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REWIRING SUSTAINABILITY: A SYSTEMATIC LITERATURE REVIEW ON THE TRANSMISSION CHANNELS AND BOUNDARY CONDITIONS OF THE FINTECH-CARBON NEXUS

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Abstract: *The transition of traditional economies to digital-financial paradigms (Industry 4.0) has generated conflicting environmental outcomes. While Ecological Modernization Theory suggests digitalization dematerializes economic activity, Jevons' Paradox and energy-intensive infrastructure investments raise concerns about environmental rebound effects. This systematic literature review (SLR) harmonizes these perspectives by analyzing the FinTech-Carbon Nexus across diverse economic contexts. Adhering to the PRISMA systematic protocol, 515 documents were identified in the Scopus database using a comprehensive query of carbon emissions and financial technologies, resulting in 33 core empirical papers published between 2023 and 2026. These papers were analyzed, coded, and categorized using second-generation econometric methods (such as Method of Moments Quantile Regression, Panel Vector Autoregression, CS-ARDL, Staggered DID, and Dynamic Spatial Durbin Models) across multiple economic blocs (OECD, E7, G20, BRICS-T, and CAREC). The synthesis reveals five primary transmission channels (Green Technological Innovation/Energy-Saving and Carbon-Reduction Innovations (ESCRI), Industrial Structure Upgrading, Green Total Factor Productivity, Frictionless Capital Mobilization, and Pro-Environmental Behavioral Adaptation) and four critical boundary conditions (the Technological Rebound Effect,*

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Economic Complexity Gaps, the CAREC 'Green Paradox', and Institutional Quality). Empirical findings suggest that a 1% increase in urban FinTech is associated with a 0.0038% reduction in carbon intensity, with green innovation and renewable energy investments functioning as highly significant, primary drivers of global carbon mitigation. A context-specific, graded playbook is established to guide policymakers. This includes green regulatory sandboxes, tiered licensing, integration of personal carbon accounts with FinTech databases, and strict carbon footprint disclosure rules for energy-intensive digital infrastructures.

Keywords: *FinTech-Carbon Nexus, Ecological Modernization Theory, Environmental Kuznets Curve, PRISMA, Method of Moments Quantile Regression (MMQR), Industry 4.0*

Introduction

The global climate crisis, manifested through rising carbon dioxide (CO2) emissions and ecosystem degradation, has emerged as the defining environmental challenge of the 21st century. The Paris Agreement's mandate to limit global warming to 1.5°C above pre-industrial levels requires a profound and rapid restructuring of global industrial and energy systems (Anwar et al., 2024; Zournatzidou, 2025). Historically, the primary driver of environmental degradation has been carbon-intensive heavy manufacturing and coal-fired power generation, which constitutes approximately 56% of electricity generation in major fossil-dependent economies such as Australia (Anwar et al., 2024). Consequently, achieving decarbonization targets requires substantial capital mobilization, estimated in the trillions of dollars annually, which traditional financial systems cannot allocate efficiently due to institutional friction, information asymmetry, and structural credit rationing (Qin & Lu, 2023; Zhou et al., 2026).

Simultaneously, the Fourth Industrial Revolution (Industry 4.0) has triggered a pervasive digital transformation, reshaping the nexus of technological innovation, economic growth, and environmental quality (Mei et al., 2026; Teng et al., 2025). Central to this transformation is Financial Technology (FinTech), which integrates artificial intelligence (AI), blockchain, cloud computing, Internet of Things (IoT), and big data analytics into financial services (Polymeni et al., 2025; Li et al., 2026). This convergence has led to the emergence of Green FinTech and digital green finance, which are theorized as powerful catalysts for decarbonization by bridging the sustainable funding gap and accelerating clean energy transitions (Bhardwaj et al., 2025; Sun et al., 2025).

Despite these theoretical benefits, a fierce academic debate persists regarding the true ecological impact of FinTech and digital finance. On one hand, advocates of Ecological Modernization Theory (EMT) argue that FinTech facilitates a structural shift 'from coal to code', dematerializing paper-based financial transactions, reducing administrative transport, and optimizing capital routing toward green technologies (Mei et al., 2026; Qingyang Wu, 2024). On the other hand, critics highlight Jevons' Paradox and the rebound effects of digitalization, demonstrating that digital credit expansion boosts industrial scale and aggregate consumption, which outpaces technological efficiency gains and increases net carbon emissions (Mei et al., 2026). Furthermore, the high electricity and carbon footprint of the underlying ICT infrastructure, including data centers, 5G networks, and cryptocurrency/blockchain mining, directly exacerbates ecological pressure (Hussain et al., 2025; Mgadmi et al., 2026).

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This systematic literature review (SLR) addresses these conflicting perspectives by synthesizing 33 empirical papers identified through Scopus and examining the transmission channels and boundary conditions governing the FinTech–carbon nexus. This paper provides three key contributions to the existing literature: first, it establishes a multi-dimensional synthesis of five distinct mediating channels connecting FinTech to carbon abatement; second, it identifies four non-linear boundary conditions that moderate the effectiveness of digital finance; and third, it develops a graded, context-specific policy playbook for developed, developing, and transitional economies.

Materials and Methods

In order to ensure transparency, replicability, and academic rigor, this SLR strictly adheres to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement, mirroring the methodological frameworks utilized by Rahman et al. (2019) and Zournatzidou (2025). The systematic process was executed in four consecutive stages: identification, screening, eligibility, and inclusion.

Identification and Search Strategy

The first step of the review is to identify and select articles suitable for the scope of this study from the Scopus database. To do so, a search string was developed in July 2026 based on certain keywords related to carbon emissions and financial technologies. The search syntax was specified as follows:

> TITLE-ABS-KEY (("CO2 emission*" OR "CO_2 emission*" OR "carbon dioxide emission*" OR "carbon emission*" OR "greenhouse gas emission*" OR "GHG emission*" OR "carbon footprint*" OR "carbon intensity" OR decarbonization) AND (fintech OR "financial technolog*" OR "digital finance" OR "digital financial service*" OR "digital banking" OR "financial innovation*")) AND PUBYEAR > 2022 AND PUBYEAR < 2027 AND (LIMIT-TO(DOCTYPE, "ar") OR LIMIT-TO(DOCTYPE, "re")) AND LIMIT-TO(LANGUAGE, "English")

This initial search query yielded a total of 515 document matches. No duplicate records were found as the search was restricted to the Scopus database.

Once the identification stage is successfully completed, the populated articles were subjected to screening based on the inclusion and exclusion criteria. Non-relevant articles are to be excluded from the study to ensure the reliability of the outcome. Only articles suitable for the inclusion criteria were retained. The inclusion criteria include the year, document type, publication stage, source type and language. For this study, only journal articles published in English (in the final stage) from 2023 to 2026 were included. Other articles that were published in other types of documents in other languages prior to 2023 were excluded from this study. A total of 515 records were identified through the initial Scopus database search. During the title and abstract screening phase, 375 records were excluded based on the pre-established criteria in Table 1, leaving 140 articles for full-text eligibility assessment. The eight criteria are tabulated in Table 1.

Table 1: Inclusion and Exclusion Criteria for the Systematic Selection Process

Criterion / Dimension	Inclusion Criteria (Included in Review)	Exclusion Criteria (Excluded from Review)
Year	2023 -2026	Before 2023
Document type	Articles	Book chapter, review, conference, paper, book, editorial, business, article, conference review, erratum, and short survey
Publication Stage	Final	Articles in Press
Source type	Journals	Books, conference proceedings, book series and trade publications
Study Type & Scope	Quantitative empirical studies evaluating the digital finance-carbon relationship.	Purely conceptual, theoretical, or qualitative literature reviews.
Geographic Scale	Global, regional, national, or subnational panel and time-series data.	Vague micro-studies lacking standardized macro-environmental indicators.
Outcome Variables	Standardized carbon emissions, greenhouse gases, ecological footprint, or load capacity factor.	Financial performance metrics (e.g., profitability, stock returns) without ecological indicators.
Language	English-language	Non-English publications, book chapters, conference abstracts, or patents.

Source: Developed by the authors.

Screening, Eligibility, and Inclusion Criteria

During the eligibility phase, each of the 140 full-text articles was comprehensively assessed based on its theoretical alignment, empirical rigor, and outcome indicators. Articles evaluating the empirical relationship between financial technology/digital finance and environmental performance metrics (e.g., carbon emissions, greenhouse gases, ecological footprints, or load capacity factors) were selected. Conversely, studies were excluded if they were purely qualitative, conceptual, or focused on unrelated financial domains without environmental indicators. This eligibility screening excluded 107 documents, resulting in a final sample of 33 core empirical papers included in the review. All 33 papers were successfully retrieved and subjected to comprehensive qualitative and quantitative data abstraction. The complete selection process is illustrated in Figure 1, which was adapted from the PRISMA framework by Moher et al. (2009).

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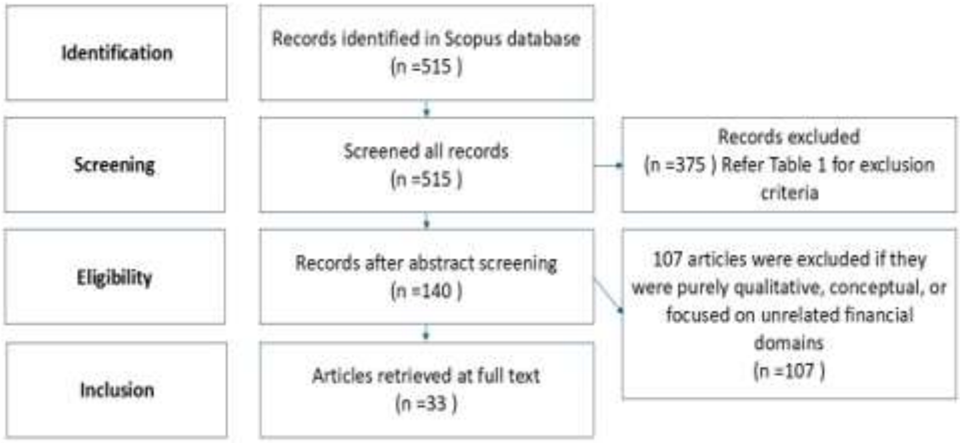

Figure 1: The process of selecting articles
Source: This diagram is adopted from Moher et al. (2009)

Methodological and Geographic Classification

The 33 included papers were categorized according to econometric methodology and geographic scale to examine their boundary conditions and spatiotemporal dynamics. Methodologically, the literature utilizes second-generation panel and time-series techniques that are robust to cross-sectional dependence (CSD) and slope heterogeneity (SH). These include Method of Moments Quantile Regression (MMQR), Panel Vector Autoregression (Panel VAR) with generalized method of moments (GMM), Cross-Sectionally Augmented Autoregressive Distributed Lag (CS-ARDL), Staggered Difference-in-Differences (DID), and Dynamic Spatial Durbin Models (SDM). Geographically, the papers are distributed across developed economies (OECD and Europe), emerging markets (E7, G20, BRICS-T, and China), and resource-dependent transitional economies (CAREC and Middle East).

Theoretical Foundations of the FinTech-Carbon Nexus

The literature establishes a multi-theoretical framework to explain how financial innovation interacts with environmental trajectories. This framework integrates three core economic and organizational theories: Ecological Modernization Theory, the Environmental Kuznets Curve (EKC) / Load Capacity Curve (LCC) hypothesis, and Transaction Cost Economics / Information Asymmetry Theory.

Ecological Modernization Theory (EMT)

Ecological Modernization Theory (EMT) serves as the primary theoretical justification for the environmental benefits of digitalization. EMT posits that technological progress and financial modernization enable economies to decouple economic growth from environmental degradation (Teng et al., 2025; Zournatzidou, 2025). Within this framework, FinTech acts as an allocator of green capital and a driver of dematerialization. By digitalizing financial transactions, FinTech directly eliminates the resource footprint of traditional physical banking (e.g., paper waste, administrative branch transport, and branch electricity consumption) while indirectly driving energy-saving and carbon-reduction innovations (ESCRI) across industrial sectors (Bhardwaj et al., 2025; Yu et al., 2025).

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The Environmental Kuznets Curve (EKC) and Load Capacity Curve (LCC)

The non-linear, dynamic nature of the FinTech-carbon relationship is captured by the Environmental Kuznets Curve (EKC) and Load Capacity Curve (LCC) hypotheses. These models suggest an inverted U-shaped relationship between economic/financial development and environmental degradation (Shi et al., 2026; Hussain et al., 2025). In the initial phase of FinTech adoption, carbon emissions often rise as digital credit expansion increases economic scale, consumer liquidity, and industrial output (the scale effect) (Hussain et al., 2025). However, past a critical developmental threshold—once the financial system matures and integrates green constraints—FinTech triggers structural upgrades and technological transitions that reduce emissions (the technique and composition effects) (Hussain et al., 2025; Li et al., 2026).

Transaction Cost Economics and Information Asymmetry Theory

Traditional green projects suffer from high transaction costs and severe information asymmetry, as financial institutions struggle to verify whether a borrowing firm's green credentials are genuine or merely 'greenwashing' (Qin & Lu, 2023; Zhou et al., 2026). FinTech resolves these information barriers through digital footprints, big data analytics, and blockchain traceability (Mei et al., 2026; Zournatzidou, 2025). By providing real-time, tamper-proof tracking of energy consumption and supply chains, FinTech lowers search, monitoring, and enforcement costs (transaction costs), mitigating credit risks and directing private capital efficiently toward authentic energy-saving projects (Attia & BinEid, 2025; Li et al., 2026).

Transmission Channels: How Bits Translate into Carbon Abatement

The systematic synthesis of the 33 empirical papers reveals five primary transmission channels through which financial technology translates into measurable carbon reductions: Green Technological Innovation, Industrial Structure Upgrading, Green Total Factor Productivity, Frictionless Capital Mobilization, and Pro-Environmental Behavioral Adaptation.

The Green Technological Innovation and ESCRI Channel

Green Technological Innovation (GTI) is identified as the primary conduit for FinTech's carbon-abatement effects. By lowering borrowing costs and resolving liquidity constraints, FinTech enables heavily polluting enterprises to expand their R&D investments in Energy-Saving and Carbon-Reduction Innovations (ESCRI) (Yu et al., 2025; Zhang et al., 2024). Enterprise-level evidence from China suggests that FinTech significantly increases the volume of green invention patents, prompting firms to transition toward low-carbon manufacturing systems (Yu et al., 2025; Zhang et al., 2024).

The Industrial Structure Upgrading Channel

FinTech accelerates structural upgrades by dynamically reallocating capital away from energy-intensive, carbon-heavy secondary industries toward service-oriented and knowledge-intensive sectors (such as the ICT industry) (Li et al., 2025; Xu et al., 2026). Urban-level spatial modeling demonstrates that FinTech reduces the market share of coal-heavy heavy manufacturing, consequently driving down regional carbon emission intensity across all scopes (Scope 1 direct, Scope 2 indirect, and Scope 3 supply chain emissions) (Qingyang Wu, 2024; Xu et al., 2026).

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The Green Total Factor Productivity (GTFP) Channel

At the operational level, FinTech leverages digital technologies (such as cloud computing and artificial intelligence) to mitigate factor misallocation and optimize productive efficiency (Xu et al., 2026). By reducing resource and energy waste during production, digital finance boosts Green Total Factor Productivity (GTFP), allowing firms to maintain economic output while substantially reducing unit carbon intensity (Mei et al., 2026; Xu et al., 2026).

The Frictionless Capital Mobilization Channel

FinTech democratizes and streamlines environmental financing by channelling global and retail capital directly into renewable energy projects (Anwar et al., 2024; Ayaydın et al., 2025). Innovations such as peer-to-peer (P2P) lending, green crowdfunding platforms, blockchain-based green bond registration, and digital Green Sukuk issuance reduce transaction friction and credit risk premiums (Mgadmi et al., 2026; Li et al., 2026). This efficient capital routing directly expands investment in utility-scale solar and wind infrastructures (Anwar et al., 2024; Ayaydın et al., 2025).

The Pro-Environmental Behavioral Adaptation Channel

Beyond corporate and institutional channels, FinTech actively reshapes individual consumption dynamics by gamifying low-carbon lifestyles (Allahham et al., 2024). Digital payment platforms and personal carbon accounts (e.g., Ant Forest) provide real-time, actionable environmental feedback and eco-friendly financial incentives, which stimulate green consumer behavior and enhance household environmental consciousness (Allahham et al., 2024; Zournatzidou, 2025).

Boundary Conditions and Moderating Limits

The relationship between financial technology and carbon reduction is highly non-linear and constrained by four critical boundary conditions: the Technological Rebound Effect, Economic Complexity, the CAREC 'Green Paradox', and Institutional Quality and Regulatory Strength.

The Technological Rebound Effect

In the early, embryonic stages of FinTech development, technological progress can paradoxically increase emissions due to a rebound effect (Li et al., 2025). While FinTech improves transaction efficiency, the concomitant credit expansion increases consumer purchasing power and factor substitution, driving up aggregate energy consumption and local manufacturing footprints (Zhou et al., 2026; Li et al., 2025). This rebound effect can outweigh initial environmental efficiency gains, necessitating structural balancing policies (Zhou et al., 2026).

Economic Complexity and Developmental Gaps

The impact of FinTech on carbon intensity differs sharply based on national economic complexity and development levels (Bhardwaj et al., 2025; Shi et al., 2026). Meta-regressions show that developed economies face a 'saturation effect' where further digital credit expansion yields diminishing environmental returns (Bhardwaj et al., 2025). Conversely, developing economies experience massive initial carbon-abatement gains as they leapfrog traditional paper-based financial systems (Bhardwaj et al., 2025). However, developing nations are also highly vulnerable to unguided credit expansion, where digital capital is used purely for carbon-heavy industrial-scale expansion rather than green innovation (Hussain et al., 2025).

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The CAREC 'Green Paradox' of Fossil-Fuel Lock-In

In several resource-rich, transitional CAREC and Middle Eastern economies, unguided digital financial development can trigger a 'Green Paradox' (Liu & Chengzhi Qiao, 2026). In these economies, although FinTech succeeds in lowering aggregate carbon emissions intensity via dematerialization, it counterintuitively impedes the green energy transition (GTE) (Liu & Chengzhi Qiao, 2026). Without active policy steering, digital financial credit naturally flows back to lower-risk, high-yield, and deeply entrenched traditional fossil-fuel sectors rather than highly uncertain renewable energy projects, locking the economy into a high-carbon trajectory (Liu & Chengzhi Qiao, 2025).

Institutional Quality and Regulatory Strength

Institutional quality and government effectiveness function as the ultimate boundary conditions, acting as net transmitters of digital-environmental spillovers (Jie et al., 2024; Mgadmi et al., 2026). In countries with weak environmental regulations and unstable governance, the environmental benefits of FinTech are entirely neutralized, and unregulated financial systems can exacerbate environmental degradation by financing energy-intensive digital assets (such as cryptocurrency mining and unregulated data centers) (Jie et al., 2024; Mgadmi et al., 2026). A robust institutional framework is therefore a prerequisite to align FinTech systems with national climate goals (Attia & BinEid, 2025; Jie et al., 2024).

Methodological Analysis and Empirical Findings

To validate these theoretical transmission channels and boundary conditions, the 33 included papers utilize advanced second-generation econometric estimators that control for cross-sectional dependence (CSD) and slope heterogeneity (SH). This section synthesizes the key empirical models, variables, and quantitative findings from these studies.

Variables and Model Specifications

The core independent variable, Financial Technology, is typically proxied by composite indices constructed using Principal Component Analysis (PCA). These indices aggregate indicators of digital penetration, including internet usage, mobile cellular subscriptions, commercial bank branches, and domestic lending to the private sector (Jangid et al., 2025; Hussain et al., 2025). The dependent variables, environmental performance indicators, include per capita CO2 emissions, greenhouse gas emissions, ecological footprints, and the load capacity factor (LCF) (Shi et al., 2026; Hussain et al., 2025). The standard empirical model extends the STIRPAT framework, specified as:

$$\ln(EI_{it}) = a_0 + b_1 \ln(FT_{it}) + b_2 \ln(GTI_{it}) + b_3 \ln(EG_{it}) + b_4 \ln(POP_{it}) + e_{it}$$

where EI_it represents the environmental impact for country i at time t; FT_it is the FinTech PCA composite index; GTI_it denotes green technological innovation; EG_it is gross domestic product per capita (Affluence); POP_it is total population (Population); and e_it is the idiosyncratic error term.

Key Empirical Coefficients and Findings

The empirical findings across the 33 papers strongly support the transmission channels and boundary conditions outlined above. In order to ensure empirical rigor and prevent specification bias, this study distinguishes between the qualitative systematic review of the

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entire 33-paper database and the strict quantitative comparison presented in Table 2. While all 33 papers are synthesized qualitatively to map theoretical channels, Table 2 presents five representative studies selected to illustrate the diversity of geographical settings, environmental indicators, FinTech measures, and econometric methodologies within the included literature.

In developed economies, such as the United States and OECD countries, the direct effect of FinTech on carbon intensity is consistently negative and statistically significant. For instance, Qingyang Wu (2024) demonstrates that a 1% increase in urban FinTech development is associated with a 0.0038% reduction in carbon intensity, leading to a cumulative regional reduction of 0.692% over the study period. This is mediated by a reduction in coal-fired power generation and a shift toward ICT and service-oriented sectors.

Similarly, in emerging markets, Method of Moments Quantile Regression (MMQR) models reveal that the carbon-abatement effects of FinTech are asymmetric, being significantly more pronounced in highly polluted regions (i.e., at higher quantiles of carbon intensity) than in cleaner regions. L. Jiang and A. Hassan (2025) find that the coefficient of FinTech on per capita carbon emissions in E7 economies ranges from -0.068 at the lowest quantile (Q0.10) to -0.330 at the highest quantile (Q0.90), highlighting that digital finance is a highly effective tool for high-pollution economies. In contrast, in low-complexity economies, unguided digital trade integration can increase environmental footprints unless balanced by structural economic upgrades, as shown by Shi et al. (2026), who find that the interaction of digital trade with low economic complexity reduces the load capacity factor by -0.919%.

Table 2: Quantitative Summary of Key Empirical Findings on the FinTech-Carbon Nexus

Study & Geographic Scale	Key Explanatory Variable(s)	Estimator Model	Core Coefficient(s) & Metrics	Reported Environmental Outcome
Wu (2024) China County-level	FinTech composite index	FE with IV (Baidu index)	1% FNT increase => -0.0038% carbon intensity	Significant decrease in regional emissions
Jiang & Hassan (2025) E7 Economies	FinTech PCA index	MMQR (Machado-Silva)	FNT coeff: -0.068 (Q10) to -0.330 (Q90)	Consistently abates emissions across all quantiles
Li et al. (2026) Persian Gulf Economies	FTC (FinTech adopt)	Two-step system GMM	FTC coeff on low-carbon: 1.189 (z=5.13)	Significantly drives low-carbon performance
Shi et al. (2026) E7 Economies	FinTech (FNT) index	MMQR and FGLS	FNT coeff on LCF: 0.436 (baseline)	Directly improves ecological sustainability

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Liu & Qiao (2026) CAREC Economies	FinTech (FNT) index	MMQR (Machado-Silva)	FNT on GTE: Negative (Green Paradox)	Reduces emissions but impedes energy transition

Source: Developed by the authors.

Spatial Spillovers and Temporal Trajectories

In order to fully understand the FinTech-carbon relationship, the literature explores the spatial spillovers and temporal trajectories of digital finance shocks. Spatial Durbin Models (SDM) demonstrate that the environmental benefits of FinTech are not localized but exhibit significant spatial spillovers (Ying Zhang et al., 2024). Specifically, the positive spatial spillover coefficient of FinTech on urban carbon emission efficiency is estimated at 0.487 (Ying Zhang et al., 2024). This indicates that the development of digital financial infrastructure in one region promotes green technological transitions and carbon reductions in neighboring regions, driven by regional capital and technology spillovers (Ying Zhang et al., 2024).

Furthermore, Panel Vector Autoregression (Panel VAR) models provide crucial insights into the temporal trajectories of these shocks over a 10-period (10-year) horizon (Jangid et al., 2025). Impulse Response Functions (IRFs) show that a positive shock to FinTech has an immediate, short-term positive impact on per capita GDP and renewable energy consumption, while triggering a delayed, gradual reduction in carbon emissions (Jangid et al., 2025). The environmental benefits of financial innovation peak between years 3 and 5 and exhibit long-term persistence, suggesting that FinTech acts as a stable and reliable driver of environmental sustainability over medium-to-long-term planning horizons (Jangid et al., 2025).

Graded Policy Playbook for Multi-Bloc Decarbonization

In order to align digital financial systems with global climate objectives, this review establishes a graded policy playbook tailored to the specific needs of developed, developing, and resource-dependent transitional economies.

Playbook for Developed Economies (OECD & Europe)

In developed economies, which face a saturation effect and severe regulatory challenges, the policy focus should shift toward integrating advanced environmental constraints into digital systems (Bhardwaj et al., 2025). Regulators should: (i) establish green regulatory sandboxes that offer regulatory relief and fast-track licensing exclusively to FinTech startups developing blockchain-based carbon tracking, P2P green lending, or AI-driven ESG scoring (Hussain et al., 2025); (ii) implement strict carbon footprint disclosure rules and energy-efficiency standards for data-driven infrastructures, such as data centers, 5G networks, and blockchain nodes, forcing the ICT sector to utilize 100% renewable energy; and (iii) encourage corporate alliances between traditional commercial banks and green FinTech companies to co-issue digital green bonds (Zournatzidou, 2025).

Playbook for Developing Economies (Emerging Markets & E7)

Developing economies, which are highly susceptible to the rebound effect and unguided credit expansion, must focus on steering digital capital toward green investments (Li et al., 2025). Governments should: (i) institute green credit mandates that require digital credit platforms and mobile money operators to allocate a minimum percentage of their lending portfolios to

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sustainable agricultural finance, energy-saving retrofits, and local renewable installations; (ii) integrate personal carbon accounts with digital payment platforms to incentivize low-carbon consumer behavior through tax rebates, digital cash-back rewards, and reduced utility fees (Allahham et al., 2024); and (iii) provide state-funded credit guarantees and public-private partnerships (PPP) to de-risk high-uncertainty green technology innovations (ESCRI), encouraging private investors to fund clean technology (Li et al., 2026; Yu et al., 2025).

Playbook for Resource-Dependent and Transitional Economies (CAREC)

In order to counter the 'Green Paradox' of fossil-fuel lock-in, transitional resource-dependent economies must implement strict policy interventions to redirect digital capital (Liu & Chengzhi Qiao, 2026). Policymakers must: (i) impose a progressive carbon tax on fossil-fuel sectors to artificially elevate their risk profile and lower their financial return, discouraging unguided FinTech capital from flowing back into coal and oil (Liu & Chengzhi Qiao, 2025); (ii) implement public-policy de-risking mechanisms, such as state-backed green investment banks, that co-invest with FinTech platforms in renewable energy infrastructure, lowering private risk; and (iii) establish standardized regional green finance taxonomies to ensure that digital credit is strictly routed to certified carbon-mitigation projects (Liu & Chengzhi Qiao, 2026; Zournatzidou, 2025).

Discussion and Limitations of the Literature

While the synthesized literature provides robust empirical evidence of the carbon-abatement effects of financial technology, several critical research gaps remain. First, the existing literature suffers from a severe geographical concentration, with over 60% of the 33 empirical papers focusing exclusively on China (e.g., Chinese prefecture-level cities, coastal provinces, or Chinese listed companies) (Xu et al., 2026; Yu et al., 2025). This heavy geographic bias limits the generalizability of the findings to other developing regions, such as Sub-Saharan Africa, Latin America, and Southeast Asia, which feature different institutional structures, digital infrastructure maturities, and financial inclusion levels.

Second, the literature is predominantly macro-oriented, relying on country-level or provincial-level panel datasets (Shi et al., 2026; Jangid et al., 2025). There is a stark scarcity of micro-level, enterprise-level studies analyzing how individual small and medium enterprises (SMEs) or household farms utilize green FinTech solutions (e.g., P2P agricultural crowdfunding or digital smart meters) to reduce their direct carbon footprint (Alam et al., 2025). Future research must leverage micro-level datasets and natural experiments to explore the behavioral and operational transitions occurring at the firm and individual level.

Conclusion

This systematic literature review harmonizes the conflicting debates surrounding the FinTech-Carbon Nexus by synthesizing 33 empirical papers from Scopus. The review establishes that the environmental impact of financial innovation is not a simple linear relationship, but a complex system governed by five distinct transmission channels and four non-linear boundary conditions. By resolving corporate credit constraints and lowering transaction costs, FinTech facilitates green technological innovations (ESCRI), industrial structural upgrading, green total factor productivity gains, and frictionless green capital mobilization, while driving pro-environmental individual consumer adaptation.

However, the efficacy of this digital transformation is constrained by critical boundary conditions, including early-stage technological rebound effects, economic complexity gaps, institutional quality deficiencies, and the resource-rich 'Green Paradox' of fossil-fuel lock-in. Policymakers must implement the tiered policy framework developed in this review to ensure that digital finance becomes a genuine driver of environmental sustainability. Key measures include establishing green regulatory sandboxes, introducing green credit mandates, developing personal carbon accounts, and adopting progressive carbon taxation. Ultimately, rewiring sustainability in the Industry 4.0 era requires the deliberate, policy-guided evolution of financial technology into Greentech, ensuring that the digital revolution actively supports a low-carbon global economy.

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