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Article

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Economic Growth, Population, and Policy Strategies: Its Effects on CO_2 Emissions

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ABSTRACT

This research work has been focused on China and India. Both Countries has a big number in population in the world and the rate of economic growth has been increasing every year. However, this is still accompanied by air pollution (CO_2 emissions). Therefore, this study aims to analyze the relationship of population and gross domestic product (GDP) to CO_2 emissions in China and India in the 1984-2014 timeframe and provide policy recommendations related to the problem being analyzed. Estimates use VECM to analyze the data collected. The results of the study show that in China and India, GDP and population in the short and long term have a positive effect on CO_2 emissions and provide policy recommendations on willingness to pay for industry and willingness to accept for the community. The Environmental Kuznets Curve hypothesis was not confirmed in the case of China and India.

Keywords: CO_2 emissions, Environmental Kuznets curve, Economic growth, Population
JEL Classifications: O44, J11, J18, Q51

1. BACKGROUND

Economic growth is an activity that illustrates the economic condition of a country in a sustainable development towards better conditions (Azam et al., 2016). The economic growth continues to increase every year which indicates an improvement (Yang et al., 2021). Its because the progress of a country is measured by economic growth that moves up significantly. The economic growth of a country continues to change to form a certain pattern which then emerges the theory of stages of economic development (de Angelis et al., 2019). According to (Whitman Rostow, 1960), the theory of the stage of economic development can be seen through several stages, namely: the stage of traditional society (traditional society), the prerequisite stage of take-off (preconditions for take off), the stage of take-off (take off), the stage to maturity (drive to maturity), and high mass consumption. However, at present shows that many countries are only thinking about aspects of economic benefits without further responsiveness at environmental costs (Yirong, 2022). Therefore, there are still many countries that are able to think about and determine effective policy strategies in order to accelerate economic growth, but do not rule out their impact on the environment detail aspects (Rahman et al., 2020). This phenomena felt by China and India, which are currently accompanied by environmental pollution, one of which is serious air pollution (*CO_2 emissions)*. These emissions are a major cause of climate change and global warming. The concentration of surface CO_2 in the atmosphere has increased since the start of the industrial revolution, due to the rapid growth of human activity (Mardani et al., 2019). Scientific evidence that shows that increasing concentrations of CO_2 in the atmosphere is a major cause of global change and climate change (IPCC, 2007).

(Wang and Wu, 2021) state that China and India are the countries with the highest levels of air pollution in the world. This is evidenced from a study conducted by Greenpeace and IQ Air Visual stating that New Delhi, India became the most polluted capital city in the world in 2018. The results showed that, on average, air pollution particles (also known as PM2.5) in the Indian capital, reaching 113.5. These numbers were two times higher than Beijing, China which is also famous for air pollution. The high rate of air pollution in New Delhi, India is caused by vehicle and industrial emissions, smoke from burning garbage and plants, and dust from construction sites.

Besides New Delhi, 14 other cities in India are also included in the list of highest air pollution, including Ghaziabad and Faridabad. As a result, shows economic growth and population are important variables that influence the level of CO_2 emissions. This becomes interesting by proving it using the Environmental Kuznets Curve (EKC). Choi et al. (2010) explain that the relationship between national income per capita and the level of environmental damage in a certain time frame is formed as an inverted U-form known as the EKC hypothesis. Many scholars have referred to the EKC concept to underlie studies of sustainable economic development (Uchiyama, 2016).

Various studies have needed research related to environmental sustainability. The study of Galeotti et al. (2006) explains that the empirical study of the EKC hypothesis for CO_2 emissions is "as best mixed." Although no ECC curve is found for CO_2 emissions as evidence of sustainable development, other ways of sustainable development have been found through international cooperation. On the other hand, (Munasinghe, 2008) states that the "sustainability" hypothesis can be the key to green growth and emphasizes that developing countries can achieve their economic growth targets while maintaining lower levels of pollution.

This research work aims to analyze economic growth, population, and its effects on CO_2 Emissions.

1.1. Case Study

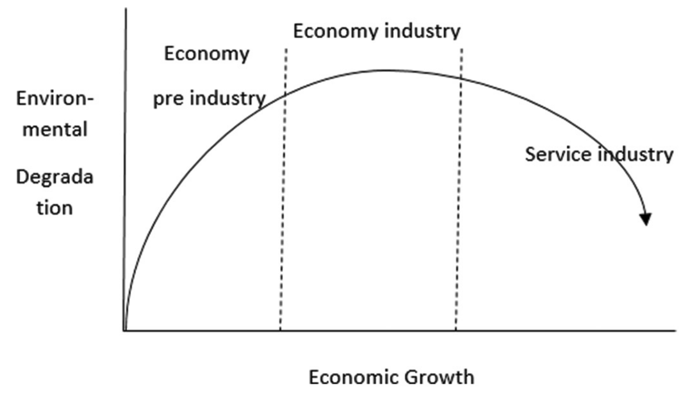
China and India with the help of eviews software as an analytical tool that is able to see the relationship between independent variables on the dependent variable both in the short and long term.

2. LITERATURE REVIEW

(Luzzati, 2015) explain that EKC theory is a theory that explains that the level of environmental damage will increase along with economic development and at a certain point (turning point) in achieving economic growth, then the level of environmental damage will decrease with increasing economic development marked by U-reverse curve (U-inverted curve). (Shahbaz & Lean, 2011) state that sustainable economic development will be achieved along with the preservation of a sustainable environment.

Several studies related to the testing of the EKC hypothesis were carried out in the category of countries with varying socioeconomic growth rates. The EKC hypothesis was studied in a focused manner in developed countries, such as the United States (Aldy, 2004), Canada (He and Richard, 2009) and found evidence of the EKC

Figure 1: Stages of economic development



Source: Panayotou, 2003

hypothesis and found evidence of EKC hypotheses in several regions and the importance of developing alternative energy (Iwata et al., 2009). A study conducted by Suri and Chapman (1998) shows that both developed and developing countries that are going through a stage of industrialization will increase the demand for energy which is quite high initially for exporting. EKC theory explains that economic growth will initially increase environmental degradation (Tenaw and Beyene, 2021). Economic growth at a certain point will then make people aware that the need for good environmental quality becomes very important (Khan et al., 2022). This point is referred to as the turning point where economic growth will reduce environmental degradation (Shaharir and Alinor, 2013).

On figure 1 shows that the EKC model explains the relationship between changes in economic structure and economic growth. The first explanation of the Kuznet U-inverse curve relationship is the stage of economic growth through the transition from agriculture to industry then post-industry to a service-based system. Environmental damage tends to increase due to changes in economic structure from rural to urban and from agriculture to industry as mass production and consumption growth. Then shows decreases with the second economic structure change from energy-based heavy industry to technology-based industries and services (Panayotou, 1993).

3. RESEARCH METHODS

This study uses time series data from 1984 to 2014. The data used is sourced from the World Bank. The dependent variable used is CO_2 emissions in China and India. While the independent variables used are gross domestic product (GDP) and population in China and India.

The method of analysis in this study uses a quantitative descriptive approach that is to find the relationship between one variable with another variable in this case is economic growth (GDP per capita) with degradation of air quality (CO_2) for the period 1984-2014. This study also uses the Vector Error Correlation Model to determine the short-term and long-term relationship between economic and population growth with air quality degradation in China and India.

4. RESULTS AND DISCUSSION

4.1. Stationary Test Results

From the Tables 1, 2, 3 and 4, the study the stationarity test used was Augmented Dickey Fuller. The test results state that the variable CO_2 emissions, GDP, and population in China and India are not stationary at the level. However, at the level of first difference India becomes stationary, when prob <alpha (0.05). Meanwhile, China becomes stationary when it is at the 2nd difference level, when prob <alpha (0.05).

4.2. Determination of the Optimal Lag

The next step that must be done is to determine the optimal lag. To determine the optimal lag must be known in advance the maximum lag length. The maximum lag is obtained from the stability test on the VAR system. Obtained that the maximum lag for the serial data in this study is 2 both China and India which can be seen that in the lag length test is determined by the highest number of stars recommended from each of the lag length test criteria (LR, FPE, AIC, SC, HQ). It shows on Tables 5 and 6.

4.3. Johansen Cointegration Test

From the results on Table 7 shows which results of research conducted with the Johansen cointegration test in China, the Trace Statistic null hypothesis test that there is no cointegration equation is rejected with a trace statistic value (67.13) greater than the critical value of 0.05 (29.79). In addition, there is also a cointegration equation rejected with a trace statistic value (20.14) greater than the critical value of 0.05 (15.49). However, the null hypothesis where there is at least 1 cointegration equation is accepted at 5% significance level because the trace statistic value (0.017) is smaller than the critical value 0.05 (3.84). While in the eigenvalue test, the null hypothesis that there is no cointegration equation is rejected because the max-eigen statistic (46.99) is greater than the critical value of 0.05 (21.13). In addition, there is also a cointegration equation rejected with a max-eigen statistical value (20.12) greater than the critical value of 0.05 (14.26). In addition, there is also a null hypothesis where at least 1 cointegration equation is accepted because the max-eigenvalue statistic (0.01) is smaller than the critical value of 0.05 (3.84).

Refer to the table 8 conducted by Johansen cointegration test in India, namely the Trace Statistic test the null hypothesis that there is no cointegration equation rejected with a trace statistic (70.04) greater than the critical value of 0.05 (29.79). There is also a cointegration equation rejected with a trace statistic (20.14) greater than the critical value of 0.05 (15.49). In addition, there is a cointegration equation rejected with a trace statistic (4.64) greater than the critical value of 0.05 (3.84). there are also 3 cointegration equations rejected with each max-Eigen statistical value (50.82) greater than the critical value 0.05 (21.13), max-Eigen statistical value (14.57) greater than the critical value 0, 05 (14.26), the max-Eigen statistical value (4.64) is greater than the critical value of 0.05 (3.84).

4.4. Granger Causality Test

From the Tables 9 and 10 the results of the granger causality test, it can be seen that all the data, both CO_2 emissions, GDP, and the population in China and India are in common, but only have a one-way relationship not two-way, and significant with an alpha level of 0.05 for some one-way relationships. This shows that this data is suitable for use in the VECM test.

4.5. VECM Country of China and India

Based on the results above in the long run, it can be explained that China's GDP has a positive effect on CO_2 emissions. The relationship of the population of the country's population has a positive effect on CO_2 emissions. That is, in the short term the population has a positive influence on CO_2 emissions. Thus, the higher the GDP and population in China, the higher the level of CO_2 emissions.

Table 1: India Indian state level stationarity test

Method	Statistic	Prob.**
ADF - Fisher Chi-square	0.00033	1.0000
ADF - Choi Z-stat	5.54015	1.0000

Table 2: India's 1st difference rate stationarity test

Method	Statistic	Prob.**
ADF - Fisher Chi-square	19.4726	0.0034
ADF - Choi Z-stat	−2.26921	0.0116

Table 3: Chinese state level stationarity test

Method	Statistic	Prob.**
ADF - Fisher Chi-square	0.45323	0.9984
ADF - Choi Z-stat	3.58715	0.9998

Table 4: Stationary test for the 2nd difference of China

Method	Statistic	Prob.**
ADF - Fisher Chi-square	35.8660	0.0000
ADF - Choi Z-stat	−3.31912	0.0005

Table 5: China optimal lag test

Lag	LogL	LR	FPE	AIC	SC	HQ
0	−1445.738	NA	4.95e+39	99.91298	100.0544	99.95728
1	−1195.703	431.0959	3.00e+32	83.28984	83.85562	83.46703
2	−1156.866	58.92493*	3.93e+31*	81.23212*	82.22223*	81.54221*

Table 6: India's optimal lag test

Lag	LogL	LR	FPE	AIC	SC	HQ
0	−1343.673	NA	4.34e+36	92.87398	93.01543	92.91828
1	−1101.357	417.7860	4.48e+29	76.78323	77.34901	76.96043
2	−1053.469	72.65782*	3.14e+28*	74.10129*	75.09140*	74.41138*

Table 7: China Johansen test

Hypothesized No. of CE (s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.802197	67.13500	29.79707	0.0000
At most 1*	0.500378	20.14102	15.49471	0.0093
At most 2	0.000614	0.017813	3.841466	0.8937

Table 8: Test of Johansen Country of India

Hypothesized No. of CE (s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.826683	70.04578	29.79707	0.0000
At most 1 *	0.395063	19.21939	15.49471	0.0131
At most 2 *	0.147948	4.643111	3.841466	0.0312

Table 9: Chinese state granger causality test

Null Hypothesis	Obs	F-Statistic	Prob.
GDPCHINA does not Granger Cause CO_2CHINA	29	4.32215	0.0249
CO_2CHINA does not Granger Cause GDPCHINA		11.5829	0.0003
POPCHINA does not Granger Cause CO_2CHINA	29	3.43809	0.0486
CO_2CHINA does not Granger Cause POPCHINA		12.0735	0.0002
POPCHINA does not Granger Cause GDPCHINA	29	1.97237	0.1610
GDPCHINA does not Granger Cause POPCHINA		12.1239	0.0002

Table 10: Indian state granger causality test

Null Hypothesis	Obs	F-Statistic	Prob.
GDP INDIA does not Granger Cause CO_2 INDIA	29	4.36661	0.0241
CO_2 INDIA does not Granger Cause GDP INDIA		1.48013	0.2477
POP INDIA does not Granger Cause CO_2 INDIA	29	3.41627	0.0495
CO_2 INDIA does not Granger Cause POP INDIA		0.91166	0.4153
POP INDIA does not Granger Cause GDP INDIA	29	2.78881	0.0815
GDP INDIA does not Granger Cause POP INDIA		8.02514	0.0021

In the short term, it can be explained in lag 1 of China's GDP that there is a positive influence on CO_2 emissions. The relationship of the population of the country's population has a positive effect on CO_2 emissions. That is, the higher the GDP and population in China, the higher the level of CO_2 emissions.

As for what happened in India based on the test results above in the long run is that GDP has a positive effect on CO_2 emissions. While the population relations of the Indian population positively influence CO_2 emissions. That is, in the short term the population has a positive influence on CO_2 emissions. Thus, the higher the GDP and population in India, the higher the level of CO_2 emissions.

Meanwhile, India in the short term is that GDP has a positive effect on CO_2 emissions. The relationship between the population of India's population has a positive effect on CO_2 emissions. That is, in the short term the population has a positive influence on CO_2 emissions. Thus, the higher the GDP and population in India, the higher the level of CO_2 emissions.

This shows that both in the short and long term the increase in population and GDP both China and India in the period 1984-2014 is accompanied by an increase in CO_2 emissions both from industrial activities, greenhouse gas gases, and activities human activity.

5. CONCLUSIONS AND SUGGESTIONS

India and China are the countries with the most population. In addition, China and India are the countries with the highest levels of environmental degradation (CO_2 emissions) in the world. However, the economic growth of India and China almost every year has increased. Based on tests that have been done, both in the short and long term between the population and GDP (Gross Domestic Gross) has a positive effect on CO_2 emissions. This shows that both in the short and long term the increase in population and GDP both China and India in the period 1984-2014 is accompanied by an increase in CO_2 emissions both from industrial activities, greenhouse gas gases, and activities human activity. Suggestion from this research is the need for the latest data that can be issued by the world bank regarding CO_2 emission data. In addition, a more in-depth analysis of the case studies raised in this research is needed.

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