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

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ARTICLE DETAILS	ABSTRACT
History **Revised format:** Feb, 2022 **Available Online:** Mar, 2022 **Keywords** Environmental Degradation; Primary Energy Consumption; Saving Rate; OLS; Granger; Causality Test.	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 CO_2 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 CO_2 and FDI negative impact on Carbon emission CO_2. Findings of the study suggest that to reduce the positive effects of energy use on CO_2 emissions, environmentally friendly technology should be promoted alongside increases in energy efficiency.

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Introduction

CO_2 emission is a global issue, and the entire globe is at risk of the consequences of poor environmental quality. CO_2 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 CO_2 emissions. CO_2 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' CO_2 emissions is critical for policymakers.

China's energy consumption was 3249.4 million tons 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.

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 per capita. Innovation, and trade.

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
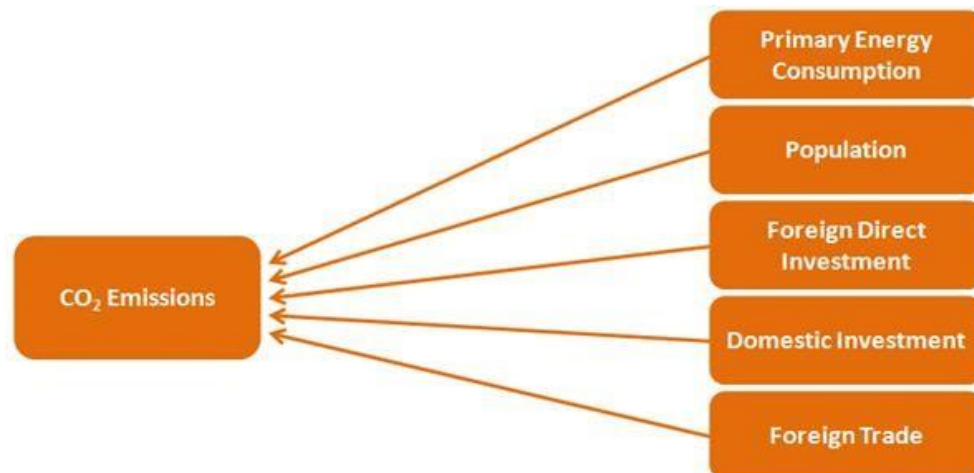
3.4.2 Mathematical Equation

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

3.4.3 Econometric Equation

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

3.5 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)

Table 3.1: 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: 1 **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 4.1, 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.

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.

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.

Pair-Wise Correlation Matrix

Correlation is a method which is used to calculate the association among DV and IVs. Pair – Wise Correlation coefficient is compulsory because the multicollinearity problems between variables are recognized. High correlation among variables demonstrates the multicollinearity trouble.

The table below indicates the results of Pair – Wise Correlation Matrix. It illustrates that only FDI is negatively correlated with CO2, PEC and POP. While, other variables are positively correlated. Overall results demonstrate that, Multi – Colinearity does not exist in the data set.

Results of Pair Wise Correlation Matrix (Model1)

Variables:	CO2	PEC	POP	FDI	DI	Trade
CO2:	1					
PEC:	0.798092	1				
POP:	0.556400	0.663788	1			
FDI:	-0.236470	-0.270026	-0.187849	1		
DI:	0.405508	0.898045	0.892966	0.074410	1	
Trade:	0.514686	0.487361	0.501898	0.407670	0.639730	1

Table 4.2: Pair Wise Correlation Matrix

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:

Breusch – Godfrey Serial Correlation Test:

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

Table 4.4: 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:

Breusch – Pagan – Godfrey Test:

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

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Table 4.5: Results of Breusch – Pagan – Godfrey Test

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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.

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

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Dependent Variable: CO2
Method: Least Square

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, 1 unit 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, 1 unit 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 CO_2 Emission. Empirical result shows that, 1 unit increase in DI it will lead (0.043454) percentage increase in CO_2 Emission.

The value of coefficient of Trade also shows the significantly (0.0000) positive impact on CO_2 Emission. Empirical result shows that, 1 unit increase in Trade it will lead (0.060021) percentage increase in CO_2 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 CO_2 in China. On the other hand, Foreign Direct Investment (FDI) decrease the carbon emission CO_2 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 CO_2 emissions in the environment.

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