The Impact of The Carbon Emissions Trading System on The European Union Decoupling Index

Zeyu Zhang *

School of Business, Macau University of Science and Technology, Macau, China

* Corresponding Author Email: 2240025925@student.must.edu.mo

Abstract. This article elaborates on the impact of the Emissions Trading System (ETS) on decoupling, and current scholars mainly focus on the Environmental Impact Population Affluence Technology (IPAT) model, Kaya identity, and Logarithmic Mean Divisia Index Method (LMDI) decomposition method for the mechanism of impact. Environmental Impact, Population, Affluence, and Technology (ETS) has had a profound impact on the European Union (EU) decoupling index. The EU ETS establishes a policy coordination framework and provides a data foundation, which is the key and institutional guarantee for the EU to achieve decoupling between economic growth and carbon emissions. It has established a cross-member-state policy coordination framework, unified carbon emission accounting standards and trading rules, and provided a continuous and accurate emission data foundation for the calculation of decoupling indices. Consequently, it has become a key institutional pillar for the EU to achieve the decoupling goal of "economic growth alongside a decline in total carbon emissions". The coordinated development of ETS and other policies has promoted environmental effectiveness, social equity, economic efficiency, and political feasibility. Taking LMDI as an example, mechanism analysis was conducted to calculate the contribution values of different factors to the decoupling index in different periods, to understand the driving mechanism of carbon emission changes.

Keywords: ETS, decoupling, economic growth.

1. Introduction

Currently, environmental issues are becoming increasingly severe and have had a serious impact on ecology, society, and human development. In recent years, there is a significant increase in global attention to environmental protection issues, and environmental protection has become a major topic of global governance. With the intensification of the impact of climate change, the international level of environmental governance and attention has unprecedentedly increased, reflected in the profound practice of controlling pollutant emissions and low-carbon goals. In December 2015, countries adopted the Paris Agreement, guiding all countries to make joint commitments to reduce emissions and actively address global climate change. The "Fit for 55" package of climate plans released by the European Commission specifically commits to reducing net greenhouse gas emissions by 55% from 1990 levels by 2030 and achieving carbon neutrality by 2050 [1]. At present, it are in a critical period of rebuilding the global climate governance system. In addition to actively cooperating to reduce emissions and achieve win-win results, countries around the world have successively launched various climate governance strategies. Among them, building a carbon emissions trading market has become one of the core policy tools for countries to achieve their carbon peak and carbon neutrality goals. According to the United Nations and air quality, Europe recognized early on that air pollution poses a threat to human health and ecosystems. As a pioneer of Emissions Trading System (ETS), the European Union has been implementing low-carbon goals through a systematic policy framework and strong enforcement in recent years, providing an exemplary role for other economies around the world. The European Union (EU) Emissions Trading System (EU ETS), as an innovative mechanism to address climate change, has attracted much attention since its establishment. The market incentive mechanism of this system reduces greenhouse gas emissions and covers major emission industries in Europe, becoming an important tool to promote the achievement of emission reduction targets in Europe.

In 2003, the European Union established the EU ETS through Directive 2003/87, which established a greenhouse gas emissions trading scheme within the Community [2]. Include all the most relevant energy activities and specific industries in its attachment to the EU ETS, with the aim of reducing greenhouse gas emissions in Europe. Under the EU's "Fit for 55" target, the carbon market is highly anticipated, but due to issues related to economic interests, social equity, and global governance, there is no consensus on its actual contribution to decoupling. The decoupling index, as a core indicator for policy evaluation, has problems such as vague measurement standards and confusion of causal relationships. This study can more clearly capture the constraint effect of mechanisms on pollutant emissions, which has strong reference significance and feasibility for international regions. The EU is composed of multiple member states with individual differences, ensuring the robustness of the study. The decoupling indicator has high feasibility in measuring the economic development of the European Union, one of the reasons being that the EU has established a comprehensive database system, which ensures the reliability of empirical analysis. This article compares whether the Tapio elasticity method, Organisation for Economic Co-operation and Development (OECD) improvement method, and Logarithmic Mean Divisia Index Method (LMDI) decomposition method can reflect the policy effectiveness of ETS from the perspective of the measurement method of decoupling index. Rationally consider the differences in policy implementation to make it more inclusive.

2. Theoretical Evolution and Measurement Analysis of Decoupling Index

2.1. Theoretical Evolution of Decoupling Index

Decoupling, as a physical concept, has been widely used in economics since the last century. The Organization for Economic Cooperation and Development introduced the concept of decoupling into environmental policy research, comparing the growth rates of environmental pressure indicators and economic driving indicators to determine whether decoupling has occurred. Finnish scholars classify decoupling states into eight types based on elasticity analysis. In the traditional growth model, pollution and economic growth are contradictory. The Environmental Kuznets Curve is an inverted "U" - shaped curve, which means that when a country's economic development level is low, the degree of environmental pollution is relatively light. However, as per capita income increases, environmental pollution tends to increase from low to high, and the degree of environmental degradation intensifies with economic growth. When the economic development reaches a certain level, with the further increase of per capita income, environmental pollution decreases from high to low, and the degree of environmental pollution gradually slows down, and the environmental quality gradually improves.

2.2. Comparison of Decoupling Measurement Methods

In recent years, the carbon emission trading system has become increasingly comprehensive, and scholars at home and abroad have made abundant research achievements on the driving mechanism of carbon emissions. At present, in measuring the influencing factors of carbon emissions, Kaya identity, Impact Population Affluence Technology (IPAT) model, LMDI decomposition method, etc. are mainly used. The Kaya identity was proposed by Kaya in 1989 to study the impact of factors such as energy intensity and population on carbon emissions. It is often used in conjunction with other methods to explore the driving mechanisms of carbon emissions. Chimeddorj and Abada explored the relationship between carbon emissions and influencing factors in Mongolia based on the Kaya identity and grey system theory, and found that energy use is a key factor affecting Mongolia's carbon emissions. Population growth indirectly drives carbon emissions by increasing energy demand [3].

The IPAT model was originally used as a method to study the factors affecting environmental quality, laying the foundation for subsequent research. The IPAT equation is used to quantify the mathematical relationship between environmental impact (I) and population (P), economic wealth (A), and technology (T). This equation provides a framework for environmental load analysis by decomposing the causes of environmental impacts. Zhou uses the IPAT equation to macroscopically analyze the importance of technological progress in reducing emissions [4]. Al Mulali found that primary energy consumption, net foreign direct investment inflows, Gross Domestic Product (GDP), and total trade were important influencing factors when investigating the main factors affecting carbon dioxide emissions in 12 Middle Eastern countries, including Egypt and Iran, from a spatial perspective between 1990 and 2009 [5].

2.3. The Decoupling Index Reflects the Policy Effectiveness of the Carbon Trading Market

When Inhwan Ko and Taedong Lee studied the importance of greenhouse gas emissions and decoupling, as well as the differences in the degree of decoupling among European countries, they used a two-way fixed effects model to demonstrate a significant negative correlation between emissions trading and emission intensity, and further validated the Customer Engagement Management (CEM) matching results. The impact of emissions trading on decoupling is influenced by specific national conditions [6]. Scholars such as Li Zhenhuan studied the necessity of decoupling the economic growth of China's tourism industry from carbon emissions and the spatiotemporal pattern based on the "Green Tourism Economy Initiative". The results showed that the decoupling index of carbon emissions in China's tourism industry fluctuated from 2010 to 2019, and the decoupling effect was not satisfactory. In the future, it will be in a state of decoupling. The decoupling level in the eastern region is gradually increasing, while the central region is fluctuating and changing. The decoupling effect is the worst in the western region. The number of spatially positively correlated provinces has increased, the number of negatively correlated provinces has decreased, and the level of decoupling between neighboring provinces has increased [7]. Zhao Xin's research on the relationship between China's air pollutant emissions and economic growth mainly shows a strong decoupling state [8].

3. The Synergistic Effect of the Carbon Emissions Trading System and other Policies

3.1. ETS Collaborates with the EU Carbon Border Adjustment Mechanism

ETS and the EU Carbon Border Adjustment Mechanism (CBAM) collaborate, although both are price-based carbon pricing tools, their core mechanisms are not the same. ETS often covers high-emission facilities such as electricity, industry, and aviation within the European Union, while carbon taxes are applied to specific goods imported from non-EU countries. The two mechanisms are parallel to ensure that various forms of carbon emissions are more effectively constrained. The same two mechanisms can set a carbon price bottom line to ensure the stability of the carbon market, but they may increase the burden, so a clear division should be made between the two mechanisms [9].

3.2. Policy Synergy between ETS and Subsidies for Renewable Energy

There is a synergistic effect between ETS and subsidies related to renewable energy, with the core being the promotion of low-carbon emission energy from solar, hydro, and wind power. On the one hand, there is a transformation in energy use from the root. Fossil fuels are the main source of carbon emissions. On the other hand, the government's implementation of carbon taxes and prices has increased the cost of fossil fuels. On the other hand, subsidies for clean energy have reduced its cost. This trade-off has prompted companies to increase their research on clean energy and transform their use of raw materials. Based on the theory of technological progress and the scale of clean energy production and application, the industry can more easily achieve emission reduction and cost reduction, thereby positively affecting the entire carbon trading market [10].

3.3. ETS Collaborates with the Social Climate Fund (SCF)

The coordinated development between the EU and SCF is an important practice for the EU to balance environmental goals and social equity in promoting green transformation, that is, to ensure the balance between environmental and social equity in the process of transitioning to green. This reflects the EU's high emphasis on social fairness and justice in the ambitious green transformation process. It attempts to alleviate climate policies, policy coordination, and mechanism design through financial support, policy coordination, and mechanism design, to mitigate the social impact that climate policies may bring, improve public acceptance, and ensure the smooth achievement of overall climate goals.

3.4. ETS and Carbon Tax Collaboration

The synergy between ETS and carbon tax, although both are price-based carbon pricing tools, has different core mechanisms. The carbon trading system often covers large fixed emission sources, while carbon taxes can be more widely applied in other aspects of daily life. The two mechanisms are parallel to ensure that various forms of carbon emissions can be constrained with stronger constraint effectiveness. The same two mechanisms can set a carbon price bottom line to ensure the stability of the carbon market, but they may increase the burden on enterprises. Therefore, a clear division should be made between the two mechanisms. But ETS and carbon tax are not opposing options, but can be combined synergistically. ETS ensures environmental benefits, provides price signals for carbon taxes, and expands coverage.

The synergistic effect of just transition policies and environmental policies has a negative impact on the costs and outputs of vulnerable groups, regions, and related industries that rely on environmental advantages, which in turn affects social security and even leads to poverty. The carbon trading market will lead to an increase in energy prices, which will have a significant impact on regions that rely on fossil fuels. Regions with a single industry may even face economic recession, causing personnel loss and further leading to regional dualism and social conflicts. Reasonably utilizing the fiscal revenue generated by carbon market auctions for transfer expenditures and improving the efficiency and relative fairness of redistribution policies are important fiscal measures to ensure fairness. Similarly, ensuring the fairness of the carbon market and the level of public acceptance is one of the government's key priorities.

The existence of the carbon market provides new market demand and business prospects, and correspondingly, more efficient low-carbon technologies will be favored. The government's relevant research and development policies will accelerate enterprises to break down technological barriers and reduce costs, which is more in line with market demand. Protecting the "stillborn" new technologies of start-up technology enterprises will make scientific research and the market full of vitality. In these collaborations, the government needs to clarify the main position of the problem and comprehensively control the macro carbon emission market. If the market mechanism is actively used in the carbon market and carbon pricing is regarded as the core policy, it will have a positive effect on the carbon market behavior of the entire society. Other policies should also be based on this pricing policy as the core. In the process of achieving the goal of carbon neutrality, methods and policies are not static. It dynamically analyze the environmental and emission problems from a dynamic perspective, taking into account both economic development and environmental protection. It make regular and periodic adjustments, clarify policy content, and set a benchmark for the industry.

4. Feasibility Analysis

4.1. Tapio Decoupling Index

GDP accounting, as an important indicator for measuring economic growth, has irreplaceable advantages. Using decoupling models to evaluate policy effectiveness. The decoupling theory is mainly divided into the Tapio decoupling model, proposed by Finnish scholars in 2005, and the OECD decoupling model proposed by the Organization for Economic Cooperation and Development in 2002. The Tapio decoupling model is based on elasticity analysis, quantifying the dynamic relationship between economic growth and environmental pressures (such as carbon emissions). The OECD decoupling model determines whether decoupling has occurred by comparing the growth of environmental pressure indicators (such as pollutant emissions) with economic driving indicators. Due to the OECD decoupling model not subdividing the intermediate states of decoupling, this may mask short-term fluctuations. The Tapio decoupling model focuses on the trend of changes in time series and evaluates the correlation between economic growth and pollutant emissions to determine whether economic growth depends on the growth of pollutant emissions. Based on the elasticity value, decoupling states are divided into 8 types (such as weak decoupling, strong decoupling, and expansionary negative decoupling). More detailed measurement of decoupling degree:

$$DI=\frac{\text{Environmental pressure change rate}}{\text{GDP change rate}} \quad (1)$$

4.2. ETS Policy

The explanatory variable of this article is the carbon emissions trading system, which was launched by the European Union in 2005 and is not negatively affected by the decoupling index. The EU ETS is a public policy initiated by the government, and its establishment, coverage, quota allocation, and other core elements are determined by the policy decision-making process rather than being influenced by the dependent variable. The participation time of EU countries in ETS is basically the same, and whether they participate or not is uniformly regulated by the EU, without being affected by variables such as the economic structure and technological level of individual countries, reducing endogenous interference.

4.3. Mechanism Analysis

Taking LMDI decomposition method as an example, LMDI can decompose carbon emission changes into multiple factors, such as economic output, energy efficiency, industrial structure, etc. By constructing a decomposition model based on LMDI, the contribution values of each factor to the decoupling index at different periods are calculated to understand the driving mechanism of carbon emission changes. Taking carbon emission intensity as an example: I = C/GDP

Among them, C is the carbon emissions, and GDP is the economic output. The decrease in carbon emission intensity means that the decoupling trend between carbon emissions and economic development is increasing.

The key factors affecting the decoupling index (carbon emission intensity I) include energy intensity E (the ratio of energy consumption E to GDP), energy structure S (the ratio of carbon emissions C to energy consumption E), and industrial structure (the ratio of GDP of each industry to totalGDP). Namely:

$$I=\frac{C}{E}\times\frac{E}{GDP} \quad (2)$$

Construct an LMDI model with a base period of t=0 and a target period of t=T. Calculate the total change in decoupling index:

$$\Delta I=I_t-I_0 \quad (3)$$

$$I=S\times E \quad (4)$$

Decompose the total change into the sum of the contributions of each factor:

$$\Delta I=\Delta I_S+\Delta I_E \quad (5)$$

The formula for calculating the contribution values of each factor is (logarithmic average weight):

$$\Delta I_S=\frac{I_T-I_0}{\ln I_T-\ln I_0}\times\ln(\frac{S_T}{S_0}) \quad (6)$$

$$\Delta I_E=\frac{I_T-I_0}{\ln I_T-\ln I_0}\times\ln(\frac{E_T}{E_0}) \quad (7)$$

ΔI_S: The contribution of changes in energy structure to decoupling index

ΔI_E: The contribution of energy efficiency changes to decoupling index

If it is positive, it indicates that the factor inhibits decoupling. if it is negative, it indicates that the factor promotes decoupling.

5. Conclusion

This article elaborates on the impact of the Emissions Trading System on decoupling, demonstrating that it is an important policy tool for promoting high-quality decoupling of the EU economy. In terms of mechanism, the LMDI decomposition method is mainly introduced. Among them, the Tapio decoupling index and OECD decoupling index were used to measure and analyze the fluctuations of environmental pressure change rate and GDP change rate, and it was found that the carbon emissions trading system has a significant impact on the EU decoupling index. The carbon emissions trading system policy has a synergistic effect with other policies, such as ETS and CBAM, renewable energy-related subsidy policies, carbon taxes, etc. It is no longer limited to ETS policies, but creates strong economic signals through other market mechanisms from a more inclusive perspective, laying a solid foundation for the EU to achieve its "carbon neutrality" goal. The coordinated development of ETS and other policies provides long-term economic incentives for enterprises to shift towards low-carbon technologies, optimize resource allocation, and achieve common prosperity.

ETS promotes economic development through strong execution, enabling the system to drive global economic development from high-quality development in the EU market. In order to achieve environmental effectiveness, improve economic efficiency, promote fair competition in the market, and reduce pollutant emissions while promoting economic development. The trading of carbon markets will create a fairer, more innovative, and higher quality world.

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