

# Legal Regulations and Economic Impacts in Carbon Emission Trading Systems

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## Abstract

As climate change intensifies, carbon emission trading has emerged as a crucial market-based tool for emission reduction. This theoretical study focuses on the legal framework of carbon trading and its economic effects, aiming to deepen the understanding of this emerging field's complexity. The research systematically reviews the evolution of regulations in major global carbon markets, comparing and analyzing the design features of carbon trading mechanisms under different legal systems. The article delves into core issues such as the legal definition of carbon emission rights, allowance allocation methods, and market regulatory mechanisms, revealing how the legal framework shapes the operational mechanisms of carbon markets. Through theoretical modeling, the study extrapolates the potential impacts of carbon trading regulations on micro-enterprise behavior, meso-industrial structure, and the macro economy. The analysis indicates that while a robust legal system is fundamental to the effective operation of carbon markets, excessive regulation may suppress economic vitality and affect market efficiency. The research also explores the synergistic effects between carbon trading and other environmental policy tools, as well as the legal challenges faced by cross-border carbon trading. This paper provides a theoretical basis for optimizing carbon trading regulations, proposing recommendations for improving the legal framework, refining market mechanisms, and strengthening international coordination, aiming to promote the symbiosis and mutual benefits of environmental protection and economic development. This study offers important theoretical insights for understanding and improving carbon emission trading systems.

## Keywords

Carbon Trading, Environmental Regulations, Economic Effects, Climate Policy, Sustainable Development

## 1. Introduction

As climate change intensifies, carbon emission trading has emerged as a crucial market-based tool for emission reduction globally. This theoretical study focuses on the legal framework of carbon trading and its economic effects, aiming to deepen the understanding of this emerging field's complexity. The research systematically reviews the evolution of regulations in major global carbon markets, comparing and analyzing the design features of carbon trading mechanisms under different legal systems. The article delves into core issues such as the legal definition of carbon emission rights, allowance allocation methods, and market regulatory mechanisms, revealing how the legal framework shapes the operational mechanisms of carbon markets. Through theoretical modeling, the study extrapolates the potential impacts of carbon trading regulations on micro-enterprise behavior, meso-industrial structure, and the macro economy. The analysis indicates that while a robust legal system is fundamental to the effective operation of carbon markets, excessive regulation may suppress economic vitality and affect market efficiency. The research also explores the synergistic effects between carbon trading and other environmental policy tools, as well as the legal challenges faced by cross-border carbon trading.

Early research mainly focused on the theoretical basis and policy design of carbon trading (Stavins, 2003; Tietenberg, 2006). With the deepening of practice, scholars began to focus on the operational effects and economic impacts of carbon markets (Ellerman et al., 2016; Narassimhan et al., 2018). In recent years, with the rapid development of global carbon markets, cross-border carbon trading and international carbon market linkage have become new research hotspots (Mehling et al., 2018; Ranson & Stavins, 2016). Furthermore, research methods on carbon emission rights continue to innovate. Peng et al. (2017) conducted a systematic review of literature on carbon emission rights research, providing important references for subsequent studies. In specific application areas, Wang et al. (2019) discussed a dynamic model of initial emission rights for medical sewage systems, offering new insights for carbon management in specific industries. However, existing research still lacks systematic analysis of the legal framework and economic impact of carbon trading. This paper provides a theoretical basis for optimizing carbon trading regulations, proposing recommendations for improving the legal framework, refining market mechanisms, and strengthening international coordination, aiming to promote the symbiosis and mutual benefits of environmental protection and economic development. This study offers important theoretical insights for understanding and improving carbon emission trading systems.

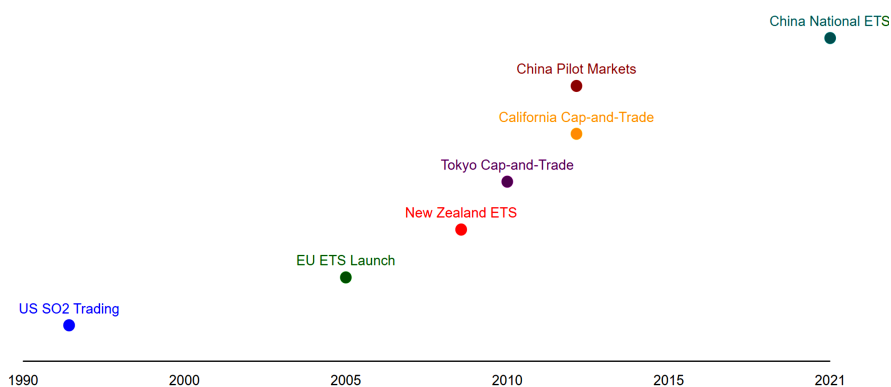
## 2. Legal Framework of Carbon Emission Trading System

### 2.1. Evolution of Major Global Carbon Market Regulations

The legal framework of carbon emission trading systems has undergone an evolution from nothing to something, from simple to complex. The earliest carbon trading practice can be traced back to the U.S. sulfur dioxide emission rights

trading program in the 1990s, which provided valuable experience for the subsequent design of carbon markets. In 2005, the European Union Emissions Trading System (EU ETS) was officially launched, becoming the world's largest carbon market, and its legal framework has gone through three stages of development. The first phase (2005-2007) was mainly a pilot period with relatively simple regulations; the second phase (2008-2012) was synchronized with the Kyoto Protocol commitment period, and the regulatory system was gradually improved; the third phase (2013-2020) achieved a wider coverage and stricter emission reduction targets. During the same period, regions such as New Zealand (2008), Japan (2010), and California (2013) successively established carbon trading systems, gradually forming distinctive legal frameworks. China, as a late starter, began carbon trading pilots in seven provinces and cities from 2013, and officially launched the national carbon market in 2021, becoming the world's largest carbon trading system. The evolution of these regulations reflects the policy orientations of various countries in addressing climate change and balancing economic development with environmental protection, providing rich practical experience for the legal framework of global carbon markets.

**Figure 1** shows the evolution process of major global carbon market regulations, intuitively reflecting important milestones such as the initial U.S. sulfur dioxide trading program, the establishment of the EU carbon market, and the recent launch of China's national carbon market.



**Figure 1.** Timeline of major global carbon market regulations.

## 2.2. Legal Definition of Carbon Emission Rights

The legal definition of carbon emission rights is one of the core issues in the legal framework of carbon trading systems, directly affecting the design and operation of carbon markets. Currently, there is no unified global understanding of the legal nature of carbon emission rights. There are mainly three views: First, carbon emission rights are viewed as property rights, such as the EU carbon market defining carbon allowances as transferable intangible assets; Second, they are viewed as administrative licenses, as some Chinese scholars believe that carbon emission rights are essentially emission permits granted by the government to enterprises; Third, a compromise view considers carbon emission rights to have dual attributes of

property rights and administrative licenses.

It is worth noting that there are significant differences between developed and developing countries in the concept and application of carbon emission rights. Developed countries tend to define carbon emission rights as tradable property rights, adopt more market-based allocation methods such as auctions, and have more mature carbon market mechanisms. In contrast, developing countries often view carbon emission rights as administrative licenses allocated by the government, mainly using free allocation methods to mitigate the impact on economic development, and their carbon markets are mostly in the initial or developing stages. These differences reflect the different positions and capabilities of countries in balancing climate change response and economic development, and also pose challenges for the coordinated development of international carbon markets.

### **2.3. Legal Provisions for Carbon Allowance Allocation Methods**

Carbon allowance allocation is the starting point for the operation of carbon trading systems, and its method directly affects the fairness and efficiency of the market. There are significant differences in allowance allocation methods among major global carbon markets, mainly including free allocation and paid allocation. Free allocation is further divided into the “grandfather method” based on historical emissions and the “benchmark method” based on industry benchmarks. Paid allocation mainly adopts the auction method. The EU carbon market has gone through a process from mainly free allocation to gradually increasing the proportion of auctions. The third phase (2013-2020) stipulates that the power sector will fully adopt auctions, while other sectors will gradually transition to auctions. China’s national carbon market currently mainly adopts free allocation, but will gradually introduce auction mechanisms in the long term. The U.S. California carbon market adopts a combination of free allocation and auctions, and sets a price floor. The choice of carbon allowance allocation methods is influenced by multiple factors, including industry characteristics, international competitiveness, carbon leakage risk, economic development stage, emission reduction targets, market maturity, policy continuity, and fairness considerations. Different industries have varying carbon emission intensities and reduction potentials, requiring differentiated allocation strategies. For industries facing international competition, excessive carbon costs may lead to carbon leakage, potentially necessitating more free allowances. Developing countries may prefer allocation methods that favor economic growth, while mature markets may focus more on providing strong price signals through auctions. The balancing of these factors reflects the complexity of carbon allowance allocation, requiring policymakers to systematically consider specific national conditions and market characteristics.

## **3. Carbon Trading Market Regulatory Mechanisms**

### **3.1. Market Entry and Exit Mechanisms**

The entry and exit mechanisms of carbon trading markets are key legal guarantees

for ensuring orderly market operation. Different countries and regions have differences in entry thresholds, participating entities, and exit conditions for carbon markets. Taking the EU carbon market (EU ETS) as an example, its entry mechanism is mainly based on emission thresholds, covering large emission sources in key sectors such as electricity, industry, and aviation. Enterprises with annual emissions exceeding 25,000 tons of carbon dioxide equivalent must participate in trading. In the initial stage of China's national carbon market, only the power sector is included, and power generation enterprises with annual emissions exceeding 26,000 tons of carbon dioxide equivalent are required to participate. The U.S. California carbon market adopts a more flexible entry mechanism, allowing voluntary participants to enter the market in addition to mandatory participants. In terms of exit mechanisms, most carbon markets stipulate that enterprises can apply for exit when their emissions are below the entry threshold for three consecutive years. However, to prevent carbon leakage and market manipulation, the exit procedures are usually strict. Some markets have also set up temporary exit or trading suspension mechanisms to cope with extreme market fluctuations. A well-designed entry and exit mechanism helps balance market liquidity and stability, and is an important guarantee for the healthy development of carbon markets.

### **3.2. Trading Rules and Information Disclosure Requirements**

The trading rules and information disclosure requirements of carbon trading markets are core legal mechanisms for maintaining market fairness and improving transparency. Major carbon markets generally adopt the "cap-and-trade" model, but there are differences in specific trading rules. The EU carbon market allows spot trading, futures trading, and over-the-counter trading, with trading platforms including energy exchanges and specialized carbon exchanges. China's carbon market currently only allows spot trading, and may gradually introduce derivative trading in the future. In terms of information disclosure, most carbon markets require participants to regularly report emission data and undergo third-party verification. The EU carbon market requires enterprises to submit the previous year's emission report by March 31 each year and return corresponding allowances by April 30. China's carbon market stipulates that key emission units should submit the previous year's emission report and verification report by March 31 each year. To prevent insider trading and market manipulation, most carbon markets have also formulated disclosure rules for price-sensitive information. For example, the EU carbon market requires member states to promptly disclose information such as national allocation plans and auction results. Well-designed trading rules and information disclosure mechanisms help improve market efficiency and enhance participant confidence, which are important guarantees for the long-term stable operation of carbon markets.

### **3.3. Violation Penalties and Dispute Resolution Mechanisms**

Effective violation penalties and dispute resolution mechanisms are important

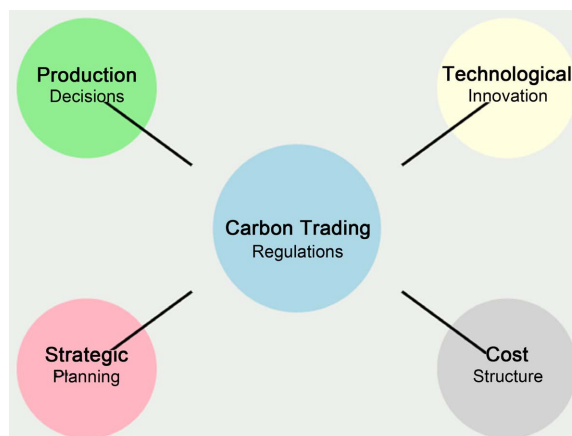
legal guarantees for ensuring fair and orderly operation of carbon trading markets. Major carbon markets have generally established strict penalty systems, but specific measures vary. The EU carbon market imposes a fine of 100 euros per ton on enterprises that fail to return allowances on time, and requires them to make up for the shortfall. China's carbon market stipulates that key emission units that fail to comply on time will be fined between 20,000 and 50,000 yuan, and the violation will be recorded in their credit records. The U.S. California carbon market adopts a tiered penalty mechanism, with a fine of \$25 per ton for the first violation, increasing to \$50 for cumulative violations. In addition, most carbon markets also have penalty clauses for illegal activities such as market manipulation and false information disclosure. In terms of dispute resolution, most carbon markets have established mechanisms combining administrative reconsideration and judicial litigation. For example, disputes in the EU carbon market can be resolved through member state courts or the European Court of Justice. China's carbon market stipulates that those who are dissatisfied with administrative penalty decisions can apply for administrative reconsideration or file administrative litigation according to law. Well-designed violation penalties and dispute resolution mechanisms not only maintain market order but also enhance participant confidence, promoting the long-term stable development of carbon markets.

## **4. Economic Impact of Carbon Trading Regulations**

### **4.1. Impact on Micro-Enterprise Behavior**

Carbon trading regulations have a profound impact on enterprise behavior, mainly reflected in production decisions, technological innovation, and strategic planning. First, carbon price signals prompt enterprises to re-evaluate their production cost structure. High-carbon emission enterprises face greater cost pressure and may reduce emissions by optimizing production processes, adjusting energy structures, or reducing output. For example, after the implementation of the EU carbon market, the power sector accelerated the transition from coal power to natural gas and renewable energy. Second, carbon trading incentivizes enterprises to innovate in low-carbon technologies. Research shows that the EU carbon market has led to a significant increase in low-carbon patent applications, especially in energy-intensive industries. China's carbon market has also promoted the application of energy-saving and emission-reduction technologies in the thermal power industry. Third, carbon trading affects enterprises' long-term strategic planning. Some enterprises have incorporated carbon asset management into their corporate strategies and set up specialized carbon management departments. Multinational companies also consider carbon cost factors more in investment decisions. However, the impact of carbon trading varies by industry and enterprise size. For small and medium-sized enterprises, compliance costs are relatively high and they may face greater challenges. Therefore, when formulating carbon trading regulations, it is necessary to consider the bearing capacity of different types of enterprises and design appropriate support policies to balance emission

reduction targets and economic development. **Figure 2** shows the main areas of impact of carbon trading regulations on enterprise behavior, including production decisions, technological innovation, strategic planning, and cost structure, intuitively reflecting the correlation between these areas and carbon trading regulations.



**Figure 2.** Main areas of impact of carbon trading regulations on enterprise behavior.

#### 4.2. Impact on Meso-Industrial Structure

The impact of carbon trading regulations on industrial structure is a gradual and far-reaching process, mainly reflected in industrial upgrading, resource reallocation, and the development of emerging industries. Carbon trading accelerates the transformation and upgrading of high-carbon industries. Taking the EU as an example, the implementation of the carbon market has promoted traditional energy-intensive industries such as steel and cement to adopt cleaner production technologies and promoted the extension of industrial chains towards high value-added and low-carbon emissions. Carbon trading leads to resource reallocation among industries. The rise in carbon prices makes low-carbon industries relatively more competitive, attracting more capital and talent inflow. For example, the establishment of China's carbon market has stimulated the rapid development of the energy conservation and environmental protection industry. Carbon trading has given birth to emerging low-carbon industries. New business forms such as carbon asset management, carbon verification, and carbon finance are constantly emerging, forming new economic growth points. However, the impact of carbon trading on different industries varies significantly. Energy-intensive industries face greater cost pressure and transformation challenges, while low-carbon service industries gain new development opportunities. Carbon trading may also lead to industrial transfer, causing "carbon leakage" problems. Therefore, when formulating carbon trading regulations, it is necessary to fully consider the characteristics and bearing capacity of different industries, adopt differentiated policies, balance emission reduction targets and industrial development, and promote the green transformation of economic structure.

### 4.3. Impact on Macro Economy

The impact of carbon trading regulations on the macro economy is complex and multidimensional, involving various aspects such as economic growth, employment, prices, and international competitiveness. In terms of economic growth, carbon trading may have a certain inhibitory effect on GDP growth rate in the short term, but in the long run, by promoting industrial upgrading and technological innovation, it is expected to drive high-quality economic development. EU studies show that after the implementation of ETS, the negative impact on GDP does not exceed 0.5%, while the long-term environmental benefits and innovation dividends may exceed this cost. Carbon trading has a profound impact on employment structure. Job opportunities in high-carbon industries may decrease, but low-carbon industries and emerging green industries will create a large number of job opportunities. The International Labor Organization predicts that the global transition to a green economy may create a net increase of 18 million jobs by 2030. Carbon trading may generate a certain degree of inflationary pressure, especially in terms of energy and raw material prices. However, this impact is often short-term, and in the long run, improved energy efficiency and the development of renewable energy will help stabilize price fluctuations. Finally, the impact of carbon trading on a country's international competitiveness varies by industry. For energy-intensive export industries, rising carbon costs may weaken their international competitiveness; but for low-carbon technology and product exports, carbon trading may actually enhance competitive advantages. Therefore, when designing carbon trading regulations, it is necessary to comprehensively consider these macroeconomic factors and adopt appropriate supporting policies, such as border carbon adjustment mechanisms and green employment training, to achieve coordination between emission reduction targets and economic development.

## 5. Synergistic Effects and International Challenges of Carbon Trading

### 5.1. Synergy between Carbon Trading and Other Environmental Policy Tools

The synergistic effects of carbon trading, as a market-based emission reduction tool, with other environmental policy tools are increasingly attracting attention. First, the coordinated use of carbon trading and carbon tax is an important topic. Some countries adopt a “dual-track” approach, such as the UK imposing a carbon price floor tax on the power sector while participating in the EU carbon market. This approach can improve the stability and predictability of emission reduction policies, but also increases policy complexity. Second, the coordination between carbon trading and renewable energy subsidy policies is also crucial. Large-scale renewable energy subsidies may reduce the demand for carbon allowances, affecting carbon prices. The EU introduced a market stability reserve mechanism in the fourth phase of ETS (2021-2030) to address this issue. Third, the combination of carbon trading and command-and-control policies such as energy efficiency

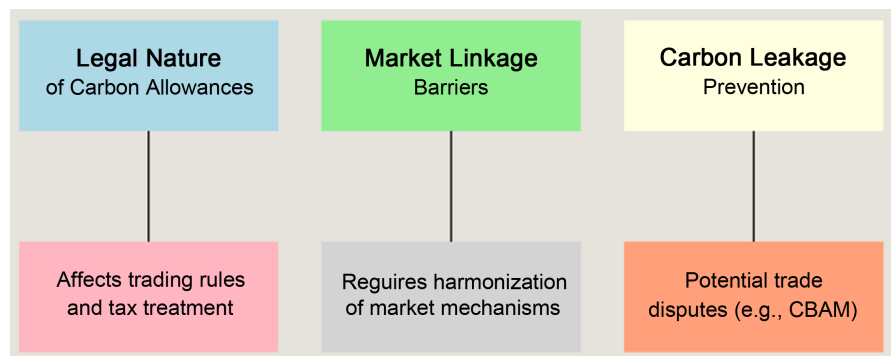
standards can achieve complementary advantages. For example, California in the United States combines carbon trading with low-carbon fuel standards, renewable energy quotas, and other policies to form a comprehensive climate policy portfolio. In addition, carbon trading can also produce synergistic effects with emerging policy areas such as green finance and circular economy. However, there may also be overlaps or conflicts between different policy tools. Therefore, when designing carbon trading regulations, it is necessary to systematically consider the interactions between various policy tools and optimize policy combinations to achieve maximum emission reduction effects and economic benefits.

## 5.2. Legal Challenges of Cross-Border Carbon Trading

With the development of global carbon markets, cross-border carbon trading faces a series of legal challenges. The first is the issue of legal recognition of carbon allowances. Different countries have different definitions of carbon allowances, some view them as commodities, some as financial instruments, which affects the legal application and tax treatment of cross-border transactions. For example, the EU recognizes carbon allowances as financial instruments and incorporates them into the MiFID II regulatory framework; while China currently views them as special commodities. The second is the legal obstacles faced by carbon market linkage. Different carbon markets have differences in coverage, allowance allocation, MRV (monitoring, reporting, verification) systems, etc., requiring legal coordination to achieve effective linkage. The successful linkage of California and Quebec carbon markets has provided valuable experience for this. The third is the legal mechanism for preventing carbon leakage. To prevent high-carbon industries from moving to regions with lax emission reduction policies, some countries and regions are considering implementing carbon border adjustment mechanisms (CBAM). The EU has announced that it will introduce CBAM in 2023, which may trigger international trade disputes. In addition, cross-border carbon trading also involves complex legal issues such as data privacy and intellectual property protection. Therefore, strengthening international cooperation and promoting the coordination and unification of carbon market-related laws are crucial for promoting the integrated development of global carbon markets.

In **Figure 3**, cross-border carbon trading faces three main legal challenges: legal recognition of carbon allowances, legal obstacles to carbon market linkage, and carbon leakage prevention mechanisms. The differences in legal attributes of carbon allowances affect the formulation. In addition to the challenges listed in **Figure 3**, the international carbon market faces a series of other issues, including market segmentation and price differences, differences in monitoring, reporting and verification (MRV) systems, carbon credit quality and double counting issues, policy uncertainties, and low participation of developing countries. For instance, in 2021, the EU carbon price was about 50 euros per ton, while the Chinese carbon price was only about 8 dollars per ton, and this price difference affected the efficiency of global carbon reduction. The quality of international carbon offset

projects varies, with controversies over the additionality and permanence of some projects. The negotiations on the implementation rules of Article 6 of the Paris Agreement reflect the complexity of avoiding double counting. Addressing these issues requires strengthening international cooperation, promoting policy coordination, establishing common technical standards and legal frameworks, while considering the development stages and capabilities of different countries, and designing flexible transition mechanisms.



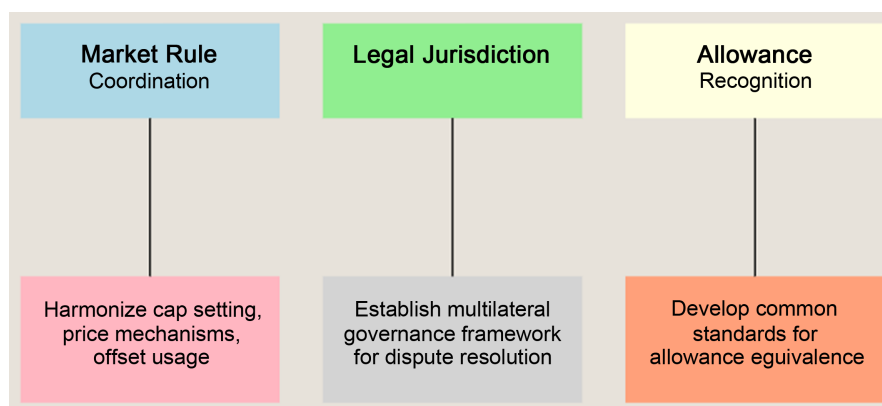
**Figure 3.** Main legal challenges faced by cross-border carbon trading.

### 5.3. Legal Issues of International Carbon Market Linkage

International carbon market linkage is an important trend in global climate change response, but it also faces many legal challenges. The first is the issue of coordinating market rules. Different carbon markets have differences in total allowance setting, price adjustment mechanisms, offset credit use, etc., requiring legal coordination to achieve compatibility. For example, when the EU and Swiss carbon markets were linked, detailed comparisons and adjustments were made to the market rules of both parties. The second is the definition of legal jurisdiction. Cross-border carbon trading involves multiple jurisdictions, requiring clear accountability mechanisms for violations and dispute resolution channels. Currently, most carbon market linkages adopt bilateral agreement methods, but as the scope of linkage expands, it may be necessary to establish a multilateral governance framework. The third is the legal basis for mutual recognition of carbon allowances. Whether allowances from different carbon markets have the same legal status and how to ensure the fairness of mutual recognition are core issues facing market linkage. For example, New Zealand's ETS once allowed the use of international offset credits, but later canceled this policy due to excessive price differences. International carbon market linkage also involves complex legal issues such as tax coordination, data sharing, and privacy protection. Therefore, promoting carbon market linkage requires not only cooperation at the technical and economic levels but also in-depth legal research and institutional innovation to construct a fair and effective global carbon market governance system.

As shown in the **Figure 4**, international carbon market linkage faces three main

legal issues: market rule coordination, legal jurisdiction definition, and carbon allowance mutual recognition. To address these issues, corresponding solution measures need to be taken. In terms of market rule coordination, key elements such as total allowance setting, price adjustment mechanisms, and offset credit use need to be harmonized. On the issue of legal jurisdiction, establishing a multilateral governance framework is crucial for resolving cross-border disputes. Carbon allowance mutual recognition requires the formulation of common standards to ensure the equivalence of allowances from different markets. The implementation of these measures requires in-depth cooperation among countries to promote the coordination and unification of carbon market-related laws.



**Figure 4.** Main legal issues faced by international carbon market linkage.

## 6. Conclusion

This study systematically analyzed the legal framework of carbon emission trading systems and their economic impact, revealing the complexity and importance of carbon trading as a market-based emission reduction tool. The study shows that a sound legal system is the foundation for the effective operation of carbon markets, but excessive regulation may suppress market vitality. Therefore, in constructing the legal framework for carbon trading, it is necessary to balance the relationship between regulation and the market, establishing a flexible yet stable institutional environment. At the same time, carbon trading has a profound impact on micro-enterprise behavior, meso-industrial structure, and the macro economy, which requires policymakers to adopt systemic thinking and comprehensively consider various economic effects. Faced with the trend of global carbon market integration, strengthening international cooperation and promoting legal coordination are crucial. Future research can further explore the synergistic mechanisms between carbon trading and other policy tools, deepen the analysis of legal issues in cross-border carbon trading, and provide theoretical support for improving the global carbon market governance system. In summary, as global actions to address climate change deepen, carbon trading legal research will continue to play an important role, providing institutional guarantees for constructing a fair, efficient, and sustainable low-carbon economic system.

## Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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