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Environmental Sustainability and Climate Change: Growing Concerns for the Banking Sector

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Abstract: This study examines how the banking sector can contribute to climate action and environmental sustainability. As climate change poses growing risks to economies, ecosystems, and public health, banks have an important opportunity to support the transition towards a low-carbon economy. Green banking incorporates environmental, social, and economic considerations into conventional financial services, enabling banks to support sustainable development while pursuing financial returns. The study considers how sustainable banking practices and environmentally responsible programmes may improve operational efficiency and profitability. It also examines barriers to implementing environmental sustainability, including the relative roles of mandatory regulation and voluntary action. The findings highlight the need for effective regulatory measures and incentives to encourage banks to adopt sustainable practices and contribute to a more resilient, low-carbon economy. Overall, the analysis underscores the banking sector's influential role in advancing the transition towards a sustainable future.

Keywords: Climate Change; Sustainability; Environment; Banking Sector; Financial Institutions

1. Introduction

Climate change is one of the most serious challenges facing society, affecting economies, ecosystems, and social well-being. Governments, organisations, and institutions around the world are working to limit its harmful effects, recognising that climate change can damage ecosystems, displace communities, and weaken economic stability (Thomä & Chenet, 2019; Haines et al., 1993). The financial sector has an important role in this response: it can help manage environmental risks, fund sustainable initiatives, and direct investment towards global climate goals. Green banking has developed as an approach that combines ethical financial practice with sustainability and supports the move towards a low-carbon economy (Goodell, 2020; Blake, 1999).

Green banking refers to financial services that take environmental sustainability into account alongside profitability. It incorporates environmental, social, and governance (ESG) considerations into decision-making and therefore extends beyond conventional banking. Its activities may include financing renewable energy, supporting environmentally responsible housing, and investing in resource-efficient industries (Albuquerque, 2018). Through these activities, financial institutions can contribute to climate action while supporting sustainable economic development. Green banking also connects environmental priorities with financial practice. It reflects the aims of international frameworks such as the Paris Agreement and the United Nations Sustainable Development Goals (SDGs), which call for lower carbon emissions and sustainable development. Green banking can thus help strengthen environmental and economic resilience as climate pressures increase (Bundesbank & Triebskorn, 2021; Zhu et al., 2007).

Green banking has developed over time in response to changing social values, regulatory expectations, and environmental priorities. Its history can be understood through six broad phases. First, ethical banking foundations in the 1970s: green banking has roots in the ethical banking movement, which called for social and environmental considerations to be included in financial decisions. Financial institutions began to recognise the importance of aligning their activities with broader social goals. Triodos Bank, founded in the Netherlands in 1980, exemplified this approach by financing projects intended to provide social and environmental benefits (Coulson, 2009). This period helped establish the foundations for incorporating sustainability into banking.

Second, increased environmental awareness in the 1980s: public and institutional concern grew about deforestation, pollution, and biodiversity loss. Financial institutions began using basic environmental risk assessments to consider how their investments might affect ecosystems. The Brundtland Report, published in 1987, further emphasised the importance of sustainable development and influenced global thinking about finance and sustainability (World Commission on Environment and Development [WCED], 1987). It popularised the principle that present needs should be met without limiting the ability of future generations to meet their own needs.

Third, global environmental frameworks in the 1990s: this decade was important for bringing sustainability into economic and financial systems. The 1992 United Nations Earth Summit in Rio de Janeiro helped establish a basis for incorporating environmental concerns into economic policy. In response to emerging global frameworks, financial institutions began developing products such as green loans and energy-efficient mortgages (Rio Declaration on Environment and Development, 1992). Cooperation among governments, non-governmental organisations, and financial institutions also expanded.

Fourth, the introduction of green bonds in the 2000s: green bonds provided a new way to finance renewable energy and other environmentally beneficial projects. In 2007, the European Investment Bank issued the first green bond, giving institutional investors a route to support sustainability-focused projects (Fatin & Whiley, 2021). Green bonds represented a shift towards financing low-carbon initiatives proactively.

Fifth, embedding sustainability in the 2010s: ESG frameworks became more widely adopted by financial institutions, influenced by regulatory expectations and consumer demand for sustainable financial products. The launch of the United Nations Principles for Responsible Banking in 2019 was an important step towards establishing sustainability as a central banking priority (UNEP Finance Initiative, 2019). Banks also began to incorporate climate-related risk assessments more extensively and to align their portfolios with net-zero carbon goals.

Sixth, mainstream adoption and technological integration in the 2020s: green banking has become more widely accepted, supported by advances in technology and data analytics. Artificial intelligence and blockchain tools have helped improve the efficiency, transparency, and traceability of green banking initiatives. The need for urgent climate action has also encouraged banks to expand their green portfolios and adopt policies aligned with net-zero commitments (Thomä & Chenet, 2019). These changes reflect growing recognition of the connection between environmental sustainability and financial stability.

Green banking differs from conventional banking in several important ways. Conventional banks tend to prioritise profitability and risk management, whereas green banks also incorporate environmental considerations into financial decisions. Traditional institutions may invest in high-carbon industries to pursue short-term returns; green banks instead seek to finance renewable energy, energy-efficient housing, and sustainable infrastructure in line with longer-term environmental objectives (Albuquerque, 2018). This approach gives green banking potential to help address climate challenges. By supporting sustainability and the growth of low-carbon industries, green banks can reduce environmental risks and contribute to economic resilience (Goodell, 2020; Rajput et al., 2013).

Despite its potential, green banking faces significant challenges. One major concern is greenwashing, in which organisations overstate or misrepresent their environmental commitments to attract investors. This can weaken the credibility of green banking and reduce public trust (Coulson, 2009). Stricter transparency requirements and stronger accountability for sustainability reporting could help address the problem. Perceived financial risk is another barrier. Investors may be deterred by uncertain returns and lengthy payback periods, even when green projects support environmental objectives. Innovative approaches such as blended finance could help reduce investment risk and attract a wider range of investors (Fatin & Whiley, 2021). Differences in regulation between regions also make it harder to expand green banking. A more consistent international framework could help standardise sustainability practices and support their effective implementation.

This article contributes to the discussion of green banking in several ways. It traces the field's development from its ethical foundations to its current role as a mainstream financial strategy. It distinguishes green banking from conventional banking, examines challenges such as greenwashing and regulatory barriers, and considers ways to address them. It also discusses the relevance of green banking across different markets and contexts.

Overall, green banking offers a way to align financial management with environmental sustainability. Its development, from the ethical banking movement of the 1970s to the wider adoption of green finance in the 2020s, reflects increasing recognition of the financial sector's role in addressing climate change. By financing renewable energy and sustainable infrastructure and integrating ESG principles, green banking can contribute to global climate goals. Achieving that potential requires addressing greenwashing, financial risks, and inconsistent regulation. Continued innovation, collaboration, and regulatory oversight can help green banking support a more sustainable and resilient future.

2.Literature Review

2.1 Defining Sustainability and Sustainable Growth

"Sustainability" and "sustainable development" are now widely used terms, but they can be difficult to define precisely. From the 1970s through the 1990s, sustainability was mainly discussed in relation to environmental concerns. At the 1992 United Nations Conference on Environment and Development (UNCED), a global action plan for sustainable development was established (Bell & Morse, 2012). One of its major outcomes was Agenda 21, which set out guidance and practices for sustainability, with a strong focus on environmental issues (Wittmayer et al., 2016).

The corporate sector also plays an important part in discussions about environmental challenges. From an economic perspective, sustainability concerns a company's ability to continue operating over time through effective economic performance and resource management. Doane and MacGillivray (2001) describe economic sustainability as the ability of a business to remain in operation. Sustainability is commonly discussed through three dimensions: economic, ecological, and social sustainability (Sumantri et al., 2022). These dimensions relate to issues such as urban and agricultural development, transport, infrastructure, energy use, access to

water, and electricity generation. Decision-makers and policymakers need to consider how the dimensions connect, depend on one another, and involve trade-offs. Doing so can support responsible action at individual, national, regional, and international levels.

The National Environmental Policy Act (NEPA) describes sustainable growth as economic growth that benefits both present and future generations without damaging the planet's resources or biological species (Kidd, 1992). Sustainability and sustainable development do not have sharply distinct boundaries. Sustainability is often understood as a long-term goal, for example, the aspiration to create a sustainable business or society. Environmental sustainability can be pursued through a range of approaches, including sustainable agriculture and food production, effective governance, technological development, recyclable materials, renewable fuels, and the development of communities in rural areas without damaging ecosystems (Bocken et al., 2014).

Financial performance refers to the extent to which intended outcomes are achieved. It has become an important subject in both academic research and the banking industry, as businesses face pressure to deliver consistent results. Corporate performance is commonly assessed using accounting-based or market-based measures. These may include a bank's profitability as a financial reporting measure and its market price at the end of the calendar year as a market measure (Demirgüç-Kunt & Maksimovic, 2002).

1.2 Financial Development and Sustainability

Definitions help explain key concepts, but researchers have also sought to identify relationships and principles that extend beyond basic definitions. Friedman (1970) argued that a business has one primary social responsibility: to use its resources in ways that increase its profits. This view implies that investment in sustainability may create additional costs and limit a firm's ability to achieve positive financial returns. From this perspective, managers may be seen as using company resources poorly if their investments do not benefit employees, shareholders, and consumers (López et al., 2007).

Management opportunism theory offers another perspective on the relationship between social responsibility and financial performance. It proposes that when financial results are favourable, managers may reduce social spending to increase their personal gains (Preston & O'Bannon, 1997; Paunescu & Man, 2020). Conversely, managers may invest in high-profile social projects to compensate for weak financial performance. Montabon et al. (2007) examined whether sustainability practices were associated with corporate financial indicators, including return on investment (ROI) and sales growth.

Overall, the relationship between financial development and sustainability has several dimensions. Different theories offer different explanations of how financial systems relate to economic growth, social welfare, and environmental outcomes. This section considers four theoretical frameworks concerning the links between financial development and economic sustainability, providing a basis for examining their implications for long-term performance.

1.3 Theoretical Perspectives on Financial Development and Sustainability

1. Resource Theory

Resource theory proposes that financial development can promote economic growth by improving how resources are allocated. Because economic activity involves barriers such as information gaps, transaction costs, and monitoring costs, financial institutions help reduce these obstacles and support exchanges and investment. A developed financial system can lower transaction costs, making it easier for businesses and individuals to trade, invest, and obtain finance (Levine, 1997).

More effective resource allocation can increase productivity and economic growth. Banks and other financial institutions can support this process by directing capital towards businesses and projects. For example, access to finance can help firms invest in infrastructure, research and development, and technology. These investments contribute to the development of physical and human capital, which supports technological progress.

Financial development may also encourage innovation, including the creation of more sustainable technologies and business models. From a sustainability perspective, this could help direct investment towards renewable energy, green technologies, and social enterprises. However, financial institutions need to consider the sustainability of the activities they fund. If lending and investment focus only on short-term returns, they may support practices that contribute to environmental damage or social inequality, weakening long-term sustainability.

2. Market Theory

Market theory proposes that economic growth can lead to financial development. As the real economy expands, businesses and individuals require more financial services, encouraging the growth of financial markets and institutions (Ang & McKibbin, 2007). Growing economic activity can increase demand for a wider range of financial products. This may contribute to the development of banking institutions, capital markets, and services suited to businesses' changing needs. The emergence of sectors such as the green economy, for example, can increase demand for finance for clean-energy projects, carbon markets, and sustainable agriculture. Financial markets may respond by developing products and services that support sustainable development. Their expansion can also

enable financial institutions to develop new approaches to longer-term economic sustainability.

Market theory also draws attention to risks that may accompany financial expansion. Rapid market growth can encourage speculation and excessive borrowing. If financial institutions focus on maximising profits without accounting for long-term sustainability, financial expansion may increase systemic vulnerabilities or contribute to speculative bubbles, including in property or technology markets. Such developments may threaten financial stability and sustainability, especially in emerging markets where regulatory protections may be limited.

A further concern is that expanding financial markets may prioritise short-term returns over long-term outcomes, particularly when investors and financial institutions have little incentive to account for environmental, social, and governance (ESG) factors. For this reason, sustainable products such as green bonds and impact investments need to become a regular part of financial markets.

3.Bi-Directional Causation Theory

Bi-directional causation theory combines aspects of resource theory and market theory. It proposes that financial development and economic growth can reinforce one another: financial development can support economic growth, while economic growth can increase demand for financial services and further expand the financial sector (Acaravci et al., 2009).

Under this view, stronger financial systems can promote growth by improving access to capital and reducing transaction costs. As economic activity increases, demand for financial services may also rise, encouraging further development of financial institutions and markets. This creates a feedback process in which finance and economic performance develop alongside each other.

This perspective is relevant to sustainability because economic growth can increase demand for investment in renewable energy, sustainable infrastructure, and climate adaptation. That demand may encourage the financial sector to create products and services that support long-term sustainability goals. However, the feedback between finance and growth can also create problems if institutions prioritise short-term profits. For example, extensive lending to activities that cause environmental harm or social inequality could intensify sustainability challenges and create risks for the financial system. Financial institutions therefore need to align their growth and lending practices with sustainability objectives and account for the wider effects of their decisions.

4. Independent Theory

Independent theory takes a more cautious view, arguing that financial development and economic growth are not necessarily directly connected. From this perspective, financial inclusion and sustainable growth do not automatically move together, and the contribution of financial development to long-term growth may be limited (Lucas, 1988; Stern, 1989).

The theory suggests that other influences—such as technological progress, education, and public policy, may play a greater role in shaping sustainable growth. It also questions the assumption that financial development always supports sustainability. Expanding financial markets or introducing financial innovations without adequate safeguards may increase instability and systemic risk.

Where regulation is weak, financial markets may be more vulnerable to speculative bubbles, excessive risk-taking, and inaccurate asset pricing. Financial institutions may also pursue short-term profits through investments in high-risk activities, including fossil fuels or unsustainable agriculture. Such investments can conflict with long-term sustainability by contributing to environmental damage, climate change, or social inequality. The independent theory therefore emphasises the need to align financial development with broader social objectives, including environmental protection, social equity, and economic resilience.
Synthesis

Together, these four theories present different explanations of how financial development relates to sustainability. Resource theory focuses on how finance can improve resource allocation and support long-term growth. Market theory proposes that economic expansion drives the development of financial institutions and services. Bi-directional causation theory describes finance and economic growth as mutually reinforcing, while independent theory cautions that financial development does not necessarily produce sustainable growth. Taken together, these perspectives provide a framework for examining the relationships between financial systems, economic growth, and sustainability. They also suggest that financial institutions should consider how their strategies affect economic stability, environmental protection, and social welfare.

3.Sustainable Banking

Green finance represents more than a banking approach; it reflects a broader change in how the banking system understands its role in society (Benedikter & Benedikter, 2011). The establishment of the International Finance Corporation's Sustainable Banking Network (SBN) in 2012 helped increase attention to green banking in developing countries (Mejia-Escobar et al., 2020). The network was created to support the introduction of green-banking practices in these countries. At the time described in the source text, 15 of the SBN's 35 member countries had introduced national green-banking policies, guidelines, principles, or roadmaps.

There is not yet one universally accepted definition of green banking; scholars and regulatory organisations describe it in different ways. The International Finance Corporation (IFC) notes that the meaning of green banking can vary according to a country's social and economic conditions and its progress towards sustainability (Freeman, 2002). Green banking has been described as banks adopting sustainable-finance standards and procedures, directing finance towards environmental objectives, considering environmental and social factors when assessing investments, preventing harmful effects, and seeking positive outcomes through their core financing activities (Renneboog et al., 2008).

The United Nations Environment Programme's description of green banking also emphasises directing capital towards environmentally beneficial activities, strengthening organisational governance and public accountability, developing greener banking practices, supporting internationally recognised principles, and introducing targeted policies and legislation (Bose et al., 2018). The IFC associates green banking with avoiding negative environmental effects and producing positive environmental outcomes through lending and investment decisions.

Green banking may help protect banks from risks such as credit losses, legal liabilities, reputational damage, and environmental risks (Tara et al., 2015). It may also give banks a competitive advantage, particularly in emerging economies where green banking is still new or not widely established. These practices can improve operational efficiency and strengthen a bank's public image. A strategic plan for green banking may also recognise benefits such as improved access to finance, stronger investment portfolios, support for new sustainable ventures, better performance rankings, and increased recognition from stakeholders (Gunningham, 2020). Despite these potential benefits, green banking has not been widely adopted in many countries, partly because of practical barriers.

Factors that may hinder the implementation of green banking include the absence of suitable classifications and standards that reflect the economic conditions of each country; limited understanding of how to integrate sustainable banking into existing operations; a shortage of research; insufficient resources and market participants; and weak information-sharing among stakeholders. Further barriers include limited green-finance capacity within financial institutions, difficulty generating returns from renewable-energy or pollution-reduction projects, a lack of technical case studies and successful examples, and the rising costs of adopting some green policies (Gallagher et al., 2018).

Classical economic perspectives have described growth as a process of economic and social change that can be measured both quantitatively and qualitatively (Boyer et al., 2016). The conventional development model has also treated economic development as a sequence of stages through which economies progress. By concentrating mainly on financial growth, this approach gave less attention to the environmental and social dimensions of development. Over time, the need to connect economic growth with environmental concerns became increasingly clear, contributing to the development of ecological sustainability. This perspective informs sustainable banking and the understanding of sustainable development as meeting present needs without compromising future generations' ability to meet their own needs.

Strange and Bayley describe environmental sustainability as an integrated framework that applies principles across different places and periods, while helping identify and address issues such as resource depletion, access to healthcare, social isolation, poverty, and unemployment. This framework includes social, economic, and environmental dimensions. Figure 1 presents the relationship among these three dimensions within the social dimension. Neglecting any one of them can contribute to systemic problems, including global warming (Boyer et al., 2016).

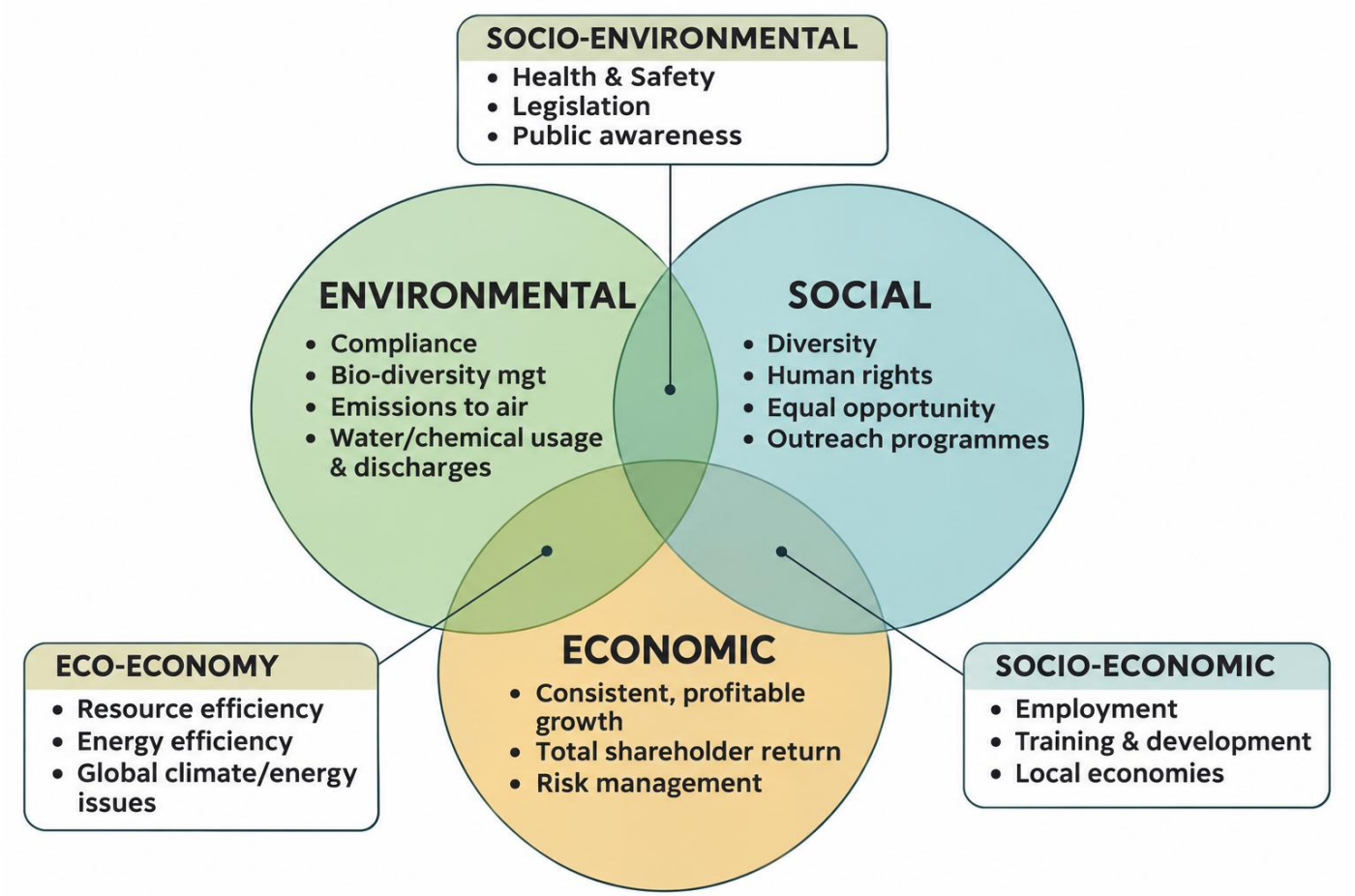

Figure 1. Model illustrating the interdependence of the three sustainability pillars, based on the triple bottom line (TBL) framework

Agenda 21 identifies business and industry as important contributors to long-term development. It notes that commercial and industrial activity is a principal source of wealth creation within the development process. It also presents cleaner production as an important route towards sustainable business and industry: production methods should use resources efficiently while reducing pollution. The document further calls for creativity, competitiveness, and voluntary action to encourage a wider range of productive and efficient solutions. As environmental sustainability has gained prominence, banks have made efforts to integrate it into their activities and operations. Major financial organisations have established sustainability criteria for the sector. The International Finance Corporation (IFC) seeks to influence markets, encourage innovation, and create business value by helping companies improve their production performance. It also aims to ensure that economic benefits reach poor and disadvantaged communities, and that growth is environmentally and socially sustainable. The IFC has played a leading role in advancing economic sustainability. Many banks apply sustainability principles and environmental, social, and governance (ESG) requirements to help secure international funding. Development finance organisations that promote sustainable finance include the German Investment Corporation (DEG), the Netherlands Development Finance Company (FMO), the French Agency for Development (AFD), and the African Development Bank (AfDB) (Volz, 2018).

3.1 The Role of Capital Investment in Green Banking: Government Support, Venture Capital, and Private Equity

Green banking has become an important concern for the global financial sector as more institutions incorporate environmental, social, and governance (ESG) factors into their operations. This shift reflects growing recognition that social and environmental sustainability can contribute to long-term financial stability and economic development. However, adopting and implementing green-banking practices requires substantial investment. Government support, venture capital, and private equity are among the funding sources that can shape this development. This section examines their roles and how they may work together to support sustainable finance.

Government Subsidies

Government subsidies can help finance green-banking initiatives, especially environmental projects that conventional financial markets may view as too costly or risky. Governments can encourage banks to adopt sustainable practices and make finance more accessible for eligible projects. Support may take the form of grants, tax incentives, or low-interest loans, reducing financial barriers

for banks and their clients (World Bank, 2020). One way governments can support green investment is by issuing green bonds. These instruments raise funds for projects with environmental aims, including renewable energy, energy-efficient infrastructure, and sustainable agriculture (Banga, 2019). Green bonds can help improve access to capital for sustainable projects. The World Bank's Green Bond programme, for example, has raised substantial funds for environmental initiatives and illustrates how such instruments can support sustainable finance (World Bank, 2020). Governments may also offer direct support to financial institutions to reduce the cost of providing green financial products. This can be particularly relevant in developing countries, where perceived project risks may discourage banks from financing environmental initiatives. The International Finance Corporation (IFC), for example, supports the adoption of green-banking approaches in developing countries through technical assistance and financing programmes. By helping to reduce costs and risks, such support can enable financial institutions to contribute to the transition towards a greener economy and to climate-change mitigation (International Finance Corporation, 2020). The effectiveness of public support depends partly on clear and consistent environmental policies. Unclear or changing regulations can make it more difficult to direct funds effectively towards green initiatives. Subsidy programmes may also be affected by political changes, creating uncertainty about their long-term availability. The development of green banking therefore requires a stable and predictable regulatory environment that can sustain these programmes (Bouma et al., 2017).

Venture Capital

Venture capital is another potential source of finance, particularly for early-stage green innovations and start-ups. Venture-capital investors can fund new technologies, business models, and financial products that support sustainable finance. Examples include green fintech platforms, clean-energy technologies, and sustainable supply-chain solutions. Because these ventures may carry higher risks, venture-capital firms may be more willing than traditional banks to invest at an early stage (Bonini & Capizzi, 2019). In green banking, venture capital can help finance clean-technology start-ups and other innovations that may later be incorporated into banking services. Green fintech platforms, for example, use technology to connect users with sustainable investment opportunities. Venture-backed platforms can make it easier for individuals and organisations to invest in such projects and for banks to offer related products (Mirza et al., 2023). Venture-capital investment may also support the technology and infrastructure needed for initiatives such as green bonds and sustainable investment funds (Yang et al., 2022). Venture-capital-backed fintech businesses may also develop tools that help banks assess and monitor the environmental effects of their lending. Such tools can give banks more information when evaluating finance for sustainable projects. Collaboration between financial institutions and venture-capital investors can therefore support the development of services and products aligned with green-banking aims (Hidayat-ur-Rehman & Hossain, 2024). Venture capital also has limitations. Its investments are generally high-risk and often seek substantial returns over a relatively short period. This approach may not fit the longer timeframes required by many green projects. Venture capital can also favour sectors with strong growth prospects, leaving smaller sustainable projects without funding even when they could produce meaningful environmental benefits (Mrkajic et al., 2019).

Private Equity

Private equity can complement venture capital by financing more mature companies that already operate in the green economy and need investment to expand. Whereas venture capital generally supports early-stage businesses, private-equity firms tend to invest in established companies with a demonstrated operating model that require further capital to grow or enter new markets. In green banking, this funding may support larger initiatives such as renewable-energy facilities, green infrastructure, and sustainable agriculture (Gandhi et al., 2024). Private equity may be particularly relevant to large infrastructure projects that require substantial initial investment but may generate returns over a longer period. For example, investment in wind or solar projects can support the growth of renewable energy while contributing to a lower-carbon economy. By providing finance for expansion, private-equity firms may help sustainable industries grow and become more established within the wider economy (Merme et al., 2014). Private-equity investment in green assets can also help banks and other financial institutions diversify their portfolios. Such investment may support offerings such as green property and clean-energy projects, helping banks respond to demand for sustainable financial products while seeking returns from these assets (Malik & Sharma, 2024). Private equity nevertheless faces challenges when financing green projects. Large infrastructure projects require considerable capital, and their returns may not be realised within the investment period preferred by some firms. Many private-equity investors aim to exit an investment within five to seven years, which may not align with the longer development and return periods of green projects. Greater cooperation among private-equity firms, financial institutions, and governments may help make projects viable for investors while supporting environmental aims (Agbloyor et al., 2023).

Interactions Among Capital Sources

Government subsidies, venture capital, and private equity are distinct sources of finance, but they can support different stages of green-project development. Government support can help lower project costs; venture capital can finance early research, innovation, and new financial products; and private equity can provide capital for scaling projects that have already demonstrated potential. Coordination among these sources can create a cycle of investment. Public support may reduce risks for private investors, venture capital can help develop new solutions, and private equity can finance larger projects as they expand. Together, these forms of investment can support the growth of sustainable finance and the transition towards a greener economy. Challenges remain. Government support may change with political priorities, creating uncertainty for banks and investors. Venture-capital firms may favour high-growth businesses over smaller initiatives with environmental value. The timeframes sought by private-equity firms

may also be shorter than the periods needed for some green projects. Addressing these issues calls for stronger coordination among governments, investors, and financial institutions so that funding can be directed effectively towards green initiatives (Steuer & Tröger, 2022).

Conclusion

Government subsidies, venture capital, and private equity can each contribute to the development of green banking. They can help financial institutions provide sustainable finance and support the transition towards a low-carbon economy. Each source has distinct strengths and limitations, while their coordination can support innovation, help successful projects expand, and reduce some of the risks associated with green investment. As demand for sustainable finance grows, cooperation among these funding sources may become increasingly important to the development of green banking and the pursuit of wider sustainability goals.

3.2 Sustainability in the Economy

Sustainable economic practices are important for maintaining economic efficiency when resources are limited. The effective use of resources helps make the most of their potential (Turner et al., 2000). For banks and other financial institutions, objectives should include not only growth and stability but also reducing adverse effects on society and the environment. Economic sustainability also involves using risk-management frameworks that help banks identify and assess the risks they may accept, while avoiding exposure to serious financial harm. Bringing sustainability and climate considerations into banking and finance creates both opportunities and risks. Sustainable finance can direct capital into emerging markets and support growth and development, but it may also expose financial institutions to unfamiliar risks. These include excessive reliance on speculative investments and the possibility of asset bubbles within the green economy. Financial markets may not be sufficiently resilient to withstand shocks caused by speculative activity. Because economic sustainability depends on effective risk management, financial institutions need to balance innovation with safeguards against market volatility and systemic risks. Banks' role in supporting sustainable practices should also be considered in relation to broader financial stability. Investment in emerging markets can contribute to positive change, but possible market distortions, including asset mispricing and reliance on high-risk investments, also require attention. Green technologies and climate-related projects may face regulatory uncertainty, technological difficulties, or changes in public policy. If these risks are not managed effectively, they could result in substantial financial losses. Economic sustainability therefore involves more than adopting good practices in sustainability, transparency, and accountability (Amran et al., 2014). It also requires a clear understanding of the risks linked to financial innovation and their possible effects on long-term stability. Financial institutions need an approach that supports innovation while reducing the likelihood of financial shocks and vulnerabilities. Strong reporting and clear accountability for senior executives and boards can help ensure that sustainability objectives are pursued without weakening financial resilience.

3.2 Social Sustainability

Social sustainability concerns the social effects of a bank's operations and processes. Businesses operate within society and should support equitable access to opportunities and contribute to social initiatives. These may include programmes relating to health, education, gender equality, political accountability, transparency, and public participation (Weber & Feltmate, 2018).
Social sustainability also includes staff training, workplace health and safety, recruitment across different cultural backgrounds, preservation of local cultures, and access to goods and services for underserved groups. It involves taking account of the interests of stakeholders, community organisations, and minority shareholders. In addition, organisations are expected to follow recognised principles such as ISO 26000:2010, which provides guidance on social responsibility (Popa & Dabija, 2019). Other approaches identified in the source text include IFC guidelines, International Labour Organization principles, the United Nations Global Compact, UNEP FI guidance, the Equator Principles, the Global Reporting Initiative (GRI) Sustainability Reporting Guidelines, and the Global Sullivan Principles. These frameworks and initiatives provide further guidance for responsible and sustainable banking.

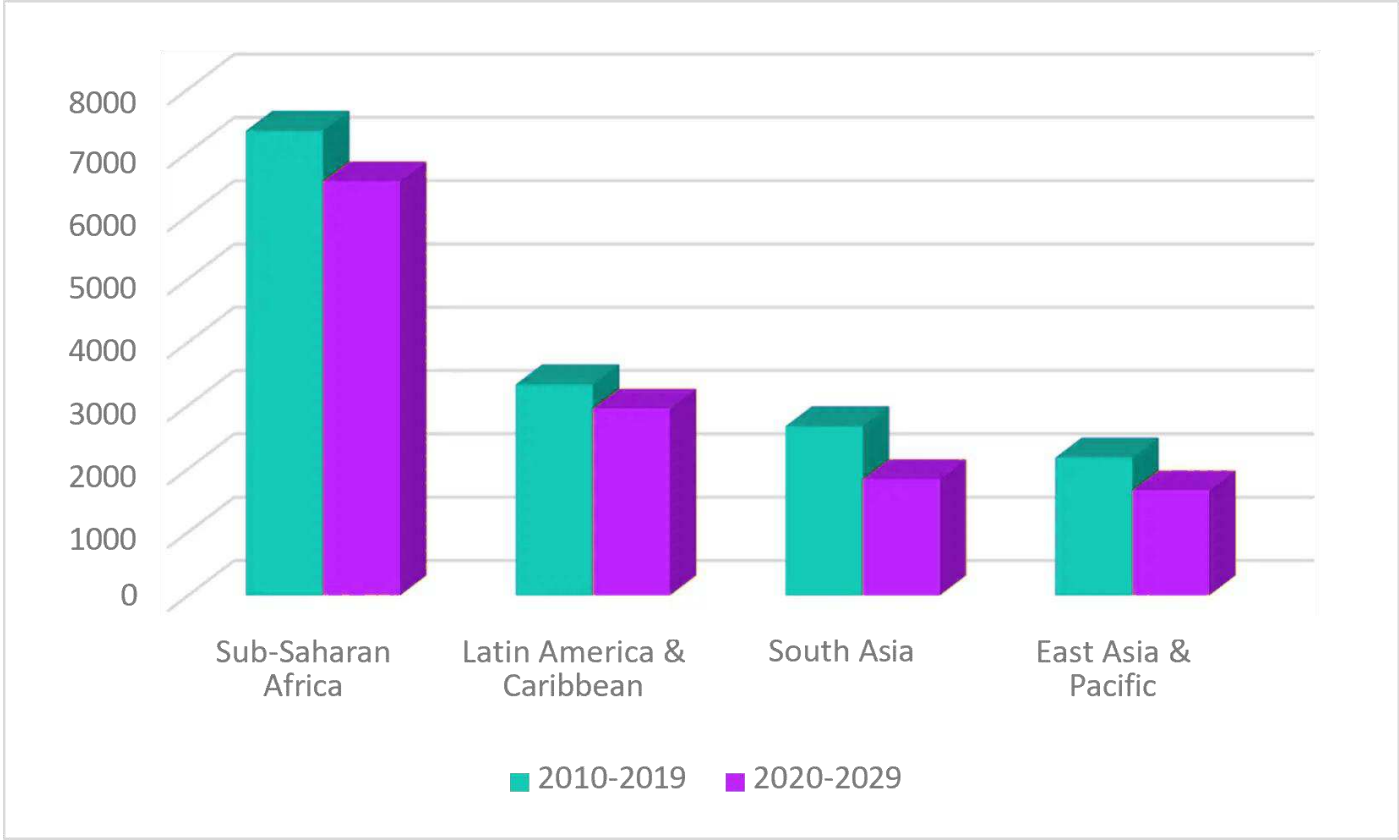

Figure 2. GDP per capita across four key regions.

Environmental degradation, including climate change, can affect major sectors such as agriculture, tourism, transport, and energy. Possible economic consequences include recessions, unemployment, migration, higher commodity prices, and instability in real-estate markets. Banks and other investment institutions are therefore concerned about both the direct and indirect effects of climate change on major financial assets, including securities issued by other banks. Banks need to consider a range of environmental issues, including compliance with environmental legislation, air pollution, climate policies, energy production and consumption, environmental costs, and the impacts associated with goods and services. They also need to assess their clients' environmental practices, potential liabilities arising from future legislation, and opportunities in markets for environmentally friendly products and services. Banks can introduce environmental initiatives within their own operations, such as using green electricity, printing on both sides of paper, choosing recyclable materials, providing staff transport, and improving water efficiency. Through their external activities, they can also direct financing towards environmentally friendly initiatives. The United Nations Environment Programme Finance Initiative (UNEP FI), together with climate funds established under the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol, provides support for integrating sustainability into banking (Dlugolecki & Loster, 2003).

4. Methodology

To estimate the relationship between financial development and economic growth, this study treats real GDP (RGDP) as the dependent variable. Financial development is measured by the ratio of domestic credit provided by the banking sector to the private sector to GDP. The regression also includes two macroeconomic control variables to reduce potential bias: the real interest rate and foreign direct investment (FDI), measured as a proportion of GDP.

4.1 GMM Estimator for Panel Data Models

The study uses the generalized method of moments (GMM) approach for panel-data models (Holtz-Eakin & Rosen, 1990; Arellano & Bond, 1991; Arellano & Bover, 1995; Ogaki, 1999). The regression models are presented below:

$$Y_{it} - Y_{it-1} = (\alpha - 1)Y_{it-1} + \beta_0 X_{it} + \mu_i + \varepsilon_{it}$$

In this equation, \(Y_{it}\) represents the logarithm of real GDP per capita, and \(Y_{it-1}\) is the previous period's per-capita income. \(X_{it}\) is a vector of explanatory variables, \(\mu_i\) represents unobserved country-specific effects, and

\(\varepsilon_{it}\) is the error term. The subscripts \(i\) and \(t\) refer to the country and time period, respectively. Rearranging Equation (1) gives:

$$Y_{it} = \alpha Y_{it-1} + \beta_0 C_{it} + \mu_i + \varepsilon_{it}$$

To account for country-specific effects, the model is transformed into first differences:

$$Y_{it} - Y_{it-1} = \alpha(Y_{it-1} - Y_{it-2}) + \beta_0(X_{it} - X_{it-1}) + \varepsilon_{it} - \varepsilon_{it-1}$$

Levine, Loayza, and Beck (2000) recommend this approach for two reasons. It helps control for potential confounding factors in the relationship between financial development and growth, and it addresses the relationship between the differenced error term in Equation (3) and the differenced dependent variable.

The estimator combines equations in differences with equations in levels to reduce potential bias associated with the difference estimator. It uses lagged levels of \(Y_{it}\) as instruments for the differenced equations and lagged differences of \(Y_{it}\) as instruments for the equations in levels. Blundell and Bond (2000), Alam et al. (2024), and Alam et al. (2022) are cited in support of the extended estimator's efficiency, alongside Kukenova and Monteiro (2008), which examines its performance.

The instruments are considered appropriate under the assumption that the levels of the explanatory variables may be associated with country-specific effects in the level equations, while changes in those variables are not. The additional moment conditions for the level equations are:

$$E\left[\left(Y_{i,t-s} - Y_{i,t-s-1}\right)(\mu_i + \varepsilon_{it})\right] = 0, \quad s = 1$$

$$E\left[\left(X_{i,t-s} - X_{i,t-s-1}\right)(\mu_i + \varepsilon_{it})\right] = 0, \quad s = 1$$

Because lagged levels are used as instruments in the differenced equations, the level equations use the most recent difference as an instrument. Using other lags would create duplicate moment conditions (Hayakawa, 2016). The study applies these moment conditions within the GMM framework to obtain consistent and efficient parameter estimates.

Overall, the study examines the relationship between financial development and economic growth in seven Sub-Saharan African countries from 1981 to 2016. It uses four estimation methods: pooled OLS, fixed effects, difference GMM (Arellano & Bond, 1991), and system GMM (Blundell & Bond, 2000). These methods address issues such as unobserved heterogeneity, endogeneity, and serial correlation. The fixed-effects model accounts for country-specific characteristics that remain constant over time. The GMM methods address endogeneity by using lagged variables as instruments and combining equations in levels and differences. The Hausman test is used to help select the model, while the Hansen test assesses the validity of the instruments.

The data come from Central Bank of Nigeria and World Bank publications. They include indicators of financial development, such as domestic credit to the private sector (DCP), as well as GDP growth. The dataset covers Sub-Saharan African economies with different levels of financial and economic development.

Note: The source's Equation (2) uses \(C_{it}\), while Equations (1) and (3) use \(X_{it}\). Please check the original equation to confirm the intended notation.

4.2 Data, Results and Analysis

The study uses panel data covering 1981–2016 for seven Sub-Saharan African countries: Nigeria, South Africa, Lesotho, Malawi, Sierra Leone, Botswana, and Kenya. The data were obtained from secondary sources, including the Central Bank of Nigeria (CBN) and World Bank publications (Iheke, 2012). The countries were selected according to data availability during the study period. They represent seven of the 48 countries in Sub-Saharan Africa. Four estimation approaches were used to examine the relationship between financial development and economic growth: pooled OLS, fixed-effects OLS, difference GMM (Arellano & Bond, 1991), and system GMM (Blundell & Bond, 2000; Alimi, 2015). The study uses these methods to assess the relationship of interest. Least-squares estimation provides an initial assessment of country-level heterogeneity. The Hausman test is applied to help choose between fixed-effects and random-effects models. As shown in Table 1, the results indicate that fixed effects are relevant in most of the regressions (Firebaugh et al., 2013). Difference and system GMM estimations are used to address potential endogeneity when examining the relationship between financial development and economic growth. The system GMM estimator combines equations in differences and levels. Lagged values in levels are used as instruments for the differenced equations, while changes in the variables are used as instruments in the level equations. GMM estimates these equations simultaneously. The Hansen test is used to assess the validity of the instruments, while the Arellano–Bond test examines second-order serial correlation. The Hansen test results

support the validity of the instruments, and the serial-correlation results support the absence of second-order correlation in the regression errors. The White test is also applied across the regressions to assess heteroscedasticity.

Table 1. Static and dynamic panel estimates of financial development and economic growt

	ESTIMATION OF A STATIC PANEL		ESTIMATION OF DYNAMIC PANELS			
	Pooled OLS	FE OLS	Diff-1 GMM	Diff-2 GMM	Sys-1 GMM	Sys-2 GMM
GDP (t−1)			1.3455	1.459	0.876	0.798
DCP	0.0345 (0.0000)	0.0078 (0.0000)	−0.0013 (0.410)	−0.0032 (0.389)	0.0048 (0.468)	0.0062 (0.489)
Coefficients	0.7022 *** (0.0000)	1.2870 *** (0.0000)			0.1457 (0.496)	0.1021 (0.419)
Instruments			6	6	8	8
Difference in over-identification (Hansen test)			(0.361)	(0.361)	(0.327)	(0.319)
Arellano-Bond test			(0.155)	(0.191)	(0.037)	(0.034)
Observations	231	231	215	215	222	222
Regions	7	7	7	7	7	7

***Note**: *** indicates statistical significance at the 1% level. The figures "6" and "8" represent the number of instrumental variables employed in the difference-GMM and system-GMM estimations, respectively. These instruments are essential for addressing potential endogeneity because they act as valid proxies for the endogenous variables. In the difference-GMM model, lagged levels of the variables are used as instruments for the first-differenced equations. In the system-GMM model, both lagged differences and lagged levels are employed as instruments. The Hansen and Arellano–Bond test results support the validity of the selected instruments and indicate that the models do not suffer from instrument over-identification.*

The same regression model was also used to examine the relationship between financial development and economic growth, with financial development serving as the dependent variable. The results were consistent with those of the growth model and showed no statistically significant relationship between financial-sector development and economic growth. These findings therefore support the independent hypothesis, which proposes that financial development and sustainable growth are statistically independent. The analysis used pooled OLS, a fixed-effects model, and a panel GMM model. It examined financial- and economic-sector development across Sub-Saharan Africa over the period 1980–2016. The findings point to the need to expand the financial sector to support sustainable growth in these countries. The development of banks as complementary financial institutions could help increase capital and improve access to finance, thereby supporting sustainable growth in Sub-Saharan Africa.

5. Conclusion

Climate change presents a significant challenge for the banking sector. As its effects increasingly threaten public health, national economies, and ecosystems, experts also recognise that environmental protection and the shift to a low-carbon economy can create financial benefits. Banks can contribute to this transition by developing banking and investment services and managing portfolios in ways that support a sustainable, efficient, low-carbon economy. Green banking considers economic, social, and environmental factors in financial decision-making, with the aim of protecting natural resources. It is also referred to as sustainable or ethical banking. To support sustained growth, microeconomic policies should promote a higher rate of sustainable development while ensuring that decisions about companies' financial and organisational activities remain connected to profitability. For example, businesses may use environmental, energy-efficiency, or environmental-services programmes to improve efficiency and financial performance. Environmental sustainability remains difficult to adopt, regulate, and implement. The two main approaches to monitoring and enforcing it are command-and-control regulation and voluntary action. Each approach has benefits and limitations. Under command-and-control regulation, governments or public authorities establish rules and procedures, and non-compliance may lead to sanctions. These may include refusing or withdrawing licences, imposing fines, or cancelling initiatives. Clear requirements and enforceable consequences can support compliance, while governments may also offer incentives to encourage implementation. However, command-and-control regulation also has drawbacks. A lack of institutional capacity may weaken the implementation of corporate sustainability measures. Public authorities may also be affected by regulatory capture, in which oversight is weakened in favour of the organisations being regulated. Finally, weak or ineffective national guidelines may allow non-compliant banks to continue operating or may compromise the regulator's authority.

Author Contributions & Declarations

Author Contributions: Conceptualization, SSD and GN; methodology, SSD and GN; validation, SSD and GN; formal analysis, SSD and GN; investigation, SSD; resources, SSD and GN; data curation, SSD and GN; writing, original draft preparation, SSD; writing, review and editing, SSD and GN; visualization, SSD and GN; project administration, SSD. Both authors have read and agreed to the published version of the manuscript.

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