

Multi-dimensional Measurement and Collaborative Prevention and Control of Carbon Financial Transaction Risks in China Under the Strategic Dual Carbon Goals

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Abstract

Under the macro-background of the strategic "Dual Carbon" goals, China's carbon financial market has entered a period of rapid development. However, accompanying transaction risks have become increasingly prominent, posing potential challenges to market stability and the capacity to serve national strategies. This study systematically investigates the identification, measurement, and collaborative prevention of carbon financial transaction risks in China. By combining qualitative analysis with quantitative models, it provides theoretical support for constructing a risk-controlled unified carbon market. The research first utilizes the SWOT analysis to examine the internal and external environments of the carbon financial market. Using the SWOT-CLPV matrix for cross-quantitative evaluation, the study reveals a complex risk pattern characterized by "high leverage (28L), high suppression (27C), high problematic nature (27P), and medium-high vulnerability (24V)." Specifically, the combination of "institutional absence" and "international rule shocks" constitutes the most critical risk (9P), identifying institutional deficiency as the core bottleneck. Furthermore, insufficient market liquidity and the transmission of energy transition risks form a significant problematic correlation (9P), indicating that shallow markets struggle to effectively hedge systemic risks arising from real-economy transitions. In the empirical measurement phase, the study selects daily transaction data from seven regional pilot markets from September 21, 2020, to September 19, 2025. Applying the GARCH-VaR model, the research quantifies carbon price volatility risks. Findings indicate that yield sequences in all pilot markets exhibit significant leptokurtosis, fat tails, and volatility clustering. The Jarque-Bera test strongly rejects the normality assumption at a 1% level, suggesting that traditional models may underestimate actual risks and require refined GARCH-family models for accurate characterization. Regional heterogeneity is evident: at a 99% confidence level, Shenzhen exhibits the highest risk (VaR of 559,700 RMB), followed by Tianjin and Beijing. Conversely, Shanghai and Hubei demonstrate superior market stability and the lowest risk levels due to better financial foundations and matured institutions. The study concludes that healthy development relies on systematic governance. A collaborative prevention system is proposed across three levels: institutional foundation, market core, and capability support. Recommendations include prioritizing special legislation to clarify the legal attributes of carbon assets, accelerating the development of standardized derivatives like futures and options to enhance liquidity, and building a unified risk monitoring platform using big data and artificial intelligence while strengthening professional talent cultivation.

Keywords

Carbon Financial Trading Risk, SWOT-CLPV Matrix, GARCH-VaR Model, Risk Measurement, Value at Risk, Regional Heterogeneity, Collaborative Prevention and Control System