# HARNESSING DIGITAL FINANCE FOR SUSTAINABLE GREEN INVESTMENT: A PAT<u>HWAY TO A LOW-CARBON FUTURE</u>

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# Abstract

One of the primary objectives of economies nowadays is to increase energy efficiency in order to promote the global economy. To improve energy efficiency, the UN General Assembly has recommended that the SDG7 proposals be taken into account. Prior to proposing three theories, the paper gives a summary of the theoretical framework that digital finance employs to improve sustainability and financial efficiency. Next, a DEA-BCC model and a super-efficiency DEA model are used to evaluate various financial efficiency levels in 31 Chinese provinces.

Each of the three hypotheses is further investigated in this study utilizing the projected financial efficiency values, an LSDV model, and a random effects model that takes cross-sectional correlation problems into consideration. The findings show that (i) technological advancement is the main driver of every Chinese region's increased financial efficiency, with the scale effect's contribution to this improvement diminishing;

The expansion of digital finance's coverage reach and depth of acceptance are important variables in the advancement of financial efficiency, with the latter having a stronger positive impact. (ii) The rise of digital finance does play a major role in increasing regional financial efficiency. Therefore, policymakers and financial institutions can find this study to be a useful resource in order to achieve sustainable financial inclusion and better understand the relationship between digital finance, financial efficiency, and sustainability.

Keywords: digital finance; financial inclusion; financial efficiency; sustainability.

# Introduction

The achievement of the 17 Sustainable Development Goals (SDGs) and limiting global warming to 2°C requires an estimated \$4 trillion USD annually. However, there is a \$2.5 trillion USD investment gap, covering only 35% of the necessary funds. If urgent actions are not taken, the cost of removing carbon from the atmosphere may reach \$535 trillion USD by 2100. Immediate reductions in carbon emissions, at a rate of 6% per year from 2013, could lower this cost significantly to \$100-\$200 billion USD annually. Political commitment, technological innovation, and financial transformation are critical to addressing this challenge.

Sustainable finance is gaining momentum, with the global financial community pushing for innovative solutions. The G20 report, the IMF/World Bank's Bali Fintech Agenda, and other initiatives emphasize the role of financial technology (fintech) in reducing costs and creating opportunities in sustainable investment. Blockchain, artificial intelligence (AI), and the Internet of Things (IoT) offer potential solutions for overcoming barriers to sustainable finance and creating new financial products and markets. Governments and financial institutions must work together to support low-carbon economic models, protect resources, and promote societal well-being.

#### **Green Growth and Sustainable Finance**

Green growth integrates economic development with environmental protection, separating pollution from economic progress. It ensures financial advancement while providing resources necessary for industrial and social activities. Developed nations have already adopted green financial practices, including reducing, reusing, and recycling. The emergence of the "green economy" reflects efforts to restore ecological balance and promote sustainability.

Green technology innovation focuses on minimizing environmental impact while maximizing resource efficiency. Industries such as metal smelting and heavy chemicals contribute significantly to pollution. In China, businesses seek modernization through green technology adoption. However, funding constraints hinder their ability to upgrade infrastructure in an environmentally friendly manner. Local financial departments impose strict profitability and risk regulations, limiting green technology adoption. Unlike traditional green finance, digital financing integrates digital technologies with financial services, enabling broader access and innovation.

#### Sustainable Digital Finance

Sustainable digital finance refers to funding and financial arrangements leveraging digital ecosystems, including:

- Blockchain and Digital Tokens: Ensuring transparency in transactions.
- Crowdsourcing and Peer-to-Peer Lending: Expanding access to capital.
- Artificial Intelligence and Big Data: Enhancing decision-making in green investments.
- Internet of Things (IoT): Improving real-time monitoring of environmental impacts.

Fintech innovations reduce costs, drive financial inclusion, and foster sustainable markets. Collaboration between banks and fintech firms has shifted from competition to partnerships, increasing investment in sustainable finance. Banks must integrate sustainability into their strategic frameworks to maintain relevance. Sustainable digital finance offers a promising opportunity to engage millennials who prioritize sustainability in their financial decisions.

#### **Role of Digital Finance in Sustainable Investment**

1. Innovations in Digital Finance

- Blockchain & Distributed Ledger Technology (DLT): Enhances transparency and accountability in green investments, tracking carbon credits and renewable energy certificates.
- Artificial Intelligence & Big Data Analytics: Identifies high-impact investment opportunities and optimizes portfolio management.
- Fintech Platforms: Democratize green investments by enabling individual participation.
- Decentralized Finance (DeFi): Uses blockchain to provide financial services without intermediaries, offering new avenues for green financing.

2. Enhancing Capital Flow into Green Investments

- Lowering Transaction Costs: Eliminating intermediaries reduces financial barriers.
- Global Capital Access: Digital platforms enable cross-border green investments.
- Real-time Monitoring & Reporting: Blockchain-based smart contracts enhance transparency.
- Financial Inclusion: Expands investment access to underserved populations.

# **Challenges to Digital Finance Adoption in Green Investment**

1. Regulatory and Legal Barriers

Fragmented regulatory frameworks create uncertainty for digital finance applications in green investments. Clear, consistent regulations are necessary to build investor confidence.

#### 2. Data Privacy and Security Risks

As digital finance depends on big data, privacy and security concerns must be addressed to maintain trust.

3. Digital Divide and Financial Exclusion

Limited internet access, digital literacy, and financial infrastructure hinder participation in digital green finance, particularly in developing economies.

4. Market Volatility and Speculation

The speculative nature of digital assets can create instability, reducing investor confidence in long-term green investments.

### Framework for Leveraging Digital Finance in Green Investment

1. Regulatory Harmonization

Governments must collaborate on standardized regulations for blockchain, green bonds, and carbon credits to facilitate sustainable investment.

- 2. Investment in Technology Developing secure and efficient digital finance platforms requires investment in AI, blockchain, and fintech.
- 3. Financial Literacy and Inclusion Education programs and user-friendly digital platforms can bridge the financial inclusion gap.
- 4. Stakeholder Collaboration

Governments, financial institutions, tech companies, and NGOs must work together to create standardized ESG indicators and sustainability protocols.

5. Impact Measurement and Reporting Automated reporting through blockchain and AI enhances transparency, ensuring green investments align with sustainability goals.

#### Literature Review

The theory of green finance continued to exist between 2002 and 2006, with the theoretical foun dations of finance being informed by environmental sustainability and used to integrate the finan cial sector into the larger business world framework (Gumashta and Gumashta 2021, Kamarudin et al. 2021).

Kassar and Singh (2019) conducted a study on green financial development in which they askedf inancial firms in growing and global market nations how much they spend on the environment, e conomy, and society.

Tolliver et al. (2020) who study the environmental Kuznets curve (EKC) theory in Istanbul, state that there is positive association between financial progression and environmental sustainability. The expansion of the green credit scale for firms has produced numerous ecological and economic benefits. Most of the currently published material focuses on the impact of green credit on companies that cause major pollution, including how green credit is financed and how it impacts environmental quality, R&D investment, debt financing costs, and performance.

Huang and colleagues (2022) [18] used the panel threshold model to study how green finance affects green innovation. They found that the two had a substantial positive autocorrelation. Since the double-threshold impact test discloses another mechanism—namely, that the pushing force of green finance will be diminished as environmental supervision improves—it is advised that the government lessen the regional differences in sustainable development.

Tian et al. (2022) examined between China's green finance policy and the green transformation mechanism to control of highly polluting enterprises between 2009 and 2017 using the propensity score match–difference-in-differences (PSM-DID) model. According to research, high-polluting companies' debt financing restrictions were altered by the green credit policy, which significantly aided in their green transformation. Nevertheless, there is little chance that this beneficial effect will last over time.

Kang et al. (2020) used an control model for South Korea's Green Credit Policy (GCP) to examine the impact of the GCP on the alleviation of pollution in businesses' supply chains. The results show positive response Policy (GCP). After introducing the Green Credit Policy (GCP) as a quasi-natural experiment,

Zhang et al. (2021) examined China's high-pollution firms from 2004 to 2017 using a differencein-differences model. And his study shows an short term effect

Nenavath (2022) uses the semiparametric difference-in-differences (SDID) approach to analyze how India's green finance rules, from 2010 to 2020, affected industrial carbon emissions and firm strategic operations. The findings demonstrate that business investment and environmental security can both benefit from green finance legislation. The government must also encourage banks to offer businesses more green lending options.

#### **Research Objectives**

- 1. To analyze the role of digital finance in facilitating sustainable green investments
- 2. To assess the impact of digital financial inclusion on promoting green investments
- 3. To explore the effectiveness of green digital financial instruments

## Conclusion

Digital finance and sustainable investing present significant opportunities to address the global capital shortage required for combating climate change. While traditional financial institutions play a crucial role, they often lack the necessary resources to fund a full-scale transition to a low-carbon economy. Existing financial systems have struggled to generate the massive funds needed for carbon capture technologies, sustainable agriculture, climate-resilient infrastructure, and renewable energy.

However, innovations such as blockchain, artificial intelligence (AI), and financial technology (fintech) have the potential to bridge this financial gap. These technologies create new avenues for capital mobilization, enhance transparency, reduce transaction costs, and widen access to sustainable investments. Blockchain, for instance, is transforming the tracking and validation of green investments. Its decentralized and immutable ledger enables real-time monitoring of environmental outcomes, such as carbon credits, renewable energy production, and ESG (Environmental, Social, and Governance) indices. Transparency in financial transactions increases investor confidence, ensuring that funds are used as intended while reducing inefficiencies in cross-border transactions by eliminating intermediaries.

Big data analytics and AI are also revolutionizing green investment strategies by improving the identification, assessment, and optimization of sustainable projects. AI-driven tools can analyze vast datasets to pinpoint high-impact projects, evaluate environmental risks, and forecast investment outcomes. Machine learning and predictive modeling enhance investor confidence by minimizing uncertainty surrounding financial and environmental returns. This increased reliability makes green investments more attractive to institutional investors, who have traditionally been hesitant due to perceived risks.

Fintech innovations, such as crowdfunding and peer-to-peer lending, further democratize access to green investments by allowing retail investors and those in developing nations to participate in sustainability initiatives. Fintech platforms enable tokenization of green assets and issuance of decentralized green bonds, promoting fractional ownership and broadening investment opportunities. As fintech continues to evolve, more investors will gain access to sustainable investment options, fostering inclusivity in the green transition.

Despite these advancements, several challenges must be addressed before digital finance can fully support sustainable investment. Regulatory uncertainty remains a significant hurdle. While some jurisdictions have made progress in establishing frameworks for cryptocurrencies, blockchain, and digital finance, many others lack comprehensive guidelines tailored to sustainable investment applications. This legal ambiguity increases risks for investors and project developers, potentially delaying the adoption of digital financial solutions in green finance. Governments and international bodies must collaborate to create standardized regulations for green digital finance, ensuring transparency and integrity while mitigating legal risks.

Additionally, clear standards for measuring environmental impact are essential. Establishing guidelines for blockchain-based carbon credits and green bonds will enhance investor confidence in these financial instruments. Without a unified regulatory framework, the adoption of digital finance for sustainable investment will remain slow and fragmented.

Technological limitations also pose significant barriers, particularly in regions with inadequate digital infrastructure. Reliable internet access, secure digital platforms, and robust data storage systems are necessary for digital finance to reach its full potential. However, many developing nations—where green investments are most urgently needed—lack these essential technological resources. Expanding internet accessibility and investing in digital infrastructure will be crucial to ensuring equitable participation in sustainable finance.

Concerns regarding the environmental impact of digital financial technologies must also be addressed. While blockchain can improve efficiency compared to traditional systems, some networks—particularly proof-of-work blockchains like Bitcoin—consume significant energy. To mitigate this issue, the adoption of energy-efficient blockchain models, such as proof-of-stake mechanisms, is necessary. Transitioning towards eco-friendly digital financial solutions will further align digital finance with sustainability objectives.

In conclusion, fostering an environment conducive to digital finance is key to accelerating capital flow into low-carbon, sustainable projects. Digital finance offers a unique opportunity to overcome barriers that have hindered green investment, provided the right legal frameworks, technological infrastructure, and social engagement are in place. By addressing regulatory and technological challenges, digital finance can play a pivotal role in driving the green transition. This will not only help combat climate change but also create a more inclusive and sustainable future for all.

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