The Relationship Between Economic Growth and Environment Issues

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Abstract. In today's world, environmental issues are occurring frequently, with global warming being particularly prominent as it already poses a threat to human survival. Some people question whether these environmental problems are caused by economic development. This study will use hypothesis testing to address this question. Specifically, by collecting data on greenhouse gas emissions and GDP growth in recent years, the research will plot line charts to observe the trends of GDP growth and greenhouse gas emissions over time, establish a correlation matrix to test the relationship between GDP growth and greenhouse gas emissions, and develop a regression model to examine the coefficient between GDP growth rate and the rate of change in carbon emissions. The study shows that higher carbon emissions are associated with faster economic growth (a 1% increase in carbon emissions corresponds to a 3.94e-9% increase in GDP), indicating a positive correlation between economic development and carbon emissions.

Keywords: Economic growth, greenhouse gas, linear relationship, hypothesis testing.

1. Introduction

Currently, the world economy is in a phase of rapid development. However, this process has given rise to numerous issues, such as rising sea levels and glacier melting caused by global warming, greenhouse gas emissions from burning fossil fuels, and the urban heat island effect resulting from human alterations to the urban surface. These problems have led a growing number of people to question whether economic development truly leads to environmental degradation. Among these, the massive emission of greenhouse gases has drawn the most attention. Therefore, this essay will examine the relationship between greenhouse gas emissions and economic development (GDP). As the greenhouse effect intensifies and even threatens the human living environment, many people believe that economic development has led to increased carbon emissions, which in turn has caused the greenhouse effect and environmental degradation. This issue urgently requires a solution to provide a feasible approach for the sustainable development of humanity in the future.

By controlling as many variables as possible (including unemployment rate, inflation rate, net exports, investment), the Hypothesis Testing model is used to test whether there is a significant relationship between GDP and carbon emissions, thereby reflecting whether economic development affects the environment. The initial sections of the paper present the research background and significance, while the subsequent sections focus on the methodology, findings, and conclusions, ultimately summarizing the research contributions and limitations.

2. Literature Review

In recent years, the sustained recovery of inflation in Japan has attracted widespread attention. Based on the characteristic facts of Japan's inflation recovery, this study systematically analyzes its driving factors and sustainability, explores the transmission mechanism of the "wage-price" virtuous cycle, and, in light of the current low inflation pressure faced by China, summarizes the implications of Japan's experience for China. This includes scientifically interpreting the policy significance of inflation data, constructing a policy system to promote wage growth, balancing domestic and international dual circulations, avoiding over-reliance on monetary policy, and preventing "Japan-

style economic stagnation." The above indicates that inflation has a significant impact on GDP; therefore, this study will control the variable of inflation [1].

Based on the GDP index and the GDP deflator, this paper employs GARCH-family models to estimate and compare the constructed time series, identifying the best-fitting model. The residuals are extracted as indicators of volatility. Furthermore, the wavelet decomposition method is applied to decompose the GDP index, the GDP deflator, and their volatility into short-term and long-term cycles. Granger causality tests are conducted between these variables at each cycle. The results show that the GDP index is best fitted by the GARCH-M (1,1) model under the t-distribution, while the GDP deflator is best fitted by the AR (1)-GARCH (1,1) model under the GED distribution. In the short term, there is a significant bidirectional Granger causality between economic growth and its volatility, as well as between inflation and its volatility. In the long term, both the inflation rate and the economic growth rate are Granger causes of inflation volatility [2].

The relationship between interregional net trade volume and its fluctuations, and regional economic growth and its volatility, is highly significant. The strength of a region's economic competitiveness and the comparative advantages of its trade conditions determine the fundamental pattern of interregional net trade volume. At the same time, much like the exceptionally complex relationship between foreign trade fluctuations and economic growth, the impact of changes in interregional net trade volume on the regional economy is also highly complex. In the short term, an expanding trade surplus or a shrinking deficit can enhance the region's economic growth momentum from the perspective of external demand. In the long term, however, a short-term expansion of the trade deficit may strengthen the region's development potential by enhancing its supply capacity. The above indicates that net exports have a significant impact on GDP; therefore, this study will control the variable of net exports [3].

Over the past three decades, the East Asian economic circle has been the region with the fastest economic growth and the largest increase in trade volume worldwide. Within this region, Northeast Asia stands as the core area and has consistently attracted global attention. Trade balance among the economies in Northeast Asia can not only reduce inter-country frictions and conflicts, facilitating trade exchanges and economic development, but also significantly contribute to regional peace and stability. Firstly, this paper examines the current state of trade balance among the Northeast Asian economies [4].

The findings underscore the significant impact of domestic investment, particularly foreign direct investment (FDI) from the European Union, on Morocco's economic growth rate, highlighting the crucial role of EU investment inflows in fostering economic expansion. Furthermore, the study emphasizes the positive correlation between EU FDI and GDP growth, indicating the importance of foreign investment in driving Morocco's economic prosperity through capital infusion and knowledge transfer. The above demonstrates that FDI has a notable influence on GDP; therefore, this study will control the FDI [5].

Based on the analysis of the impact of foreign direct investment (FDI) on China's economy, this paper concludes that FDI exerts varying degrees of positive and negative influences on multiple aspects of China's economic development. To examine the effects of FDI on GDP and investment, the author conducts empirical tests by establishing econometric models and specifically analyzes the impact of FDI in light of its industrial distribution and regional distribution in China [6].

Employment is the most critical aspect of people’s livelihoods and the most fundamental support for economic development. Expanding employment requires economic growth as a prerequisite, as it is difficult to resolve insufficient employment without a certain level of economic growth. In recent years, China’s economic growth has noticeably slowed, and the issue of employment has become increasingly prominent. The above indicates that employment has a significant impact on GDP; therefore, this study will control the variable unemployment [7].

Unemployment is both an economic and a social issue. Excessively high unemployment rates often become a factor of social instability, affecting harmonious societal development. International empirical studies indicate that unemployment rates tend to decline with economic growth. However,

the findings of these studies vary significantly. In light of this, this paper conducts an in-depth empirical analysis of the relationship between economic growth, poverty, and unemployment in Mongolia based on officially published statistics from 1995 to 2018, utilizing econometric modeling and evaluation methods for assessment [8].

The issue of global climate change is becoming increasingly severe, with greenhouse gas emissions, primarily represented by carbon dioxide and methane, emerging as critical factors affecting sustainable human development. As the world's largest energy consumer and carbon emitter, China has proposed the "Dual Carbon" goals, demonstrating its firm commitment to addressing climate change. The urban and rural construction sector, being a crucial domain for ecological civilization advancement, has become a concentrated area of resource consumption and carbon emissions in China, accounting for a quarter of the country's total emissions. However, there is currently a lack of systematic research on carbon emissions in this sector. Particularly in Beijing, the scale and complexity of its urban and rural construction activities impose higher demands for carbon reduction. Therefore, an in-depth study on carbon emission accounting and reduction pathways in Beijing's urban and rural construction sector will not only enrich and refine the research system of carbon emission accounting and reduction analysis but also provide scientific basis and decision-making support for formulating carbon peak implementation plans in this sector. Moreover, it holds significant practical importance for promoting green development strategies and achieving the "Dual Carbon" goals [9].

Against the backdrop of China's urbanization rate reaching 65.22%, the fact that energy consumption per unit GDP in urban built-up areas remains 1.8 times higher than that of developed countries highlights the structural contradiction between scale expansion and low-carbon transition. This contradiction urgently needs to be resolved under the "Dual Carbon" strategic goals and high-quality development requirements. This study aims to deeply deconstruct the coupling coordination mechanism between multidimensional factors within the two systems of new urbanization and low-carbon development, comprehensively evaluate their current coordination level and influencing factors, predict the coordinated evolution trends of the two systems under different policy scenarios, and propose recommendations to promote high-quality coordinated development of both systems, thereby contributing to the achievement of urban low-carbon transition goals [10].

-The aforementioned literature addresses the selected variables of this study—namely inflation, employment, net exports, and foreign direct investment (FDI) in two key aspects. First, it elucidates the relationships between these variables and GDP, highlighting their role as control variables in this research. These variables, excluding the core subject of study (greenhouse gases), were chosen precisely due to their established linkages with GDP, ensuring a structured analysis of macroeconomic influences.

Second, some of the literature explores strategies for urbanization and low-carbon development. However, despite extensive research, none of the studies I have reviewed provide a definitive conclusion on whether economic development directly influences carbon emissions. This gap underscores the need for further empirical investigation to clarify the complex interplay between economic growth and environmental impacts.

This study focuses on the relationship between global economic development and carbon emissions, providing development pathways and insights for worldwide progress. It addresses this research gap by using EU data to quantify the linear relationship between economic growth and carbon emissions, thereby clarifying the complex interplay between economic growth and environmental impact.

3. Methodology

3.1. Correlation Matrix Between Variables

Table 1. Correlation matrix

	GDP growth	Emissions	Inflation	FDI	CA	Unemp
GDP growth	1.0000					
Emissions	0.1741	1.0000				
Inflation	0.1919	0.0134	1.0000			
FDI	0.2842	0.2123	-0.4078	1.0000		
CA	0.0428	-0.2335	-0.1985	0.1367	1.0000	
Unemployment	0.0203	0.3805	-0.1807	0.0744	-0.6519	1.0000

According to Table 1. The first column discusses whether the direction of change between GDP and various variables is consistent. From the data, we can observe that when GDP rises, greenhouse gas emissions also increase. This is because, in the early stages of industrial development, generating a certain amount of greenhouse gas is unavoidable.

3.2. Trend Analysis

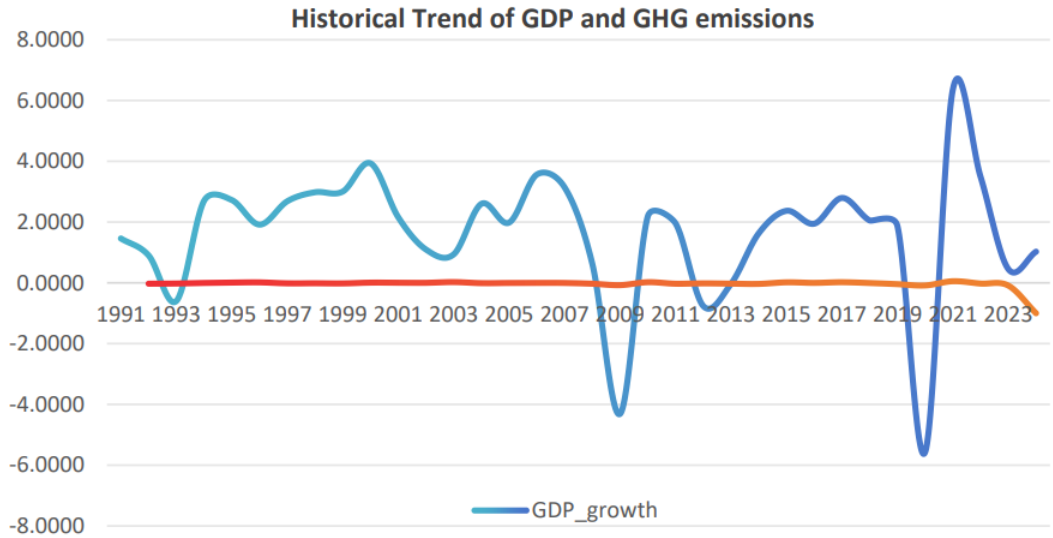

Figure 1. Historical Trend of GDP and GHG emissions

Fig. 1 has selected data from the European Union over the past 33 years and created this line chart. We can clearly observe the changing trends in GDP and greenhouse gas emissions in recent years.

3.3. Regression model

Mathematical formulas:

$$\text{GDP growth}_t = \alpha + \beta_1 \text{Emission}_t + \beta_2 \text{Inflation}_t + \beta_3 \text{Unemployment}_t + \beta_4 \text{FDI}_t + \beta_5 \text{Current Account}_t \quad (1)$$

t shows denote year, and α is constant term.

β is coefficient of each explanatory variable, emissions are the change rate of Greenhouse Gas emissions, inflation is the change rate of inflation, which is measured by consumer price, unemployment is the change rate of unemployment, which is measured by % of total labor force.

Current Account is the change rate of current account balance, which is measured by % of GDP.

FDI is change rate in Foreign Directive Investment, which is net inflows measured by % of GDP

ε is the error term.

This is the established linear regression equation. The annual GDP growth rate equals a constant plus the coefficient of each explanatory variable multiplied by the annual growth rate of each

explanatory variable. When β_1 equals zero, it indicates that GDP growth is unrelated to greenhouse gas emissions.

Table 2. The value of β

	Economic Growth
Emissions	3.94e-9*
	(2.29e-9)
Inflation	0.3630037
	(0.2346949)
FDI	0.1176888
	(0.2179765)
Current Account	0.13987558*
	(0.0724307)
Unemployment	0.2808133*
	(0.3155)

***p<0.01 **p<0.05 *p<0.1

This table 2 displays the estimated coefficient values for each explanatory variable, all of which are evidently non-zero. When the p-value exceeds 0.1, the relationship between the variable and GDP is considered statistically insignificant. However, at the 10% significance level, the relationship between GDP and greenhouse gas emissions is clearly significant. For every 1% increase in carbon emissions, GDP increases by (3.94e-9) %.

4. Results

The coefficient of GHG emission is positive 3.94e-9 percent. It means When carbon emissions increase by 1%, the economic growth rate increases by approximately 3.94e-9 percent. The p-value of 0.097 is less than 10%, so it is statistically significant at the 10% significance level.

As for the control variables, a 1% increase in the current account corresponds to a 0.1398758% increase in economic growth. A one percent increase in the unemployment rate corresponds to an approximately 0.2808133 percent increase in the rate of economic growth. They are significant.

A 1% increase in the inflation rate is associated with an approximately 0.3630037% increase in the economic growth rate. An increase of 1% in FDI results in an increase of 0.1176888% in economic growth. A 1% increase in the current account corresponds to a 0.1398758% increase in economic growth. A one percent increase in the unemployment rate corresponds to an approximately 0.2808133 percent increase in the rate of economic growth. However, they are not significant.

5. Conclusion

Based on the data and graph above, it can be concluded that there is a positive correlation between economic growth and carbon emissions, and $\beta_1$is statistically significant ($\beta_1 \neq 0$). The result shows that GHG emissions can boost economic growth, though it is just a small influence. The positive link can be explained that economic growth may be driven by the activities that may have environmental costs in EU countries.

Since only 24 years of data were available for collection, the conclusions drawn may lack a certain degree of robustness.

GDP is also influenced by numerous factors beyond those examined in this study. However, due to limitations in data availability, only these four variables are discussed.

Incorporating More Complex Systemic Perspectives and Non-Linear Relationships

The relationship between economic activity and carbon emissions is not simply linear; future research must adopt more sophisticated systemic models.

This conclusion offers an important insight: in the short term, relying on high-carbon emission industries (such as heavy industry and manufacturing) represents a relatively accessible path for

developing countries to achieve rapid economic take-off and alleviate poverty, as it leverages mature and cost-effective fossil fuel technologies.

However, from a long-term perspective, continued investment in high-carbon infrastructure (such as coal-fired power plants) poses significant risks. Given that such infrastructure can have a lifespan of several decades, it effectively locks economies into a high-emission pathway for years to come, making a future transition difficult and causing them to miss opportunities in developing green technologies.

Furthermore, building economic development on non-renewable resources is fundamentally unsustainable. The most critical issue is that the consequences of climate change, including extreme weather events, sea-level rise, and biodiversity loss, will ultimately undermine the economy. The resulting damage is likely to incur colossal costs that could far exceed the benefits gained from early-stage economic growth.

Therefore, this relationship is not a "law" that can be relied upon indefinitely, but rather a "dependency" that needs to be broken as soon as possible within a specific time window. The goal is to decouple economic growth from carbon emissions.

Therefore, this discovery should inform our approach to balancing economic development with environmental protection through the following strategic pathways:

Achieving Energy Structure Transformation: Vigorously develop renewable energy sources (solar, wind, hydro, nuclear) to gradually replace high-carbon energy sources like coal and oil. This shifts the engine of economic growth from "burning carbon" to "harnessing technology" (e.g., photovoltaic panels, wind turbines). This transition not only reduces emissions but also creates new green jobs and industrial chains, forming new drivers of economic growth.

Generating More GDP with Less Carbon: Promote energy-efficient technologies and standards across all economic sectors (industry, construction, transportation). Through technological innovation and management optimization, we can increase the GDP produced per unit of energy consumed. Consequently, even as the total economy expands, the growth rate of energy consumption and carbon emissions can slow down or even achieve absolute decoupling. The exceedingly small coefficient *a* (3.94e-9) itself suggests significant potential for decoupling—indicating that only a minimal increase in carbon emissions is required to support economic growth.

Shifting towards Green Services and High-Tech Industries: Facilitate the transition of the economy from energy-intensive manufacturing towards knowledge-intensive, technology-intensive, and service-oriented sectors. For instance, developing industries such as software, finance, R&D, and cultural tourism, which have a far lower carbon intensity per unit of GDP compared to sectors like steel and cement. This enables sustained economic development without a significant increase, or even with a reduction, in carbon emissions.

Driving Change from the Demand Side: Advocate for green lifestyles, encouraging consumers to purchase energy-efficient products and electric vehicles, and guiding investors to favour companies with strong ESG (Environmental, Social, and Governance) performance. Market demand acts as a powerful conductor. When both consumers and investors demonstrate a preference for green options, companies are incentivized to proactively pursue green transformation, thereby creating a virtuous cycle.

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