

本书由国家社会科学基金重大项目  
“绿色经济实现路径——中国碳金融交易机制研究”（12&ZD059）和  
中国滨海金融协同创新中心项目资助

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## ——风险及防控

Carbon Finance Risks of  
Trading and Their Controls

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## 摘 要

本书聚焦碳金融交易，以碳金融相关经济和金融理论及研究文献为基础，借鉴欧盟等国际经验，结合我国区域碳金融交易实践，基于 VaR、CVaR 模型对交易风险进行度量，提出了完善中国碳金融发展的建设统一市场及逆向建模创新产品等措施建议。

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杜莉，经济学教授、博士生导师、吉林省政府特聘专家、中国金融学会理事，现就职于吉林大学任总会计师。长期致力于欧洲经济和金融政策研究，著《低碳经济时代的碳金融机制与制度研究》《欧盟区域经济政策》《中国-欧盟：发展循环经济推动老工业基地振兴》等图书。

## 导论（代序）

当代人类社会的进步主要体现在技术上的进步，而推动技术进步的本质是技术进步背后的思想。碳金融技术是现代金融技术的一个分支，是用金融技术手段促进节能减排，是更好地服务人类实体经济发展的现代金融的创新。现代金融管理和发展的核心在于风险管理，而碳金融交易市场的风险及防控则是碳金融管理和发展的技术核心。因此，研究“碳金融交易市场的风险及防控”具有重要的理论意义。

21 世纪初，全球气候极端天气与雾霾天气增多使得人类前所未有地关注并重视低碳经济发展。尤其是 2010 年 12 月 11 日，《联合国气候变化框架公约》第十六次缔约方坎昆气候变化会议的召开，参与各国进一步加深了对全球气候变暖的认识；2011 年以来，全球极端天气多发、多个国家 PM2.5 连续出现新高；2013 年以来，中国局部地区大面积雾霾天气持续时间再创新高；2014 年作为全球最大碳排放国的美国 and 全球最大发展中国家的中国达成了《温室气体减排协议》。根据中美双方的协议，中国的温室气体排放量力争从 2030 年左右开始减少，这一减排目标将为中国碳减排市场带来巨大的发展机遇。因此，加快建立中国碳减排市场及与之相适应的碳金融体系，实施碳金融发展战略具有重要的现实意义和长远的战略意义。同时，已有一越来越多的专家学者和政府官员发表报告并建言：以碳金融手段支持节能减排、产业结构调整、化解产能过剩和解决环境危机。

从国际角度看，人类面对气候变化的长期挑战，需要通过调整对实体经济的产业结构调整、节能减排和创新清洁能源替代高耗能、高污染、高碳能源等方式来实现科学可持续发展。金融是经济的核心，金融技术能够在服务实体经济中起到促进、调节和引导作用，实现经济的产业结构调整、节能减排和创新清洁能源发展。金融技术这种作用的发挥就是靠碳金融交易和碳金融产品的创新，于是在国际上碳金融交易市场伴随着碳排放权交易的出现应运而生。

碳金融是以金融的方法来解决实体经济的问题，正是抓住了主要矛盾，抓住了核心，而用碳排放权交易及碳金融方法解决低碳经济发展，恰恰能够引导和解决好世界乃至中国的产业结构、经济结构，甚至能够改变我们人类的经济发展模式、消费模式，更甚至会改变我们的生活模式，这些改变必将使得碳金融一盘棋走活，中国低碳经济可持续发展的满盘棋皆赢。

金融管理的核心是风险管理，碳金融是依托碳排放权交易的金融行为，因此作为金融范畴的碳金融管理和创新，其核心必然与风险的识别、价格风险分析和管控紧密联系。由此，发展好碳金融交易市场必须首先厘清碳金融交易市场的风险，然后依据风险价格模型，通过逆向建模的方法设计出不同风险特征的市场交易产品和衍生产品，这样碳金融交易的风险才能更加可控、交易品种也才能更加丰富。

当前中国碳金融制度尚不完善，碳金融体系及相关配套措施发展滞后。中国要发展好碳金融交易市场必须把控好风险，只有这样，政策制定者和监管者及碳金融产品的利益相关者才都能依据风险模型管控风险，碳金融交易市场才能更加繁荣，更好地发挥其作用，服务好实体经济的发展。

近年来在国际市场，包括中国经核证的减排量 CCER（英文全称为 Chinese Certified Emission Reduction,）、清洁发展机制 CDM（英文全称为 Clean Development Mechanism）、碳基金、碳税、碳排放权现货和期货交

易等碳金融相关业务创新不断涌现。目前中国传统能源在发展经济过程中占据能源消耗的80%以上，高能耗、高排放、高污染、低效率的情况使中国经济的可持续发展面临严峻的挑战。因此，中国急需探索建立适合低碳经济发展配套的碳金融交易市场。

我们把碳排放权交易及其金融活动的市场统称为碳金融交易市场。近年来，国内先后在北京市、天津市、上海市、重庆市、深圳、广东省、湖北省等7省市设立了碳交易所开展碳排放权交易。伴随这7个碳排放权交易市场的建立，我国碳金融交易产品也不断涌现，交易产品的价格波动等风险也同时暴露出来。因此，人们在碳排放交易市场价格波动和风险暴露后，进一步加深了对碳交易和碳金融风险的认识和重视，但对我国碳金融交易市场的风险及控制仍缺乏系统和科学的认知。在这种发展背景下，中国碳金融交易市场的统一、风险及防控，倍受关注。

本书从碳金融发展的经济学原理入手，分析了国内外碳金融的交易模式、交易工具和衍生产品，再从碳金融交易市场体系，深入分析科学分类市场交易风险，比较交易市场的价格波动风险，结合发达国家经验，提出了我国发展碳金融交易市场的风险及防控政策建议，对完善中国上述7省市区域性碳排放交易相关机构内控体系建设和国内统一的碳金融交易制度和平台建设具有现实意义，与此同时，进一步通过基于风险模型逆向建模的碳金融创新理论的提出和举例应用，将对推进碳金融市场的健康发展具有重要的创新引导作用。本书共分6章，主要内容如下：

第1章，绪论。本部分在对国内外学术界关于低碳经济学理论、碳减排政策工具、碳交易的成本理论、金融支撑理论、碳汇经济对碳金融的对冲风险理论、风险资产定价理论、行为金融学、博弈论及信息经济学、逆向产品建模技术、新巴塞尔协议市场风险分析理论等经济学理论进行梳理的基础上，进行深入研究，充分借鉴相关经济和金融理论的有益价值，力求从总体上提出碳金融相关新的理念、观点，为研究中国碳金融交易市场的风险识别和管控奠定理论基础。

第2章，碳金融相关金融与经济理论回顾。本部分选取碳金融市场发展所涉及的金融和经济理论，梳理碳交易相关理论基础包括交易成本理论、福利经济学理论、环境金融学理论；梳理碳金融风险防控相关理论包括碳金融风险分类、碳金融风险管理、碳金融风险的评估与防控；分析了碳金融产品的价格影响因素包括需求因素对碳价格的影响、政策因素对碳价格的影响、配额对碳排放权价格的影响；还分析了其他碳金融市场和风控可能相关理论基础包括行为金融学、博弈论及信息经济学、逆向产品建模技术、新巴塞尔协议市场风险分析理论。通过总结和提炼上述理论，力求为碳金融交易市场的风险研究进一步奠定理论及实践依据，并从中获得创新的启示。

第3章，国内外碳金融交易的发展及风险管控。本部分具体总结了国际碳交易市场发展现状，包括碳交易市场及碳金融形成的背景，国际碳交易市场的发展现状及问题；分析了中国碳交易市场发展状况，从我国CDM市场概况、我国碳交易市场现状分析了我国碳金融交易机制面临的困境；进而分析了碳金融市场的关键风险结构，包括不确定性风险、流动性风险、政治风险、欺诈风险等主要风险。并以欧盟为例，对碳交易市场风险管控机制进行了举案探讨，包括碳金融风险监督机制、碳金融风险防控机制和碳金融风险应对机制。

第4章，中国碳金融交易风险的实证分析。本部分针对我国已有区域性碳金融交易市场的碳金融产品价格特征进行分析，深入分析导致风险的成因，并借鉴巴塞尔协议框架下风险分析原理，对碳金融交易市场的风险进行了系统分析。通过实证分析和检验，研究获得了碳金融交易市场交易价格波动的风险防范、风险规避和价格风险管理的思路。

第5章，基于风险价值VaR（英文全称为Value at Risk）模型及条件风险价值CVaR（英文全称为Conditional Value-at-Risk）模型的我国碳金融交易市场的风险度量研究。本部分回顾了常见风险度量模型，重点对VaR模型与CVaR模型进行了对比分析，并对两种模型的不同计算方



法进行了比较。最后,基于我国碳金融交易区域性市场进行了 VaR 与 CVaR 值的实证比较,还分析指出了 CVaR 方法在我国碳交易市场风险度量应用中存在的问题。

第 6 章,关于碳金融交易风险管控的对策建议。本部分基于中国碳金融交易市场风险形成原因的分析,总结性地对我国碳金融交易市场风险管控提出了完善法律框架、加强政策指导,构建规范的碳交易市场体系;运用技术手段、建立严格的碳金融风险防控体系;循序渐进地构建统一的碳交易市场等对策措施,并对规范中国统一的碳金融交易市场的建设,提出了有效防控碳金融交易市场风险应着力建设的主要措施与建议。

关键词:碳金融,市场交易,统一市场,风险体系,风险管控

## Introduction

Progress in contemporary human society is mainly reflected in technological advances, and to promote the essence of technological progress is behind the idea of technological progress. Carbon finance technology is a branch of modern financial technology, financial technology is a means to promote energy conservation, is to better serve the modern financial innovations human solid economic development. The core of modern financial management and development is risk management, and carbon finance market risks and prevention technology is the core technology of carbon finance management and development. Therefore, the study of “carbon financial market risks and prevention” has important theoretical significance.

At the beginning of 21st century, the global weather and climate extremes fog and haze makes humans ever increasing attention and importance of low-carbon economy. Especially the December 11, 2010, the Sixteenth Party Climate Change Conference in Cancun, “the United Nations Framework Convention on Climate Change” was held among the participating countries to further deepen the understanding of global warming; since 2011, the world's extreme weather multiple, multiple national PM2.5 continuous emergence of new high; since 2013, large areas of China in some areas of fog and haze duration highs; 2014 as the United States the world's biggest carbon emitters China and the world's

largest developing countries to reach China the “greenhouse gas emissions reduction agreement.” According to the agreement of the two sides, China’s greenhouse gas emissions and strive to decrease from about the beginning of 2030, this reduction targets will bring great opportunities China’s carbon emissions market. Therefore, to accelerate the establishment of Chinese carbon market and with suitable carbon finance system, the implementation of carbon finance development strategy has important practical significance and long-term strategic significance. At the same time a growing number of experts, scholars and government officials issued a report and suggestions: carbon financial instruments to support energy conservation, industrial restructuring, to resolve overcapacity and solve the environmental crisis.

From an international perspective, the human face of the long-term challenges of climate change, the need for the real economy through industrial restructuring, energy conservation and clean energy innovation and high energy consumption and high pollution, high-carbon alternative energy and other ways to achieve sustainable development of science. Finance is the core of the economy, finance and technology can play in serving the real economy to promote, regulate and guide, to achieve economies of industrial restructuring, energy conservation and the development of clean energy innovation. Financial technology play such a role is to rely on carbon trading and carbon finance innovative financial products, so in the international carbon finance market with the advent of carbon emissions trading emerged.

Carbon finance is the way to solve the financial problems of the real economy, is to seize the main contradiction, caught the core, but with carbon emissions trading and carbon finance solutions to low-carbon economic development, just be able to guide and solve the world as well as the industrial structure, China’s economic structure, and even change our human economic development

model, consumption patterns, and will even change our lifestyle, these changes will make the game go live a carbon finance and sustainable development of China's low carbon economy full game all win.

Core financial management, risk management, carbon finance is relying on the financial behavior of carbon emissions trading, and therefore the scope of carbon finance as a financial management and innovation at its core is bound with risk identification, risk analysis and control prices closely. Thus, the development of good carbon finance market must first clarify the risk of carbon finance market, and then on the basis of risk pricing model, by inverse modeling approach to design different risk characteristics of the market and sell products and derivatives, the risk of such carbon finance transactions can be more controllable, the transaction can be more abundant varieties.

China's current system is imperfect carbon finance, carbon finance system and related measures for the development lag. China wants to develop the carbon finance market risk must be controlled well, the only way, policy makers and regulators, and the interests of stakeholders carbon financial products based on the risk model was able to control the risk of carbon finance market can be more prosperous, better to play its role in the development of the real economy, the service is good.

In recent years, international markets, including China certified emission reductions CCER (English called Chinese Certified Emission Reduction), the Clean Development Mechanism CDM (English called the Clean Development Mechanism), carbon funds, carbon tax, carbon emissions spot and carbon futures and other finance-related business innovation are emerging. At present, Chinese traditional energy in the process of economic development to occupy more than 80% of energy consumption, high-energy, high-level radioactive discharge, high pollution and low efficiency in the case of sustainable development

of China's economy is facing serious challenges. Therefore, China urgently needs to explore the establishment of a low-carbon economy for supporting the development of carbon finance market.

We market carbon emissions trading and financial activities collectively referred to as carbon finance market. In recent years in our country, has set up a carbon exchange to carry out carbon emissions trading in Beijing, Tianjin, Shanghai, Chongqing, Shenzhen, Guangdong, Hubei and other seven provinces. With the establishment of these seven carbon emissions trading market, China's carbon finance trading products continue to emerge, the risk of price fluctuations and other trading products also exposed. Therefore, people in the carbon emissions trading market price volatility and risk exposure, further deepened the financial risks of carbon trading and carbon awareness and attention, but China's carbon trading market risk and financial control systems are still lacking and cognitive science. In the background of this development, unified China carbon finance market, the risks and prevention, much to the concern.

In this paper, the development of carbon finance economics analyzes the trading patterns of domestic and international carbon finance, trading tools, and derivative products, from carbon finance market system, in-depth analysis of the scientific classification of market trading risk, the risk of price fluctuations in the market combined with the experience of developed countries, put forward policy proposals risk and prevention of the development of carbon finance market, and to improve the seven Chinese provinces and regional emissions trading agencies and national unity of the internal control system of carbon trading system and platform construction finance has practical significance, meanwhile, further important guiding role through innovative risk model is proposed based on inverse modeling of carbon finance innovation theory and example applica-

tions, will promote the healthy development of the carbon finance market. The full text of this research paper is divided into six chapters, the main contents are as follows:

#### Part I: Introduction.

This section talks about the domestic and foreign academic economic theory on carbon, carbon reduction policy tools, the cost of carbon trading theory, the theory of financial support, carbon sinks to carbon finance economic hedge risk theory, risk asset pricing theory, behavioral finance, game theory and information theory, economics, economics, reverse modeling technology products, Basel II market risk analysis theory on the basis of combing conduct in-depth research to fully draw on the useful value of the relevant economic and financial theory, and strive to make carbon finance-related new ideas, perspectives for the study of Chinese carbon finance market risk identification and control theoretical basis.

#### Part II: Review of carbon finance related financial and economic theory.

This section selected financial and economic theory of carbon involved in the development of the financial market, the theoretical basis of the relevant sort of carbon trading, including transaction cost theory, welfare economics, environment, finance theory; combing carbon financial risk control theory, including carbon finance risk classification, assessment and risk management, prevention and control of carbon finance, carbon finance risks; analysis of the factors affecting the price of carbon finance products including the impact of the carbon price demand factors, the impact of the carbon price policy factors, the impact on carbon emissions quota price; also analysis of financial markets and wind control other carbon-related rationale may include behavioral finance, game theory and information economics, reverse modeling technology products, Basel II market risk analysis theory. Risk research by summarizing and refining

the above theory for carbon finance market is further laid the theoretical foundation, and derive inspiration innovation.

Part III: Development of domestic and international carbon finance trading and risk management and control.

This section summarizes the specific status of the international carbon trading market, including background carbon markets and carbon finance the formation of an international carbon market development status and problems; analysis of the development of China's carbon trading market, from our CDM market overview, China's carbon market analysis of the status quo of China's carbon finance dilemma faced by trading mechanism; then analyzes the key risk structure of the carbon finance market, including major risks and uncertainties risk, liquidity risk, political risk, fraud risk. And in the EU, for example, on the carbon trading market risk management and control mechanisms are discussed cite the case, including carbon finance risk oversight mechanism, financial risk control mechanism of carbon and carbon financial risk coping mechanisms.

Part IV: An empirical analysis of carbon finance transaction risks.

This section features a carbon price of financial products for our existing regional carbon finance market is analyzed in-depth analysis of the causes leading to the risk, and learn the principles of risk analysis under the Basel II framework, the financial risk of carbon trading market system analysis. Through empirical analysis and testing and research to obtain carbon trading market price fluctuations in financial risk prevention, risk aversion and price risk management ideas.

Part V: Based on value at risk VaR (English full Value at Risk) model and conditional value at risk CVaR (English called the Conditional Value-at-Risk) risk of carbon finance market model measurement.

This section reviews the common risk measurement model, focusing on the VaR model with CVaR model were compared and analyzed, and the two models of different calculation methods were compared. Finally, based on the regional market of carbon finance transaction empirical comparison of VaR and CVaR value, but also pointed out the CVaR method of analysis of the carbon trading market risk measurement problems in the application.

Part VI: Suggestions on carbon risk management and control of financial transactions.

This section analyzes the reasons for the formation of carbon-based financial market risks, targeted financial transactions on China's carbon risk management and control by improving the legal framework, strengthening policy guidance, to build standardized carbon trading market system; the use of technology to establish a strict carbon finance risk prevention and control system; build a unified carbon market and other countermeasures gradual, and carbon finance market construction specifications reunification of China, the main measures and recommendations proposed effective prevention and control of carbon financial market risk should focus on construction.

Keywords: carbon finance, market trading, unified market, risk systems, risk management and control



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