

CARBON CREDIT TRADING AND CAPITAL MARKET EFFICIENCY: A SYSTEMATIC LITERATURE REVIEW

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Accepted: September 11, 2026	Reviewed: September 12, 2026	Published: September 30, 2026
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Abstract

This study aims to synthesize research trends, identify the multifaceted impacts of carbon policies, and map the complex inter-market dynamics related to carbon credit trading and capital market efficiency through a systematic literature review. The method employed is a systematic literature review analyzing scholarly articles, with a rapidly increasing publication trend between 2020 and 2025. Results indicate that carbon credit trading policies significantly drive technological innovation, enhance firm market value, improve carbon emission efficiency, and allocate capital towards green initiatives. Carbon markets exhibit complex price dynamics characterized by high volatility, long-memory, and multifractality, often challenging the Efficient Market Hypothesis. Policy uncertainty, negative news, and external economic shocks significantly amplify price fluctuations, while market liquidity and green financial certificates can stabilize prices. Strong interactions exist between carbon prices and clean energy and commodity markets, demonstrating two-way causality and potential systemic risks. The theoretical contribution of this study is to extend the understanding of how carbon pricing mechanisms interact with existing capital market structures, particularly by highlighting the heterogeneity of impacts based on firm and regional characteristics. Despite challenges such as low pilot-market stability and strategic corporate behaviors like 'carbon washing', the study concludes that carbon credit trading has significant implications for green finance, climate risk management, and corporate decarbonization strategies, necessitating robust frameworks to navigate these complexities and encouraging further research in emerging economies and longitudinal analyses.

Keywords: *Carbon credit trading; Capital market efficiency; Carbon markets; Climate policy; Green finance*



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1. Introduction

The global challenge of climate change necessitates innovative economic mechanisms to mitigate greenhouse gas emissions, positioning carbon credit trading as a pivotal instrument in this endeavor. Carbon markets facilitate the allocation of emission allowances, creating financial incentives for industries to reduce their carbon footprint and fostering a transition towards a low-carbon economy. The growing integration of these environmental markets with traditional financial systems, particularly capital markets, has profound implications for investment decisions, risk management, and overall economic stability. Understanding the intricate dynamics between carbon credit trading and capital market efficiency is therefore critical for policymakers, investors, and regulatory bodies navigating this evolving landscape.

Previous scholarship has extensively explored various facets of carbon credit trading, including its design, performance, and environmental effectiveness, often examining price volatility, the influence of regulatory changes, and the impact of macroeconomic factors on carbon asset valuation (Lyu et al., 2020; Yao et al., 2022). Researchers have also investigated the interplay between carbon markets and other commodity markets, revealing complex spillover effects and interdependencies that shape market behavior, which underscores the multifaceted nature of carbon trading systems and their expanding influence beyond direct environmental compliance.

Specific investigations into the relationship between carbon credit trading and capital market efficiency have yielded a diverse array of findings. Some studies indicate that carbon market mechanisms enhance transparency and information dissemination within capital markets, potentially improving efficiency by incorporating environmental risks and opportunities into asset pricing (Yan & Shi, 2024; Uddin et al., 2025). Other research explores how the pricing of carbon credits influences corporate valuations and the cost of capital, suggesting a direct link between environmental performance, market perception, and financial efficiency. However, the exact nature and consistency of these impacts remain subjects of ongoing academic debate. Significant inconsistencies and methodological variations arise from differences in market contexts, regulatory frameworks, data periods, and econometric approaches (Du et al., 2022; Tang et al., 2022); some analyses suggest carbon markets increase capital market efficiency, while others find limited or even negative effects, particularly for specific industries or market segments (Kong et al., 2023).

Despite this growing body of literature, previous reviews have predominantly focused on narrow geographic sub-regions or specific econometric models, creating a clear gap in holistic cross-regional syntheses. The novelty of this review lies in systematically synthesizing cross-market interactions, policy spillover mechanisms, and institutional variances across both mature developed markets (EU, UK) and developing pilot systems (China) over a critical post-pandemic transition period (2020–2025). By evaluating the interplay between carbon pricing instruments and capital allocation efficiency through a unified framework, this study bridges the divide between environmental economics and corporate finance literature.

To address these imperatives, this study comprehensively analyzes the academic literature on carbon credit trading and capital market efficiency, guided by four core research questions:

1. (RQ1) Research Trends & Scope: What are the historical trajectories, geographic distributions, and methodological trends in carbon credit trading and capital market efficiency literature between 2020 and 2025?
2. (RQ2) Policy Impact & Market Efficiency: How do carbon credit trading policies influence corporate capital allocation efficiency, green innovation, and firm valuation?
3. (RQ3) Inter-Market Dynamics & Spillovers: What are the cross-market spillover mechanisms, volatility structures, and systemic risks linking carbon credit trading with clean energy, commodities, and broader financial markets?
4. (RQ4) Institutional Challenges & Future Directions: What structural barriers, strategic behaviors (e.g., carbon washing), and research gaps exist particularly regarding emerging markets and long-term market evolution?

2. Research Method

This systematic literature review employed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, encompassing four phases: identification, screening, eligibility, and inclusion. A comprehensive search for relevant studies was conducted across Scopus, ScienceDirect, and Google Scholar databases to ensure broad coverage of academic literature. These three major databases were selected due to their comprehensive indexing of high-impact peer-reviewed finance, environmental economics, and multi-disciplinary energy journals. The temporal range of 2020–2025 was deliberately chosen to capture the rapid institutional transformation following Phase IV of the EU ETS, the formal national rollout of China's carbon ETS market (2021), and post-COVID financial transition dynamics, ensuring an up-to-date analysis of contemporary market behaviors.

The search strategy involved several Boolean string combinations, including “carbon credit trading” AND “capital market efficiency”; “carbon market” AND “market efficiency” AND (finance OR investment); “emissions trading” AND “capital markets” AND efficiency; and “carbon pricing” AND “financial markets” AND efficiency.

Table 1 presents the inclusion and exclusion criteria applied during the selection of articles for this review.

Table 1. Inclusion and Exclusion Criteria

Criteria	Inclusion	Exclusion
Publication Type	Peer-reviewed journal articles, high-impact conference proceedings.	News articles, blogs, opinion pieces, books, theses, dissertations, research reports, abstracts only.
Topic Relevance	Explicitly addresses carbon credit trading mechanisms alongside capital market efficiency or financial allocation.	Focuses solely on physical environmental impacts without examining capital market dynamics.
Availability & Language	Full text accessible in English or Indonesian.	Full text unavailable or published in languages other than English or Indonesian.
Timeframe	Published between 2020 and 2025	Published prior to 2020

Source: Developed by the Authors (2026)

The initial database search yielded 465 records (Scopus: $n = 229$; ScienceDirect: $n = 138$; Google Scholar: $n = 98$). After removing 37 duplicate records, 428 unique articles remained. Title and abstract screening led to the exclusion of 300 articles. The remaining 128 articles underwent full-text eligibility assessment, of which 88 were excluded due to secondary thematic relevance, lack of empirical rigor, or unsuited analytical frameworks, leaving 40 articles for inclusion.

To ensure academic rigor, each study was evaluated across five specific quality criteria operationalized as follows:

1. Topic Relevance: Direct alignment with carbon trading and capital market efficiency dynamics.
2. Methodological Clarity: Robustness of econometric models, identification strategies (e.g., DID, TVP-VAR), and hypothesis testing.
3. Sample Transparency: Clear definition of sample selection, data periodicity, and geographic market scope.
4. Analytical Clarity: Rigorous presentation of empirical results and statistical significance.
5. Theoretical/Practical Contribution: Novel insights provided to environmental finance literature or policy design.

Each criterion was scored on a 3-point rubric (1 = Poor/Inadequate, 2 = Satisfactory, 3 = Excellent). Scoring was conducted independently by two reviewers, with inter-rater discrepancies resolved through joint re-evaluation. A minimum threshold score of 12 out of 15 (80%) was required for inclusion. While all 40 final included studies achieved high operational scores (averaging 3/3 per criterion upon consensus), Table 2 details the scoring distribution rubric for transparency.

Table 2. Article Quality Assessment Rubric and Scoring Operationalization

Assessment Criterion	Score 1 (Poor)	Score 2 (Satisfactory)	Score 3 (Excellent)
Topic Relevance	Peripheral mention of carbon trading or finance.	Discusses carbon trading and financial markets generally.	Directly analyzes carbon trading interaction with capital market efficiency.
Methodological Clarity	Unclear methodology or invalid econometric specification.	Standard empirical methodology with minor reporting gaps.	Highly rigorous identification strategy (e.g., DID, Wavelet, TGANs) with robustness checks.
Sample Transparency	Vague sample period, missing sample sizes or regional details.	Sample period and dataset defined but lacking descriptive depth.	Fully transparent data sourcing, clear timeframes, and precise geographic boundaries.
Clarity of Results	Ambiguous findings or unsupported statistical claims.	Clear presentation of findings with basic statistical validation.	Comprehensive reporting of statistical significance, effect sizes, and dynamic interactions.
Contribution	Repetitive study offering minimal new empirical insight.	Incremental contribution to regional literature.	Substantial theoretical contribution or major policy implications for sustainable finance.

Source: Developed by the Authors (2026)

3. Results and Discussion

3.1 Study Characteristics and Publication Trend

To address RQ1, the literature from 2020 to 2025 demonstrates a marked upward trajectory in publication volume, reflecting intensifying scholarly interest in green finance integration. Publications grew from 4 articles in 2020 to a peak of 9 annual publications across 2022, 2024, and 2025, driven by the rollout of China’s national carbon market and EU ETS reform phases.

Table 3. Characteristics of the Reviewed Articles

Aspect	Key Findings & Analytical Distribution
Total Analyzed Studies	40 peer-reviewed articles (2020–2025).
Geographic Coverage	China (62.5%), European Union (20%), United Kingdom (7.5%), Global/Cross-Country (10%).
Dominant Empirical Methods	Difference-in-Differences (DID), TVP-VAR, Connectivity Networks, Multifractal Detrended Fluctuation Analysis (MF-DFA), Deep Learning (TGANs).
Core Thematic Clusters	1. Policy Impacts on Valuation & Capital Allocation 2. Price Dynamics & Market Efficiency 3. Inter-Market Spillovers & Systemic Risk 4. Strategic Corporate Behaviors & Institutional Challenges

Source: Developed by the Authors (2026)

3.2 Impact of Carbon Credit Trading Policies on Capital Markets

In addressing RQ2, the synthesized empirical evidence confirms that carbon credit trading policies significantly alter corporate resource allocation and capital efficiency, though the mechanisms operate with notable regional and firm-level heterogeneity.

Mechanisms of Capital Realignment: Emission Trading Schemes (ETS) internalize the negative externality of carbon emissions into corporate financial statements. This cost-internalization forces capital markets to reprice asset valuations. Highly compliant and eco-efficient firms experience lower capital costs and valuation premiums, driving green total factor productivity (Dinca et al., 2025; Kong et al., 2023). Capital allocation efficiency improves as financial institutions direct debt and equity financing toward green technology ventures (Wang et al., 2022).

Comparative Synthesis across Regional Mechanisms:

1. **Developed Markets (EU ETS & UK ETS):** Regimes characterized by mature compliance mechanisms, stringent baseline caps, and sophisticated derivative markets generate strong price signals. In these regions, capital reallocation operates primarily through direct equity re-rating and shift in corporate cost of capital. High allowance prices incentivize immediate capital expenditures in decarbonization.
2. **Developing & Pilot Markets (China ETS):** China's carbon trading landscape relies heavily on intensity-based allocations and regional pilot systems. Here, market signals operate alongside administrative credit quotas and state-directed green banking guidelines. Consequently, the effect on corporate valuation depends heavily on firm ownership structure (SOEs vs. POEs) and local government enforcement stringency (Yao et al., 2022; Zhang & Zhang, 2020).
3. **Empirical Inconsistencies & Divergence:** While studies like Tang et al. (2022) demonstrate valuation gains for green innovators, others (Jiang et al., 2025) note short-term performance drag for carbon-intensive firms facing high abatement costs without immediate technological alternatives. This divergence highlights that market efficiency gains are non-linear and moderated by sector-specific capital flexibility.

3.3 Price Dynamics and Carbon Market Efficiency

Addressing both RQ2 and RQ3, the literature evaluates whether carbon credit pricing exhibits informational efficiency conforming to the Efficient Market Hypothesis (EMH).

EMH Violations and Non-Linear Dynamics: Across both developed and pilot markets, carbon price series consistently exhibit non-linearities, high volatility clustering, long-memory characteristics, and multifractality (Lyu et al., 2020; Tang et al., 2022; Lee et al., 2020). These empirical properties violate Weak-Form Market Efficiency, demonstrating that historical price information can be used to forecast future movements.

Drivers of Volatility vs. Stabilization Factors:

1. **Destabilizing Factors:** Regulatory uncertainty, abrupt policy revisions regarding allocation caps, macro-economic shocks, and negative news sentiment significantly

amplify carbon price volatility (Tang et al., 2022; Yan & Shi, 2024).

2. Stabilizing Factors: High trading liquidity, active participation of institutional financial market makers, and integration with green certificate systems cushion price shocks and enhance price discovery (Du et al., 2022).

3.4 Inter-Market Interactions and Spillover Effects

In response to RQ3, the reviewed studies demonstrate that carbon credit markets do not operate in isolation; rather, they are deeply interconnected with traditional commodities, clean energy, and equity markets through complex transmission channels. Transmission Channels & Spillover Mechanisms:

1. Bidirectional Clean Energy Feedback: A well-documented bidirectional causality links carbon prices and clean energy stock returns (Liu et al., 2023). Rising carbon credit prices increase fossil-fuel operational costs, enhancing relative profitability and investment demand for clean energy stocks. Conversely, strong clean energy sector growth signals declining future demand for carbon allowances, exerting downward pressure on allowance prices.
2. Fossil Fuel & Commodity Interdependence: Carbon allowances serve as an indispensable input cost for coal and natural gas power generation (Kong et al., 2023). Fuel-switching dynamics (e.g., gas-to-coal shifts driven by macro shocks) alter allowance demand, creating instantaneous cross-market volatility spillovers (Flori, 2024).
3. Systemic Risk & Tail Dependence: Network and copula-based analyses (Uddin et al., 2025; Zhang & Zhang, 2020) reveal that during financial stress or geopolitical crises, extreme downside risks spill over intensely between carbon markets and broader stock indexes, threatening broader financial stability.

3.5 Challenges, Strategic Corporate Behavior, and Directions for Future Research

To address RQ4, the review synthesizes major structural challenges, corporate gaming behaviors, and critical geographic imbalances that restrict current carbon market effectiveness.

Pilot Market Instability & Corporate Strategic Behaviors: Nascent pilot carbon markets frequently suffer from low liquidity, fragmented trading platforms, and over-allocation of initial allowances, which mutes price signals (Jiang et al., 2025). Furthermore, under severe emission reduction mandates and financial constraints, companies frequently engage in strategic behaviors such as 'carbon washing' (symbolic environmental compliance) or earnings management to mask real compliance costs (Wang & Lyu, 2025; Chen & Tian, 2024; Zhu et al., 2022).

Institutional Constraints in Emerging Economies: A significant finding of this review is the acute imbalance in literature focus: while China and the EU dominate research, evidence from emerging markets in Southeast Asia (e.g., Indonesia, Vietnam), Latin America, and Africa remains sparse.

Barriers to Capital Efficiency in Emerging Regions:

1. Institutional Opacity & Regulatory Fragmentation: Emerging markets often lack standardized Measurement, Reporting, and Verification (MRV) protocols, increasing information asymmetry for foreign and domestic capital.
2. Shallow Financial Infrastructure: Absence of liquid carbon derivative instruments (futures, options) prevents market participants from hedging price risks, suppressing long-term institutional investment.
3. Socio-Economic & Industrial Constraints: Heavy reliance on subsidized fossil fuel energy structures creates political resistance to high carbon prices.

Table 4. Mapping of Research Questions to Empirical Evidence and Synthesis

Research Question	Key Representative Literature	Core Empirical Synthesis
RQ1: Scope & Trends	Lyu et al. (2020), Yao et al. (2022)	Exponential growth in research (2020–2025); China and EU dominate empirical settings using advanced DID and time-varying econometric models.
RQ2: Policy & Valuation	Kong et al. (2023), Dinca et al. (2025), Tang et al. (2022)	ETS policy internalizes carbon costs, steering equity re-ratings toward green firms while penalizing inefficient heavy emitters.
RQ3: Inter-Market Dynamics	Liu et al. (2023), Flori (2024), Uddin et al. (2025)	Violations of EMH through multifractality; strong bidirectional spillovers between carbon allowances, clean energy, and fossil commodities.
RQ4: Challenges & Future	Chen & Tian (2024), Wang & Lyu (2025)	Structural hurdles include carbon washing, low liquidity in pilot markets, and severe lack of empirical studies in emerging economies.

Source: Developed by the Authors (2026)

4. Conclusion and Suggestions

4.1 Theoretical Contribution and Practical Implications

This systematic literature review integrates disparate threads across environmental economics and sustainable finance to deliver dual contributions:

Theoretical Contribution: It conceptualizes the precise transmission channels through which carbon price signals filter into corporate capital allocation and asset pricing, explicitly accounting for regional institutional variations and market maturity levels.

Practical Implications:

1. For Policymakers: Urgent need to harmonize MRV standards, eliminate over-allocation of initial allowances in pilot markets, and establish robust derivative frameworks to stabilize price signals.
2. For Investors & Portfolio Managers: Carbon credits must be integrated as active dynamic risk drivers in asset valuation models, rather than passive compliance metrics.

4.2 Limitations and Future Research Directions

Despite its comprehensive scope, this review is limited by the geographical concentration of existing literature on China and the EU, alongside a reliance on short-

term econometric windows. Future research should expand longitudinal studies to capture long-term structural transitions, investigate emerging carbon markets in Southeast Asia and Latin America, and explore advanced AI-driven dynamic hedging strategies in carbon asset management.

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