch – Pagan – Godfrey Test:

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F-Statistic:	1.208650	Prob. F(623):	0.3374
Obs* R^2:	7.191517	Prob. Chi – Square:	0.3035

Results of Breusch – Pagan – Godfrey Test

The results indicate that, the probability values of Heteroskedasticity test is insignificant (0.3374), this shows that the problem of Heteroskedasticity does not exist in the data set.

Empirical Results OLS

In table the value of coefficient of Primary Energy Consumption (PEC) explains the positively significant (0.0000) impact on CO2 Emission. Empirical result shows that, 1 unit increase in Primary Energy Consumption, it will lead (0.774264) percentage increase in CO2.

Table: 6 Results of Ordinary Least Square (OLS) (Effect of PEC on CO2)

Dependent Variable: CO2

Variables:	Coefficient	Std. Error	t-Statistic	Prob.
PEC:	0.774264	0.098501	7.860495	0.0000
POP:	0.890850	0.171594	5.191620	0.0000
FDI:	-0.028814	0.012375	-2.328279	0.0290
DI:	0.043454	0.088380	0.491670	0.2276
Trade:	0.060021	0.010600	5.662195	0.0000
CO2 (-1):	0.170905	0.087875	1.944868	0.0641
C:	-0.855511	0.068660	-12.46013	0.0000

R^2:	0.998597	Adjusted R^2:	0.998232
Durbin-Watson Stat:	2.168303		

The value of coefficient of Population (POP) shows the positively significant (0.0000) impact on CO2 Emission. Empirical result shows that, 1unit increase in POP it will lead (0.890850) percentage increase in CO2. The value of coefficient of FDI also shows the significantly (0.0290) negative impact on CO2 Emission. Empirical result shows that, 1unit increase in FDI it will lead (-0.028814) percentage decrease in CO2 Emission. The value of coefficient of Domestic Investment (DI) also shows the insignificantly (0.2276) positive impact on CO2 Emission. Empirical result shows that, 1unit increase in DI it will lead (0.043454) percentage increase in CO2 Emission. The value of coefficient of Trade also shows the significantly (0.0000) positive impact on CO2 Emission. Empirical result shows that, 1unit increase in Trade it will lead (0.060021) percentage increase in CO2 Emission.

Conclusion:

The main objective of present study is to investigate the effect of Energy Consumption on environment in China. This study used the annual time series data of People's Republic of China over the period of 1990 to 2020 collected from different data bases. The study employs Ordinary Least Square test for relationship among variables and Granger Causality Test is for bidirectional relationship. Firstly; the study finds the result of descriptive statistics. Secondly, the present study analyses Pair wise correlation matrix results which show that there is no multicollinearity in the data. The study also analyses autocorrelation and heteroskedasticity results which indicate that this problem is not exist. Empirical results indicate several crucial findings. In the Model, Primary Energy Consumption, Population, Domestic Investment and Trade boast the carbon emission CO2 in China. On the other hand, Foreign Direct Investment (FDI) decrease the carbon emission CO2 in this region.

This study offers some key policy recommendations to the government and policymakers based on the findings and debate, which can aid in the reduction of CO2 emissions in the environment.

- ❖ To reduce the negative effects of energy use on CO2 emissions, environmentally friendly technology should be promoted alongside increases in energy efficiency.
- ❖ Restriction energy usage through efficiency improvements and expanding the renewable energy generation base not only facilitate the transition towards a low carbon economy but also largely improve energy security.

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