Influencing Factors Model of Carbon Emissions from a Global Perspectives

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Abstract. This paper studies the relationship and differences between carbon emissions and industrial development in four countries with different development levels from a global perspective. First, the Tapio decoupling model was established, and the overall dependence of countries of various development levels on carbon emissions was analyzed from strong to weak. Then, establish a panel data model to study the influencing factors of carbon emissions in countries with different development levels from 2015 to 2019. The results show that the added value of industry and agriculture has a significant positive effect on carbon emissions in countries of various development levels, and forest area has a significant negative effect on carbon emissions. Developed countries are still the largest emitters. Therefore, industrial and agricultural production is still the most important factor affecting carbon emissions, and the increase in forest area helps reduce the impact of carbon dioxide.

1. Introduction
Since the second half of the 20th century, the global economy has developed rapidly, while environmental problems, mainly climate warming, have become increasingly serious. Human economic activity, especially carbon dioxide emissions from energy consumption dominated by fossil fuels, has become a major cause of global warming [1]. In this context, a series of issues, such as the relationship between economic development and carbon dioxide emissions, whether there are differences in carbon dioxide emissions between different economies and countries, and what factors affect carbon dioxide emissions, are obviously of great practical significance and deserve long-term attention. Based on the global perspective and the world bank's classification criteria. This paper divides the world's economies into four categories, and analyzes the decoupling state of Tapio from the economic development of different economies. Then the panel data model is built to analyze the factors that influence carbon emissions. Finally, the paper draws a conclusion and puts forward some Suggestions for China's low-carbon economic development in the future.

2. Sample selection and variable definition
This paper examines the differences in the relationship between carbon emissions and economic growth in different economies worldwide [2]. Firstly, according to the classification standard of the world bank,
countries in the world are divided into four types of economies according to the standard of per capita gross national income (GNI), as shown in Table 1.

Table 1. The division of economies in the world

| Type of economy                  | GNI(unit:dollars) |
|---------------------------------|-------------------|
| Low-income economies            | ≤ 1036            |
| Middle-lower income economies   | 1036-4085         |
| Middle-higher income economies  | 4086-12615        |
| High-income economies           | ≥ 12616           |

Second, research variables must be selected. Explaining variables are selected as the "carbon dioxide emissions (y)", to analyze the possible effect of carbon dioxide emissions factors, explain variables are selected as the "industrial production (in - du)", "forest area (fore)", "added value of agriculture (agri)".

3. Establishment of the model

3.1. Tapio decoupling model

The decoupling model is designed to describe the positive or negative relationship between two factors in an economy and the strength of the relationship [3]. Based on this, this paper will use the decoupling model to test whether there is a positive or negative correlation between carbon dioxide emissions and economic development in different economies in the world. In this paper, the Tapio decoupling elasticity coefficient of carbon dioxide emissions and economic growth in a region is defined as:

\[
E(y_{GDP}) = \left( \frac{\Delta y}{y} \right) \left( \frac{\Delta GDP}{GDP} \right) \quad (1)
\]

In formula (1), \(E(y_{GDP})\) represents the elastic coefficient of Tapio decoupling model; \(\Delta y\) said one time increment per capita carbon emissions; \(\Delta GDP\) for the same period GDP increment. Data show that the GDP of the four types of economies from 2015 to 2019 was in an overall increasing stage, so only strong decoupling, weak decoupling, expansionary connection, and expansionary negative decoupling can occur in this paper. The specific division of these four situations is shown in Table 2

Table 2. Tapio decoupling status

| State                     | \(\Delta y\)      | \(\Delta GDP\)    | yGDP       |
|---------------------------|-------------------|-------------------|------------|
| Expansionary decoupling   | (0, +∞)           | (0, +∞)           | (1.3, +∞)  |
| Expansive connection      | (0, +∞)           | (0, +∞)           | (0.7, 1.3) |
| Weak decoupling           | (0, +∞)           | (0, +∞)           | (0, 0.7)   |
| Strong decoupling         | (−∞, 0)           | (0, +∞)           | (−∞, 0)    |

3.2. Panel data

This paper uses the data of carbon dioxide emissions of four different economies from 2015 to 2019 to establish a panel data model to analyze the influencing factors and influence degree of carbon emissions. Panel data is a combination of time series and cross section. The panel data can be used to further analyze economic phenomena and avoid multicollinearity. We built the following panel data model:

\[
y_{it} = \beta_0 + \beta_1 in\_du_i + \beta_2 for\_e_i + \beta_3 agri_i + \epsilon_{it} \\
(i = 1, 2, 3, 4; t = 1, 2, L 16)
\]
Where, $y_i$, $indu_i$, $fore_i$, and $agri_i$ respectively represent the per capita carbon dioxide emissions, industrial added value, forest area and agricultural added value of category $i$ economy in year $t$, $\varepsilon_i$ is the error term, $\beta_0$ represents the cross-sectional difference of different economies, and $\beta_i$ measures the impact intensity of different factors on carbon dioxide emissions.

4. Empirical results analysis

4.1. Tapio decoupling index of carbon emissions and economic development of different economies

In this paper, carbon dioxide emissions per capita are used to calculate the elastic value of the decoupling state between them and economic growth. The data were substituted into equation (1) to obtain the decoupling elasticity values of the four economies. The results are shown in Table 3.

| Type of economy                  | Decoupling elasticity coefficient | Decoupling state     |
|---------------------------------|----------------------------------|----------------------|
| Low-income economies            | 0.612                            | Weak decoupling      |
| Middle-lower income economies   | -1.031                           | Strong decoupling    |
| Middle-higher income economies  | 0.078                            | Weak decoupling      |
| High-income economies           | -0.351                           | Strong decoupling    |

The strong decoupling of high-income economies indicates that the economic development of high-income economies no longer relies on the traditional way of consuming fossil energy and has basically transformed into a low-carbon economy. But as a result of this transformation is basically to transfer many energy-intensive processing and manufacturing to developing countries, and high-income economies' per capita carbon emissions are still far higher than low-income and low-income economies' per capita emissions, thus high-income economies still should take on more responsibility [4-5]. But many developed countries pulled out of the Kyoto protocol on the grounds of their national interests, showing that the task of reducing emissions worldwide is a long way off.

Above examines the different economies in 2015-2019 phase of carbon emissions and the decoupling of economic development, but only the research of the relationship between economic growth and carbon emissions is not enough, the world economies within the scope of carbon emissions is influenced by what factors, these factors of different types of economies, whether there is a difference, such as size, about these problems still need further study. The following is an empirical analysis by establishing panel data.

4.2. Analysis of the influencing factors of carbon emission

In this paper, the panel data model is used to analyze the influencing factors of carbon emission. Panel data models are mainly divided into three categories: mixed effect model, fixed effect model and random effect model. Therefore, this paper first determines the specific type of model (2) through f-test and Hausman test.

(1) According to the F test, the mixed effect model or the fixed effect model should be established. The null hypothesis of F test is: establish the mixed effect model. Since the P value of the F test is 0.001, the null hypothesis is rejected at the 1% level. Therefore, the mixed effect model is excluded and the fixed effect model is selected.

(2) According to Hausman test, it is determined whether to establish an individual random effect model or an individual fixed effect model. The null hypothesis of Hausman test is to establish an individual random effect model. The P value of H test is 0.000, that is, the null hypothesis is rejected at the 1% level.

(3) Determine the establishment of individual fixed effect model. In the process of modeling, considering the possibility of autocorrelation, AR (2) was tried to be added to eliminate autocorrelation. Model as follows:
\[ y_n = 1.718 + 0.076 in du_n + 0.036 \text{fore}_u + 1.201 AR(2) + \varepsilon_n \]

According to formula (3), at the significance level of 5%, all the coefficients are significant, and the fitting coefficient is 0.979, indicating a high fitting degree. Under the condition that other factors remain unchanged, for every unit of industrial added value increased, carbon dioxide emissions increased by 0.076 units. Other factors being unchanged, for every unit of agricultural added value, carbon dioxide emissions increased by 0.024 units.

According to the cross-sectional difference shown in table 4, high-income economies still have the highest co2 emissions (mean 5.055), while there is little difference in the mean co2 emissions of low-income economies, middle- and low-income economies and middle - and high-income economies (-1.301, -1.611, -1.553, respectively). Thus, although the analysis above indicates that high-income economies have changed from weak decoupling to strong decoupling, they are still the major producers of carbon emissions. Now climate warming is actually caused by carbon emissions accumulated in the history of developed countries. On the other hand, in low-income economies, middle- and low-income economies and middle - and high-income economies, most countries still take extensive economic growth as their development model, and extensive economic development mechanism inevitably harms the environment [6]. In view of the increasingly serious global environmental problems, the economic development of developing countries can no longer follow the old path of development before governance, and must accelerate the transition from extensive economic growth mode to intensive economic growth mode.

5. Conclusion

In this paper, Tapio decoupling model and panel data model are used to analyze the correlation between economic growth and carbon emissions in four different types of economies in the world, and the influencing factors of carbon dioxide emissions are also analyzed.

1. Tapio decoupling model shows that the economic development of low-income countries is accompanied by the growth of carbon emissions, and the decoupling index generally shows an upward trend, which indicates that the economic development of backward countries is still at the cost of environmental damage, and the economic development of these countries is in urgent need of transformation [7]. The sound development momentum and low carbon dioxide emissions of middle- and high-income economies indicate that economic development is no longer based on the premise of damaging the environment, which also confirms the feasibility and necessity of developing a low-carbon economy. Although all high-income economies are strongly decoupled from each other, it is impossible to judge the relative intensity of carbon dioxide emission reduction in these economies from a single decoupling state. In fact, the panel data model shows that high-income economies have a large carbon emission base and are still the regions that need to focus on reducing emissions.

2. Panel data model shows that the added value of industry and agriculture is the main reason for the growth of carbon emissions, and the increase of forest area can play an important role in carbon dioxide emission reduction. Meanwhile, developed countries (high-income countries) remain the world's leading producers of carbon dioxide emissions.

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