



Green Finance practices in the present era of Digitalization: Progress & challenges

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Abstract

In the present era of Digitalization a remarkable transformation has taken place in the economy not only in India, but also in the entire globe due to climatic changes, ozone and depletion and other environmental issues. The business firms realized the significance of “Go Green concept” and adopted many Green initiatives for their sustainable development. Green Finance is one component of a broader movement towards socially and environmentally conscious business practices. It has emerged as a critical and transformative force for a sustainable economy by directing financial resources towards environmentally friendly and socially responsible projects that have positive environmental benefits and contribute to sustainable development. Green finance can be seen as a financial instrument crafted with the noble goal of aligning financial choices with the evolving requirements of both society and the environment. Its aim is to encourage investments that foster sustainable development. On this backdrop, present study has been undertaken to overview the present Green Finance Practices, its progress and challenges in India as well as Globally.

Keywords: Green finance, sustainable finance, environmental, social and governance (esg), climate change mitigation and green innovation

Introduction

There is growing attention from governments and regulators towards crucial matters such as climate change and global warming, resulting in a pressing need to investigate the factors that make it possible for businesses to engage in Green Finance (GF). The externality of environmental pollution prioritizes the need of Green Innovation (GI) in public management. GF distributes financial resources to the research and development (R&D) of clean energy and environmentally friendly goods and processes; it is complementary to the GI process for environmental protection. GF policies help to alleviate the impacts of financial constraints and GI impaired industries involving new products, processes, services and the global market.

Although green finance is expanding significantly, a fully harmonized regulatory framework and categorical criteria for determining what is green and what is not are not yet available. For this reason, the European Union and competent financial regulatory authorities are developing rules on green finance. These will enable investors interested in green finance to avoid the risk of greenwashing, that is, unsubstantiated or false claims that investments are green. According to the European Commission, sustainable finance (or green finance) refers to the “process of taking environmental, social and governance (ESG) considerations into account when making investment decisions in the financial sector, leading to more long-term investments in sustainable economic activities and projects” (European Commission 2021). This leads to a greater focus on long-term investments in sustainable economic activities and projects. The European Commission further elaborates on ESG considerations, highlighting environmental factors like climate change and pollution, social factors such as human rights and inequality, and governance factors, including institutional policies and employee relations. In simpler terms, green finance is a segment of finance aimed at supporting economic growth while also alleviating

environmental pressures, all while taking into consideration ESG factors. In recent times, there has been increasing recognition of the significance of ESG factors. ESG factors, previously viewed as non-financial aspects of businesses, are now fundamental values embraced by companies, major financial institutions, and shareholders worldwide. These factors are now given utmost importance in core management strategies adopted by businesses for sustainable management and investment.

In recent decades, green finance instruments have attracted considerable attention due to their role in international cooperation and national policies regarding sustainability and climate change. To understand the concepts of green finance, it is important to start by understanding the definition of “sustainability”. It is imperative to note that there are several definitions available to explain this term. Sustainability was presented as “meeting the needs of the present without compromising the ability of future generations to meet their own needs” in the publication Our Common Future by the United Nations in 1987. Sustainable finance generally involves the integration of sustainability with economic and financial practices. Green finance is part of sustainable finance and concerns financial instruments facilitating environmentally sustainable development, energy transition, and the fight against global warming. Investors and financial institutions can actually contribute to combating climate change by investing in enterprises and projects pursuing objectives related to energy transition and environmental protection. Green finance provides financial support for firms engaged in green innovation, including the purchase of green equipment, the introduction of new environmentally efficient technologies, and the training of their personnel. Second, green funding from various projects can assist stakeholders (organizations, governments, and regulators) in spending R&D funds on environmental challenges and minimize the associated risk with green legislation. Lastly, green policies have higher costs than

conventional practices, and green finance can assist an organization in covering these expenses without encountering significant financial obstacles. As a result, green finance-driven economic growth can significantly support green policies, lessen environmental pollution, and build sustainable cities.

Though there is no trace to the origin of the term green finance, it was widely used after the 'Earth Summit', held in Rio de Janeiro, Brazil, in 1992. International Finance Corporation (IFC) defines green finance as the "financing of investments that provide environmental benefits" (IFC, 2016). It includes various financial instruments and assets like green bonds, green banks, carbon market instruments, fiscal policy, green central banking, financial technologies, community-based green funds, etc., that promote green and sustainable projects (Sachs *et al.*, 2019). Green finance helps countries to boost investment in environmentally sustainable projects and achieve the status of a low-carbon economy. It also attracts investment from socially responsible investors and reduces financing constraints on green projects.

Literature review

Green finance has gained significant attention recently as the global community realizes the urgent need for sustainable and environmentally friendly financial practices. This increasing trend leads to exploring a diversity of topics from relatively new arenas of research, providing potential scope for future research. Green finance can be seen as a financial instrument crafted with the noble goal of aligning financial choices with the evolving requirements of both society and the environment. Its aim is to encourage investments that foster sustainable development.

With the rising challenges of climate pressure and environmental degradation, sustainable development has become an important topic of global concern (Long *et al.*, 2023; Ma & Chang, 2023). The environmental, social, and governance (ESG) concept measures the sustainability of business operations and their influence on social values across three dimensions: environmental, social, and governance (Liu *et al.*, 2024). While actively guiding enterprises to implement green development concepts, improve social responsibility, and governance efficiency, it has also become a crucial metric for the society to assess the extent of sustainable development (Zhao *et al.*, 2025). Improving ESG performance is a key factor for countries to maintain international competitiveness and a necessary way to attain sustainable development (Wang *et al.*, 2024).

Green finance has been the subject of extensive research, with various aspects related to greenhouse gas emissions (Saeed Meo and Karim 2022; Wu *et al.* 2023), climatic disasters (Ezroj 2020), environmental disclosures (Brooks and Schopohl 2020; Lyon and Shimshack 2015; Steuer and Tröger 2022), the economic consequences of global warming and temperature shifts (Burke *et al.* 2015; Dell *et al.* 2012), the relationship between temperature and aggregate risk (Lamperti *et al.* 2021), and the influence of climate policy risk on the financial system (Lin *et al.* 2022) being examined. Green finance manifests in various forms, such as green bonds, which fund eco-friendly projects (Yu 2016); Socially Responsible Investing (SRI), which evaluates ESG factors in investment choices (Walls 2024); and impact investing, which strives to yield financial gains alongside positive social and environmental effects (Yasar

2021). Governments, organizations, and individuals are recognizing the need for a more sustainable and responsible approach to finance, and are taking steps to integrate ESG factors into financial decision-making. As awareness of the importance of sustainability continues to grow, it seems likely that green finance will become an increasingly important part of the financial system.

Bhatnagar and Sharma 2022 ^[4]; Debrah *et al.* 2023; Mohanty *et al.* 2023 ^[12]; Zhang *et al.* 2019 emphasize the importance of regulatory and policy support, technological innovation, and the role of stakeholders. Bhatnagar and Sharma (2022) ^[4] outline the factors that influence the implementation of green financial practices, emphasizing regulatory support in the process of integrating green financial products into traditional financial markets. Mohanty *et al.* (2023) ^[12] highlight the broad spectrum of the research topic by revealing the relationship between economic performance and the social value of green finance, with an emphasis on green bonds and renewable energy. Their conclusion is that financial literacy should be improved, and digital technologies should be integrated in the context of green finance. Debrah *et al.* (2023) find that Green finance "needs to be fully understood" and therefore they propose research hot topics such as the green bond market and greenium, green credit (loans), carbon investment and market, green banking, market stress, and domestic and international climate finance policies.

Zhou *et al.* (2020) demonstrated that green finance significantly enhances the correlation between economic development and environmental performance, fostering the advancement of a green economy. Many studies have also found that green finance notably enhances green productivity (Fu *et al.*, 2023; Jiakui *et al.*, 2023) ^[7] and clean energy efficiency (Zhang *et al.*, 2022), further demonstrating the key function of green financial resources in promoting sustainable development. In addition, many researchers have discovered that improving ESG performance can result in green technological innovation considerably (Long *et al.*, 2023), which is contribute to higher enterprise value (Fatemi *et al.*, 2018). ESG performance will also be driven by variables such as digital finance (Mo *et al.*, 2023), government environmental attention (Liu *et al.*, 2024), and internationalization activities (Hu *et al.*, 2023). Therefore, investigating the nexus between green finance and national ESG performance is crucial. Wang *et al.* (2022) examine whether green finance contribute to ESG performance for Chinese listed companies, while Sun *et al.* (2023) specifically focused on manufacturing enterprises to examine the effect of green finance on the ESG performance of Chinese manufacturing enterprises. Scholars also examine how green finance pilot zone policies affected ESG results (Chen *et al.*, 2022; Shen & Liao, 2020), revealing a promoting effect of green finance on ESG performance. Although the above-mentioned literature has promoted the research on green finance and ESG performance, there are still several unresolved issues.

Objectives & Methodology

Driven by the need for science-based adequate strategies for the transition to sustainable economies, we focus mainly on the integration of ESG criteria in the process of conceptual understanding and the practical application of green finance. Thus, the main objective of this study is to identify the

current trends & practices of green finance for sustainable development, its progress & challenges as well as to propose recommendations for future research and practice. In such a case, it is logical that this study addresses the following research objectives

1. To overview the evolution and concept of Green Finance
2. To study the necessity of Green Finance in Business firms
3. To study the recent trends & practices of Green Finance
4. To analyse the progress and challenges of Green Finance practices
5. To study the significance of Green Finance in sustainable development of the firms
6. To analyse its impact in India as well as the Globe

In order to achieve the objectives, secondary data was used by obtaining from various online and offline journals, Magazines and reports etc. The study is of merely qualitative in nature.

Results & Discussion

The ESG concept provides a comprehensive framework for green development, social progress, and corporate governance, reflecting the sustainable development goals. To improve ESG performance, three aspects-environment, society, and governance-should be comprehensively considered. Carrying out environmental governance actions

and investing in green projects are effective ways to enhance ESG performance. Sustaining ESG activities require continuous and long-term financial support. Adequate funding and a favorable financial environment are indispensable for promoting ESG initiatives. Creating a conducive financial environment and ensuring sufficient funds are key factors in driving the development of ESG undertakings. However, there are two major challenges in improving ESG performance. Firstly, the existing financial system fails to achieve fair resource allocation. Traditional financial markets usually have monopolistic structural characteristics.

Green finance is commonly defined as a range of financial tools and mechanisms aimed at addressing funding challenges specifically linked to environmental conservation initiatives and the promotion of sustainable projects. It is a critical means of financing low-carbon and green initiatives for individuals, corporations, and governments. It can provide investment and financing with environmental advantages in a more comprehensive framework of sustainable development. Green finance provide financial supports for various activities, including investment and financing, operations, and other activities, improve information transparency, alleviate information asymmetry, aggregate social capital, provide monetary assistance for green development, effectively alleviate financing constraints, promote sustainable practices, and provide intrinsic motivation for improving ESG performance.

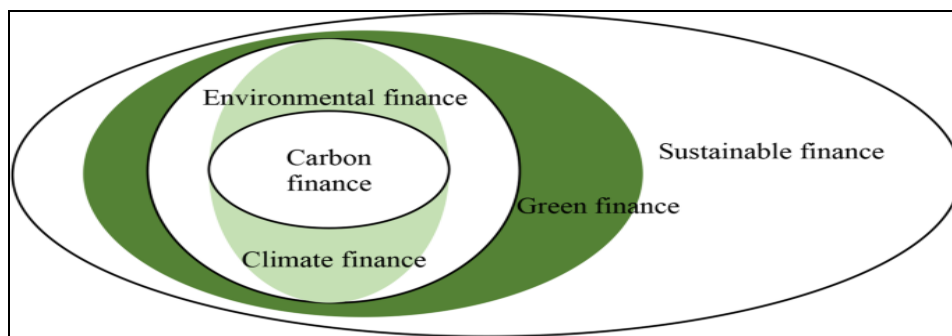


Fig 1: The relationships of different green terms to green finance

Green Finance: the financial instruments and mechanisms that support investments in environmentally friendly projects and initiatives. In India, banks play a significant role in promoting green finance and supporting the country's sustainable development goals. So, bank financing, if at least a portion of it is used in green projects, would contribute to environmental up-gradation and global climate change mitigation. In India both public and private sector banks have increasingly adopted this concept and have significantly altered their operational processes to support and funded projects like renewable energy projects-windmills, biomass project and generation of solar electricity.

In the developed countries a good number of banks are committed to work to save the earth by taking encouraging socially responsible business practices. In the world many developing countries green banking practices is yet to come in practice. For example, some banks of the (USA) United States of America and the (EU) European Union are very active among the banks in the green initiative to protect the environment. The leading banks are extending their credits to the customers who have undertaken the green projects.

All the countries across the world ensures that Zero carbon emission by 2050.

Green finance practices involve leveraging various financial instruments and strategies to direct capital toward environmentally sustainable projects and initiatives. The core aim is to promote a transition to a low-carbon, resource-efficient economy while ensuring long-term financial stability and environmental well-being.

1. Key Green Finance Instruments and Practices

- **Issuance of Green Financial Instruments:** Financial institutions, corporations, and governments issue specific products to raise capital for eco-friendly projects.
- **Green Bonds:** Debt securities where the proceeds are used exclusively for projects with environmental benefits, such as renewable energy, clean transportation, and sustainable waste management.
- **Green Loans/Credit:** Loans offered with preferential terms (e.g., lower interest rates) for projects like

installing solar panels, purchasing electric vehicles, or improving a building's energy efficiency.

- **Green Equity Funds:** Investment vehicles that pool capital to invest in companies and projects committed to environmental sustainability, such as clean technology and sustainable agriculture.
- **Green Mortgages:** Home loans designed to incentivize the purchase or renovation of energy-efficient properties.
- **Carbon Financing/Credits:** A market-based mechanism where funds are linked to projects that reduce or remove a set amount of greenhouse gas emissions.
- **Integration of ESG Factors:** Environmental, Social, and Governance (ESG) criteria are integrated into core investment and lending decisions to assess risks and opportunities related to sustainability.
- **Risk Management and Transparency**
- **Climate Risk Assessment:** Financial institutions increasingly evaluate the potential impact of climate change on investments and loan performance.
- **Transparent Reporting:** Adhering to standardized reporting frameworks (like the EU Taxonomy or the Green Bond Principles) ensures transparency and accountability in tracking the environmental impact and financial performance of green investments. This helps prevent "greenwashing," where investments are misleadingly marketed as environmentally friendly.
- **Policy and Regulatory Support:** Governments and regulatory bodies (e.g., central banks, securities commissions) establish frameworks, guidelines, and incentives to encourage green investments and lending. Examples include tax incentives for green projects or mandatory sustainability reporting for listed companies.
- **Innovation and Technology:** Leveraging technological advancements like AI, big data analytics, and blockchain to streamline project evaluation, risk assessment, and enhance transparency in green finance transactions.
- **Capacity Building:** Educating professionals and raising awareness among investors and the public about the benefits and complexities of green finance to drive demand and ensure effective implementation.

Project Examples

- **Renewable Energy:** Financing solar farms, wind power installations, and biofuel production.
- **Infrastructure:** Funding the development of energy-efficient buildings, clean public transport systems, and sustainable waste and water management facilities.
- **Conservation:** Investments in sustainable agriculture, forestry, biodiversity protection, and nature-based solutions.

Green finance practices are progressing through increased adoption of green bonds, sustainable banking, and new

financial products like green loans and mortgages. Globally, the market has expanded, though the rate of growth has recently slowed, and key challenges remain in translating initial groundwork into substantial capital flows. Despite these challenges, initiatives continue to advance with a focus on new instruments, enhanced transparency, and supporting climate resilience.

2. Core Activities

- **Integrating Environmental, Social, and Governance (ESG) Factors:** Incorporating ESG considerations into core investment analysis, risk management, and credit rating methodologies to assess a company's sustainability and long-term resilience.
 - **Risk Management:** Evaluating and mitigating climate-related financial risks within investment portfolios and operations to safeguard against potential losses from climate change impacts, regulatory shifts, or environmental disasters.
 - **Transparent Reporting:** Implementing robust and transparent reporting frameworks (e.g., using standards like GRI or SASB) to track and disclose the environmental impact and performance of green investments.
 - **Policy and Regulatory Support:** Collaborating with policymakers and regulators to establish clear guidelines, definitions (taxonomies), and incentives (e.g., tax breaks, subsidies) that create an enabling environment for green finance to thrive and prevent greenwashing.
 - **Innovation and Technology:** Utilizing technology like AI, data analytics, and blockchain to streamline project evaluation, enhance transparency, and improve access to green finance for a wider range of participants.
- ## 3. Key areas of Progress
- **Market expansion:** The global green finance market has expanded significantly, though growth has slowed in recent years.
 - **New financial instruments:** Issuance of green bonds has surged, providing a major source of capital for sustainable projects.
 - **Rise of green loans and mortgages:** Products like green loans for energy-efficient upgrades and green mortgages that offer preferential terms are becoming more common.
 - **Sustainable banking practices:** Banks are integrating green principles into their operations, moving beyond traditional lending to support environmental projects and reduce their own footprint.
 - **Government and international initiatives:** Governments and international bodies are promoting green finance through policies, incentives, and large-scale targets, such as India's goal of mobilizing significant green finance for its renewable energy targets.

- **Focus on climate resilience:** Investment is increasingly directed toward adaptation, including climate-resilient infrastructure, water management, and sustainable agriculture, as seen in India.

4. Ongoing Challenges

1. **Slowdown in growth:** Despite the long-term growth, the annual increase in climate finance flows has slowed, which is a concerning trend.
2. **Translating groundwork into capital:** A major challenge is converting policy initiatives into significant, real-world private and public capital flows for investments.
3. **Barriers to investment:** Financial, legal, and regulatory barriers remain significant deterrents to green finance, particularly in emerging economies.
4. **Transparency and trust:** While transparency in reporting is seen as a driver for adoption, building trust in green finance practices is an ongoing need.
5. **The impact of adopting Green Financing**
 - First, green finance provides financial support for firms engaged in green innovation, including the purchase of green equipment, the introduction of new environmentally efficient technologies, and the training of their personnel.
 - Second, green funding from various projects can assist stakeholders (organizations, governments, and regulators) in spending R&D funds on environmental challenges and minimize the associated risk with green legislation.
 - Lastly, green policies have higher costs than conventional practices, and green finance can assist an organization in covering these expenses without encountering significant financial obstacles. As a result, green finance-driven economic growth can significantly support green policies, lessen environmental pollution, and build sustainable cities.

6. Public Policy in India on Green initiative

India has started on green finance as early as 2007. In December 2007, the Reserve Bank issued a notification on “Corporate Social Responsibility, Sustainable Development and Non-financial Reporting – Role of Banks” and mentions the importance of global warming and climate change in the context of sustainable development.

In 2008, The National Action Plan on Climate Change (NAPCC) was formulated with a vision to outline the broad policy framework for mitigating the impact of climate change.

In 2011 The Climate Change Finance Unit (CCFU) was formed within the Ministry of Finance as a coordinating agency for the various institutions responsible for green finance in India.

In 2012 the major strategic moves implementation of the sustainability disclosure requirements.

Since 2012 Security and Exchange Board of India (SEBI) made it mandatory for top 100 listed entities based on market capitalization at BSE and NSE to publish annual business responsibility reports.

In May 2017, SEBI issued guidelines for green bond issuance specifying the disclosure requirements. In addition, the Ministry of Corporate Affairs imposed mandatory reporting of the progress on Corporate Social Responsibilities (CSR) under the Companies Act, 2013.

In October 2017, Report of the Committee on Corporate Governance has proposed that the board of directors shall meet at least once a year to specifically discuss strategy, budgets, board evaluation, risk management, ESG and succession planning.

7. Financial Incentives by Government of India

Financial incentives introduced in India. These incentives are in line with India’s commitments under the 2015 Paris Agreement to reduce greenhouse gas emission intensity by 33 to 35 per cent below 2005 levels, and to achieve 40 per cent of installed electric power capacity from non-fossil sources by 2030.

The Government of India (GOI) offers 30 per cent of the installation cost of the rooftop solar panels as subsidy to the institutional, residential and social sectors in most states. In some of the special category states, the subsidy is up to 70 per cent of the installation cost. In addition, beneficiaries can avail a generation-based incentive wherein they can receive Rs 2 per unit of generation, if the generation exceeds 1100kWh -1500kWh per year. Further, the excess power can be sold at a tariff set by the government.

The Reserve Bank has also been taking proactive policy measures to promote and support green finance initiatives. It has included the small renewable energy sector under its Priority Sector Lending (PSL) scheme.

8. Government Initiatives

Considering the above initiatives, we will assess the progress of green finance in India, including the general awareness environmental sustainability. From the above mention data, it is clearly state that India focusses the major green in initiative are mentioned below

- **National Action Plan on Climate Change (NAPCC):** Outlines India's strategy for addressing climate change.
- **National Solar Mission, National Wind Energy Mission:** Promote renewable energy deployment. Aiming for 450 GW of solar energy by 2030.
- **Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME) Scheme:** Incentivizes EV adoption.
- **Green Bond Guidelines:** SEBI has issued guidelines for the issuance of green bonds.
- **India Renewable Energy Development Agency (IREDA):** A dedicated financial institution for renewable energy projects.
- **National Clean Energy Fund (NCEF):** Finances clean energy projects.
- **Sovereign Green Bonds:** Issuance of sovereign green bonds to fund green projects.

As announced by central Government, India is committed to achieve the Net Zero emission target by 2070. The study

attempts to explore the landscape of green finance in India, focusing on its relevance, progress and future projects

9. Green Finance Initiatives in India

Both Government and private sectors in India have launched various green finance initiatives to support environmentally friendly projects. SBI was the first bank in India to install windmills to generate green energy. Some of the notable initiatives include

1. **Green Banking:** Many Indian banks have adopted green banking practices, which involve reducing their environmental footprint and promoting sustainable banking practices.
2. **Sustainable Finance:** Indian banks have launched sustainable finance initiatives, which involve providing financial support to environmentally friendly projects.
3. **Green Bonds:** Indian banks have issued green bonds to raise funds for environmentally friendly projects.
4. **Renewable Energy Financing:** Indian banks have launched renewable energy financing initiatives to support the development of renewable energy projects in India.

10. International Initiatives and Actions

International organizations have contributed substantially to addressing environmental challenges and promoting green finance development. For instance, the United Nations Environment Programme (UNEP) seeks to promote economic development in accord with ecological preservation. The UNEP Financial Initiative (UNEP FI) was launched in 1992 when banks introduced the UNEP Statement on environmental sustainability. Currently, UNEP FI has over 275 banks as signatories, representing over 45% of global banking assets. Through UNEP FI, these banks commit to sustainable practices and contribute to the advancement of green finance.

Another noteworthy initiative is the United Nations Global Compact (UNGC). Established on July 26, 2000, it represents the most significant business sustainability effort globally. With the involvement of 15,478 business entities in over 165 countries, including developed and developing nations, the U.N. Global Compact covers many sectors and business sizes. It aims to promote the implementation of sustainable practices by enterprises to support global sustainable development objectives.

There are many other frameworks established or co-created by UNEP FI to catalyze the incorporation of sustainability principles into financial market practice.

Table 5: Financial institutions in international initiatives on the environment (as of June 2022)

Initiative	Launch Year	No. of Current Signatory Organizations
UNEP- F.I.	1992	275
UN global compact	2000	15,478
EP	2003	129
UN-PRI	2006	3800
UN-PSI	2012	> 200
UN-PRB	2019	275

Source: Information obtained from the websites of UNEP-FI and each initiative

The E.U. has significantly contributed to advancing global sustainable development by consistently striving to establish a sustainable financial system. The E.U. has built a technical expert group (TEG) to support green development by constructing the E.U. taxonomy, which is officially published on June 22, 2020, and subsequently implemented on July 12, 2020. This taxonomy offers a framework for defining and categorizing sustainable activities, helping investors and financial institutions towards environmentally friendly investments.

Green finance significantly promotes a country’s ESG performance through green innovation and industrial structure upgrading. The level of economic development determines the availability of resources for environmental, social, and governance initiatives. A higher gross domestic product enables investment in green infrastructure and social projects. There is a clear connection between a country’s ESG performance and its economic development. In developed countries, abundant economic resources endow governments and enterprises with greater capabilities to invest in activities that enhance ESG performance. For example, they can increase investment in the construction of environmental protection facilities and promote corporate social responsibility projects.

Conclusion

Green finance is an essential component of sustainable development, and Indian play a crucial role in promoting

green finance. Despite the challenges, Indian public and private sectors have made significant progress in promoting green finance. It is evident from the study that green financing plays a crucial role in promoting sustainable initiatives. Thus, a transition from a rising economy to a green economy necessitates that a country’s leadership offers green financing. To assure green economic growth, nations around the world have invested in green projects to promote, invent, and employ environmentally friendly technologies to safeguard the environment and maximize environmental performance. Because of new stakeholders' and institutions' understanding of environmental issues, regulatory authorities are likely to seek out extra ecologically acceptable financial resources. In an effort to establish environmental legitimacy, this type of environmental proactivity will be required when new methods of providing financial resources and green financing arise.

Overall, the success factors that are crucial for developing the green finance market are: effective interaction between public officials and private actors, international collaboration and capacity building, active underlying securities markets, improved disclosure and capital market incentives; and the provision of strong guidance on what is ‘green’ and the agreed definition has to be consistent with international guidelines.

Future studies can explore the green finance opportunity in developing countries. Future studies can also explore how

the challenging policy and institutional environments affect the development of green finance and investment markets in developing countries. Such studies should take into account the unique institutional and policy barriers that exist in developing countries.

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