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Research Paper

Research on decoupling model based on Tapio-Impact of COVID-19 on the environment during the epidemic

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Abstract
Tackling climate change and fighting the New Coronavirus epidemic (COVID-19) is a major challenge for mankind at present. The emission of carbon dioxide from fossil fuels is the main driving force of climate change. Economic growth drives energy consumption. With the global outbreak of COVID-19, countries suspend their economic activities and implement strict domestic and international tourism restrictions, and human activities show a trend of large-scale reduction. The global blockade resulted in a record reduction of 240.2 billion tons of global carbon dioxide emissions by 8% in 2020. More and more countries and regions have adopted more measures of external blockade and internal isolation, and the pace of production has slowed down. Environmental pollution is showing a good trend all over the world.The novel coronavirus pneumonia case reported by WHO was 83879647 by the end of December 2020. The impact of COVID-19 epidemic will last for a long time, which is a great catastrophe in history, thus greatly reducing the global CO_2 emission, especially the biggest beneficiary of the environment. However, the number of COVID-19 infected people is rising, slowing down the global economic growth, reducing energy consumption and reducing CO_2 emissions. This paper uses the decoupling model to study GDP and CO_2 emission for analysis, The empirical results show that GDP and CO_2 emission are relatively decoupled, indicating that the degree and speed of global environmental degradation are slow, which is an ideal state. All countries should actively promote the construction of new ideas for Global Climate Governance negotiations and the breakthrough of action plans, and make their own contributions to the global response to climate change, so as to promote the conclusion of a new agreement on Climate Governance facing the future.
Keywords：*COVID-19*、*GDP*、*CO_2* 、*Decoupling*

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I. INTRODUCTION

Climate change is a major social, economic and environmental challenge facing countries all over the world, and has increasingly become a priority agenda in international relations. At present, the number of newly confirmed cases of COVID-19 in the world is still increasing. There is still great uncertainty about how long the epidemic will last and what new changes will occur. However, the spread of the epidemic will have a significant impact on global climate governance.

Due to COVID-19, the global economy is facing a severe recession, which will have an impact on carbon dioxide emissions. The interdependence of the global economy through the supply chain means that even without the implementation of the blockade policy, the reduction of economic activities in one country will lead to the reduction of emissions in other countries. Relevant policies need to be formulated to turn short-term epidemic related emission reduction into stable climate action.

COVID-19 is first of all a global health crisis, but the pandemic also has a significant impact on socio-economic activities and energy use, so it also has an impact on CO_2 emissions. Due to population blockade, mobility restrictions and reduced energy demand, the global emission level will have the largest annual decline in history in 2020.The global blockade will reduce global carbon dioxide emissions by 240.2 billion tons in 2020 - a record decline according to researchers of the future earth global carbon project.

During the peak period of COVID-19 blockade, the passenger flow from ground transportation decreased by about half. By December 2020, due to continuous restrictions, emissions from road transport and aviation will still be lower than those in 2019, about 10% and 40% lower respectively. In 2020, the total carbon

dioxide emissions caused by carbon dioxide fossils and land use change in human activities will be about 39 kilotons of carbon dioxide.

COVID-19 created the biggest global crisis in generations, and brought shock waves to health systems, economy and society all over the world. Faced with an unprecedented situation, governments are focusing on controlling the disease and revitalizing their economies. The World Bank released the GDP data of all countries in the world in 2020. The total GDP of all countries in the world was US $84.706 trillion, a decrease of US $2.902 trillion from US $87.608 trillion in 2019.

In addition, the pandemic and subsequent recovery measures may affect emissions in the coming years. Due to the unpredictable future trend of the pandemic and the great uncertainty of the national and international recovery trajectory, the degree of this impact is unprecedented.

II. REVIEW OF LITERATURE

The quantitative research on the relationship between energy consumption and economic growth has attracted extensive attention of econometrics. Scholars try to explore the relationship between economic growth and energy consumption from the statistical data of various countries, and explore the existence and influencing factors of Environmental Kuznets curve (EKC) between energy consumption and economic growth [1-2];In the 1990s, the organization for economic cooperation and development (OECD) first put forward the concept of "decoupling" in the economic sense in its report "indicators for measuring the decoupling relationship between economic growth and environmental impact", which is used to explore how to reduce or block the relationship between economic development and environmental damage, It provides a useful theoretical research framework for the study of the relationship between energy consumption and economic development [3];Paula's research on India from 1950 to 1996 shows that there is a long-term equilibrium relationship between India's energy consumption and economic growth [4]; Lee's research shows that there is a two-way causal relationship among economy, capital and energy in 18 developing countries [5];

Apergis' research on coal consumption and economic growth in 15 emerging countries from 1980 to 2006 shows that there is a two-way causal relationship between them [6]; How to decouple economic growth from energy consumption without compromising the speed and quality of economic growth has become a key and hot issue [7]; The phenomenon of reducing resource consumption while economic development can be called resource utilization decoupling.Weizs ä cker and Schmidt Bleek of Wuppertal Institute in Germany were the pioneers of decoupling. At the end of the 20th century, they proposed to increase the resource utilization efficiency of the world and developed countries by 4 and 10 times respectively within 50 years, so as to realize the decoupling of resource consumption and economic growth [8-9]; At present, many scholars at home and abroad mainly discuss the definition, state division and methods of decoupling from multiple angles. From the definition of decoupling, decoupling is mainly used to reflect the change of dependence between economic growth and material consumption [10];

From the perspective of decoupling state division, OECD countries have established a set of index system based on driving force environmental pressure environmental state, analyzed the decoupling situation between economic development and material consumption and environmental pressure, and divided it into relative decoupling and absolute decoupling. Based on the views of vehmas, Tapio and other scholars, decoupling is further divided into eight categories: strong decoupling, weak decoupling, declining decoupling, strong negative decoupling, weak negative decoupling, expansionary negative decoupling, growth connection and declining connection [11-13]. Bruce Prideaux, Dr Michelle Thompson and Dr Anja pabel show that COVID-19 can prepare for the transformation of climate change [14]. Franois Gemenne, Anneliese depoux also explained the response to the COVID-19 pandemic, indicating that we have the ability to deal with climate change [15].

III. MATERIALS AND METHODS

Decoupling means that the response relationship between two or more physical quantities with corresponding relationship does not exist. Since the 1990s, OECD has constructed absolute decoupling and relative decoupling index models based on DPSIR (driving force pressure state response feedback). The concept of decoupling has been widely concerned and recognized. On this basis, Tapio introduces the elastic coefficient and uses the elastic decoupling index to describe six decoupling states in more detail.

According to Tapio's definition of decoupling index, it can be concluded that in a given period, the decoupling index Di between CO_2 emission (c) and economic growth GDP (g) is expressed in six decoupling States, in which strong decoupling is the most ideal state of sustained GDP growth and CO_2 reduction; Strong negative decoupling is a decline in GDP, but it is an unfavorable state of continuous CO_2 growth, and weak decoupling is a relatively optimistic state.

Tapio decoupling index construction mode, if the growth rate of (c) is faster than that of (g), it is said that the two show a decoupling relationship. The decoupling relationship is divided into two states. If the growth rate of both is positive, but the growth rate of (g) is higher than that of (c), it becomes "relative decoupling"; If (g)

increases steadily and (c) decreases instead, it is "absolute decoupling".

According to the changing relationship between (c) and (g), the conceptual description of "decoupling" and "negative decoupling" is shown in Figure 1. The decoupling conceptual model is further subdivided according to the relationship between (c) and (g). According to the changing relationship between (c) and (G), "decoupling" and "negative decoupling" are divided into six types: relative decoupling, expanded negative decoupling, strong negative decoupling, declining negative decoupling, declining negative decoupling and absolute decoupling.

According to the conceptual model, these six states are determined by the changes of three groups of values, and each data plays a certain role. "Decoupling" and "negative hook" should not only focus on (c) and (g), but also analyze the changes of (c) / (g). If it is less than 0, it means that they are decoupled, and if it is greater than 0, it means that they are negative decoupled.

In decoupling, the state of (g) continuously decreasing (g < 0), (c) (c > 0) and (g) and (c) (C / g > 0), that is, the relationship between (g) and (c) is "strong negative decoupling", which is the most unfavorable state in the development of (g) and (c).

While (g) continues to grow (G > 0), (C < 0) and (g) and (c) (C / g < 0) decrease at the same time, that is, the relationship between (g) and (c) is "absolute decoupling". Although some of these decoupling and negative decoupling states have achieved simultaneous growth or reduction of (g) and (c), these states are not particularly strict "decoupling" or comprehensive "negative decoupling",It can be roughly summarized into four states: relative decoupling, recession decoupling, expansion negative hook and recession negative hook. Although these four states are not the ideal situation pursued by low-carbon economy, they can achieve the most ideal state of (g) development and (c) by adjusting the change of a certain index. The meanings of each decoupling type are shown in Table 1:

Table 1 implications of decoupling

Decoupling type	Meaning
Absolute decoupling optimal state	GDP growth CO_2 emission reduction C < 0, GDP > 0, (C / GDP) < 0
Compared with the ideal state of relative decoupling,	GDP growth CO_2 emission increases C > 0, GDP > 0, (C / GDP) < 0
Expansion negative hook general state	GDP growth CO_2 emission increase C > 0, GDP > 0, (C / GDP) > 0
Compared with the negative state of recession,	both GDP and CO_2 emission are decreasing, C < 0, GDP < 0, (C / GDP) > 0
Recession decoupling negative state	GDP recession CO_2 emission is also decreasing recession decoupling C < 0, GDP < 0,(C/GDP)<0
The most negative state of strong negative decoupling is	GDP recession and CO_2 emission is increasing, which makes the environment worse C > 0 and GDP < 0,(C/GDP)>0

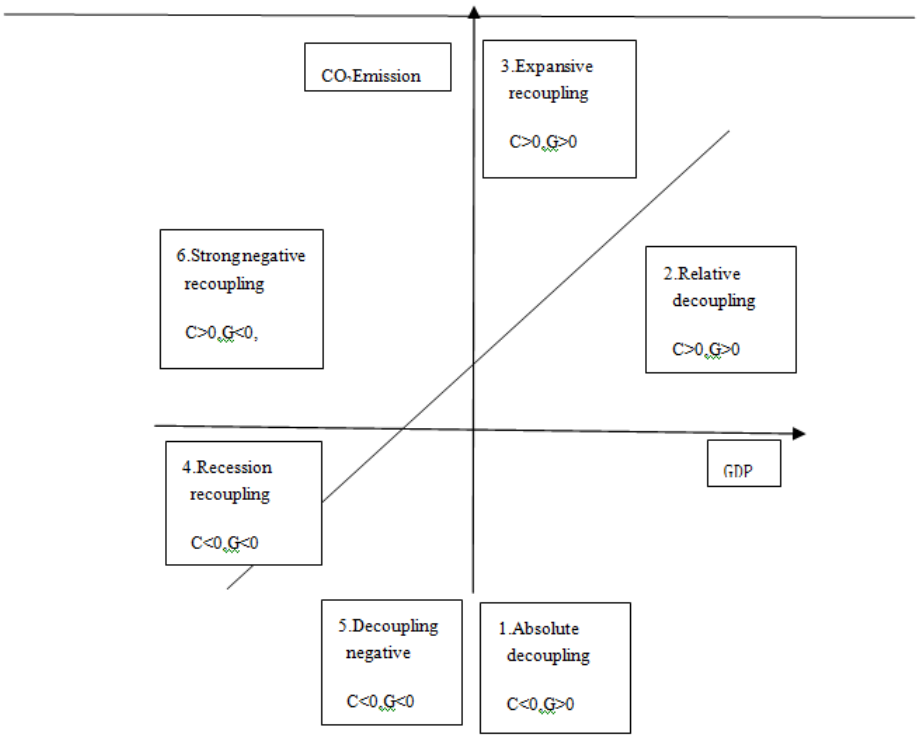

Figure 1 analysis model of relative and absolute decoupling between GDP and CO_2

IV. EMPIRICAL ANALYSIS

Tapio decoupling index: study the calculation formula of decoupling index between global GDP (g) growth and CO_2 (c) from 2019 to 2020 under COVID-19 epidemic:
Decoupling index Di = △ C / C / △ GDP / GDP;
Decoupling factor = 1-di;
The growth rate of CO_2 is faster than that of GDP: C > GDP is the decoupling relationship;
The growth rate of the two is regular: C > 0, GDP > 0, GDP > C is relative decoupling;
GDP > 0 growth, C > 0 decline, which is absolute decoupling
There are two understandings of decoupling CO_2 emissions from GDP growth:
1. In a certain period of time, the rate of CO_2 emission or the deterioration rate of an environmental index or an environmental pressure index
When the rate of change is less than the GDP growth rate, it is considered to be the stage of relative decoupling or weak decoupling.
2. On the contrary, it is considered as the linkage stage.
To explore the relationship between GDP growth and CO_2
DI=CI/GI
Where: Di is decoupling index; Ci is CO_2 emission index; GI is the GDP growth index.
When Di > = 1, that is, the development rate of CO_2 is synchronous or faster than the growth rate of GDP, and the two are in the linkage stage; Di = 1 is the turning point of linking and relative decoupling. The greater the di value, the higher the dependence of GDP growth on CO_2; When Di < 1, that is, the growth rate of CO_2 is slower than that of GDP, which is in the stage of relative decoupling. The smaller Di value indicates that the impact of GDP growth on CO_2 emission is low; When Di = 0, i.e. CO_2 emission remains unchanged or environmental pressure remains unchanged, GDP growth can still be maintained.

V. EMPIRICAL RESULTS

Table II statistical values of COVID-19, GDP and CO_2 from 2019 to 2020

COVID-19,2020.12The number of confirmed infections worldwide is 83879647		
2020 World GDP	84706	In trillion dollars
2019 World GDP	87608	In trillion dollars
2020 World CO_2Emission	31.5	Gt
2019 World CO_2Emission	33.4	Gt

Decoupling index; DI =△C/C/△GDP/GDP;
DI=△31.5/33.4/△84706/87608
=0.94311377/0.966875
=0.97542454
Decoupling factor; =1-DI;
=1-0.97542454
=0.0245746

Empirical results; Di < 1, that is, the development rate of CO_2 is slower than that of GDP, which is in the stage of relative decoupling. In a certain period of time, when the rate of CO_2 emission or the deterioration rate of an environmental index or the change rate of an environmental pressure index is less than the growth rate of GDP, it is considered that there is a relative decoupling stage, showing a relative decoupling stage, indicating that the current global environmental deterioration degree and speed are slow, which is an ideal state.

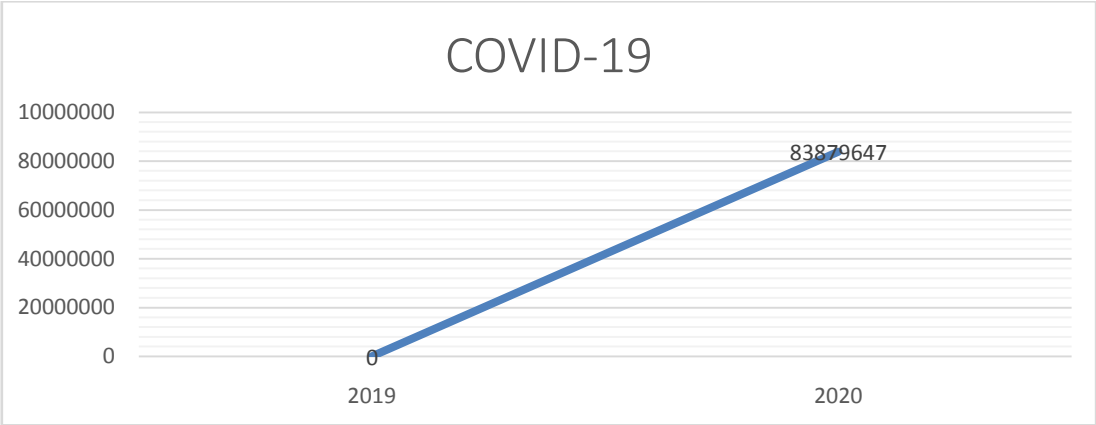

Figure II, COVID-19,2020.1-2020.12 Global confirmed infection

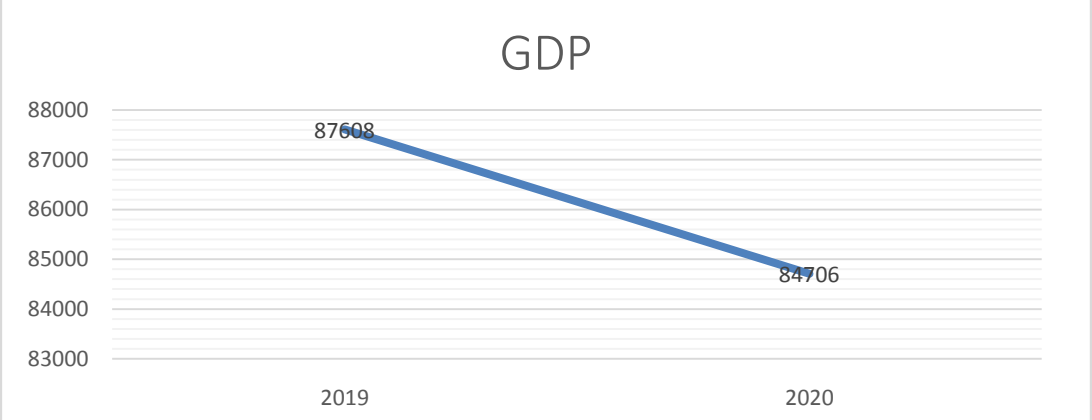

Figure III, 2019-2020 World GDP trillions of US dollars

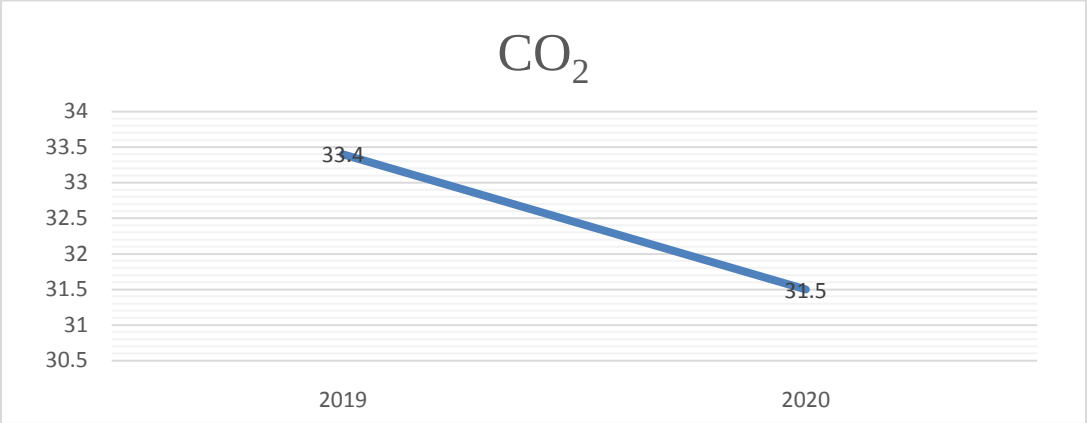

Figure IV, Global energy related co_2 emission-2019-2020

VI. CONCLUSIONS

Empirical results; Di < 1, that is, the development rate of CO_2 is slower than that of GDP, which is in the stage of relative decoupling. In a certain period of time, when the rate of CO_2 emission or the deterioration rate of an environmental index or the change rate of an environmental pressure index is less than the growth rate of GDP, it is considered that there is a relative decoupling stage, showing a relative decoupling stage, indicating that the current global environmental deterioration degree and speed are slow, which is an ideal state.

Urban air pollution is decreasing. Due to the practice of home isolation and shutdown all over the world, there is real evidence that air pollution in urban areas of various countries has been greatly reduced. The amount of medical waste caused by the epidemic will be 4-5 times that in normal times. Medical waste is different from ordinary waste. They may contain COVID-19, which is regularly sterilized and treated by burning. However, burning garbage also aggravates the environmental impact.

Our way of production and life has not changed. Once we resume production and work, the air quality

will soon return to the previous state, or even become more serious. According to a study in natural climate change, after the global financial crisis in 2008-2009, it was followed by the strong emission growth of emerging economies, the recovery of emission growth of developed economies and the sharp increase of fossil fuels caused by world economic development. CO_2 is the "primary indicator of global industrial activities". Since China resumed production and work, the CO_2 emission level has gradually returned to normal. If emission reduction measures are not taken to control air pollution, the emission reduction during the epidemic will have no effect on the mitigation of climate change.

Although air pollution decreased to some extent during the epidemic, the impact is only superficial, temporary and local, and the long-term impact of the epidemic on economy and health is disastrous for mankind. The COVID-19 epidemic crisis is a new beginning and an opportunity to make changes for environmental protection. We should pay more attention to the impact of everyone's behavior on the environment, because human beings are also a part of the global ecosystem. We should all reflect on environmental protection from a long-term perspective.

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