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Does the Environment Kuznets Curve Theory Exist in China?

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Abstract

China's rapid economic growth has led to predictions that it will surpass the United States as the world's top economic power. However, this growth comes at the cost of increased emissions. The relationship between environmental degradation and income per capita is discussed through the Environmental Kuznets Curve (EKC) theory. A study conducted in China used variables such as GDP per capita, coal energy consumption, renewable energy consumption, and private sector domestic credit. The study utilized 31 years of time series data from 1991 to 2021 and employed the ARDL method for data processing. The findings suggest that the EKC hypothesis holds true in the short term, indicating an inverted U curve. However, in the long term, the EKC hypothesis does not hold. Coal energy consumption has a positive and significant impact on CO_2 emissions in the long run. Similarly, renewable energy consumption shows a negative and significant effect on emissions in the long run. Private sector domestic credit has a positive and significant influence in the long run. It can be concluded that the EKC theory does not apply to China, and it is not possible to reduce emissions by simply improving the economy.

Keywords: EKC, CO_2 Emissions, Renewable Energy Consumption, Fossil Energy Consumption, Financial Development, Autoregressive Distributed Lag

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INTRODUCTION

The interrelationship between economic progress and environmental challenges has been a subject matter of significant understanding within the field of economics. Despite the potential benefits that economic advancement may bestow, it is also accompanied by the potential adverse outcomes of ecological

deterioration. Industrialization is the right way to improve the economy. Ndiaya and Lv (2018) have also verified that the upsurge in industrial production has a momentous impact on the advancement of the economy.

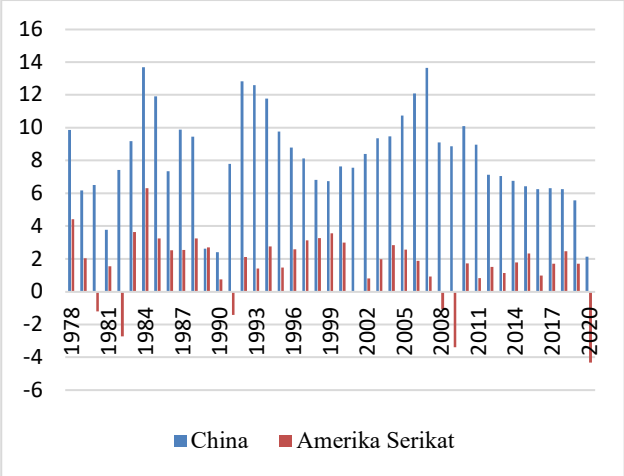

Figure 1. Comparion of GDP Growth Between China and The United States (percent)
Source: Our World in Data (1978 – 2020)

Industrial processes can also increase emissions that are harmful to the environment. The increase in greenhouse gases on earth is caused by increased energy consumption needed in the process of economic growth (Tamazian & Bhaskara Rao, 2010). It is projected that China will ascend to the position of the primary economic powerhouse globally, supplanting the United States from its current status.

China has the fastest economic growth recorded in history (Kroeber, 2020). China's rapid and stable economic growth since the era of economic reform has made it increasingly open to international markets, reflected in its active participation in global trade (Arora & Vamvakidis, 2011). Trade openness since the era of economic reform has successfully transformed China into a new global economic power. Figure 1 comparison of GDP growth between China and the United States.

In the context of fostering economic development, it is imperative that a nation possesses sound and fitting financial development to buttress the unfolding of this process. Zhang (2012a) Financial development pertains to the progression and advancement of the banking system, both domestic and foreign investment streams, stock exchanges, in addition to other financial markets.

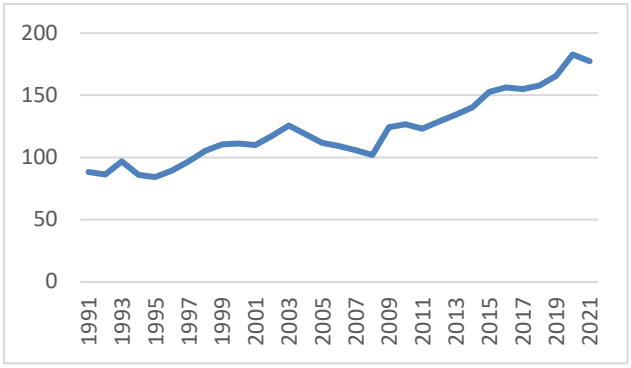

Figure 2. China's Domestic Credit to Private Sector 1991 – 2021 (%GDP)
Source: World Bank, 2023

According to Hassan (2011) there is a reciprocal relationship between Financial Development and Economic Growth, the development of a good financial system can support economic growth and good economic growth will support further financial development. Financial development also impacts China's economic growth. Zhang (2012) says financial planning plays an important role in China's economic growth. Figure 2 shows the growth of China's financial development represented by private sector domestic credit.

Figure 2 illustrates that the escalation of financial development in China is an ongoing process. Additionally, China boasts the world's

most populous nation, as well as being ranked as the top manufacturing country globally by the United Nations study. The robust economic framework of China has resulted in the country being identified as "The New Economic Powerhouse". China's growing economy is also increasing its demand for energy.

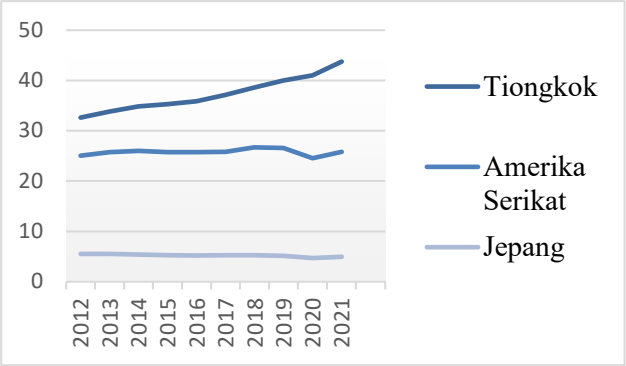

Figure 3. China's Energy Consumption 2012 – 2021
Source: Our World in Data, 2023

China's prevailing energy composition continues to be predominantly fueled by fossil energy sources, while its intensity of energy consumption remains significantly higher than that of developed nations and the global average energy consumption level (Fan & Xia, 2012). Figure 1.3 shows comparison of China's electrical energy consumption with other countries. The manifestation of substantial energy consumption as depicted in Figure 3 has resulted in a considerable detoriation of environment in China. Figure 4 illustrates a consistent rise in China's cumulative carbon emissions since 2012.

As a prominent global economic force, China is confronted with the pressing concern of environmental contamination. He (2019) Prolonged and disproportionate exposure to atmospheric pollution can lead to critical health issues that have the potential to adversely impact the productivity of laborers in the forthcoming times. The Chinese government is also committed to addressing environmental degradation through "The 14th Five Year Plan" which designed to accelerate the transition to the use of renewable energy.

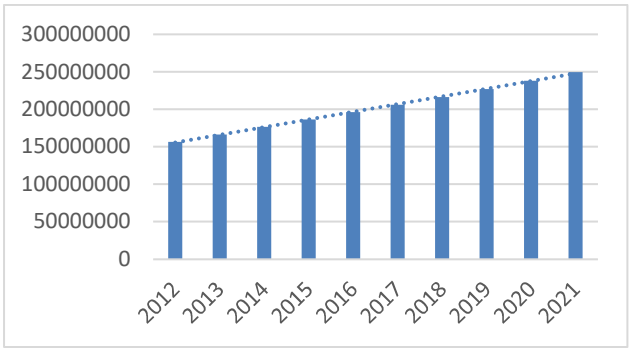

Figure 4. China's Cumulative Carbon Emissions (metric tonnes)
Source: Our World in Data

One theory that explains the relationship between economic growth and environmental degradation is the environmental Kuznets curve theory. Grossman and Krueger in Yandle (2013) EKC elucidates that carbon emissions will witness an increase owing to economic growth; however, it is noteworthy that such emissions are anticipated to plummet in tandem with the economy's sustained expansion.

RESEARCH METHODS

This study employs a quantitative research approach, utilizing a Chinese case study spanning the years 1991 to 2021. Quantitative research is a research approach that focuses on the collection of numerical data and the use of statistical methods to analyse the data in this study (Abdullah, 2015). Data collected from reliable sources such as the world bank, BP statistical report, our world in data, IEA, and CNREC. In the data processing process,

researchers use the Eviews 12 application and use the Autoregressive Distributed Lag (ARDL) method.

This study, the variables that are linked include CO_2 emissions, GDP per capita, GDP per capita^2, electricity consumption from coal, energy consumption from renewable sources, and private domestic credit. The dependent variable is the variable that will be influenced by other variables or become the variable to be examined in a study. This study uses the variable of China's cumulative CO_2 emissions.

The data taken has a time span between 1991 - 2021 with units of metric tonnes. Cumulative CO_2 emissions are the total CO_2 emissions from fossil fuel combustion processes, industrial activities, and households. Independent variables are variables that are considered as causes or factors that affect the dependent variable, the following are the independent variables used in this study, namely: GDP per capita, this investigation utilizes GDP per capita information denominated in US dollars spanning from 1991 to 2021.

GDP per capita represents the aggregate GDP divided by the entire population within a single year. GDP per capita2, this variable is used to see if a U-curve is formed or not. Electricity Production from Coal, this study uses data on electricity production from coal in China with a time span of 1991 - 2021 with units of Terrawatt hour.

Electricity consumption in China is still dominated by electricity from coal. Consumption of Renewable Energy, this study uses renewable energy consumption data from 1991 - 2021 in Terrawatt hour units. This data is representative of the Chinese government's commitment to reducing emission levels. Domestic Credit to Private Sector, this study uses data on private sector domestic credit as a per cent of GDP. The percentage is the percentage share of the total gross domestic product. The percentage shows how much financial loans are given to the private sector including companies, individuals, and households.

RESULTS AND DISCUSSION

Based on the ARDL estimation results in the short run, there is evidence to support the formation of the Environmental Kuznets Curve in the case study of China. According to the conditions for the formation of the EKC curve, the coefficient value of quadratic GDP per capita must be negative and the coefficient value of GDP per capita must be positive.

In the error-correction form model in Table 1, the values of YCAP2 (-35.77359) and YCAP (3739.225) are known, which are in accordance with the conditions for the occurrence of the EKC. The occurrence of the EKC theory in China in the short-term relationship indicates the existence of a relationship between GDP per capita and CO_2 emissions, while confirming the validity of the EKC theory in China.

While based on the ARDL estimation output in the long run, there is no evidence to support the formation of the Environmental Kuznets Curve in the case study of China. The EKC theory requires that the coefficient value of GDP per capita is quadratically negative and the coefficient value of GDP per capita is positive while in the long-run model the value of GDP per capita is quadratically 242.1889 and the increase in fossil energy consumption is still much larger than the coefficient value of GDP per capita which is -1562.687 and this suggests

that EKC does not occur in China. The long-term relationship estimation results show different results from the short-term estimation model where EKC occurs in the short-term estimation while in the long-term estimation EKC does not occur in the Chinese case study.

Table 1. Short-Term ARDL Estimation Results

Variable	Coefficient	t-Statistic	Prob	Conclusion
D(CO(-1))	1.805.449	1.408.742	0.0001	Significant
D(CO(-2))	1.826.967	1.106.424	0.0002	Significant
D(YCAP)	3.739.225	1.433.732	0.0003	Significant
D(YCAP(-1))	5.520.390	1.255.420	0.0004	Significant
D(YCAP(-2))	4.081.133	1.110.684	0.0005	Significant
D(YCAP2)	-3.577.359	-3.601.937	0.0006	Significant
D(YCAP2(-1))	-3.953.389	-1.302.945	0.0007	Significant
D(YCAP2(-2))	-3.333.540	-1.130.532	0.0008	Significant
D(CRED)	-3.260.228	-1.355.976	0.0009	Significant
D(CRED(-1))	-3.733.341	-1.197.122	0.0010	Significant
D(CRED(-2))	-2.170.974	-1.038.540	0.0011	Significant
D(RENEW)	-2.605.380	-1.784.223	0.0012	Significant
D(RENEW(-1))	0.748217	6.176.019	0.0013	Signifikant
D(RENEW(-2))	0.735663	6.330.657	0.0014	Significant
D(COAL)	-0.742691	-3.535.562	0.0015	Significant
D(COAL(-1))	-9.922.223	-1.417.412	0.0016	Significant
D(COAL(-2))	-8.315.100	-1.407.507	0.0017	Significant
CointEq(-1)	-2.134.781	-1.516.208	0.0018	Significant
R-squared	0.994644	Adjusted R-squared		0.984526

Source: Output Eviews 12, 2023

Based on the ARDL estimation results, fossil energy consumption has a positive and significant effect on CO_2 emissions. Electric energy consumption from coal used as a proxy for Fossil Energy Consumption in China shows a value that is still quite high when compared to energy consumption from renewable sources. Coal is favoured as the main fuel to produce electrical energy in China.

These results are in line with research by Cheikh (2021) revealing that energy consumption from fossil fuels significantly increases CO_2 emissions. Haseeb (2018) conventional energy consumption plays an important role in increasing CO_2 emissions. The utilization of coal is more attractive due to its abundance, affordability, and established infrastructure.

Nevertheless, there is a repercussion that must be acknowledged because of meeting the escalating energy demands, specifically a surge in CO_2 discharges. The findings of this investigation are congruent with Pata (2021) assertion that traditional energy consumption may have a bearing on augmenting CO_2 emissions over the long run. Wu (2012) also

affirmed that in regions where coal-fueled power stations were clustered, there was a notable escalation in CO_2 emissions.

Table 2. Long-Term ARDL Model Estimation Results

Variable	Coefficient	t-Statistic	Prob	Conclusion
YCAP	-1.562.687	-1.214.885	0.0003	Significant
YCAP2	2.421.889	1.005.049	0.0006	Significant
CRED	2.812.659	-9.597.198	0.0000	Significant
RENEW	-4.329.241	2.353.368	0.0007	Significant
COAL	5.199.310	2.164.581	0.0000	Significant

Source: Output Eviews 12, 2023

Based on the estimation results of the ARDL model in the long term, it can be concluded that Renewable Energy Consumption has a negative and significant effect on CO_2 Emissions. The use of renewable energy is able to reduce CO_2 emissions because it produces fewer emissions that are harmful to the environment. The Chinese government expressed China's commitment to reducing CO_2 emissions through the policy of "The 14th Five-Year Plan", one of the points of which is to encourage the use of energy from renewable sources (CNREC, 2019).

Although not as extensive as the utilization of fossil fuel, the utilization of sustainable energy in China is progressively escalating year by year, and predicated on the estimation outcomes of the ARDL model, it will ultimately diminish CO_2 emissions. This outcome is also corroborated by Zou's (2016) exploration, which accentuates that the transition of energy utilization to renewable origins can notably curtail all-inclusive CO_2 emissions.

In accordance with Zou, Lorente (2021) declared that endorsing the utilization of sustainable energy can curtail CO_2 emissions. Sustainable energy generates fewer emissions that are deleterious to the environment and can attenuate the level of CO_2 in the atmosphere. Based on the estimation results of the ARDL model in the long term, it can be concluded that the variable Domestic Private Sector Credit (FD) as a proxy for Financial Development has a positive and significant effect on CO_2 emissions.

Private Sector Domestic Credit is a variable used to describe monetary resources provided by financial institutions to the private sector such as business credit financing, stock purchases, and loans. Private sector domestic credit is one of the variables used to measure the level of financial development in a country. Financial development in a country refers to the development of the financial sector (Jin Zhang, Wang, & Wang, 2012b).

Private Sector Domestic Credit has the capability to act as a catalyst for economic growth and subsequently impact the rise of air pollution in an indirect manner. Mahmood (2021) stated that the increase in financial development that occurred in China and India had an effect on environmental degradation. Haseeb (2018) in BRICS member countries states that financial development has an influence on increasing CO_2 emissions. Good financial development will certainly attract investors and

ultimately increase economic growth, but it is also a cause of increased CO2 emissions.

CONCLUSION

The results of the estimation on the short-term equilibrium of EKC theory occur in China. However, it is different in the long-term equilibrium where EKC theory does not occur in China due to the level of fossil energy consumption and the structure of society that still cannot fully reduce CO2 emissions.

Electric energy consumption from coal is proven to have a positive and significant effect on CO2 emissions in China both in the long-run equilibrium but a negative and significant effect on CO2 emissions in the short-run equilibrium. Coal is still a favourite energy source in China due to its abundant availability and supported by ready supporting facilities so that the consumption of electric energy from coal is expected to continue to increase along with economic growth.

Consumption of energy from renewable sources has been shown to negatively affect CO2 emissions in China in both the short and long term. Different from conventional fuel power plants, power plants from renewable sources such as hydropower, wind, and solar can produce energy without producing CO2 emissions that are harmful to the environment. The economy can continue to run without causing further damage to nature.

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